A Dynamic Multilevel Examination of Cross-Cultural Differences in Visual Perceptual Learning

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A thesis submitted in partial fulfilment of the requirements by

Birmingham City University

for the degree of Doctor of Philosophy

March 2022

Abstract

The present thesis uses a multilevel cultural framework to explore cross-cultural differences in visual perceptual learning (VPL). Specifically, the thesis aims to investigate VPL trajectories when people are compelled to engage in global processing. Due to a common global advantage during perception across populations (also known as the global precedence effect), any differences observed between people from different cultural backgrounds during training would reflect the prevailing influence of culture on VPL processes (Chapter 1). A shape discrimination task and a sequence learning task were employed to examine this hypothesis. At the outset, an integrated multilevel cultural framework was examined to define the macro (group) and micro (individual) levels of culture that may operate on VPL processes (Chapter 2). Culture was thus characterised by the individualism-collectivism construct at the macro level, while the independent-interdependent self-construal construct described variations at the micro level. Chapter 3 subsequently employed this framework to examine cultural differences in VPL using a shape discrimination task that implicates the *differentiation* mechanism of VPL. Following this, Chapter 4 employed a priming manipulation to investigate the dynamic influence of culture at the micro individual level of analysis. Chapter 5 then extends the investigation into another domain of VPL using a sequence learning task that implicates the *unitisation* mechanism of learning. Chapter 6 synthesised the results of the previous chapters and documented the systematic design process of an electroencephalogram (EEG) study using the shape discrimination task. Collectively, the outcomes suggest that cultural characteristics, when defined using a dynamic multilevel framework, can operate differentially on VPL processes as it is context- and task-dependent. The findings serve as an intriguing foundation for research in the interdisciplinary domain of culture and cognition. Future studies could employ neuroscientific methods and alternative micro and macro level features that better represent cultural characteristics within varying psychological domains. Research on diversity in learning offers novel insights into the dynamic multilevel nature of culture, which can be translated into real-world training paradigms.

Keywords: culture, multilevel, visual perceptual learning, differentiation, unitisation

Acknowledgements

First, and always foremost – thank you, God.

To my supervisory team, Professor Eirini Mavritsaki, Dr Panagiotis Rentzelas, Professor Maxine Lintern, and Professor Zoe Kourtzi – I can never thank you enough for all your support during this PhD. I would not have been able to do it without your continuous guidance and understanding, especially during a global pandemic. I must especially thank Eirini and Panos, who I (inappropriately) call my 'academic parents', for supporting, guiding, and encouraging my aspirations since my undergraduate degree.

To my parents – thank you for my whole life mum and dad. I love you both very much. Your grace and patience in raising me is astounding and I aspire to always hold on to these values in all that I do, and towards all the people that I meet. As I embark into the next step of my life, I hope to be able to give you even a fraction of what you have given me.

To my one constant for the last nine years - Josiah Ng, thank you for always being there for me both virtually and in person. You have been through all the tears, struggles, successes, and the late-night video calls all these years. Being overseas on my own would have been unbearable without your support and encouragement every single day.

To the research team at the Adaptive Brain Lab in the University of Cambridge – especially Poly, Lizzie, Vasilis, and Avram – thank you. Thank you for always providing me with help, guidance, and advice on my research. A special thanks to Professor Zoe for welcoming me to her lab and allowing me to learn from her amazing team.

To my colleagues in BCU, who were also my teachers – thank you for the knowledge and extraordinary experiences I have had in BCU. I must especially thank Dr Emma Bridger and Neale Samways who have helped me in profound ways. Thank you to Lovain, Angus, and Faheemah from the BLSS DRC for all these years of patience in answering my queries and processing all my paperwork. Thank you, BCU, for the funding, but also for bringing together such wonderful people who I got to meet. I will always be grateful for the BCU family I have established here in the UK who I must also thank for the surprise gifts when I am stressed, the advice, rants, banter, moves, hospital visits, and that one Christmas movie night.

To my siblings (Nicole, Weng Ee, Jon, and Mag) and my extended family (KB Chens, Ipoh Chens, Australia Chens, and Belgium Godparents) – thank you for all your love and support. My life would be incomplete without all of you.

To my best friends, friends, and everyone else who have come and gone (a special mention for Dr Steve McCabe and Dr Nicolas Geereart for PhD advice in my formative undergraduate years) – you have in small and big ways shaped me into the person I am today. Thank you.

To all the participants of this thesis – you may never see this, but I hope you know that my research would not be complete without your contributions.

Dissemination

The contents of Chapter 3 have been presented at the Vision Sciences Society 2018 Annual Conference. An abstract for the conference submission is available in the Journal of Vision (see Appendix A1). The chapter has also been accepted for publication in the International Journal of Psychology (see Appendix A2).

The contents of Chapter 4 have been presented at the Vision Sciences Society 2019 Annual Conference. An abstract for the conference submission is available in the Journal of Vision (see Appendix A3). The chapter is also being prepared for a submission to the Cross-Cultural Psychology journal.

The contents of Chapters 2 and 5 are also being prepared for submission to journals (e.g., Cross-Cultural Research, The Journal of Social Psychology, British Journal of Social Psychology, or the Journal of Personality Assessment).

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List of Abbreviations

AHS	Analysis-Holism Scale
ANOVA	Analysis of Variance
COS	Cultural Orientation Scale
EEG	Electroencephalogram
EFA	Exploratory Factor Analysis
EOG	Electrooculogram
ERP(s)	Event-Related Potential(s)
EU	European
fMRI	Functional Magnetic Resonance Imaging
GPE	Global Precedence Effect
h^2	Communalities
HC	Horizontal Collectivism
HI	Horizontal Individualism
ICA	Independent Component Analysis
ICD	Integral Curve Difference
KMO	Kyser-Myer Olkin (Measure of Sampling Adequacy)
PAF	Principal Axis Factoring
PI	Performance Index
RHT	Reverse Hierarchy Theory
RT(s)	Reaction Time(s)
SCS	Self-Construal Scale
SES	Socioeconomic Status
SLT	Sequence Learning Task
SPSS	Statistical Package for the Social Sciences
SS	Sum of Squares
UK	United Kingdom
UK	United Kingdom
VC	Vertical Collectivism
VI	Vertical Individualism
VPL	Visual Perceptual Learning
WEIRD	Western, Educated, Industrialized, Rich, and Democratic

COVID-19 Impact Statement

This statement outlines the changes to the thesis due to the measures implemented for the COVID-19 pandemic (see Appendix B for extension approval). The lack of access to international participants and the proximity required for laboratory studies that violate government restrictions were the key barriers to continuing the electroencephalogram (EEG) study planned for the present thesis. In its place, the research direction was expanded to investigate the unitisation mechanism of VPL. The initial research plan for the disrupted EEG study will be discussed below, followed by the justification for subsequent amendments to the research direction in this thesis.

The present thesis aimed to investigate cultural differences in visual perceptual learning (VPL). A multilevel framework was used to define culture at an individual (micro) and group (macro) level. Specifically, independence-interdependence self-construal (Ishii, 2013; Singelis, 1994; Vignoles et al., 2016) – representing the individual level, and individualism-collectivism cultural systems (Hofstede, 1980, 2001, 2011) – representing the group level, have been associated with variations in cognitive styles (see Chapter 1 for complete literature review). Accordingly, the Glass (1969) pattern discrimination task was employed to investigate if learning trajectories would diverge due to cultural differences in analytic and holistic thinking styles (Choi et al., 2007). Participants were trained to discriminate global forms embedded in noise, and the outcomes of these studies presented an interesting avenue for further research using an EEG methodology. Indeed, to supplement the behavioural evidence observed (see Chapters 3 and 4), an EEG study was designed and piloted to investigate the time course of VPL when people from different cultures learned to discriminate global forms despite perceptual uncertainties.

The psychophysiological underpinnings of cultural differences in VPL remains a relatively unexplored domain despite the recognition of how exposure to different cultural systems can shape attentional processes and influence VPL (Shkurko, 2020). Therefore, the proposed EEG research methodology would reconcile the discourse around the time course of VPL within a cross-cultural context. The conjoint use of EEG and the Glass (1969) pattern discrimination task could reveal cultural differences in the temporal dynamics of global shape processing during VPL. Behavioural measures typically reflect the outcome of an array of computational processes, while the sensitivity of neural measures will facilitate the isolation of these processes to reveal the time course in which cultural variations operate on VPL processes (Chiao et al., 2013; Kwon et al., 2021; Rule et al., 2013). However, as mentioned earlier, the restrictions relating to the COVID-19 pandemic disrupted data collection for the EEG study. In its place, Chapter 6 presents a series of three mini pilot studies designed to explore the experimental design for an EEG study investigating cross-cultural differences in VPL. Besides that, an examination into the unitisation mechanism of VPL (Goldstone, 1998, 2000) was assimilated into the existing research project (see Chapter 5).

The unitisation mechanism of VPL was incorporated into the present thesis to ensure continuity as it could also be examined using the same multilevel cultural framework (see Chapter 6). Indeed, the symbol sequence learning task (Wang et al., 2017), which engages global processing like the Glass (1969) pattern discrimination task, was used to investigate how people from different cultures learn despite the global precedence effect (Mills & Dodd, 2014). However, unlike the Glass (1969) pattern discrimination task which implicates the differentiation mechanism of VPL, the sequence learning task implicates the unitisation mechanism. *Unitisation* describes the integration of complex sequences into a singular unitised representation following training (Goldstone, 1998, 2000; Liang et al., 2020). Therefore, instead of distinguishing patterns embedded in noise, participants learned to construct perceptual wholes from a complex configuration of events in the online sequence learning task (Wang et al., 2017).

The online implementation of the experiment negates the barriers and restrictions caused by the pandemic whilst also providing an alternative direction for investigating cultural differences in VPL. Notably, this change in research direction provides a deeper insight into the mechanisms of VPL within a cross-cultural context. Taken together, due to the disruption caused by COVID-19 restrictions, this thesis presents an examination into two distinct mechanisms of VPL (differentiation and unitisation). To this end, two learning tasks were employed to identify if cultural differences in VPL would manifest differentially despite the common global advantage that people across the world may exhibit (global precedence hypothesis; Mills & Dodd, 2014). The importance of the present research and future directions, such as the use of EEG and functional magnetic resonance imaging (fMRI), will be discussed in Chapter 7.

Chapter 1: Literature Review

The present thesis aims to investigate cross-cultural differences in visual perceptual learning (VPL) using a multilevel cultural framework. Accordingly, this chapter presents an overview of existing research on VPL and culture. The literature review begins with an introduction to VPL. This section outlines the features and mechanisms of VPL and how it can vary as a function of individual differences. Following this, the second section reviews previous operationalisations and conceptualisations of culture at macro and micro levels. The third section then evaluates existing research on the influence of culture on cognition and behaviour. The literature review will culminate in a proposal for an interdisciplinary research project that integrates knowledge from the fields of VPL and culture. The final section of this chapter outlines the research plan, justification, and importance of the present thesis in examining cross-cultural differences in VPL.

1.1 Visual Perceptual Learning

VPL represents the acquisition of visual skills through training on task-relevant features, subsequently allowing individuals to perform an initially difficult task more accurately (Sagi, 2011; Song et al., 2007; Watanabe & Sasaki, 2015). The mastery of a perceptual skill typically begins with a chaotic search amongst the information variables within a visual scene (Runeson & Andersson, 2007). Indeed, an abundance of informational variables are available in the environment that vary in their degrees of usefulness (Gibson, 1963, 1969; Gibson & Gibson, 1955). As such, our visual systems must routinely filter through an abundance of sensory information to ensure attention is efficiently allocated to pertinent information in the visual field during learning (Qu et al., 2017). Attentional mechanisms thus play an essential role in regulating information overload by rapidly prioritising and selecting information that can subsequently inform VPL trajectories. Alternatively, individuals can also enhance their perceptual skills and environmental perceptions by learning to rely on more useful visual cues or variables through the education of attention or training (Jacobs et al., 2011; Lu et al., 2011; Rop & Withagen, 2014; van der Kamp et al., 2013).

During training, individuals learn to attend to the key visual features for interpreting a scene while ignoring ambiguous information (Dosher & Lu, 2017; Gerlach & Starrfelt, 2018; Liu & Luo, 2019; Mayhew et al., 2012; Mollon et al., 2017). Accordingly, the increase in perceptual experience through error feedback or repeated exposure during VPL can shift attention from nonspecifying variables in the visual scene to more specifying variables (Jacobs et al., 2011; van der Kamp et al., 2013). Here, specifying variables refer to the useful elements of the visual property which facilitates accurate perception, whereas nonspecifying variables are ambiguous information that may result in inaccurate perceptual judgements. Practice and training can thus allow individuals to identify useful specifying variables while ignoring nonspecifying ones to improve visual performance. Indeed, there is extensive literature on how VPL allows the visual system to spatially focus attention on the most pertinent elements of an informationally dense visual field (Rop & Withagen, 2014). The effects of VPL have been observed in single feature discrimination tasks (e.g., orientation, colour, phase, spatial acuity), pattern discrimination tasks (e.g., textures, depth, motion), as well as in object or feature identification tasks (e.g., Casey & Sowden, 2012; Dosher et al., 2010; Dosher & Lu, 2017; Frangou et al., 2019; Mayhew et al., 2012). Notably, the means by which VPL occurs can be summarised by the *differentiation* or *unitisation* mechanisms (Goldstone, 1998, 2000).

1.1.1 The Differentiation and Unitisation Mechanisms of Visual Perceptual Learning

According to Goldstone (1998, 2001), perceptual learning can occur through differentiation and unitisation mechanisms. The *differentiation* mechanism allows individuals to distinguish seemingly identical stimuli easily via training. Specifically, individuals can learn to extract distinctive stimuli features while ignoring irrelevant contextual information to enable efficient discrimination of stimuli (Angulo et al., 2019; Gibson, 1969; Hall, 2016; Lachmann & van Leeuwen, 2008). In contrast, through a *unitisation* process, tasks that initially required the detection of several parts can be accomplished by detecting a single unit from a complex configuration or sequence (Goldstone, 1998, 2000; Liang et al., 2020). At an abstract level, both the differentiation and unitisation mechanisms may present commonalities depending on the requirements of tasks and stimuli (Hall, 2021; Landers, 2020). Individuals can learn to differentiate and decompose perceptual wholes into parts if there are independent sources of variations in the visual objects, whereas learning through unitisation can occur by consolidating and integrating frequently occurring parts into a perceptual whole. Both mechanisms thus involve specific featural descriptions of objects and conjunctions of features, although variations in tasks and stimuli may elicit different mechanisms (Goldstone, 1998, 2000; Hall, 2021).

Differentiation. When VPL occurs through a differentiation process, perceivers learn to attend to the informational specifying variables in the visual scene while ignoring ambiguous contextual variables (Gibson, 1963, 1969; Gibson & Gibson, 1955). Indeed, VPL strengthens the appropriate visual channels that aid in categorisation while pruning or reducing inputs from irrelevant channels (Dosher & Lu, 1998). As mentioned above, human visual systems are frequently exposed to an abundance of sensory information (Qu et al., 2017). Therefore, the differentiation process can support the process of categorisation based on specific visual features or dimensions, particular during the perception of complex visual objects or scenes (Angulo et al., 2019; Goldstone, 1998, 2000; Lachmann & van Leeuwen, 2008). For example, Mayhew et al. (2012) identified an increase in sensitivity to global forms embedded in noise following several training sessions. VPL in the Glass (1969) pattern discrimination task allowed observers to make accurate categorical judgements of radial and concentric patterns despite the perceptual uncertainties induced by the noise. The behavioural evidence of VPL reported in Mayhew et al.'s (2012) study was further associated with neural activation changes in brain regions linked to the recognition of global forms. It thus appears that training facilitates experience-dependent changes in categorical decision processes due to shifts in participants' internal categorisation criteria (Mayhew et al., 2012). Specifically, VPL can occur through training whereby the perceiver learns to detect, differentiate, and categorise objects and properties with discriminable features (Dosher & Lu, 2017).

Unitisation. In contrast to the differentiation mechanism that delineates objects into distinct parts, unitisation integrates separate parts into perceptual wholes (Goldstone, 1998, 2001). *Unitisation* involves the “chunking” of features through the learning of complex configurations that can subsequently be accessed as a complete functional unit (Goldstone, 1998, 2000). In examining the effects of unitisation, Laberge (1973) reported that observers responded more quickly to letters compared to letter like controls; however, this difference was attenuated through practice as observers became more acquainted with the unfamiliar stimuli. It was proposed that the frequent and consistent presentation of unfamiliar stimuli during training became processed as a single functional unit, thereby improving the observers’ reaction times in detecting the target stimuli. To explain these findings, Mozer et al. (1992) proposed a neural network whereby visual parts that co-occur in a patterned manner become bound together by synchronising neurons into configural units. Specifically, repeated exposure to a series of stimuli during perceptual learning results in a configural representation of single parts into an integrated functioning unit. Consequently, activating single units in the neural network is enough to trigger the reproduction of the entire sequence of perceptual features. Indeed, this unitisation process whereby conjunctions of stimulus features are combined and perceived as a functional unit following training has been extensively examined (e.g., Czerwinski et al., 1992; Liang et al., 2020; Shiffrin & Lightfoot, 1997; Smyth & Naveh-Benjamin, 2018; Wenger & Rhoten, 2020). The process of unitisation observed in these studies demonstrates that the human brain can extract structure from a stream of events following VPL. It can identify spatial and temporal regularities – allowing one to learn the contingencies and patterns of co-occurring stimuli through repetition and associative pairings (Wang et al., 2017).

1.1.2 Visual Hierarchies and its Impact on Visual Perceptual Learning Processes

The differentiation and unitisation mechanisms of VPL demonstrate how complex visual scenes or configurations can be understood or perceived efficiently within various tasks and contexts (Goldstone, 2000; Hall, 2021; Landers, 2020; Schyns et al., 1998). At the core of these mechanisms, attention drives the selection of relevant sensory information to assist perceptual learning, while perceptual training can help reduce or overcome the limitations of attention (Dosher et al., 2010; Dosher & Lu, 2017). It is thus difficult to detach perceptual learning processes from attentional processes as the focus of attention is often needed to establish relevant sensory representations and mediate learning (Ahissar & Hochstein, 1993, 1997, 2004; Dosher et al., 2010; Goldstone, 1998). However, there is contradictory evidence of where learning occurs in the visual hierarchy (Maniglia & Seitz, 2018; Wang et al., 2016). Two notable but contradictory theories illustrate the process in which VPL can occur: the classic view of visual hierarchy (Hubel & Wiesel, 1968) and the reverse hierarchy theory (RHT; Ahissar & Hochstein, 1997).

According to the traditional and classic view of visual hierarchy, information processing during VPL is implicit and hierarchical: neuronal cells of lower areas (V1, V2) first receive visual input consisting of basic visual features such as a distinct colour or orientation (Hubel & Wiesel, 1968). The primary visual cortex (V1) neurons have small receptive fields that specialise in spatial frequency and orientation. These visual features are subsequently integrated and processed in higher cortical levels (V3, V4), resulting in a generalised spatial parameter representing global features and categories. Therefore, visual percepts are assumed to emerge from local elements integrating to form more global shapes in a bottom-up manner (Tanskanen et al., 2008). Consequently, learning-induced visual improvements are often location-, feature- and orientation-specific as processing begins at the lower levels of the visual cortex; this matches the fine spatial retinotopy characteristic of the lower visual areas (Fahle, 2005; Schoups et al., 1995).

In support of the learning specificity following training, Qu et al. (2017) reported evidence of bottom-up attention towards nonsalient task-irrelevant geometric shapes following VPL. Their findings suggest that extensive training supports the detection of specific learned features even in the absence of perceptual awareness or task relevancy. The effects of VPL in this context then persisted and remained stable over months, suggesting the formation of a new cortical circuit to mediate learning effects (Qu et al., 2017). Collectively, the classic view of visual hierarchy suggests that information processing during VPL begins with the detection of simple features to derive higher-level percepts. However, despite our ability to rapidly capture and process visual scene categories, humans also have paradoxical initial blindness to the finer details of the scene, which contradicts the classical view (Hochstein & Ahissar, 2002). Ahissar and Hochstein (1997) have thus argued that information processing during VPL may instead begin at higher cortical levels that are associated with spatial generalisation.

The RHT describes a visual perceptual process that follows the classic visual hierarchical pathway in the reverse direction (Ahissar & Hochstein, 1997). Attentional mechanisms mediate learning by selecting relevant neural populations and increasing their functional weights in a top-down guided process (Ahissar & Hochstein, 2004; Reavis et al., 2018). Therefore, high-level learning must precede low-level learning, cascading from high cortical levels to low cortical levels, as it enables the backward search process based on task-specific goals or prior knowledge (Ahissar & Hochstein, 2004). Indeed, when explicit perception begins at the high-level visual cortex, attention is diffused within a larger receptive field due to an approximate integration of low-level visual input. Detailed information is subsequently integrated into later vision through feedback connections as explicit visual perception proceeds to lower-cortical areas in a top-down fashion. VPL thus occurs when these top to bottom level modifications guide and enhance the perception of task-relevant information while pruning irrelevant details (Ahissar & Hochstein, 2004). Taken together, the RHT provides an alternative account for VPL which occurs in a reverse hierarchical nature, thereby allowing the generalisation of learning from easy to more complex tasks (Ahissar & Hochstein, 2004; Asher et al., 2019; Ding et al., 2003; Hochstein & Ahissar, 2002; Tan et al., 2019). Notably, the RHT supports the notion that people prioritise global perception without the conscious processing of individual elements to form a perceptual whole (Ahissar & Hochstein, 2004). This concept also aligns with the global precedence effect (GPE) that stipulates how global analysis is often prioritised over more fine-grained local analysis (Mills & Dodd, 2014; Navon, 1977; Rezvani et al., 2020).

The GPE describes people's tendency to exhibit increased sensitivity to global information (e.g., Čeněk et al., 2020; Chamberlain et al., 2017; Hakim et al., 2017). Although visual scenes typically contain both global and local information, people exhibit an attentional bias to global features during the early stages of visual information processing due to the GPE (Lao et al., 2013). However, the prevailing influence of individual and cultural differences may attenuate or strengthen this global advantage. For example, Navon (1977) figures have been applied extensively in research investigating the GPE as it can incite preferential attention towards the global or local elements of these figures (Kühnen & Oyserman, 2002; Lao et al., 2013; McKone et al., 2010; Navon, 1977; Yang et al., 2019). McKone et al. (2010) found that East Asians had faster responses to global target letters in the Navon stimuli, thus revealing a global advantage amongst East Asians. In contrast, Davidoff et al. (2008) and Caparos et al. (2012) found a strong local bias amongst remote Rwandan and Namibian African populations in this task, thereby challenging the universality of the GPE. However, Hakim et al. (2017) reported no compelling evidence of cultural differences in the Navon task. Eye-tracking studies have also disputed evidence of cultural differences in directing attention towards global information (Evans et al., 2009; Miellet et al., 2010). Further research is thus needed to examine the perceptual and attentional bias that manifests differently across individuals and cultures under varying task conditions and environments. Research on the RHT and the GPE could present compelling evidence of differences in VPL trajectories, especially if these differences manifest despite the common global advantage people exhibit during initial perception.

1.1.3 The Role of Individual Differences in Visual Perceptual Learning Abilities

Research has evidenced considerable individual differences in perceptual learning trajectories and abilities in detecting specifying variables (Rop & Withagen, 2014; Withagen & Caljouw, 2011; Withagen & van Wermeskerken, 2009). For instance, Rop and Withagen (2014) reported variations in perceptual learning trajectories across individuals and learning environments. Participants utilised feedback in easy environments but not challenging ones, and performance diverged when errors were harder to detect. Therefore, while some observers are more proficient at detecting specifying variables, some may not possess the same quality and are less receptive to feedback (Menger & Withagen, 2009). Indeed, although the provision of feedback during training could guide observers through the perception of different informational variables, only some will eventually recognize useful specifying information that can subsequently improve performance (Muller-Gass et al., 2019; Withagen & Caljouw, 2011; Withagen & van Wermeskerken, 2009). Individual variations in perceptual systems and their impact on the detection of informational variables should thus be considered when examining the differences in VPL processes. It is essential to consider how these variations can develop from a range of interacting factors such as biology, genetic specifications, and environmental influences (de-Wit & Wagemans, 2015; van der Kamp et al., 2013; Withagen & van Wermeskerken, 2009).

Our visual and perceptual systems construct meaning from the environment by making inferences based on previous visual experiences, biases, expectations, knowledge, and assumptions (de-Wit & Wagemans, 2015; van der Kamp et al., 2013). Individual variations in cognition, learning capacities, and feedback responses are dynamic and can grow, develop, or change over the lifetime (e.g., Menger & Withagen, 2009; van der Kamp et al., 2013; Withagen & van Wermeskerken, 2009). For example, learned abilities and learning capacities could decline with age (Withagen & Caljouw, 2011). Additionally, differences in perceptual experience as represented by age have also influenced susceptibility to visual illusions (Brosvic et al., 2002; Doherty et al., 2008). Doherty et al. (2010) observed that children below the ages of 7 were less affected by misleading contextual information in the Ebbinghaus illusion. In contrast, adults exhibited greater context sensitivity and were more susceptible to this size perception illusion. These differences in susceptibility to illusions across age groups indicate an intra-individual variability in perception (de Wit et al., 2015). Specifically, the inability of an observer to detect or exploit an optical variable could be attributed to individual differences in perceptual experience or attentional propensity. Perceptual abilities evolve and vary in their degrees of adaptiveness to ensure the usefulness of detected information in the observers’ environments (Withagen & Chemero, 2009). Sociocultural environments thus play a significant role in shaping perceptual systems that allow one to strive in their lived environments (Proulx et al., 2016; Schriber & Guyer, 2016).

Individual differences, experiences, and the environment can influence the development of the perceptual system and VPL processes (Ramey et al., 2019). Exploratory and participatory behaviours in a social environment allow people to develop perceptual abilities to act appropriately in their environments (Goldfield, 1995). Therefore, perception reflects a mental representation of the environment, and experience can significantly benefit visual systems and attentional deployment (Awh et al., 2012; Pollmann, 2019). Indeed, as the human brain develops throughout a person's lifespan, it is susceptible to the effects of experience, social contexts, and sociocultural environments (Fuhrmann et al., 2015; Kilford et al., 2016; Schriber & Guyer, 2016). Goh et al. (2007) postulated that cultural immersion could regulate perceptual systems to adapt to distinct environments over the years. It is thus estimated that cultural influences could also underlie VPL differences. However, there is a lack of research in this domain. Hence, there is a great theoretical interest in examining the impact of culture on VPL mechanisms and why these differences may arise.

1.2 Defining Culture as a Dynamic Multilevel Framework

The prominence of the interdisciplinary area of social and cognitive psychology warrants diverse research methods and measures to illustrate an accurate and systematic representation of dynamic cultural influences on psychological processes such as VPL. For example, cultural influences on cognition and behaviour have been characterised using constructs such as individualism-collectivism, independence-interdependence, and analytic-holistic thinking styles (e.g., Choi et al., 2007; Kanagawa et al., 2001; Koo et al., 2018; Masuda et al., 2008; Nisbett et al., 2001; Oyserman et al., 2002; Oyserman & Lee, 2008; Senzaki et al., 2014; Yu et al., 2021). Therefore, the following section will examine existing approaches and measures for conceptualising cultural differences. The literature review will define macro and micro levels of culture, and how integrating both systems could inform a multilevel framework to explain cross-cultural differences in cognition and behaviour.

1.2.1 Definition of Culture

There are many ways to define culture (Cohen & Kitayama, 2020; Markus & Hamedani, 2019). Within the context of the present thesis, culture will be defined as a collective set of knowledge, experiences, identities, beliefs, and values that can distinguish one group of people from another (Hofstede, 1980, 2001; Leung & van de Vijver, 2008). The antecedents of cultural manifestations and adaptations can be attributed to ecological, environmental, and sociopolitical contexts (Berry et al., 2002; Markus & Hamedani, 2019). Indeed, culture is an outcome of physical environments and historical events that have shaped languages, religions, occupations, and social conditions (Han et al., 2019b). Berry and colleagues (2002) further stipulated culture as an evolving system that adapts according to ecological and sociopolitical upheavals. Consequently, social interactions and interactions with the environment contribute to the construction and maintenance of shared values, ideologies, and beliefs within a society (Greenfield, 2013, 2018). Cultural traditions are thereby passed down from one generation to the next through these socialisation processes to inform the languages that people speak, the behaviours that help people to adapt to their environments, and the attitudes and values that inform how people think and behave (Cohen & Kitayama, 2020; Freeman et al., 2009; Gintis, 2007; Nguyen-Phuong-Mai, 2017). To account for the transfer of cultural values, knowledge, and ideologies, Erez and Gati (2004) described culture as a nested structure. Cultural systems can be conceptualised into macro and micro levels that range from the macro level of a global culture (Caprar et al., 2015), down to the micro individual level as represented by personal attributes and self-concepts (Markus & Kitayama, 1991, 2010; Motti-Stefanidi, 2018; Na et al., 2020).

1.2.2 The Macro System

At the macro level, a socially constructed ideology creates a shared meaning system that informs behavioural patterns and dispositions (Caprar et al., 2015; Greenfield et al., 2003; Kitayama & Park, 2010). Accordingly, the differentiation of societies based on broad cultural dimensions provides a means of generalising the values, behaviours, and characteristics that make a culture unique. For instance, Asian cultures such as those of China, Korea, or Japan are often grouped under the umbrella of neo-Confucianism heritage which values collective harmony and interdependence (de Vliert et al., 2013; Hong & Chiu, 2001; Wu et al., 2018). In contrast, Western European or North American cultures are circumscribed by political systems (Ezcurra, 2021) and Judeo-Christian cultural traditions that emphasise individualism and independence (Hofstede, 1980, 2001, 2011; MacDonald, 2018). Therefore, a macro level approach in cultural research offers a collective insight into our understanding of cognition and behaviours across different cultures.

Geographical classifications represent a fundamental method of cultural classification at the macro level (Van De Vijver & Leung, 2000). Indeed, although country level analyses represent the lowest entropy of classification, it can contribute interesting insight into our understanding of culture. For instance, ecological and socio-political factors influence the cultural systems of society (Gelfand et al., 2017; Kitayama et al., 2019). The ecological and historical foundations of culture are governed by factors such as pathogen exposure (Fincher et al., 2008; Rotella et al., 2021; Thomson et al., 2018), climate (de Vliert et al., 2013; Vliert, 2013), societal threats (Gelfand et al., 2011), genetic dispositions (Chiao & Blizinsky, 2010; Minkov et al., 2015), religion, mode of subsistence (Talhelm et al., 2014), and cognitive differentiation (Gelfand et al., 2017). Collectively, these factors can contribute to unique cultural systems at a national level resulting in the cognitive and behavioural differences between nations (Van De Vijver & Leung, 2000). However, broad geographical classifications based on country boundaries may be reductive and detract from meaningful research data as it does not account for the shared value and system variations that could be characteristic of different nations (Khan et al., 2017).

Increases in wealth and technological advancements have resulted in cultural shifts around the world (Greenfield, 2009; Hamamura, 2012; Inglehart & Baker, 2000; Muthukrishna & Schaller, 2020; Schaller & Muthukrishna, 2021; Sheetal & Savani, 2021; Votruba & Kwan, 2018; Wang et al., 2017; Wang & Brockmeier, 2002; Zhou et al., 2018). The convergence of cultural values and shared norms across different societies in response to rapid globalisation and migration has diminished the effectiveness of geographical classification as a means of differentiating cultural groups. Therefore, cultural distinctions should not be limited to nationalities but rather be inclusive of collectives who are bound by the same cultural experience and environment (Cohen, 2009). These within-country variations have been reported in numerous studies: People from Hokkaido, a small island in Japan, are more independent and analytic than people from mainland Japan (Hamamura & Takemura, 2018; Kitayama et al., 2006; Yamawaki, 2012); Eastern and Western Europeans also exhibited a similar pattern of observations (Kühnen & Oyserman, 2002; Varnum et al., 2008, 2010; Vignoles et al., 2016), although Western Europeans were still more interdependent and holistic than North Americans (Kitayama et al., 2009). Besides that, southern Italians were more interdependent than northern Italians (Knight & Nisbett, 2007), as were Chinese rice-farmers in the north of the Ningxia province compared to wheat-farmers in the south of the province due to the differences in their means of subsistence (Dong et al., 2019; Talhelm et al., 2014). Similarly, Turkish farmers and fishermen were more holistic than Turkish herders as their work required cooperation, while herders typically work and make decisions independently (Uskul et al., 2008). Collectively, the within-country variations in cultural adherence suggest the importance of considering the shared values, norms, and characteristics that can better define cultural groups. Therefore, expanding research beyond geographical boundaries could be advantageous for improving generalisation. It is essential to consider other determinants such as age, gender, ethnicity, and socioeconomic status (SES) that impact the cultural systems within a country (Boer et al., 2018; Brewer & Venaik, 2011, 2012; Han et al., 2019; Lawrence et al., 2020; Na et al., 2020; Poirel et al., 2008; Vandello & Cohen, 1999).

The application of cultural taxonomies was introduced to circumvent the limitation of geographical classifications and allow for better generalisations of cultural group characteristics at the macro level (Daniels & Greguras, 2014). Hofstede (1980, 2001, 2011) identified six dimensions, specifically within organisational contexts, to explain the observed psychological differences between cultures. These dimensions are power distance, individualism-collectivism, masculinity-femininity, uncertainty avoidance, long-term-short-term orientation (pragmatic vs normative), and indulgence restraint. Hofstede's (1980, 2001, 2011) organisation of culture into overarching dimensions has facilitated an expansion of comparative research on culture and its influence on biology, behaviours, and cognition (Oyserman et al., 2002). Indeed, since the publication of Hofstede's (1980) influential analysis of cultural frames, the individualism-collectivism dimension is arguably the most well-received amongst the six proposed dimensions (Hofstede, 2011; Schimmack et al., 2005; Sent & Kroese, 2020; Stump & Gong, 2020; Wong, 2001). The individualism-collectivism constructs have been frequently used in cross-cultural research to explore differences in cognition and behaviours (e.g., Choi et al., 2007; Kanagawa et al., 2001; Koo et al., 2018; Masuda et al., 2008; Nisbett et al., 2001; Oyserman et al., 2002; Oyserman & Lee, 2008; Senzaki et al., 2014; Yu et al., 2021). Individualism represents a worldview that centralises the individual, including personal goals, uniqueness, and personal control (Schimmack et al., 2005). In contrast, collectivism represents a worldview that attempts to unify several different levels of referent groups (i.e., family, ethnic, or religious groups) within attitudes, beliefs, and behaviours. Prioritising group goals and maintaining harmonious relationships are thus characteristic of collectivistic societies (Hofstede, 1980, 2001, 2011). Notably, these culturally informed macro features and worldviews have been proposed to shape cognitive styles, cultural orientations, and self-systems (Koo et al., 2018).

Tsai et al. (2006) advocated the classification of cultures on continuous dimensions as the basis of cross-cultural comparisons. Indeed, implementing value classifications in lieu of country classifications allowed cross-cultural comparisons beyond physical geographical boundaries (Khan et al., 2017). However, according to Gerhart and Fang (2005), Hofstede's country-level cultural index only explains two to four percent of individual-level variance. Therefore, it presents a theoretical limitation as it cannot account for differences in individual behaviour, which is an important consideration within cross-cultural research (Fischer, 2009; Minkov & Hofstede, 2014; Taras et al., 2016). Furthermore, despite its widespread application, Hofstede's (1980, 2001, 2011) model has been criticised for its stringent conceptualisation of culture as a nation, as well as its limitation as a static rather than dynamic construct (Gómez-Rey et al., 2016; Kirkman et al., 2006).

Culture is dynamic, and the manifestation of cultural patterns can change across time and space (Beugelsdijk & Welzel, 2018; Singelis et al., 1995). The static characterisation of culture using stable values like the individualism-collectivism construct does not account for the dynamic changes in social processes that could occur within a society (Hong et al., 2000). Shifts in social, economic, and structural developments could impact the cultural values that characterise a nation as well as the individuals that make up the nation (Oyserman et al., 2002). Therefore, it is important to consider individuality to gain a more holistic view of cultural variations (Dheer et al., 2014; Greenfield, 2013, 2018; Harrington & Gelfand, 2014; Yamawaki, 2012). Research incorporating the micro system of culture could contribute valuable insights in cross-cultural research as it considers individual differences and the dynamic nature of culture.

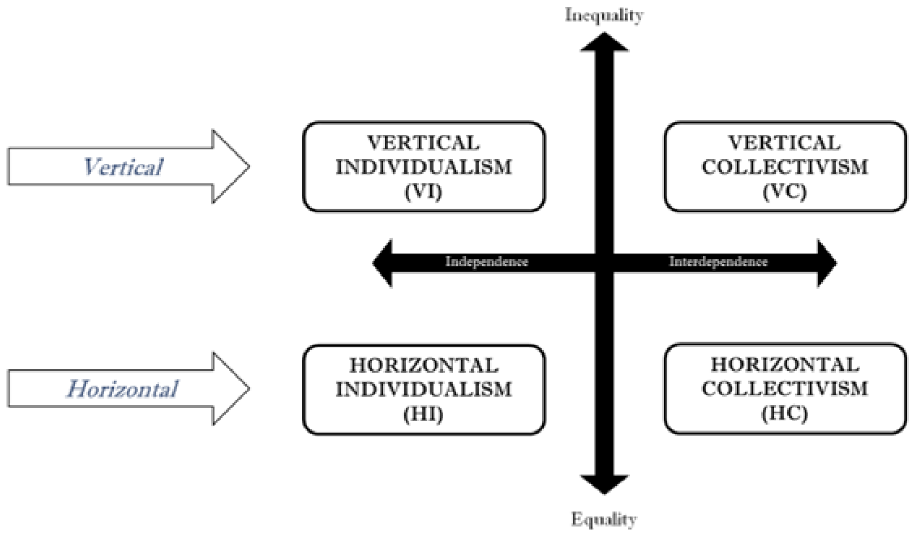
1.2.3 The Micro System

Despite the utility of the individualism-collectivism dimensions for classifying societies using a broad and generalised representation of macro cultural systems (Hofstede, 1980, 2001, 2011), it is important to consider an individual level of analysis at the micro level. For instance, although an individual may appear to be relatively collectivistic on one dimension, they may be more individualistic on other dimensions due to underlying factors that are not immediately apparent (Hong & Chiu, 2001). Furthermore, although Hofstede's (1980, 2001, 2011) national cultural index was derived based on a national level unit of analysis, past research has identified significant cultural differences even within smaller geographic areas (Caparos et al., 2020; Dong et al., 2019; Talhelm et al., 2014; Tempelaar et al., 2012; Trémolière et al., 2021). Indeed, the individualism and collectivism dimensions of culture can be broken down into several conceptually distinct components such as self-reliance or independence, self-direction, or individuality (Ho & Chiu, 1994). Vignoles et al.'s (2016) multinational survey further identified seven distinct dimensions within the independent (versus interdependent) construct, including characteristics such as self-containment, self-direction, self-reliance, consistency, self-expression, and self-interest. Triandis (1995) also added vertical and horizontal features to describe individual level variations in adherence to individualism or collectivism within different contexts or situations (Lee & Choi, 2005). A common denominator in these findings emerges: the prominence of the individual in cultural expressions. It is thus essential to consider micro systems to gain a holistic understanding of the discrete components that interact dynamically to inform macro cultural systems.

To supplement Hofstede's (1980, 2001, 2011) individualism-collectivism dimensions which were derived from a national level unit of analysis, horizontal and vertical orientations were used to characterise the acceptance of hierarchies and power dynamics that exist within individualistic and collectivistic societies (see Figure 1.1; Singelis et al., 1995; Triandis, 1995). The horizontal dimension relates to the emphasis on equality, while the vertical dimension relates to the acceptance of hierarchy and unequal distributions of power (Triandis, 1995; Triandis, 2012). The addition of the horizontal and vertical dimensions thereby contributes to a four-category cultural classification system that reflects within-culture and individual level variations in cultural orientations: vertical individualist, vertical collectivist, horizontal individualist, and horizontal collectivist orientations.

Figure 1.1

An Illustration of the Triandis' (1995) Horizontal and Vertical Dimensions of Culture



Note. Individuals with horizontal orientations value equality, whereas those with vertical orientations value hierarchy and social standings.

Horizontal collectivism (HC). HC relates to the cultural dimension whereby individuals are part of an integrated group where the collective interest is prioritised, and everyone is treated equally. HC societies such as Brazil, some parts of Latin America, and the Israeli kibbutz value interdependence and an egalitarian view of the community (Torelli & Shavitt, 2010).

Vertical collectivism (VC). VC orientations are associated with compliance and respect towards authority figures within the social hierarchy (Triandis & Gelfand, 1998). As such, some members within integrated VC societies possess more privilege and status than others. Therefore, inequality is a norm and sacrificing self-interest for the benefit of the group is a characteristic of this cultural orientation. Korea, Japan, and India are examples of VC societies that place authority figures in high esteem, and group goals are prioritised over personal goals (Triandis & Gelfand, 1998).

Horizontal individualism (HI). HI orientations describe independence and autonomy amongst individuals who are generally at an equal status. For instance, HI societies such as Australia, Sweden, and Norway exercise equality and value unique self-expression rather than competing to increase personal status by surpassing others (Nelson & Shavitt, 2002).

Vertical individualism (VI). VI extends a similar concept of an individualistic and autonomous self. However, there are hierarchical differences that make individuals differ in terms of status and power. Competition and inequality are the norm in VI societies as individuals seek to stand out and build their reputation through achievements and competitions (Torelli & Shavitt, 2010). The United States, United Kingdom (UK), and France are examples of VI societies where social standings are highly valued (Triandis, 1995; Triandis & Gelfand, 1998).

The application of Triandis' (1995) cultural typology presents a practical opportunity for expanding cross-cultural research on biology, cognition, and behaviour from a micro level perspective (e.g., Lee & Choi, 2005). For instance, Hispanic-Americans exhibit more HC values than European Americans who exhibit more VI (Torelli et al., 2015; Torelli & Shavitt, 2010). Females have also been reported to exhibit greater HC and decreased VI than males (Kurman & Sriram, 2002; Lalwani & Shavitt, 2013; Nelson & Shavitt, 2002). Taken together, the horizontal and vertical individualism-collectivism dimensions could facilitate an extension of cross-cultural findings to within-culture or individual-level units of analysis. Considering individual level factors in cross-cultural research could reveal the complex interaction of sociocultural variables that mediate the observed differences in human psychological processes (Han & Humphreys, 2016).

Individual differences in a culturally constructed 'self' system can also regulate cognition and behaviour (Flinkenflogel et al., 2019; Gelfand et al., 2017; Han & Humphreys, 2016). This conceptualisation of the 'self' within a cultural domain has been illustrated by the independent and interdependent self-construal constructs proposed by Markus and Kitayama (1991). Independent and interdependent self-construals describe the perception, understanding, and interpretation of the self in relation to others (Markus & Kitayama, 1991; Triandis, 1989). Notably, these self-construals have been characterised as an expression of individualism and collectivism at the individual trait level (Fiske et al., 1998; Markus & Kitayama, 1991; Oyserman & Markus, 1993). Accordingly, there are variations in how people from different cultural backgrounds conceptualise themselves (Kühnen & Oyserman, 2002; Park et al., 2016; Voyer & Franks, 2014). For instance, individuals from Western cultures typically adopt independent self-concepts and perceive themselves as unique, distinct, and autonomous over their personal choices. In contrast, individuals of East Asian cultures typically embrace interdependent self-conceptualisations that are related to fulfilling the expectations of others and meeting culturally inscribed standards (Markus & Kitayama, 1991). Consequently, behavioural manifestations and differences arise from these social concessions in consideration of the needs and perspectives of close others (Ames & Fiske, 2010; Flinkenflogel et al., 2019; Han, 2015; Kitayama & Park, 2014; Miyamoto et al., 2018; Park & Huang, 2010).

In summary, different representations of the self can inform cognition and behaviour under varying circumstances, particularly if there is an apparent lack of differences at the macro level (Verplanken et al., 2009). The self-system is intrinsically plural, flexible, and dynamic rather than static and singular (Benet-Martínez et al., 2002; Gardner et al., 1999; Hong et al., 2000; Nguyen-Phuong-Mai, 2017). It is thus difficult to pinpoint the exact cultural mechanisms or variables responsible for regulating how people of different cultures think, feel, and act within different contexts (Oyserman et al., 2002). Therefore, it is important to examine cultural differences at a micro level beyond the differentiations defined by nationality or geographical boundaries. Indeed, people can construe themselves in multiple ways, and an individual could possess both independent and interdependent self-concepts in varying degrees (Verplanken et al., 2009). These cultural meaning systems subsequently influence behaviours depending on the context as people often adapt their attitudes and behaviours to suit the environment and subjective norms (Suh et al., 2008; Trafimow & Finlay, 1996). Even at the individual level, cultural systems are represented by many complex dimensions that operate in a reciprocal and dynamic manner, allowing people to learn and adapt to different contexts and situations.

1.2.4 A Dynamic Multilevel Framework of Culture: Combining the Macro and Micro Systems

Cultural systems on both micro and macro levels account for how individual members of societies dynamically interact to influence global cultures and vice versa (Erez & Gati, 2004; Goodwin et al., 2020; Khan et al., 2017; Kim & Sasaki, 2014; Motti-Stefanidi, 2018). Indeed, a dynamic mechanism underlies these seemingly distinct levels of culture (Briley et al., 2014; Erez & Gati, 2004; Motti-Stefanidi, 2018). For example, globalisation which operates at the macro level of culture could impact the cultural norms and behaviours of individual members through top down-processes (Beumer et al., 2018; Chen et al., 2020; Hong & Cheon, 2017; Vignoles et al., 2016; Wang et al., 2017). Reciprocally, changes at the individual level could alter culturally shared norms and values of a society through bottom-up processes. As such, a multilevel approach encompassing macro and micro components of culture could offer substantial insight into the dynamic interactions between the different levels of culture. An examination of these cultural systems can contribute to greater theoretical knowledge of how culture facilitates psychological processes such as cognition and behaviours (Ames & Fiske, 2010; Han, 2015; Kitayama & Park, 2010, 2014; Miyamoto et al., 2006; van der Kamp et al., 2013; Xi et al., 2018). Furthermore, due to the continuous evolution of culture across time and space, it is increasingly important to examine the dynamic processes and changes that may drive the psychological variations observed between people of different cultural backgrounds and sociocultural orientations under varying contexts and environments (Briley et al., 2014; Erez & Gati, 2004; Hong et al., 2000; Sedikides et al., 2011; Xi et al., 2018).

A multilevel cultural model could provide a comprehensive explication of culture and predict the societal trends that underlie cultural variations or universals (Gelfand et al., 2017). It should encompass a system of measurements at both the macro and micro level to account for the variance in values and norms that underlie cultural differences in cognition and behaviour (Imai et al., 2016;

Imai & Masuda, 2013; Masuda et al., 2016; Masuda & Kitayama, 2004; Norenzayan et al., 2002). Incorporating multiple levels of analysis will offer a global perspective on a seemingly culturally dispersed world. The acceleration of globalisation has increased people's contact and exposure to cultures and values that differ from their own, thereby creating unified cultural experiences across the globe (Han & Humphreys, 2016; Xi et al., 2018). However, widespread immigration and globalisation have also contributed to a divergence in the physical, cognitive, and affective features of social interactions that could further augment cultural differences in psychological processes (Imai et al., 2016; Masuda et al., 2016; Wang et al., 2017). Therefore, considering the dynamicity of culture within a multilevel framework is increasingly pertinent for characterising the changes that occur at national (macro) and individual (micro) levels (Han & Humphreys, 2016).

To illustrate, although an individual may exhibit dominance in one cultural construct, it may not remain stable under different circumstances (Suh et al., 2008). A spillover effect can occur whereby activation spreads from one cultural construct to a network of other constructs in response to culturally associated cues in the environment (Xi et al., 2018). These effects are particularly evident amongst bicultural individuals who have multiple internalised cultural systems that guide thoughts, feelings, and behaviours interchangeably in response to contextual cues (Benet-Martínez et al., 2002; Chen et al., 2022; Hong et al., 2000; Mok & Morris, 2012; Ng et al., 2010). Indeed, the confluence of two seemingly opposed cultures over a long enough period can cultivate biculturalism in values, languages, lifestyles, education, religion, and child-rearing practices. The internalisation of a second culture becomes integrated alongside the individual's original culture (Hong et al., 2000). For example, Chinese Americans who have immigrated do not lose their cultural identity as they acculturate to the mainstream culture; rather, their native Chinese identity remains differentially accessible when activated by specific contexts or circumstances (Hong et al., 2001). Therefore, cultural knowledge is not merely a static construct but a dynamic system consisting of latent knowledge structures in the mind that can be made salient through environmental cues (Briley et al., 2014; Hong et al., 2000; Xi et al., 2018).

Since culture is a construct represented in the mind, a cognitive component has been proposed to underlie the dynamic view of culture (Briley et al., 2014). Indeed, culture has been described as a diffused network of diverse, but sometimes conflicting, knowledge structures that can be activated or inhibited based on environmental or situational demands to influence cognition and behaviour (Hong et al., 2001; Oyserman & Lee, 2008). The cognitive perspective is supported and exemplified by two conceptual models: Oyserman and Sorensen's (2009) situated cognition approach and Hong and Chiu's (2001) dynamic-constructivist approach. These approaches account for the broad application of dynamic models in cross-cultural research. Both offer insights into the cultural characteristics which influence cognition and behaviour (Brewer & Gardner, 1996; Kühnen & Oyserman, 2002; Matsumoto & Kupperbusch, 2001; Mok & Morris, 2012; Ng et al., 2010; Wang et al., 2013; Xi et al., 2018), thereby accounting for cultural interconnectedness and the complexities of increasingly polyglot and pluralistic societies.

The Situated Cognition Approach. The situated cognition approach proposes cultural syndromes to be a loosely defined network of beliefs and attitudes that exist in varying degrees in all cultures (Oyserman & Sorensen, 2009). Situational and contextual factors regulate accessibilities to these cultural syndromes – to the extent that individuals may think or act in ways that are independent of the culture to which they belong in different contexts (Hagger et al., 2014; Hagger et al., 2014). The ease of accessibility to cultural syndromes are also dependent on the frequency and recency of its application (Briley et al., 2000, 2005; Briley & Wyer, 2002; Danziger & Ward, 2010). Therefore, accessibility varies from person to person, and people may not always be aware of the cultural influences that act upon their thoughts and behaviours as the processes underlying automatic and implicit systems may differ from the processes governing conscious and explicit systems (Corneille & Hütter, 2020; Ellis, 2005; Greenwald & Lai, 2020; Shoda et al., 2014).

The Dynamic-Constructivist Approach. The dynamic-constructivist theory is another cognitively oriented approach that assumes culture to be an associative network of cultural norms, values and behaviours which can be accessed when the situation demands it (Chiu & Hong, 2006; Hong & Chiu, 2001). Therefore, activating an individual's cultural identity or an aspect of the culture they represent can increase the accessibility of the associated network in memory to influence cognitions and behaviours. Indeed, cultural syndromes can be accentuated or weakened depending on the context (Hong & Chiu, 2001). Several cultural frame shifting techniques that can achieve this, including exposure to cultural symbols or icons (Briley & Wyer, 2002; Chen et al., 2005; Hong et al., 2000), priming using language for bicultural individuals (Briley et al., 2005; Ross et al., 2002), describing similarities or differences between family and friends (Trafimow et al., 1991), and singular or plural pronoun circling tasks (Brewer & Gardner, 1996; Gardner et al., 1999).

Taken together, the dynamic view of culture could reveal the context and circumstances in which culture could manifest (Briley et al., 2014; Hong & Chiu, 2001; Oyserman & Sorensen, 2009). Within an experimental context, the dynamic nature of culture can be investigated using priming or cultural frame shifting techniques (Benet-Martínez et al., 2002; Flinkenflogel et al., 2019; Hong et al., 2000). Priming methodologies operate under the premise that people can dynamically integrate or dissociate from features of their cultures (Hong & Chiu, 2001; Oyserman & Sorensen, 2009). Since contradictory cultural constructs cannot simultaneously guide processing (Xi et al., 2018), it is assumed that these knowledge structures can be activated and accessed by cues such as language or cultural icons (Hong et al., 2000). For example, interdependent self-construal priming has been observed to facilitate attention to social context (Wang et al., 2013). Choi et al. (2016) also reported that priming independent and interdependent self-construal amongst Western participants enhanced analytic or holistic thinking styles. Response times for detecting contextual relative to focal changes in a change-blindness task were halved for those primed with interdependence, suggesting that interdependent self-construal is associated with context-dependent modes of thinking that facilitate faster responses (Choi et al., 2016). However, regardless of the priming manipulation, all participants were generally faster at identifying focal changes in the task, indicating the prevailing tendency of analytic thinking amongst Westerners. The behavioural evidence observed at both the micro individual level (i.e., interdependence self-construal) and macro group level (i.e., Westerners) thus supports the application of a dynamic and multilevel cultural framework. Priming methodologies could provide a controlled examination of specific cognitive or behavioural processes that are modulated by salient cultural values (Flinkenflogel et al., 2019; Han, 2015).

To summarise, cross-cultural research remains a relevant and essential field of inquiry. There is a compelling need to examine the generalisability of existing theories that are typically constructed from westernised contexts and perspectives (Gelfand et al., 2017). Accordingly, integrating multiple investigative approaches in cultural research, such as priming or cultural frame shifting techniques, is vital for providing a dynamic and universal insight into the influence of culture on human psychological processes (Yamazakia & Kayes, 2010). Cultural theories and constructs should be broadened to include cultural intersections when explaining cognitive and behavioural differences within varying contexts and environments (Greenfield, 2018a; Kashima et al., 2019; Kwon et al., 2021; Wang et al., 2017). Since the macro and micro systems of culture present limitations when used independently, a combination of both systems will provide an extensive and inclusive cultural framework for examining cross-cultural differences in VPL in the present thesis.

1.3 The Impact of Culture on Cognition and Behaviour

As mentioned previously (see Section 1.1.2), the basic and implicit process of perception could be similar across individuals and societies as suggested by the RHT (Ahissar & Hochstein, 1997) and the GPE (Mills & Dodd, 2014; Navon, 1977; Rezvani et al., 2020). However, individuals can still acquire and engage in distinct perceptual inference habits depending on the cultural environments and systems they are exposed to (Segall et al., 1963). Indeed, research has identified cross-cultural differences in perception (Kastanakis & Voyer, 2014), attention (Ueda et al., 2018), memory (Alea & Wang, 2015; Leger & Gutchess, 2021), and learning (Toyama & Yamazaki, 2018; Yamazakia & Kayes, 2010). The following section will integrate the discussion on cognition (see Section 1.1) and culture (see Section 1.2) by reviewing existing literature on cultural differences in cognition and behaviour and the possible antecedents of this phenomenon. The knowledge and insights outlined within this cultural domain will then be extended to a proposal of how it can impact VPL processes.

1.3.1 Cultural Differences in Cognition and Behaviour

Attention has been assumed to be a universal ability (Yoo et al., 2021). However, many cross-cultural studies have reported differences in how people from different cultural backgrounds direct attention (Correa-Chávez & Rogoff, 2009; Lufi et al., 2017; Rogoff et al., 1993). For one, the pictographic nature of Chinese characters that includes multiple sets of strokes requires attention to be directed at the entire character as focusing on a single stroke may be confusing (Lufi et al., 2017). Besides that, Mayans tend to take in more information with roaming eyes like that of a hummingbird's flight pattern (Rogoff et al., 1993), while middle-class European Americans tend to converge their attention to one event at a time (Correa-Chávez & Rogoff, 2009). These differences in visual deployment were attributed to cultural differences in learning whereby children from Mayan communities learn through observations and participation in multiple simultaneous events. In contrast, children from western, educated, industrialised, rich, and democratic (WEIRD) cultural backgrounds (Henrich et al., 2010a, 2010b) are typically taught in direct and didactic ways that involve frequent refocusing of attention during learning (Shneidman & Woodward, 2016). Taken together, differential cognitive and behavioural processes such as attention and perception can be informed by sociocultural and environmental influences (Miyamoto et al., 2006).

Cultural differences in perceptual strategies and attentional propensity relate to an unconscious and automatic inference process that has been constructed from a representation of the world (e.g., Ames & Fiske, 2010; Flinkenflogel et al., 2019; Kitayama & Park, 2010, 2014; Miyamoto et al., 2006; van der Kamp et al., 2013). For example, the differential allocation of attentional resources across cultures can be attributed to differences in mode of subsistence and work practices (Dong et al., 2019; Talhelm et al., 2014, 2018; Uskul et al., 2008). Herding which is historically a prominent means of subsistence in Western cultures has been linked to independence and analytic thinking due to the self-reliant and solitary nature of this activity (Uskul et al., 2008). Contrastingly, communal rice-farming practices, which were an essential means of subsistence in East Asian cultures, fostered interdependence and holistic thinking styles due to the collaborative needs of this activity (Talhelm et al., 2014). Within-nation variations further inform the observed differences in attentional propensity; rice cultivation in China has been associated with a greater sense of collectivism and interdependence due to the demand for reciprocal labour exchange compared to wheat cultivation which is associated with individualism and independence (Dong et al., 2019; Talhelm et al., 2014). Evidently, national level differences and psychological differences in social orientation (independence versus interdependence) and cognitive styles (analytic versus holistic thinking) can be attributed to historical determinants such as mode of subsistence, work practices, and social cohesion. Specifically, individualism and independence in Western cultures have been linked to more analytic thinking and an attentional bias toward focal and salient objects (Masuda & Nisbett, 2006; Miyamoto et al., 2006). In contrast, collectivism and interdependence in Eastern cultures have been linked to a bias toward contextual or background information and a propensity for broader distributions of attention (Boduroglu et al., 2009; Ji et al., 2004).

As an illustration, Japanese participants have been observed to detect contextual changes more rapidly than their American counterparts (Masuda & Nisbett, 2006). Chua et al. (2005) have further reported attentional biases amongst Chinese participants who spent more time looking at the background of a scene compared to Americans. These findings were attributed to the emphasis on interdependent self-conceptualisations and interrelatedness in Chinese culture that encourages sensitivity to contextual surroundings. Western independent self-construal have also been observed to facilitate more attention towards one’s face (Sui et al., 2009; Sui & Han, 2007). Additionally, as mentioned earlier, the priming of interdependent self-construal amongst Western participants could induce changes in attentional patterns as reflected in faster reaction times (RTs; Choi et al., 2016). Taken together, the individualism-collectivism and independence-interdependence constructs prominent in Western and Eastern cultures represent unique cultural systems that impact attentional biases and behaviours (e.g., Kanagawa et al., 2001; Koo et al., 2018; Masuda et al., 2008; Na et al., 2020; Nisbett et al., 2001; Oyserman & Sorensen, 2009; Senzaki et al., 2014; Yu et al., 2021).

Despite the extensive evidence of observed cultural differences in attention and perception, it is crucial to consider individual differences and situational contexts when making cultural generalisations of cognition and behaviour. Indeed, internalised attentional patterns are dynamic as people may activate different attentional patterns depending on the context, circumstance, or environmental demands (Senzaki et al., 2014). As such, cultural differences may not always manifest behaviourally. For instance, Rayner et al. (2009) have presented contradictory findings that raise doubts about cultural influences on basic attentional and processing mechanisms. Other studies have also reported an absence of any cultural influences on how people attend to a visual scene (e.g., Evans et al., 2009; Hakim et al., 2017; Lawrence et al., 2020; Rayner et al., 2007), thereby providing support for the GPE. However, cultural differences have been reflected in neural processes in the absence of covert behavioural differences (Flinkenflogel et al., 2019; Kim & Sasaki, 2014; Lin et al., 2008; Ng et al., 2010). Furthermore, there is compelling support for the dominant influence of culture on cognition and behaviour (Han et al., 2013; Jiang et al., 2014; Kim & Sasaki, 2014; Varnum et al., 2010, 2014; Yu et al., 2021). For example, the persistent effect of cultural differences in attention has been observed in a study identifying the prevailing tendency for holistic processing and broader distributions of attention amongst East Asians despite explicit instructions to ignore the irrelevant contextual information (Amer et al., 2017). Therefore, the analytic and holistic systems of thought were proposed to be a useful construct that can be used to efficiently define the attentional and processing differences identified across cultures (Choi et al., 2007; Koo et al., 2018).

Analytic and holistic systems of thought relate to how contexts are considered in reasoning and decision making (Na et al., 2020). Indeed, the analytic and holistic tendencies that people adhere to could reflect an adaptation mechanism for people to strive within their lived environments. Holistic thinkers exhibit more diffused and global allocation of attentional resources, prioritising relevant and irrelevant information to thoroughly understand the interrelatedness between objects (Maddux & Yuki, 2006; Nisbett & Masuda, 2003; Spina et al., 2010). In contrast, analytic thinkers exhibit more local attentional patterns directed towards focal objects and categorise based on formalised rules (Nisbett et al., 2001). Notably, analytic and holistic thinking styles map onto the attentional and perceptual differences across cultures and individuals discussed earlier. Evidently, these cognitive styles serve as an explanatory construct for describing cultural differences in various behavioural and cognitive processes.

Based on the examples discussed throughout this section, Western cultures have greater affinities for analytic thinking while Asian cultures are typically more holistic (Choi et al., 2007; Koo et al., 2018; Uskul et al., 2008). Furthermore, values of independence and individuality dominant in Western cultures have been linked to a greater tendency for analytic thinking, while interdependence and the emphasis on social relations in Asian cultures have been associated with holistic thinking (Kitayama & Salvador, 2017; Nisbett et al., 2001). Taken together, the distinction between analytic and holistic thinking styles can describe the locus of attention and the attentional styles characteristic of individuals from different cultural backgrounds (Choi et al., 2016; Kim et al., 2010; Masuda & Nisbett, 2006; Nisbett et al., 2001). However, culture is dynamic and evolves in tandem with environmental demands and sociological shifts in society; this has a subsequent impact on the value and belief systems that people hold (Wang et al., 2017).

Liu et al. (2017) presented compelling evidence on the impact of cultural immersion on psychological processes. Immigrating to a new country with different social conventions necessitates close engagement with the culture for one to ‘fit in’ and adapt to the new environment. As such, this prolonged cultural immersion can impact neuropsychological functions and processes over time (Derntl et al., 2009, 2012; Liu et al., 2017). Chinese immigrants’ behavioural responses during emotion processing resembled North Americans rather than their native Chinese counterparts (Liu et al., 2017). The Chinese immigrants were more affected by to-be-ignored faces when trying to identify voices, a behaviour replicated among North Americans, thus indicating a greater bias towards faces over voices, consistent with the importance of eye contact in Western societies. Interestingly, the Chinese immigrants' neural responses did not match the behavioural findings, as their neural activity more analogous to native Chinese participants from China. Nonetheless, longer living durations in Canada were associated with greater similarities to the neural patterns of North Americans, thus providing evidence that immersion and engagement to a new culture can result in behavioural accommodations and alterations in brain responses.

In a similar domain, Athanasopoulos et al. (2010) also reported neural evidence of how people can adapt to their lived environments. Individuals from Greece who lived in the United Kingdom (UK) for a shorter period exhibited greater sensitivity to light and dark blue colour distinctions unique to the Greek language. Interestingly, those who have stayed in the UK for more prolonged durations did not exhibit this colour sensitivity, instead resembling the English participants who were native to the UK. A dynamic transition appears to occur over time, initially with behavioural adaptations followed by later modifications of neural processes underlying cognitive processing at early perceptual and later semantic stages (Athanasopoulos et al., 2010; Liu et al., 2017). This experience-dependent neuroplasticity represents a neural reorganisation that follows from an accumulation of environmental inputs, cognitive demand, and behavioural experiences (Holtmaat & Svoboda, 2009; Kleim & Jones, 2008). Taken together, Liu et al. (2017) and Athanasopoulos et al.'s (2010) findings demonstrate the relative stability of perceptual learning as people adapt to their lived environments. The extended immersion in the host culture allows people to adapt and alter their native patterns of cognitive processing by learning to perceive more relevant visual information in the host culture.

1.3.2 Can Culture Influence Visual Perceptual Learning Processes?

Diversity in the environment contributes to individual and cultural differences in learning trajectories, detection of information, and susceptibility to illusory biases (Danks & Rose, 2010; Witkin & Berry, 1975). As discussed above (see Section 1.3.1), the informative variables in a perceptual task can vary in utility to individuals who may selectively attend to preferred variables or features during perception (Withagen, 2004). Consequently, individual and cultural differences in perceptual and learning strategies could be revealed through the variations in which informational variables are attended to (Davidoff et al., 2008; Jacobs et al., 2001; Markus & Kitayama, 2010). For instance, individuals from different cultural groups could initially detect either local or global informational variables consistent with the analytic or holistic processing styles prevalent in their cultures (Li et al., 2018; Masuda et al., 2008; Nisbett et al., 2001). Accordingly, visual perceptual training could subsequently reveal the distinct learning and information processing strategies that exist between different cultural groups and provide an index of improvement as individuals learn to shift their reliance on more useful informational variables in the given task (de Vries et al., 2015; Rop & Withagen, 2014).

To this end, van der Kamp et al. (2013) examined cultural differences in VPL using an illusion task where participants were instructed to estimate the midpoint of a straight line flanked by arrow-like fin points. Mere repetitive exposure to the stimuli in the absence of feedback reduced the illusory bias among Westerners. In contrast, East Asians were susceptible to the bias regardless of the amount of practice. It was proposed that Westerners had better performance in this estimation task due to their analytic thinking tendencies and propensity to ignore irrelevant contextual information that caused the illusory bias. In contrast, East Asians were less flexible in changing their use of informational variables to overcome the bias, likely due to their tendency for global and holistic processing during perception. Clearly, cultural differences in information processing strategies could impact the outcomes and trajectory of VPL. However, due to the novelty of research in this domain, further investigation using diverse methodologies are needed to examine how culture can manifest differentially within varying task conditions.

Neuroscientific methods have presented key evidence of individual and cultural differences in cognition and behaviour (Ambady & Bharucha, 2009; Chiao, 2018; Gutchess et al., 2006; Han & Ma, 2014; Jenkins et al., 2010; Kwon et al., 2021; Rule et al., 2013). For example, the use of EEG and the measurement of event-related potentials (ERPs) offer a valuable means of exploring the electrocortical markers of VPL. Despite its spatial limits, ERPs which provide millisecond temporal resolution can reveal the timeframe in which individuals allocate attention and process information (Knyazev, 2013; Knyazev et al., 2018). As such, EEG studies have been monumental in identifying when perceptual learning occurs (Ding et al., 2003; Shoji & Skrandies, 2006; Skrandees et al., 1996; Song et al., 2007; Su et al., 2020; Zhen et al., 2018).

ERPs can reveal the electrophysiological evolutions and developments underlying information processing (Meaux et al., 2014). For instance, in addition to behavioural improvements, nonspecific decreases in N1 ERP amplitudes were reported following training in orientation discrimination (Ding et al., 2003; Song et al., 2007). Decreases in the N1 component has been proposed to reflect diminished attentional modulation following learning as less attention is required when observers become increasingly learned in the given tasks (Schiltz et al., 1999). Nonspecific N1 decrements generalised across stimuli conditions also suggested learning transfer between differentially oriented stimuli (Ding et al., 2003; Song et al., 2007). Furthermore, Song et al. (2007) also reported larger orientation specific P3 amplitudes following VPL. The component, which peaks around 300 to 400 ms after stimulus onset, was proposed to reflect enhanced confidence following training (Song et al., 2007; Wilkinson & Seales, 1978). Alternatively, target P3 amplitudes have been associated with the allocation of resources for encoding and categorisation, whereby larger amplitudes indicate a greater distribution of resources for difficult stimuli (Goto et al., 2010;

Johnson, 1988; Lewis et al., 2008). Evidently, ERPs are robust indices of the neural processes underlying VPL (Meaux et al., 2014).

ERPs have been also used to ascertain the stages of information processing influenced by culture (Lewis et al., 2008). For instance, cultural differences have been observed at relatively early stages of the perceptual processing stream as reflected in the P1 ERP component (Kitayama & Murata, 2013; Lao et al., 2013; Lin et al., 2008; Petrova et al., 2013). Differences in the P1 component suggest that cultural influences operate on stimulus-driven attentional processes or low-level perceptual processing streams (Kitayama & Murata, 2013). Indeed, the differences observed in the early stages of processing indicate that individuals from different cultures fundamentally perceive the world in different ways. However, contradictory evidence argues that cultural influences manifest in later rather than earlier stages of perceptual processing as reflected in the P3 and N400 ERP components (Goto et al., 2010; Lewis et al., 2008; Na & Kitayama, 2011). Later stage cognitive processing reflects a selective control of attention, whereby cultural influences may induce greater demands for sustained attentional control in tasks that deviate from people's dominant processing styles (Hedden et al., 2008). Cumulatively, these findings provide important evidence on the time course of processing strategies that differ between cultures. Since attentional modulation is linked to perceptual learning processes (Gilbert et al., 2001), the studies presented above are thus important precedents for an examination into the neural processes underlying cultural differences in VPL. Specifically, the ERP components identified could reveal the stages at which culturally influenced neural activity may manifest when people of different cultural backgrounds initially perceive stimuli and subsequently make perceptual judgements (Kitayama & Murata, 2013; Lewis et al., 2008; Rule et al., 2013).

Research examining the behavioural characteristics of VPL and its corresponding neural mechanisms provide an insight into the physiological changes that may arise due to perceptual plasticity in response to different sociocultural environments (Knyazev et al., 2018). Using an EEG-fMRI paradigm for the Glass (1969) pattern discrimination task, Mayhew et al. (2012) identified two distinct task-relevant temporal components resulting from behavioural improvements after training at 105 ± 16.1 ms poststimulus and 242 ± 19.2 ms poststimulus. These components are of interest as they reflect distinct processes whereby differential responses to global forms at the earlier latencies has been linked to visual form integration, while later latencies around the second component have been associated with perceptual classification judgements (Das et al., 2010; Johnson & Olshausen, 2003; Ohla et al., 2005; Tanskanen et al., 2008). Interestingly, these temporal components can also be mapped to the N1 and P3 components that reflect cultural differences in attentional processes (Goto et al., 2010; Lao et al., 2013; Lewis et al., 2008; Lin et al., 2008; Song et al., 2007). Therefore, the temporal components identified at early and later stages of global form processing following VPL in the Glass (1969) pattern discrimination task (Mayhew et al., 2012), as well as the implication of cultural influences in early (Kitayama & Murata, 2013) and later attentional mechanisms (Goto et al., 2010; Lewis et al., 2008) suggest a need to unify these findings. Therefore, EEG measures could reveal important evidence of how culture could act upon the earlier or later perceptual systems to impact VPL processes.

Due to the complexity and dynamicity of culture and its impact on sociocultural environments and human psychological processes, there is great theoretical interest in exploring the attitudes and behaviours that arise as a function of both individual and cultural differences. Indeed, cultural environments contribute to variations in information processing and attentional styles, as evident in the global (holistic) and local (analytic) processing biases that are prominent in Eastern and Western cultures (Chua et al., 2005; Gutchess et al., 2006; Kitayama et al., 2003; McKone et al., 2010; Nisbett et al., 2001; Nisbett & Masuda, 2003). Consequently, VPL processes can also be informed by people’s preferred or dominant perceptual and attentional strategies. Furthermore, since there are inconsistencies in the cultural characteristics used to explain the dynamic differences in cognition and behaviours (van Gog & Scheiter, 2010), it is important to employ a multilevel framework within the context of VPL to contribute new evidence and reconcile inconsistent findings. Neuroscientific research could also provide supplementary evidence at the neural level of how cultural influences may emerge (Ambady & Bharucha, 2009; Chiao, 2018; Gutchess et al., 2006; Han & Ma, 2014; Jenkins et al., 2010; Kwon et al., 2021; Rule et al., 2013).

1.4 Summary and Frame of Thesis

To summarise, culture can be conceptualised and differentiated by macro and micro constructs to explain the cognitive and behavioural differences that manifest across nations, societies, and individuals. At the macro level, cultural definitions are moving beyond geographical classifications based on country boundaries as they may discount the numerous interacting factors that contribute to cultural systems (Khan et al., 2017). Instead, Hofstede's (1980, 2001, 2011) national cultural index have been used as an alternative representation of the macro level since it encompasses institutional value systems, societal constructs, and interaction patterns (Khan et al., 2017; Kim & Sasaki, 2014). Indeed, the explication of the individualism and collectivism constructs have propelled research to explain the universality and differences in psychological processes that arise as a function of culture (Gelfand et al., 2017). For example, research has linked the individualism-collectivism dimensions to sociocultural orientations and cognitive styles (e.g., Choi et al., 2007; Koo et al., 2018; Masuda et al., 2008; Na et al., 2020; Nisbett et al., 2001; Oyserman et al., 2002; Oyserman & Lee, 2008; Senzaki et al., 2014; Yu et al., 2021).

People from Western or individualistic cultures are typically characterised at the micro level by independent self-construals, individualist orientations, and analytic cognitive styles (Choi et al., 2007; Cramer et al., 2016; Koo et al., 2018; Markus & Kitayama, 1991). In contrast, people from Asian or collectivistic cultures are typically characterised by interdependent self-construal, collectivist orientations, and holistic cognitive styles. However, although cultural groups can be differentiated by social orientation and cognitive styles, these attributes may not necessarily correlate at the individual level (Kitayama et al., 2009, 2019; Martin et al., 2019; Na et al., 2010, 2020). For instance, the multiplicity of cultural identities presents a methodological issue as individuals who embody multiple cultural values can create an error variance in macro level definitions (Hong et al., 2000). Therefore, research should explore the influence of culture on cognition using a dynamic multilevel framework consisting of both micro and macro levels. It is also important to overcome the typical convention of using geographical classifications, two-country comparisons, and single levels of analysis at only the macro or macro level in order to advance our understanding of cross-cultural differences in psychological processes such as VPL (Boer et al., 2018; Lawrence et al., 2020; Varnum et al., 2008).

Extensive research evidence has attributed the various individual (micro) and group (macro) cultural characteristics described above to cross-cultural differences in attentional styles and perceptual strategies (e.g., Choi et al., 2007; Kanagawa et al., 2001; Koo et al., 2018; Masuda et al., 2008; Senzaki et al., 2014; Singelis, 1994; Varnum et al., 2008; Yu et al., 2021). Indeed, sensitivity to global or local structures during perceptual organisation are proposed to be shaped by experience, culture, and genetics (e.g., Caparos et al., 2012; Davidoff et al., 2008; De-Wit, & Wagemans, 2015; Van Der Hallen et al., 2015). Variations in how global representations are constructed during perception due to cultural differences are significant as these differences could subsequently inform VPL trajectories (Choi et al., 2007; Koo et al., 2018). However, some studies have reported weak or absent cultural effects on attention and perception (Evans et al., 2009; Hakim et al., 2017; Miellet et al., 2010; Rayner et al., 2007). For example, while some have identified that Americans had greater tendencies to fixate on focal objects than Chinese participants who made more saccades towards background information (Chua et al., 2005; Goh et al., 2009), others have reported insignificant differences between both cultures in eye-movement and gaze strategies (Evans et al., 2009; Lawrence et al., 2020). It is estimated that cultural characteristics other than participants' nationalities could influence perceptual and attentional strategies, hence the importance of considering micro levels of analysis to reconcile the contradictory evidence in previous research.

Inconsistencies in past research could also be attributed to cultural manifestations which are task dependent (Alotaibi et al., 2017). For instance, rich visual scenes could undermine the subtle differences that exist across cultures. Indeed, the use of simpler stimuli such as geometric figures has presented evidence of cultural differences (Cramer et al., 2016; Lao et al., 2013; Petrova et al., 2013; Ueda et al., 2018). Alternatively, cultural influences may only implicate cognitive processes under specific task conditions or even specific processing stages during visual perception as revealed by EEG and ERP studies (Lewis et al., 2008). Therefore, the tasks and methodology employed in cross-cultural research should be carefully designed to measure and isolate the different components of attention and perception to attribute them to specific cultural constructs.

Collectively, some limitations need to be addressed at the conceptual level to advance cross-cultural research on cognition and behaviour (Caprar et al., 2015). First, taking into consideration the role of individuals when defining culture, as well as understanding the role of macro cultures in defining the individual, will be critical for obtaining a clear visualisation of the dynamic and multilevel nature of cultural systems (Autio et al., 2013; Steel & Taras, 2010). Therefore, the direct assessment of cultural constructs at an individual level circumvents the limitations of macro level distinctions such as geographical or national level classifications. Second, culture is not always explicitly revealed through verbal or written expression (stated culture) as reflected in survey or questionnaire responses. As such, behavioural and neural indicators are needed to reveal latent cultural dimensions. Accounting for both latent and stated culture in research could provide a more comprehensive reflection of cultural influences on psychological processes. Third, it is difficult to conceptualise culture when individuals could embody the attributes of multiple cultural systems, many of which are latent and implicit. Situational or contextual factors could trigger the manifestation of these latent structures in behaviours (Hong et al., 2000), hence the importance of careful task selection and methodological design (i.e., priming techniques and neuroscientific methods) in cross-cultural research. Taken together, the inconsistencies in defining, measuring, and conceptualising culture in previous literature warrants further research to establish a dynamic and multilevel framework of culture that can explain differences in VPL. Specifically, these considerations will be essential for examining the VPL processes implicated by cultural influences at both micro and macro levels. Indeed, the limited research in this domain presents an opportunity to examine how individualism-collectivism, independent-interdependent, and analytic-holistic cultural constructs could impact the differentiation and unitisation mechanisms of VPL.

1.4.1 Overarching Aim

The overarching aim of this thesis is to identify if there is variability in VPL processes across cultures. Specifically, a multilevel approach will be used to explain how interacting cultural factors at macro and micro levels can influence the differentiation and unitisation mechanisms of VPL in global tasks. The individualism-collectivism construct (Hofstede, 1980, 2001, 2011) will be the central construct representing cultural systems at the macro level. At the micro level, culture will be represented by independent-interdependent self-construals (Markus & Kitayama, 1991), individualistic and collectivistic cultural orientations (Triandis, 1995; Triandis, 2001), and analytic-holistic thinking styles (Choi et al., 2007; Koo et al., 2018). These cultural characteristics will be used as explanatory variables for differences in perceptual strategies that inform VPL processes.

The divergent results within cross-cultural domains can be linked to differences in research methodology, population sample, and conceptual frameworks. Therefore, to narrow the focus of the investigation, the present study concentrates on the potential impact of global processing mechanisms as the first step towards examining cultural differences in VPL. Consistent with the GPE, people have a cognitive disposition to allocate processing priority to global information (Mills & Dodd, 2014; Navon, 1981; Rezvani et al., 2020). Consequently, the manifestation of any cultural differences in VPL despite the GPE will provide considerable evidence of the dominant influence of culture on information processing (Goh et al., 2013; Hedden et al., 2008).

To this end, the present thesis has adapted the Glass (1969) pattern discrimination task and a symbol sequence learning task to investigate VPL differences within a cross-cultural context

(Frangou et al., 2019; Garcia et al., 2013; Li et al., 2012; Mayhew et al., 2012; Wang et al., 2017). These tasks compel observers to engage in global processing during VPL and can be used to investigate the differentiation and unitisation mechanisms of VPL (Goldstone, 1998, 2000). The cultural differences observed in both tasks will demonstrate the influence of culture within various contexts and task domains. As discussed above, individualistic or Western cultures and individual-level characteristics such as independence have been linked to analytic thinking styles. Therefore, it is hypothesised that these cultural characteristics could be associated with slower VPL trajectories compared to people from collectivistic or Asian societies and more interdependent individuals. Collectivism and interdependent self-construals are cultural characteristics linked to more holistic thinking styles (Ji et al., 2000; Peng & Nisbett, 1999). As such, these holistic tendencies could support faster VPL trajectories in both tasks that engage global processing. The Glass (1969) pattern discrimination task and the sequence learning task will be detailed in Chapters 3 and 5.

As a general format, the five subsequent chapters will introduce key literature justifying each chapter's research aims, followed by the methods, results, and discussions. The present thesis will begin with a preliminary exploration into the utility of existing measures that can capture and differentiate cultural values and attitudes at the macro (group) and micro (individual) levels (Chapter 2). Following this, the Glass (1969) pattern discrimination task will be used to investigate cultural differences in VPL during differentiation, whereby people from different cultural backgrounds learn to discriminate global patterns despite perceptual uncertainty (Chapter 3). A priming methodology will then be employed to causally examine the impact of social orientations on VPL (Chapter 4). Chapter 4 investigates the dynamic nature of the multilevel cultural framework and highlights the importance of considering micro level cultural characteristics. Following this, the present thesis extends the cross-cultural investigation into the unitisation mechanism of VPL using a sequence learning task (Chapter 5). The subsequent chapter presents a series of three mini pilot studies with varying tasks parameters to identify the persistence of culturally induced perceptual bias on VPL despite increased perceptual uncertainty (Chapter 6). Notably, Chapter 6 explores the feasibility of an EEG experimental design to examine cultural differences in VPL using the Glass (1969) pattern discrimination task. Finally, a critical summary of the experimental findings and future directions will be presented in the concluding chapter of the thesis (Chapter 7).

1.4.2 Importance of Research

A complex combination and interaction of historical, economic, ecological, and ideological factors shape the cultural meanings and practices across and within nations (Gelfand et al., 2017; Kitayama et al., 2019). Consequently, the conceptualisation of culture as a multilevel knowledge structure could reveal its extensive influence on attitudes, norms, values, beliefs, and behaviours. Furthermore, as societies become globalised and industrialised, people may become more analytic due to increased independence and individual initiative, subsequently influencing learning and perceptual strategies. Therefore, considering the dynamic multilevel nature of culture is increasingly relevant in our multicultural societies (Luo, 2016), particular within VPL domains (Atkins et al., 2016). Cultural differences in VPL remain a relatively unexplored domain despite the recognition of how exposure to different cultural beliefs and social milieus can guide cognition and behaviours (Park & Huang, 2010). Indeed, cultural systems can shape the configuration of learning patterns and abilities that differentiate students' academic performance in diverse educational environments (Martínez-Fernández & Vermunt, 2015). It is thus important to further our understanding of the dynamic cognitive, metacognitive, cultural, and contextual components that gives rise to differential learning patterns and strategies (Martínez-Fernández, & Vermunt, 2015). Research in this domain can be applied to a broad range of visual training paradigms that have both general and cross-cultural applications (Bower et al., 2013; DeLoss et al., 2015; Deveau et al., 2014a, 2014b; Lu et al., 2011; Polat, 2009; Zhang et al., 2014; see Section 7.3).

Chapter 2: Defining a Multilevel Cultural Framework

As discussed in Chapter 1, there are many ways to define culture (Erez & Gati, 2004; Hofstede, 1980, 2001; Taras et al., 2010, 2016). Therefore, Chapter 2 presents a methodological examination into existing measures and definitions of cultural systems. The findings reported in this chapter aimed to establish an explanatory framework for the subsequent experimental chapters in the thesis (Chapters 3 to 5). Indeed, the outcomes of this chapter were used to define a multilevel cultural framework encompassing both macro and micro levels of culture that can explain cultural differences in VPL processes. It is important to consider both the macro and micro levels of culture as part of a multilevel framework as each level may differentially impact cognition and behaviour (Erez & Gati, 2004; Kashima et al., 2019; Steel & Taras, 2010). Therefore, the macro level cultural constructs examined in the present study are geographical distinctions and Hofstede's (1980, 2001, 2011, 2017) individualism-collectivism dimensions. The micro level was defined by individual characteristics such as cultural orientations (Triandis & Gelfand, 1998), self-construal (Singelis, 1994), and thinking styles (Choi et al., 2007). This chapter will begin with a review of the fundamentals of a multilevel cultural framework, followed by the aims, design, and methodology of the study presented here. Results are reported and discussed in the final section.

2.1 Background

The conceptualisation and operationalisation of culture at both the macro and micro levels reflect the diversity and variability in which cultural differences can be defined and understood (Goodwin et al., 2020; Gould & Grein, 2009; Leung et al., 2011, 2005). At the macro level, the use of country of origin as a proxy for culture in cross-cultural research remains widely accepted despite presenting methodological limitations (Van De Vijver & Leung, 2000). Besides geographical distinctions, Hofstede's national culture distinctions across six dimensions can also be used as a macro level descriptor (Hofstede, 2001, 2011, 2017; Hofstede & Minkov, 2010). Indeed, the use of aggregated constructs like the individualism-collectivism dimension to characterise a nation is advantageous as it describes the maintenance and relative stability of shared cultural knowledge, value systems, societal constructs, and interactional patterns (Beugelsdijk & Welzel, 2018; Khan et al., 2017; Kim & Sasaki, 2014; Lehman et al., 2004; Schimmack et al., 2005). It can thus be used to represent theoretical and empirical frameworks for cross-cultural psychological research beyond geographical boundaries and distinctions.

As discussed in Chapter 1, the use of geographical distinctions and the individualism-collectivism dimension is not without limitations and criticisms. The constructs have been challenged for oversimplifying cross-cultural differences, neglecting within-country heterogeneity, and for the static conceptualisation of culture (Beugelsdijk & Welzel, 2018; Goodwin et al., 2020; Kirkman et al., 2006, 2017; Oyserman et al., 2002; Steel & Taras, 2010; Taras et al., 2016). The rise of media globalisation, internationalisation of educational systems, migration and open borders, and the convenience of worldwide communications has created more global communities with shared knowledge, values, and ideologies (Caprar et al., 2015). Therefore, nations, societies, communities, and individuals worldwide have been unified and divided in ways that may no longer be fully captured by geographical distinctions or Hofstede's national dimensions (Steel & Taras, 2010). For example, widespread immigration, increases in wealth, and technological advancements have been observed to drive individualism within typically collectivistic cultures (Greenfield, 2009; Hamamura, 2012; Inglehart & Baker, 2000; Zhou et al., 2018), while cultural orientations can also differ across individuals and generations (Cohen, 2009; Ma et al., 2016; Parry & Urwin, 2011). Clearly, cultural orientations within a nation can be shaped by dynamic and interactive factors such as individuality, ethnicity, religiosity, political, social, and socioeconomic influences (Chao & Moon, 2005; Heiphetz & Oishi, 2022; Miyamoto et al., 2018; Taras et al., 2016). As such, it is vital to consider individual-level variances within a collective since mere ethnic- or country-level classifications could neglect individual level differences in our understanding of culture and its influence on cognition and behaviours (Gelfand et al., 2011; Hofstede, 2011).

Micro systems also contribute to the complexity of culture at an elementary level (Steel & Taras, 2010), and its influence on cognitive and behavioural processes have been reported in previous cross-cultural research (Goh et al., 2007; Kraus & Kitayama, 2019; Magid et al., 2017). Therefore, the direct assessment of cultural constructs at an individual level can be used to circumvent the limitations of macro level distinctions such as geographical or national level classifications. For instance, Hofstede's (1980) individualism-collectivism constructs at an individual level can be represented by independent self-construals or individualistic self-concepts (Fiske et al., 1998; Oyserman & Markus, 1993; Triandis, 1996). Another consequence of individualism can be related to judgment, reasoning, and inferences that are attributed to individual personalities and traits (Morris & Peng, 1994; Na et al., 2020; Triandis, 2001). Thus, individual-level variances could be assessed by these culturally specific manifestations of cognition and behaviour to demonstrate how different levels of culture can interact in a complex and reciprocal manner. Indeed, to account for within-country variances, social and cultural orientations, as well as cognitive styles have been used as cultural descriptors at the micro individual level (Chao & Moon, 2005; Choi et al., 2007; Koo et al., 2018; Singelis, 1994; Triandis & Gelfand, 1998; Uskul, Nisbett, et al., 2008; Vignoles et al., 2016). It is important to consider the intersectionality of these individual level differences as they can supplement traditional macro level conceptualisations of culture (Boer et al., 2018; Clauss-Ehlers et al., 2019; Vignoles et al., 2016).

Cultural systems at the micro level can be measured using scales and questionnaires to assess the attitudes and behavioural intentions of individuals from different cultural backgrounds (Choi et al., 2007; Markus & Kitayama, 1991, 2010; Singelis, 1994; Triandis, 1989; Triandis & Gelfand, 1998; Varnum et al., 2010; Vignoles et al., 2016). For one, social orientations can be assessed by Singelis' (1994) self-construal scale (SCS). Social orientations describe the variations in self-perceptions in relation to others, and these perceptions are represented by independent and interdependent self-construals (Markus & Kitayama, 1991; Wang et al., 2017). Independent self-construals have been linked to autonomy and individualistic orientations, whereas interdependent self-construals are associated with an emphasis on collectivistic orientations and interrelatedness with others (Varnum et al., 2010). Furthermore, individuals with interdependent self-construal are also more likely to exhibit holistic cognitive styles as interdependence encourages attention to the broader context (e.g., Choi et al., 2016). However, the efficacy and validity of Singelis' (1994) SCS have been inconsistent across studies (Dowd & Artistico, 2016; Gudykunst & Lee, 2003; Hardin et al., 2004). Levine et al. (2003) found persistent flaws in the SCS due to its insensitivity in identifying cultural differences in self-construals. Therefore, constructs such as cultural orientation and cognitive styles, as measured on Triandis and Gelfand's (1998) Cultural Orientations Scale (COS) and Choi et al.'s (2007) Analysis-Holism scale, respectively, were proposed as alternatives for conceptualising culture at the micro level.

Triandis and Gelfand's (1998) COS is a compelling measure contributing to individual-level cultural analyses. It illustrates the extent to which individuals can be integrated into groups based on a horizontal or vertical differentiation on the individualism-collectivism dimensions (Shavitt & Cho, 2016). The horizontal and vertical dimensions of individualism and collectivism describe hierarchical and power structure differences within a society (Singelis et al., 1995). Individuals can be categorised into four dimensions on the COS: HI, VI, HC and VC (see Figure 1.1). The HI dimension has been related to self-direction and self-reliance, while VI relates to autonomous power, competition, and the pursuit of greater social standings within a hierarchy (Nelson & Shavitt, 2002; Oishi et al., 1998; Torelli & Shavitt, 2010). For the collectivism dimension, HC is predictive of benevolence, sociability, and cooperation, while VC best predicts conformity tendencies within a hierarchical society (Soh & Leong, 2002). Collectively, horizontal and vertical differentiations provide a broader view of culture beyond the individualism-collectivism national distinctions to allow more universal predictions of cultural differences, especially at an individual level (Shavitt & Cho, 2016). Indeed, the COS could be used to assess adherence to cultural orientations and supplement macro level differentiations to explain observed cross-cultural differences in cognition and behaviours.

To further expand on the micro level cultural conceptualisations, cognitive style variations could be used to represent a different facet of culture at the individual level – namely, one that describes common thought processes (Choi et al., 2007; Koo et al., 2018; Na et al., 2020; Uskul et al., 2008). Analytic thinking is characterised by an inclination to allocate attentional resources to focal objects or events. In contrast, holistic thinking is associated with a more diffused allocation of attentional resources to both focal and contextual information. These alternative frameworks for conceptualising cultures at the micro individual level have become pivotal in cross-cultural research (Na et al., 2020). Indeed, the AHS differentiates holistic tendencies on four dimensions: causal attributions, perceptions of change, locus of attention, and attitude towards contradictions (Choi et al., 2007; Koo et al., 2018). Notably, analytic and holistic cognitive styles have been linked to independence and interdependence, respectively, as well as the individualism-collectivism constructs (Koo et al., 2018; Masuda et al., 2008; Na et al., 2020; Nisbett et al., 2001; Oyserman et al., 2002; Oyserman & Lee, 2008; Senzaki et al., 2014; Yu et al., 2021). The reciprocal relationship between these cultural constructs allows researchers to integrate the attributes of individual members within a society to establish a collection of characteristics representing the group (Boer et al., 2018; Fischer, 2009; Goodwin et al., 2020; Tsui et al., 2007). Accordingly, the utility of the AHS, like the COS and SCS, can be adapted to varying research aims and objectives to conceptualise or differentiate cultures and individuals based on social orientation, cultural orientation, and cognitive style differences (Martín-Fernández et al., 2022).

Accounting for both individual and collective level constructs to describe and conceptualise culture would address the limitations of using only single units of analysis (Fischer, 2009). Focusing solely on the individual neglects the complex outcomes of group interactions and increasingly diverse and globalised societies. Furthermore, existing individual level measures (e.g., AHS, SCS, COS) have been criticised for inconsistent validity and reliability (Dowd & Artistico, 2016; Hardin et al., 2004; Levine et al., 2003), particularly when employed in demographically complex populations (Han et al., 2019). For instance, even micro characteristics such as living arrangements could influence how strongly one adheres to the cultural values prevalent in their societies and nation (Brewer & Venaik, 2011; Heu et al., 2019; Vandello & Cohen, 1999). Multilevel analyses, poly-contextual approaches, and the consideration of intracultural variations should thus be used as a standard protocol within cross-cultural research (Morris et al., 2015; Simko & Olick, 2021; Tsui et al., 2007). Indeed, this multilevel approach has been further advocated by different researchers (Boer et al., 2018; Brewer & Venaik, 2011, 2012; Chen et al., 2020; Goodwin et al., 2020; Oyserman et al., 2002; Steel & Taras, 2010; Van De Vijver & Leung, 2000; Vignoles et al., 2016).

A stringent methodology and analysis strategy is needed to implement a multilevel framework of culture for explaining cultural differences in psychological processes (Boer et al., 2018; Han et al., 2019; Na et al., 2020; Schimmack et al., 2005). For example, the assumption that individuals will have a similar understanding of the constructs described in different measures and scales neglects key cultural features such as linguistics, thereby contributing to a lack of measurement comparability and equivalence (Boer et al., 2018; Han et al., 2019). This measurement bias and lack of equivalence could result in overgeneralisations and inconsistent research findings. Therefore, examining and establishing measurement equivalence is essential for drawing valid and meaningful cross-cultural comparisons at the macro and micro levels. Psychometric property analysis strategies including exploratory factor analyses (EFA) can be used to establish cross-national measurement equivalence when individual-level measures are administered to culturally diverse groups (Boer et al., 2018; Han et al., 2019; Na et al., 2020). Establishing measurement equivalence will subsequently allow the clearer attributions of observed cross-cultural differences in cognition and behaviour to specific cultural constructs rather than to differential comprehension of the cultural measures used (Boer et al., 2018).

2.1.1 Aims of Study

The present study seeks to conceptualise a multilevel framework that can inform how culture will be defined and assessed in the present thesis. The exploratory examination of a multilevel framework in this chapter could subsequently be used to establish more robust methods of analysis and drive the interpretation of behavioural findings within the context of culture to minimise type 1 errors (false positives) in comparative research. To this end, three existing micro-level measures (COS, AHS, and SCS) are administered to participants from different cultural backgrounds to establish a multilevel cultural framework consisting of both macro (group) and micro (individual) level features. Specifically, Triandis and Gelfand's (1998) COS, Choi et al.'s (2007) AHS, as well as Singelis' (1994) SCS will be used as the micro individual level cultural representations in addition to demographics variables such as ethnicity, language, living arrangements. Cultural groups at the macro level will be defined by geographical distinctions (Asian vs Western regions) and Hofstede's (1980, 2001) individualism-collectivism dimension. The individualism-collectivism level distinction was specifically derived from Hofstede's (2017) country comparison tool that provides detailed insight into the shared value dimensions of different nations. When used to make cross-cultural comparisons of cognition and behaviour, there should be a clear measurement equivalence in the administered measures. Indeed, the operationalisation and measurement of cultural characteristics should be standardised and relevant across groups to circumvent issues of bias and equivalence (Han et al., 2019). Metric equivalence should thus be examined to determine whether different cultural measures perform similar functions across samples, where the items in the assessed construct should exhibit similar factor loadings across groups defined at a macro level (He & van de Vijver, 2012; van de Vijver & Leung, 2021). These cultural constructs can then be used to explain observed cross-cultural differences in cognition and behaviour. Overall, the present study aims to explore and examine the following hypotheses (H):

H1. The reliabilities of the COS, SCS, and AHS are within acceptable levels, and the factor structures of each scale are consistent with the dimensions they were originally designed to assess (Choi et al., Triandis & Gelfand, 1998; Singelis, 1994).

H2a. The COS, SCS, and AHS factor structures should be comparable and equivalent between groups defined by geographical regions at the macro level (Asia vs West).

H2b. The factor structures of the COS, SCS, and AHS should be comparable between groups defined by Hofstede's (2017) individualism-collectivism dimensions at the macro level (Individualistic vs Collectivistic).

H3. Living arrangements, time lived elsewhere, ethnicity, and background can influence how strongly one adheres to the cultural values prevalent in their sociocultural environment.

H4. To assess concurrent and predictive validity, respondents who are more collectivistic and hold interdependent self-construal as measured using the COS and SCS respectively should exhibit higher holism scores on the AHS than respondents who are individualistic and hold independent self-construal.

The outcomes of the present chapter inform the macro and micro level features of the multilevel cultural framework that can explain the behavioural findings observed in the subsequent experimental chapters of this thesis.

2.2 Method

2.2.1 Participants

Respondents for the survey were recruited through opportunity sampling. A link to the survey was advertised on social media platforms (e.g., Facebook and Twitter) and on Birmingham City University's Research Participation Scheme (RPS). Those who participated through the RPS were rewarded with research credits. A total of 392 respondents completed the initial demographics section of the questionnaire. Four respondents were excluded for being under the age of 18 when completing the questionnaire. Seventeen respondents were excluded due to response bias following a visual inspection of the data. For example, participants who responded with the same answer for all items on the questionnaire were omitted. Row-wise standard deviation was also calculated to verify the exclusion of these cases. On each scale, standard deviations close to zero suggest careless responses or a lack of engagement (Panda et al., 2021).

Table 2.1

Demographics of Respondents

Variables	Frequency
Gender	
Female	278
Male	90
Other	3
Living Arrangements	
Alone	78
Significant Others	191
Housemates	102
Lived Elsewhere	
Yes	193
No	177
Prefer not to say	1
Ethnicity	
White	143
Black	11
Asian	168
Mixed	14
Other	35

The remaining 371 respondents were an average of 24.74 years old (*SD* = 5.88). Of these respondents, 363 completed Triandis and Gelfand's (1998) cultural orientation scale, 363 completed Singelis' (1994) self-construal scale, and 351 completed Choi et al.'s (2001) analysis-holism scale. Table 2.1 provides a demographics summary of respondents. For ethnic backgrounds, 'white' ethnicity included those of British, European, and Irish descent, 'black' ethnicity included those of the Caribbean and African descent, 'Asian' ethnicity included those of Indian, Pakistani, Bangladeshi, Chinese, and Filipino descent, 'mixed' ethnicity included those of mixed black and white descent as well as white and Asian descent, while the 'other' category included those of Arab, Kurdish, Hispanic, and Latino descent as well as those who refrained from answering the question.

Respondents were first categorised into 'Asian', 'Western', or 'Other' cultural backgrounds based on their self-reported nationalities (see Table 2.2). The Asian and Western geographic regions were defined by the United Nations standard country or area codes for statistical convenience (United Nations Statistics Division, 2016). As such, the Asian category included respondents from Malaysia, China, India, Taiwan, Vietnam, Thailand, Pakistan, Singapore, Philippines, Indonesia, Japan, Korea, Hong Kong, Myanmar, Sri Lanka, Cyprus (Western Asia), Jordan (Western Asia), Lebanon (Western Asia), and two whom were of unspecified Asian nationality. Western respondents were from Europe (Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russia, Spain, Sweden, and Switzerland), the Americas (USA, Latin America, and Canada), and Oceania (Australia and New Zealand).

The 'Other' category consisted of respondents (n = 19) who did not fall under categories of Western or Asian countries. Respondents grouped into this category were from Kenya, Egypt, and South Africa. This category also included individuals who could not be classified based on their self-reported demographics. For instance, one respondent was a white European born in Singapore, holding British and German nationalities, and had lived in India, New Zealand, and France for 11 years, eight years and seven months, respectively. Therefore, respondents who did not indicate their nationalities, had dual nationalities from a combination of Asian and Western countries, or reported substantial variances between their nationalities, place of birth, and years lived in a different country were classified under the 'Other' category (see Appendix C for a detailed breakdown of participant characteristics). The data of participants in the 'Other' category were excluded from the analyses where cultural groups were differentiated based on geographical regions at the macro level.

Table 2.2

Respondents Categorised by Geographical Regions

Cultural Background	N	Percentage (%)
Asian	144	38.8
Western	208	56.1
Other	19	5.1

Hofstede's individualism-collectivism constructs (Hofstede, 2001, 2011; Hofstede & Minkov, 2010) were used as the second macro level differentiation alongside geographical distinctions. Hofstede's (2017) comparison tool assigns an individualism score to countries. Therefore, the respondents in the present study could be classed as individualistic or collectivistic based on their self-reported nationalities. Based on this classification system, each category's sample sizes were more comparable than the geographical classification system (see Table 2.3).

Table 2.3

Respondents Categorised by the Hofstede's (2017) Individualism-Collectivism Dimension

Hofstede's Category	N	Percentage (%)
Individualistic	186	50.1
Collectivistic	172	46.4
Unavailable	13	3.5

One respondent from Cyprus and one from Myanmar were excluded from this analysis as these countries were not assigned a score on Hofstede's (2017) comparison tool. The comparison tool also reported intermediate individualism scores for Japan (46 out of 100) and India (48 out of 100). While these countries are traditionally collectivistic in maintaining group harmony, Japan is also represented by situational individualistic characteristics within workplaces, while India's dominant religion of Hinduism has been attributed to individualistic traits (Hofstede, 2017). Nevertheless, these countries were categorised as collectivistic in the present analysis as their individualistic scores were below the midpoint mark of the individualism dimension.

2.2.2 Design

The present study employed a between-subjects design comparing measurement equivalence of three existing cultural instruments when completed by people from different cultural backgrounds. At the macro level, cultural background was defined by geographical regions (Asians vs Westerners) and Hofstede's (2017) national classification tool (individualism vs collectivism). At the micro level, the cultural instruments used to assess individual level variations in cultural values were Triandis and Gelfand's (1998) COS, Singelis' (1994) SCS, and Choi et al.'s (2007) AHS. Comparing the responses of participants from different cultural backgrounds can reveal the validity and reliability of these instruments in differentiating cultures based on values of individualism, independence, and analytic thinking versus values of collectivism, interdependence, and holistic thinking. Previous studies have observed clear variations between Asian and Western cultures in these values; Asians tend to be more collectivistic, interdependent, and holistic, whereas Westerners tend to be more individualistic, independent, and analytic (Choi et al., 2007; Uskul et al., 2008; Talhelm et al., 2014; Masuda & Nisbett, 2006; Senzaki et al., 2014; Masuda et al., 2008; Nisbett et al., 2001). Additionally, due to the complexity of culture, factors such as age, gender, living arrangement, ethnicity, length of time spent outside of birthplace will also be considered as possible explanatory constructs for predicting cultural variations. Taken together, the independent variables for this exploratory study are cultural background (defined by Asian vs Western geographical regions and individualistic vs collectivistic cultures). The effects of age, gender, living arrangement, ethnicity, and length of time spent outside of birthplace will also be examined. The dependent variables are cultural orientations, self-construal, and cognitive styles as measured by the COS, SCS and AHS.

2.2.3 Materials

Participant Demographics. This questionnaire collected demographic information such as nationality, gender, age, ethnicity, birthplace, living arrangements, and years lived in the UK (Yeh, 2003; see Appendix D). Participants were assigned to the corresponding cultural backgrounds based on their nationalities. Furthermore, the information provided in this questionnaire were analysed in the regression analyses to account for the influence of these confounding variables on social and cultural orientations.

Triandis and Gelfand's (1998) COS. The 16-item COS (see Appendix E) assessed individualism and collectivism on four dimensions: VI (acceptance of inequality between individuals), VC (acceptance of hierarchies within collective societies), HI (equality between individuals), and HC (equality within the collective society). The COS consisted of items such as "I'd rather depend on myself than others", which measured HI; "Winning is everything", which measured VI; "I feel good when I cooperate with others", which measured HC; and "Parents and children must stay together as much as possible", which measured VC. Participants indicated their responses on 9-point Likert scales ranging from 1 (Never or Definitely No) to 9 (Always or Definitely Yes). Scores were calculated for each of the four dimensions by summing up the responses on each subscale. Participants were grouped into the HI, VI, HC, or VC dimensions depending on their highest scores on the subscales. As more than 10% of the respondents (n = 40) could not be categorised due to similar scores on more than one subscale, separate scores were also calculated for an individualism and collectivism dimension by summing up the HI and VI subscales as well as the HC and VC subscales, respectively. Uncategorised respondents following the aggregated scoring procedure was reduced to 3% (n = 9).

Singelis (1994) SCS. The 24-item SCS (see Appendix F) was used to identify the self-construal and social orientations of individuals from different cultural groups. The SCS consisted of items that measured participants' independent self-construal (e.g., "I enjoy being unique and different from others in many respects") and interdependent self-construal (e.g., "I have respect for the authority figures with whom I interact"). Responses were measured on 7-point Likert scales ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). Scores were calculated by summing up the responses and dividing the sum by the number of questions in each subscale. Each participant had two scores and was assigned with independent or interdependent self-construal depending on the higher score. Approximately 3% of respondents (n = 9) had equal scores on both subscales in this measure.

Choi et al.'s (2007) AHS. The AHS (see Appendix G) is a 24-item measurement tool used to assess analytic or holistic modes of thought on four dimensions: locus of attention, causal perception, perception of change, and attitude towards contradiction (Choi et al., 2007). The AHS measures individual differences in cognitive styles. Items such as "The whole is greater than the sum of its parts", assessed locus of attention; "Nothing is unrelated", assessed causality; "We should avoid going to extremes", assessed tolerance of contradiction; and "Current situations can change at any time", assessed change perceptions (Koo et al., 2018). Responses were measured on 7-point Likert scales ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). Six items on the AHS were reversed-coded before the composite scores were calculated. All items on the AHS were summed up to produce a composite holism score (Choi et al., 2007). Higher scores represent more holistic thinking styles. Specifically, higher holism scores indicate increased tendencies for attending to the whole rather than parts, attributing causality between events, perceiving future events as cyclic rather than linear, and compromising when faced with contradictions.

2.2.4 Procedure

The study was approved by Birmingham City University's Research Ethics Committee (Reference: Chua #011.18; See Appendix H1). The online questionnaire was administered through Qualtrics (Qualtrics, Provo, UT). The first section consisted of the information sheet (see Appendix I) and consent form (see Appendix J), the second section consisted of demographic questions, and the three subsequent sections were composed of the COS, SCS, and AHS measures that were presented in a randomised order. Respondents were directed to a debrief page upon the submitting their responses at the end of the study (see Appendix K). The questionnaire was also back translated to Mandarin Chinese by two unrelated bilingual individuals proficient in both languages to recruit a more diverse sample of respondents from Asian cultural backgrounds (See Appendix L). Thirty-four respondents completed the Mandarin Chinese version of the questionnaire, while the remainder completed the questionnaire in English (see Appendix M for Cronbach's reliabilities comparison). Respondents took an average of 25 minutes to complete the questionnaire.

2.2.5 Analysis

IBM SPSS Statistics, Version 25 (IBM, 2017) was used for data analysis. The data was analysed in 5 parts; the first was a reliability analysis to assess the internal consistency of the three cultural instruments. The reliabilities of these instruments were compared between Asian vs Western groups (geographical distinctions) and Hofstede's (2017) individualistic vs collectivistic groups. The second was a factor analysis using the principal axis factoring (PAF) extraction method to examine the construct validity of the three questionnaires (Tabachnick & Fidell, 2019; Yong & Pearce, 2013). The factor structures of each instrument were compared between cultural groups to establish measurement invariance and equivalence. The final analysis was a correlation and multiple regression analysis to identify the potential effect of demographic factors in predicting responses on the cultural instruments (AHS, COS, and SCS). Respondents were also categorised as either individualistic or collectivistic (COS) and independent or interdependent (SCS) based on their scores in each measure to allow for individual level classifications. All categorical variables examined in the regression analyses were first coded into dummy variables. A supplementary analysis comparing the questionnaire scores between groups defined by geographical boundaries and Hofstede's (2017) individualism-collectivism constructs have also been included in the appendices (see Appendix N). These exploratory analyses do not align with the objectives of Chapter 2, although they present some interesting insights into how the scores of each measure (COS, SCS, AHS) are represented in differentially defined population samples.

2.2.6 Ethical Considerations

Ethical approval was obtained from Birmingham City University's Research Ethics Committee (Reference: Chua #011.18; see Appendix H1). Respondents had to be above the age of 18 to provide informed consent for participating in the study. Respondents were asked to their own unique identity code that would allow them to remain anonymous and withdraw their data if they wished. The contact details of the research team and the research ethics committee was provided at the beginning and end of the study.

2.3 Results

2.3.1 Reliability Analysis

Cronbach's alphas (α) were calculated to assess the internal consistency and reliability of each instrument as well as its subscales.

COS. Cronbach's reliability for the overall scale was .703 (N = 363). Specifically, α values for the HI, VI, HC, or VC dimensions were .687, .707, .642, and .675, respectively. As mentioned above, separate scores were calculated for an individualism (sum of HI and VI) and collectivism (sum of HC and VC) dimension. The individualism dimension had a reliability of .732, while the collectivism dimension had a reliability of .733. Generally, the reliabilities on the HI, VI, HC, and VC were also comparable to previous findings (Germani et al., 2020, 2021; Li & Aksoy, 2007; Soh & Leong, 2002; Stavropoulos et al., 2020). Table 2.4 presents the reliabilities for the cultural groups distinguished by geographical regions and Hofstede's (1980, 2001) individualism-collectivism dimensions. A comparison between the two macro level distinctions revealed that the reliabilities for the COS was at an acceptable range when the individualistic-collectivistic constructs were used. In contrast, the reliabilities for the Western group were within a questionable range.

Table 2.4

Cronbach's Reliabilities of the COS (Triandis & Gelfand, 1998) for Cultural Groups Defined by Geographic Regions and Hofstede's (2017) Individualism-Collectivism Dimensions

Cultural Orientations	All	Geographic Regions		Hofstede's Dimension	
		Western (*n* = 203)	Asian (*n* = 142)	Individualism (*n* = 182)	Collectivism (*n* = 168)
Overall (16-items)	.703	.679	.764	.703	.750
HI	.687	.619	.732	.629	.730
VI	.707	.707	.660	.700	.685
HC	.642	.599	.667	.610	.672
VC	.675	.632	.737	.660	.701
Individualism	.732	.703	.743	.710	.742
Collectivism	.733	.675	.785	.703	.771

Note. Separate scores were also calculated for an individualism and collectivism dimension by summing up the HI and VI subscales as well as the HC and VC subscales, respectively.

SCS. Cronbach's reliability for the overall scale was .692 (N = 363). Specifically, α values for the 12 independent and 12 interdependent items were .719 and .715, respectively. These values were consistent with previous findings (e.g., Singelis, 1994; Na et al., 2019). As seen in Table 2.5, the reliabilities of the subscales were generally at an acceptable level when both macro level distinctions were used. However, the individualistic group had questionable reliabilities on the SCS when items from both dimensions were analysed collectively.

Table 2.5

Cronbach's Reliabilities of the SCS (Singelis, 1994) for Cultural Groups Defined by Geographic Regions and Hofstede's (2017) Individualism-Collectivism Dimensions

Self-Construal	All	Geographic Regions		Hofstede's Dimension	
		Western (n = 204)	Asian (n = 140)	Individualism (n = 182)	Collectivism (n = 169)
Overall (24-items)	.692	.606	.768	.590	.764
Independence	.719	.726	.702	.725	.712
Interdependence	.715	.615	.762	.641	.761

AHS. Cronbach's reliability for the overall scale was .650 (N = 351). Alpha values for the four dimensions of causality, contradiction, change perception, and attention was .736, .624, .675, and .719, respectively. As seen in Table 2.6, although the scores were slightly lower than the reliabilities reported by Cheek and Norem (2017) for the AHS (.760 to .850), reliabilities for the AHS were comparable for both macro level distinctions.

Table 2.6

Cronbach's Reliabilities of the AHS (Choi et al., 2007) for Cultural Groups Defined by Geographic Regions and Hofstede's (2017) Individualism-Collectivism Dimensions

Cognitive Style	All	Geographic Regions		Hofstede's Dimension	
		Western (n = 199)	Asian (n = 134)	Individualism (n = 177)	Collectivism (n = 162)
Overall (24-items)	.650	.653	.667	.665	.649
Causality	.736	.742	.698	.759	.676
Contradiction	.624	.631	.578	.645	.567
Perception of Change	.675	.675	.651	.693	.636
Locus of Attention	.719	.718	.734	.718	.729

Taken together, the reliability analyses for the COS, SCS, and AHS for macro groups defined by geographical regions as well as Hofstede's (1980) individualism-collectivism dimension revealed generally comparable outcomes. The scale reliabilities were also generally consistent with previous research (Choi et al., 2007; Hao et al., 2020; Na et al., 2020; Singelis, 1994; Triandis & Gelfand, 1998); Choi et al. (2007) reported reliabilities ranging from .560 to .710 for the AHS. Triandis and Gelfand (1998) reported reliabilities ranging from .730 to .820 for the COS. Singelis (1994) observed alphas ranging from .690 and .740 for the SCS independent and interdependent subscales. Cheek and Norem (2017) also reported reliabilities ranging from .740 and .850 for the AHS and SCS. The implications of these findings are considered further in the Discussion (see Section 2.4).

2.3.2 Testing Construct Validity

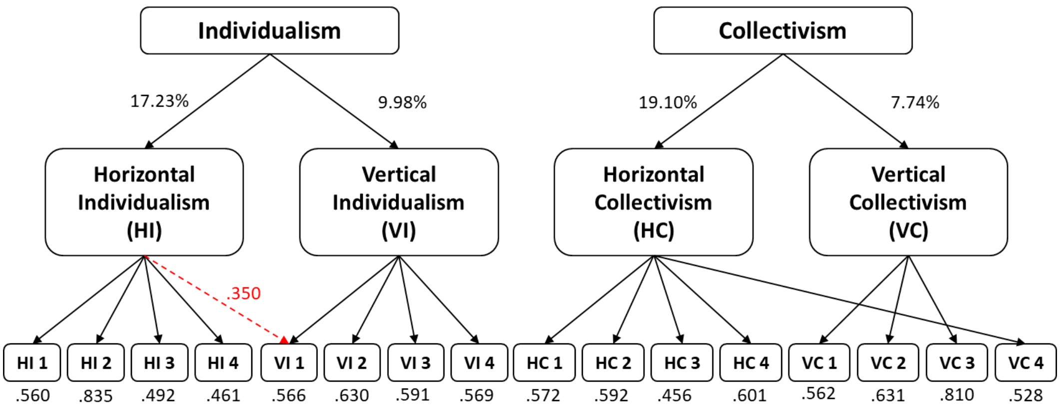
An exploratory factor analysis (EFA) is data driven and provides an insight into the factor structure and construct equivalence of an instrument (Yong & Pearce, 2013). Therefore, a factor analysis was carried out to identify if the underlying patterns extracted in the present dataset matches the previously reported factors for the COS, SCS, and AHS. The outcomes presented here will inform the multilevel framework in the present thesis and inform analysis strategies that can be applied to future cross-cultural comparative research (Boer et al., 2018). The correlation matrices for all scales are attached in the appendices (See Appendix O). Assumptions related to multicollinearity were met. The present study defined factor loadings of 0.32 as weak, 0.45 as reasonable, 0.55 as good, 0.63 as very good, and 0.71 as excellent (Tabachnick & Fidell, 2019). Items with factor loadings greater than .300 were considered relevant and interpretable factors (Stevens, 1986).

Cultural Orientation Scale. Sixteen questions on the COS were factor analysed using a PAF method with Varimax (orthogonal) rotation. An orthogonal rotation was used as the individualism-collectivism constructs are separate and distinct (Li & Aksoy, 2007). The Kaiser-Meyer Olkin (KMO) measure of sampling adequacy (*KMO* = .750) and Bartlett's Test of Sphericity (χ^2 (120) = 1245.79, $p <$ .001) indicated that the sample size was satisfactory (N = 363), and the responses were factorable.

The analysis yielded four factors[1] (eigenvalues greater than 1 and based on the Scree plot inflection), explaining a total of 54.04% of the total variance for the dataset (see Appendix P1). The first factor was labelled horizontal collectivism due to high loadings by the four HC items in the scale. However, one of the item loadings originated from a VC item (VC4: "It is important to me that I respect the decisions made by my groups"). Interestingly, the deviation of VC4 and its loading on the HC dimension was also reported in previous research (Soh & Leong, 2002; Li & Aksoy, 2007; Germani et al., 2020). Decision-making often involves a social component; group efforts often facilitate the decision-making process due to the diversity of each member's knowledge and expertise (Larrick, 2016). Therefore, the item deviation could be attributed to changes in perceptions towards group dynamics in decision-making; there is perhaps a shift towards greater acceptance of a democratic process in making decisions that could impact the group. The first factor (HC) explained 19.10% of the variance (*Extraction Sum of Squared [SS] Loadings* = 15.62) for the sample.

Figure 2.1

Factor loadings of Triandis and Gelfand's (1998) COS for all Participants (N = 363)



Note. The percentage values represent the amount of variance each subscale accounted for. The analysis yielded four factors that align with Triandis and Gelfand's (1998) findings, although on VC item on group decisions loaded onto the HC factor. A VI item was a complex variable with high loadings on a second factor (HI).

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[1] A parallel analysis (O'Connor, 2000) revealed that up to nine factors with eigenvalues above .039 should be retained. Therefore, all four factors extracted from the PAF were retained and discussed as the lowest eigenvalue value observed was 1.24 (see Appendix P1).

The second factor was labelled horizontal individualism due to the high loadings from the four HI items of the scale. The variance explained by this factor was 17.23% (Extraction SS Loadings = 13.41). The third factor was labelled vertical individualism, with high loadings stemming from the four VI items, and this factor accounted for 9.98% of the variance (Extraction SS Loadings = 6.64). As seen in Figure 2.1, one of the VI items ("It is important that I do my job better than others") was classed as a complex variable as it also had a factor loading of .350 on the HI factor. The overlap for this item can be attributed to commonalities between both factors as they relate to the individualism dimension. Furthermore, economic growth has motivated cultural shifts across societies and nations towards individualism (Greenfield, 2009; Hamamura, 2012; Inglehart & Baker, 2000; Zhou et al., 2018). Similarly, there is a shift in the discourse around workplace identities where individuals are increasingly individualistic and competitive (Barrett & Dailey, 2018). Indeed, traditional organisational hierarchies are transforming – becoming simpler – and employees are empowered to be proactive and self-managing in the workplace (Romme, 2019). The fourth and final factor was labelled vertical collectivism due to factor loadings from the three remaining VC items. This factor accounted for 7.74% of the total variance (Extraction SS Loadings = 4.25). However, the eigenvalue for the VC factor structure following extraction was .680, thereby suggesting that the VC construct was not strongly represented within the present sample.

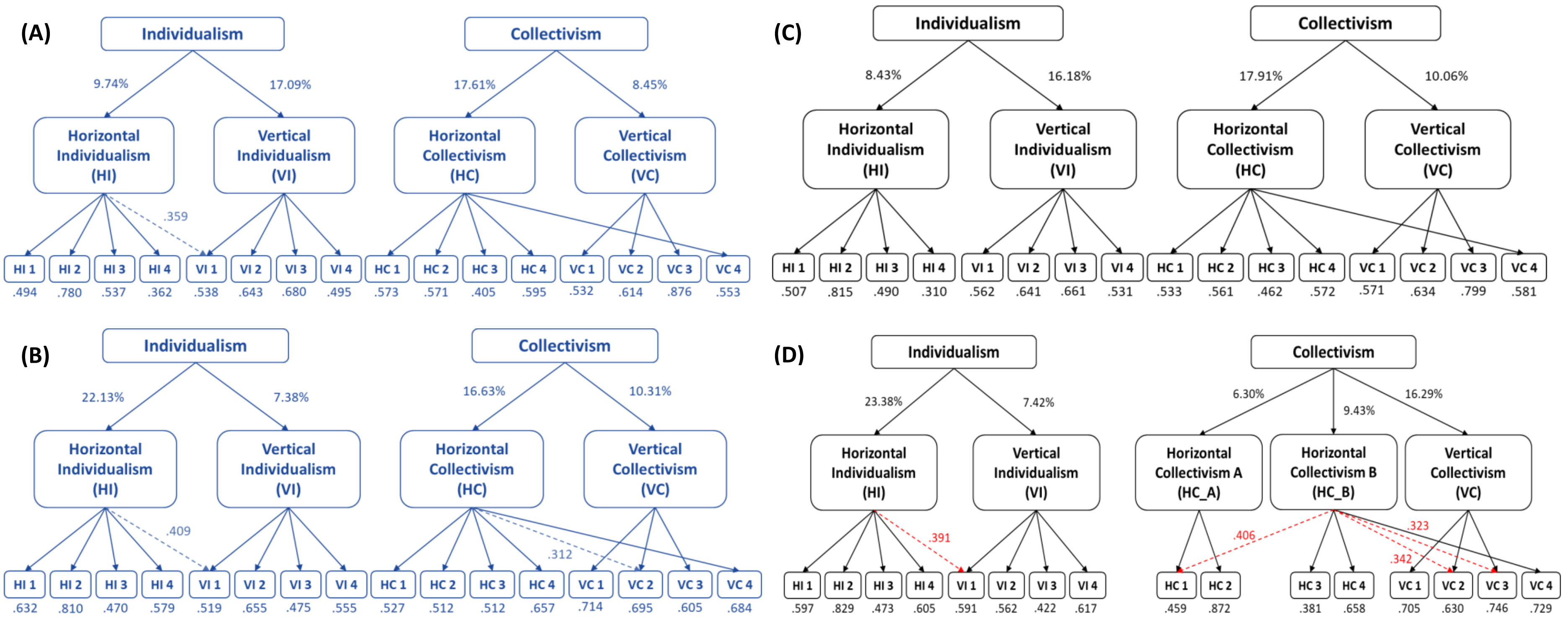
Taken together, the patterns of response for the COS parallels with previous research (Kurman & Sriram, 2002; Lalwani & Shavitt, 2013; Li & Aksoy, 2007; Soh & Leong, 2002; Triandis & Gelfand, 1998). The factor loadings ranged between reasonable and excellent for the sample (see Appendix P1 for factor loadings table). However, the communalities of the variables included were low (*M* = .399; *Range* = .249 to .707). Scale items should have communalities of at least 0.400 (Costello & Osborne, 2005; Osborne et al., 2011), although Child (2006) suggests that only items with communalities lower than .200 should be excluded. Since this is an exploratory study, these items were considered in subsequent analyses following Child's (2006) recommendations.

Measurement equivalence for the COS was established for the individualistic and collectivistic groups distinguished using Hofstede's (2017) dimensions as there were similar factor loadings between both groups (see Appendix P2). However, as seen in Figure 2.2 (A; B), there was a group difference in the variances of the four factors. The VI and HC factors accounted for most of the variance on the COS for the individualistic group. In contrast, the horizontal dimensions accounted for most of the variance for the collectivistic group, suggesting that the collectivistic sample in the present study may have more salient perceptions of equality. These group differences were explored further as a supplementary analysis (see Appendix N). Nonetheless, the variance values were not used as an indicator of measurement equivalence across groups, as this was suggested to be redundant when making comparisons on psychological constructs (Cheung & Lau, 2012). Instead, due to the differences in factor structure variances, a supplementary analysis was conducted to explore the value differences between the differentially defined groups (see Appendix N).

When geographic regions were used as the macro level distinction instead of the individualism-collectivism constructs, five factor structures were identified for the Asian group instead of the four factors identified for all participants above (see Appendix P3 and P4 for factor loading tables). Therefore, as seen in Figure 2.2 (C; D), measurement equivalence could not be established for the COS when geographical distinctions were used. This discrepancy in findings could be due to a difference in understanding of the underlying constructs being measured on the COS when cultural groups were defined by geographical regions (Boer et al., 2018). Therefore, the use of Asian and Western geographical distinctions could present limitations related to measurement equivalence, and value differences observed on the COS should be interpreted with caution.

Figure 2.2

Factor loadings of Triandis and Gelfand's (1998) COS for Individualistic (A) and Collectivistic (B) Groups as well as Western (C) and Asian (D) Groups



Note. The percentage values represent the amount of variance each subscale accounted for. Figure 2.2(A) represents the factor loadings for the individualistic group (*n = 182*), while Figure 2.2(B) represents the factor loadings for the collectivistic group (*n = 168*). By geographical regions, Figure 2.2(C) represents the factor loadings for the Western group (*n = 203*), while Figure 2.2(D) represents the factor loadings for the Asian group (*n* = 142). Five factors were identified for the Asian group instead of the four reported for the other groups.

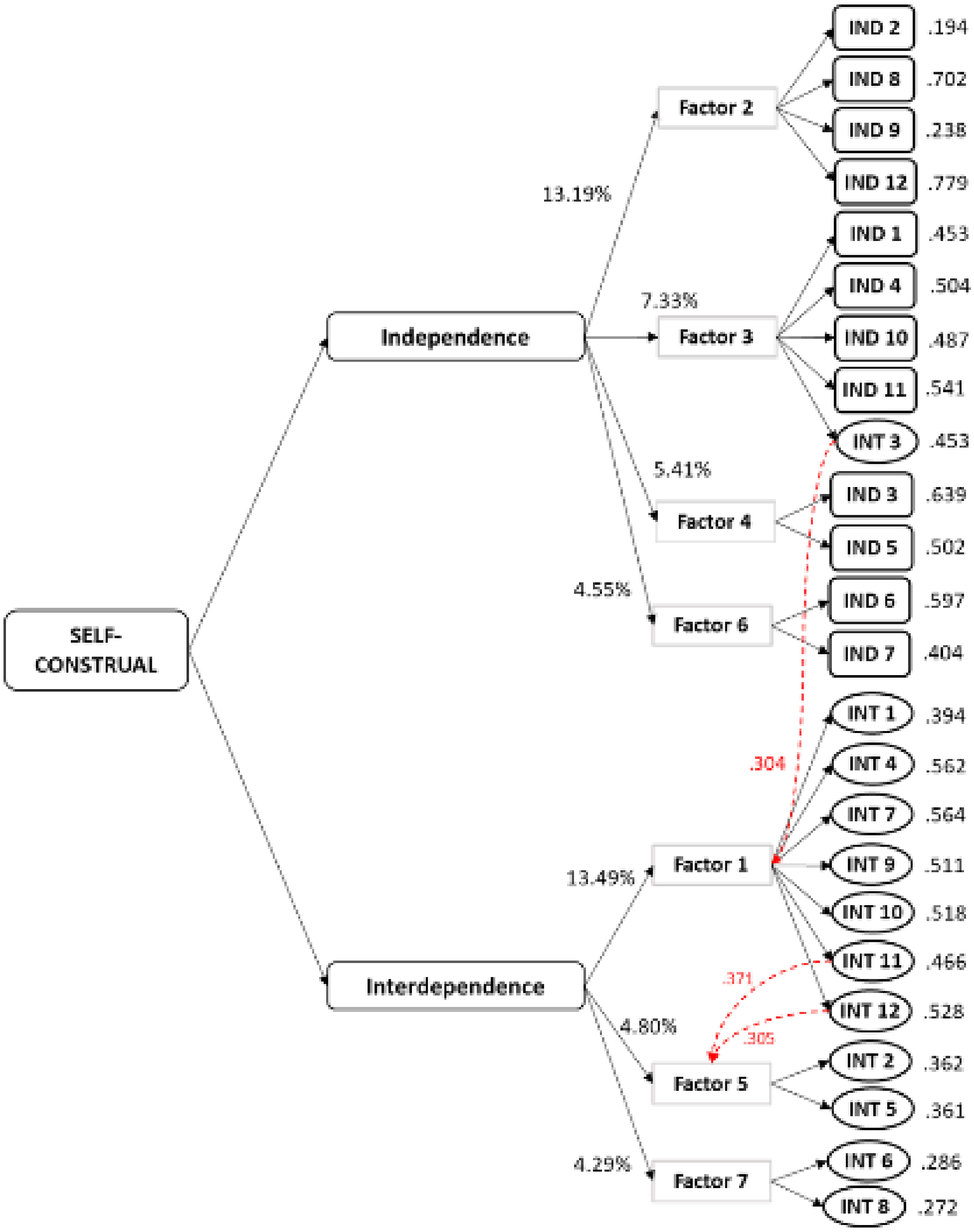
Self-Construal Scale. A PAF analysis with a Varimax (orthogonal) rotation of twenty-four items from the SCS was conducted on data gathered from 363 respondents. The KMO (*KMO* = .737) and Bartlett's Test of Sphericity ($p < .001$) indicate that the data meets the criteria for a factor analysis. Despite the purpose of the SCS in assessing only two constructs (independent and interdependent self-construal), the analysis yielded seven factors[2] explaining a total of 53.07% of the variance for all the variables (see Appendix Q1 for factor loadings table).

For the interdependence dimension, the first (related to relational interdependence), fifth (related to respect for authority figures), and seventh factor (related to a sense of responsibility towards others), accounting for 13.49%, 4.80%, and 4.29% of variance respectively, consisted of 11 interdependent self-construal items (see Figure 2.3). For the independence dimension, factor two (related to behavioural consistency and acting the same way), four (related to assertiveness), and six (related to being distinct) consisted of eight items which accounted for 13.19%, 5.41%, and 4.55% of the variance. Interestingly, factor three, which accounted for 7.33% of variance, consisted of five factor loadings – four of which were independent items (related to self-precedence) and one of which was an interdependent item (INT 3: "I respect people who are modest about themselves"). This finding was replicated in Wang's (2000) study. Wang (2000) reasoned that although modesty has been a highly valued trait in East Asian cultures (e.g., Fu et al., 2016; Koh & Wang, 2012), American cultures may be reweighting the importance placed on this value. There were also three complex variables in the dataset which had loadings greater than .300 on two factors, and these included three interdependent items (INT 3, INT 11, and INT 12). Nevertheless, these complex variables loaded on factors that consisted of similar items (e.g., an interdependent item loading on factors that consist of other interdependent items).

[2] A parallel analysis (O'Connor, 2000) revealed that up to thirteen factors with eigenvalues above .024 should be retained. Therefore, all seven factors extracted from the PAF were retained and discussed as the lowest eigenvalue value observed was 1.03 (see Appendix Q1).

Figure 2.3

Factor loadings of Singelis' (1994) SCS for all Participants (N = 363)



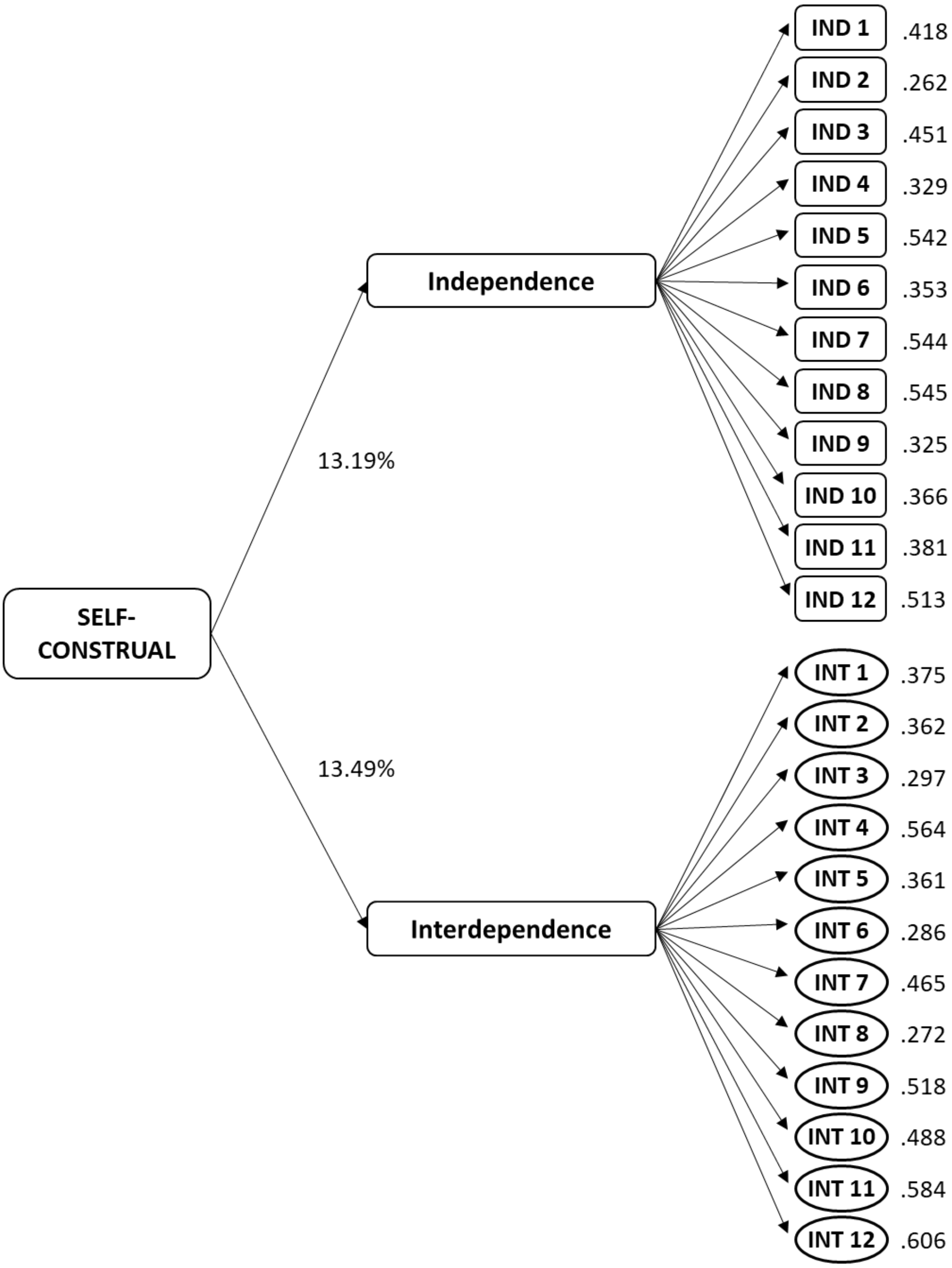
Note. The interdependent dimension was composed of three factor structures that consisted of 11 interdependence items from the original SCS (Singelis, 1994). The independent dimension was composed of four factor structures that consisted of 12 independent items and one interdependent item (INT 3). There were also three complex variables (red dotted lines) from the interdependence items, although these loaded on factors that also consisted of interdependence items. The percentage values represent the amount of variance each subscale accounted for.

The communalities of the variables included were generally at an acceptable level (Child, 2006), although two items (IND 2: "I feel comfortable using someone's first name soon after I meet them, even when they are much older than I am." and IND 9: "I value being in good health above everything.”) had a low amount of variance (15.30% and 16.90%) in common with the other variables. It is estimated that these items may not be appropriate representations of self-construals. For example, interest and concern over personal wellbeing are rising, with healthcare information readily shared and available on platforms such as social media (Ker et al., 2014; Li et al., 2018). Therefore, the ease and convenience of access to health-related information could have changed perceptions surrounding good health for the self, hence the low communality for the item. Taken together, some items on the SCS may be outdated. Furthermore, Wang (2000) also proposed that at least three items were required to meet a loading criterion, thereby invaliding factors four to seven for the sample in the present study. As such, a second PAF analysis with varimax rotation was carried out with a preset for a two-factor solution designated for the SCS (Singelis, 1994).

As seen in Figure 2.4, the analysis revealed two factors, each loaded with 12 items corresponding to the 12 independent and 12 interdependent self-construal items by Singelis (1994). Factor loadings on the preset analysis ranged from very weak to good (.262 to .606), indicating inconsistency and variations in the strength of factor loadings. Indeed, the two factors accounted for only 26.68% of the total variance. Furthermore, the communalities of the items ranged from .072 to .267, with twelve items presenting communalities below the 0.200 cut-off point (see Appendix Q2 for factor loadings table). There is a need to evaluate the construction of items in the SCS as it could impact the interpretation of behavioural findings in cross-cultural comparative research.

Figure 2.4

Factor loadings of Singelis' (1994) SCS on a Two-Factor Preset for all Participants (N = 363)



Note. Two factors were identified, with each factor corresponding to the 12 independent and 12 interdependent self-construal dimensions by Singelis (1994). Factor loadings with the preset ranged from very weak to good, indicating inconsistency and variations in the strength of factor loadings. The percentage values represent the amount of variance each subscale accounted for.

To establish measurement equivalence for the SCS when groups were differentially defined at the macro level, separate factor analyses according to Hofstede's (1980, 2001) individualism-collectivism dimensions revealed nine factors for the individualistic group (*KMO* = .659, p < .001), while eight factor structures were extracted for the collectivistic group (*KMO* = .724, p < .001; see Appendix Q3 and Q4 for factor loadings table). Four factors, including 11 SCS independence items, accounted for 36.75% of the variance for the individualistic group (*n* = 182). However, one of the items (IND 9: "I value being in good health above everything.") loaded as a standalone single-item factor. As mentioned earlier, perceptions of health and wellbeing are closely intertwined with globalisation (Beumer et al., 2018), and socioeconomic, political, and environmental changes have shifted the discourse around personal health and wellbeing (Martens et al., 2010). Therefore, it is estimated that the original characterisation of independence and interdependence by Markus and Kitayama (1991) to differentiate North American and East Asian cultures based on health priorities may no longer be relevant due to these sociocultural shifts. Indeed, the factor structure identified from the collectivistic group (*n* = 169) also could not be clearly defined based on Singelis' (1994) independence and interdependence constructs.

Similar findings were also identified for groups differentiated by geographical boundaries. Although both Western (*KMO* = .658, *p* < .001) and Asian (*KMO* = .717, *p* < .001) groups exhibited eight factors respectively on the SCS, the item loadings were not matched between both groups (see Appendix Q5 and Q6 for factor loadings table). Factor structures and variance for the Western (*n* = 204) and Asian (*n* = 140) groups as well as the individualistic and collectivistic groups were similar. Therefore, due to the general lack of equivalence, any findings related to the SCS, such as those in Appendix N, should be interpreted with caution as extraneous factors (e.g., misinterpretation of items between cultural groups) could impact the comparability of findings (Boer et al., 2018).

Analysis-Holism Scale. Twenty-four items on the AHS were factor analysed using PAF with an Oblimin (oblique) rotation. An oblique rotation was used for the AHS as the four original dimensions are conceptually related, where all dimensions contribute to a composite holism score (Choi et al., 2007). The measure of sampling adequacy (*KMO* = .764) and Bartlett's Test of Sphericity (p < .001) both indicate that the sample of 351 respondents was sufficient for the factor analysis.

The analysis yielded six factors[3] explaining a total of 55.29% of the variance for all the variables (see Appendix R1 for pattern matrices). Factor 1 accounted for 17.15% of the total variance. The item loadings for this factor originated from five attention items (Attention 1, 2, 3, 4, and 5), and an item from the attitude towards contradiction dimension (Contradiction 5). Factor 2, which accounted for 12.71% of the variance, consisted of three causality attribution items (Causality 4, 5, and 6), one change perception item (Change 5), and one attention item (Attention 6). Five items from the attitude towards contradiction dimension loaded into two distinct factors, Factor 3 (Contradiction 2, 3, and 4) and Factor 5 (Contradiction 1 and 6), which accounted for 8.11% and 4.96% of the total variance, respectively. Factor 5 consisted of three causality attribution items (Causality 1, 2, and 3) which accounted for 4.96% of the total variance. Lastly, five change perception items loaded into Factor 6, which accounted for 4.66% of the variance (Change 1, 2, 3, 4, and 6). The loadings on the pattern matrix were generally consistent with the structure matrix (see Appendix R2), except for one item from the contradiction dimension (Contradiction 5) which correlated with the items in the change perception factor structure.

The communalities of the variables included were generally at an acceptable level. However, one variable (Contradiction 5: "Choosing a middle ground in an argument should be avoided.") had a low amount of variance (16.60%) in common with the other variables in the analysis. In summary, six factors were identified in the analysis contrary to the four designated dimensions of the scale (Choi et al., 2007). Furthermore, the item loadings on each factor were also inconsistent with Choi et al.'s (2007) four original dimensions for the AHS.

[3] A parallel analysis (O'Connor, 2000) revealed that up to thirteen factors with eigenvalues above .026 should be retained. Therefore, all six factors extracted from the PAF were retained and discussed as the lowest eigenvalue value observed was 1.12 (see Appendix R1).

Table 2.7

Factor Loadings (Pattern Matrix) with a Four-Factor Preset for the AHS (Choi et al., 2007)

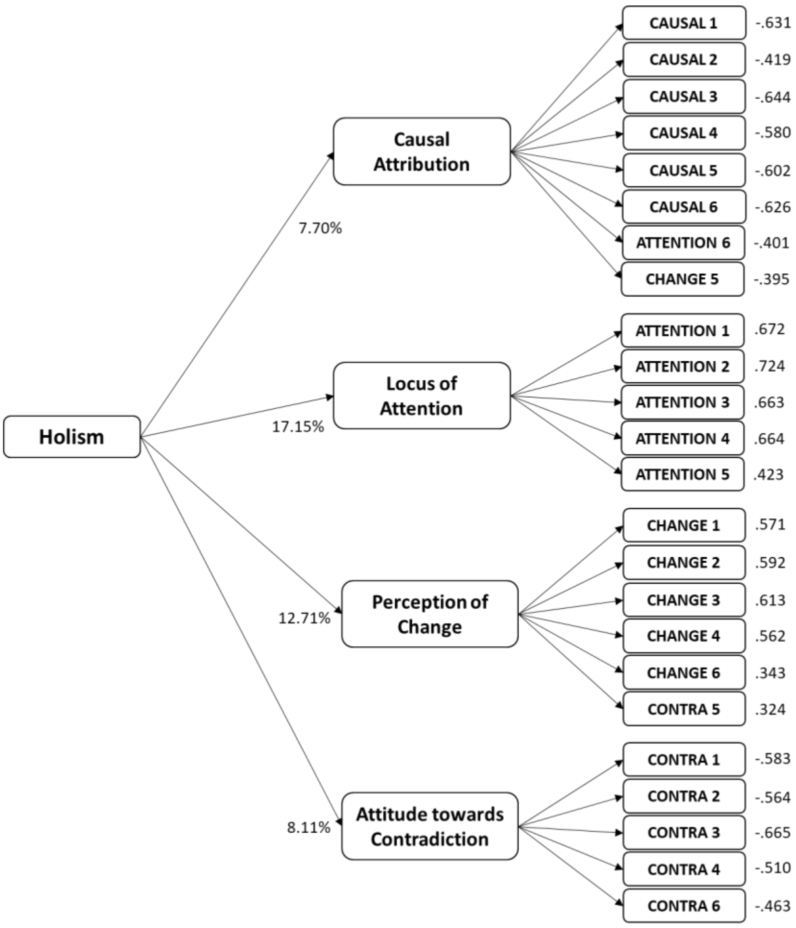
AHS	Factor Loadings					Descriptives	
	1	2	3	4	Communality	*M*	*SD*
Factor 1: Locus of Attention							
ATTENTION2	**.714**	-.072	-.127	.143	.559	4.54	1.39
ATTENTION1	**.681**	.046	.028	.010	.444	4.85	1.42
ATTENTION4	**.658**	-.049	-.024	.049	.445	4.53	1.48
ATTENTION3	**.634**	-.136	-.041	-.001	.470	4.83	1.47
ATTENTION5	**.375**	.032	-.044	-.246	.245	5.18	1.27
Factor 2: Change Perceptions							
CHANGE3	.024	**.613**	.138	.013	.395	4.43	1.53
CHANGE2	-.008	**.585**	.080	-.021	.357	4.66	1.44
CHANGE1	-.081	**.557**	.013	.122	.353	4.23	1.57
CHANGE4	-.107	**.526**	.165	-.119	.360	4.10	1.48
CHANGE6	-.111	**.326**	-.029	.188	.171	3.81	1.48
CONTRADICTION5	-.195	**.292**	-.199	.049	.170	4.32	1.48
Factor 3: Attitude Towards Contradiction							
CONTRADICTION3	.055	.025	**-.638**	-.085	.454	5.23	1.28
CONTRADICTION1	.015	-.134	**-.577**	.097	.347	4.68	1.42
CONTRADICTION2	.060	.086	**-.569**	-.032	.350	5.48	1.19
CONTRADICTION4	-.077	-.027	**-.500**	-.099	.273	5.16	1.24
CONTRADICTION6	.096	-.122	**-.445**	.019	.243	4.79	1.56
Factor 4: Causal Attributions							
CAUSALITY3	-.091	-.239	-.081	**-.653**	.477	5.08	1.28
CAUSALITY1	-.159	-.129	.003	**-.638**	.393	5.45	1.26
CAUSALITY6	.046	.094	-.007	**-.613**	.401	5.56	1.03
CAUSALITY5	.254	.165	.030	**-.583**	.468	5.61	1.09
CAUSALITY4	.073	.155	-.099	**-.538**	.370	5.53	1.12
CAUSALITY2	-.008	-.164	.015	**-.412**	.187	4.70	1.62
ATTENTION6	.011	.298	-.126	**-.378**	.274	6.01	0.89
CHANGE5	.087	.313	-.122	**-.340**	.261	6.11	0.90
Eigenvalue	4.12	3.05	1.95	1.85			
% of Total Variance	17.15	12.71	8.11	7.70			
Total Variance				**45.67%**			

Note. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation. The four-factor preset revealed structures that were mostly consistent with Choi et al.'s (2007) proposed dimensions. However, one attitude towards contradiction item loaded on the change perception factor. One attention item and change perception item also loaded on the causal attribution factor.

As the factor loadings extracted from the present dataset deviated from the four dimensions originally proposed for the AHS, a preset four-factor solution was administered. The PAF analysis with Oblimin rotation revealed that the four factors accounted for 45.67% of the total variance (see Table 2.7). However, the items loaded on this preset four-factor solution also did not fully match the four dimensions proposed by Choi et al. (2007) although some similar patterns emerged (see Figure 2.5). Following the factor preset, only three items (Contradiction 5, Attention 6, and Change 5) did not load on their designated dimensions. The communality for three items were also below .200 when the preset was used.

Figure 2.5

The Structure Matrix of Choi et al.'s (2007) Analysis-Holism Scale on a Four-Factor Preset (N = 351)



Note. The percentage values represent the amount of variance each subscale accounted for. The structure matrix represents the correlations between items on the scale and the factors extracted.

There was also a lack of measurement equivalence for the AHS as the factor structure extracted for the individualistic group (*KMO* = .705, $p < .001$; see Appendix R3 and R4) was not matched with the collectivistic group (*KMO* = .711, $p < .001$; see Appendix R5 and R6). Six factors were identified for the individualistic group ($n = 177$), with two causality items (Causality 5 and Causality 6) and one attention item (Attention 6) accounting for the largest amount of variance (15.30%). In contrast, eight factors were identified for the collectivistic group ($n = 162$), where four attention items (Attention 1, 2, 3, and 4) accounted for the largest variance (19.07%). For the groups distinguished by geographical regions, both Western ($n = 196$; *KMO* = .707, $p < .001$) and Asian ($n = 134$; *KMO* = .688, $p < .001$) participant groups had seven extracted factors. However, a visual inspection revealed a discrepancy of the item loadings on each factor between both groups (see Appendix R7 and R9 for comparison). Therefore, there was also a lack of measurement equivalence for the geographically distinguished groups. Furthermore, although the dimensions of the AHS should be correlated (Choi et al., 2007), the factor correlation matrix for the sample in the present study revealed only small to moderate correlations between the factors (see Table 2.8).

Table 2.8

Correlation Matrix for Extracted Factors on the AHS (Choi et al., 2007) for all Participants

Factors	1	2	3	4	5	6
1	–					
2	.072	–				
3	-.070	-.171	–			
4	-.163	-.280	.128	–		
5	.195	.052	-.344	-.104	–	
6	-.326	.167	.046	.217	-.151	–

Note. The factor correlation matrix for the sample ($N = 351$) in the present study revealed only small to moderate correlations between the factors, thereby contradicting Choi et al.'s (2007) conceptualisation of the AHS.

The factor analyses suggest that the SCS and AHS may have insufficient construct validity and a lack of measurement equivalence for cross-cultural group comparisons. In contrast, the overall data patterns of the COS identified in the present study appears to be consistent with the original conceptualisation of the scale, albeit with one item deviation. Measurement equivalence was also established for the macro groups defined by Hofstede's (2017) individualism-collectivism dimension for the COS. Nonetheless, the inconsistent factor structures identified for the three measures could be attributed to cultural shifts or changes in values structures across societies (Chen et al., 2020). Accordingly, it is important also to consider the demographics of individuals, societies, and nations that contribute to the multilevel cultural framework. The concurrent and predictive validity of the SCS, COS, and AHS will thus be examined in the next section.

2.3.3 Examining the Influence of Demographic Variables on Scale Responses and Assessing the Concurrent and Predictive Validity of the COS, SCS, and AHS

The analyses presented in this section assessed H3 and H4 (see Section 2.1.1). A multiple regression analysis (enter method) was run to predict COS individualism scores based on gender, age, ethnicity, living arrangement, years lived outside of the country of birth, geographical background, and Hofstede's (2017) individualism-collectivism dimension. These variables did not predict COS individualism scores (p = .068), although the collectivistic group variable added statistical significance to the regression model (B = 6.62; p = .038). The regression model for COS collectivism scores was also not significant (p = .460). However, one variable, living alone (B = -2.90; p = .035), added statistical significance to this model, suggesting that living alone was predictive of lower COS collectivism scores. A second regression analysis for the SCS revealed a significant model for the independence subscale (F(13, 362) = 1.82, p = .039), whereby White ethnicity (B = -.333; p = .015) was predictive of lower independence scores on the SCS. In contrast, the regression model for the SCS interdependence scores was not significant (p = .085). The third regression analysis revealed that the demographic variables were not predictive of AHS holism scores (p = .366).

Concurrent validity was assessed by comparing participants' scores on the SCS and COS. Members of individualistic and Western cultures are associated with more independent self-construal, while those from collectivistic or Asian cultures are characterised by more interdependent self-construal (Choi et al., 2007; Markus & Kitayama, 1991; Yu et al., 2021). The COS was designed to assess the horizontal and vertical attributes of individualism and collectivism, while the SCS measures adherence to independence and interdependence values. Table 2.9 shows the relationship between the cultural variables measured by the two scales. As predicted, the COS individualism scores were significantly correlated with the SCS independence scores (moderate association).

Similarly, there was a significant positive correlation between the COS collectivism and SCS interdependence scores (moderate-strong association). The positive correlation between COS collectivism and SCS independence scores seem paradoxical, and it is estimated that this finding could be attributed to variations in the cultural constructs that each scale is assessing (e.g., cultural orientation vs social orientation) or the lack of construct validity of the scales (see Section 2.3.2). Alternatively, the vertical items in the COS collectivism subscale, which relates to the endorsement of hierarchy, could be linked to values of independence that people may hold.

Table 2.9

Correlation Matrix of all Variables Measured by the COS, SCS, and AHS

	AHS Holism	COS Individualism	COS Collectivism	SCS Independence	SCS Interdependence
AHS Holism	–				
COS Individualism	.047	–			
COS Collectivism	.164*	.067	–		
SCS Independence	.054	.345**	.213**	–	
SCS Interdependence	.293**	-.07	.524**	-.004	–

$*p < .05$, $**p < .001$

The predictive validity of the COS and SCS was also assessed by examining if holistic thinking styles could be predicted by COS individualism and COS collectivism or independent and independent self-construal. The ways in which people from different cultures define the self has been linked to differences in cognitive styles; interdependent self-construal is related to more holistic thinking, while independent self-construal has been associated with more analytic thinking styles (e.g., Choi et al., 2007; Dong et al., 2019; Haberstroh et al., 2002; Krishna et al., 2008; Talhelm et al., 2014; Uskul, Nisbett, et al., 2008). Indeed, there were significant positive correlations between holism scores and COS collectivism and SCS interdependence scores (see Table 2.9). A multiple regression analysis further revealed that the COS individualism and COS collectivism scores and the SCS independence and SCS interdependence scores could predict AHS holism scores, $F(4, 338) = 8.54$, $p < .001$, $R^2 = .092$, Adjusted $R^2 = .081$. However, only the SCS interdependence scores added statistical significance to this prediction ($B = 4.76$; $p < .001$).

2.4 Discussion

The exploratory nature of this methodological chapter aimed to establish the foundations of a multilevel framework consisting of micro (individual) and macro (group) level cultural features. The framework could then support and explain the behavioural findings reported in the subsequent experimental chapters of this thesis. The measures and instruments used in cross-cultural research should capture the multifaceted nature of culture to provide a comprehensive narrative of the value differences that exist across nations and individuals (Dowd & Artistico, 2016; Goodwin et al., 2020; Lux et al., 2021; Simko & Olick, 2021). Therefore, the present study assessed the measurement equivalence of micro (individual) level measures such as Triandis and Gelfand’s (1998) COS, Singelis’ (1994) SCS, and Choi et al.’s (2007) AHS when used on groups differentially defined at the macro level. The macro level examined in the present study was defined by geographical boundaries (Asian vs Western regions) and Hofstede’s (2017) individualism-collectivism dimensions. The reliability and validity (construct, concurrent, and predictive) of the COS, SCS, and AHS were also examined to assess the utility of these instruments in predicting how adherence to values of individualism, independence, and holism (Choi et al., 2007; Koo et al., 2018; Na et al., 2020; Singelis, 1994; Triandis & Gelfand, 1998). This exploratory study has revealed some interesting findings and inconsistencies. These have implications on how research employing these measures should interpret observed differences (or lack thereof) between cultural groups.

The AHS, COS, and SCS had moderate internal consistencies that were generally comparable to previous studies (e.g., Choi et al., 2007; Germani et al., 2020; Hao et al., 2020; Li & Aksoy, 2007; Stavropoulos et al., 2020; Triandis & Gelfand, 1998). Therefore, H1 was accepted. All three measures in this study presented moderate levels of reliability. However, some items on the scales may be outdated following globalisation and sociocultural shifts (Chen et al., 2020; Vignoles et al., 2016). Irrelevant or uncorrelated items on these cultural scales could significantly reduce the alpha values and internal consistencies. Cultural measures should thus be systematically revised and updated following recent research to ensure the reliability of the measures when used in different populations, especially within cross-cultural comparison research (Lux et al., 2021; Martín-Fernández et al., 2022; Minkov et al., 2017). Indeed, the moderate internal consistency foreshadowed the subsequent construct validity tests that identified several complex variables and scale items that did not load on their predicted factors.

Cultural instruments should accurately and consistently capture the cultural values and beliefs that one holds in varying situations and circumstances (Boer et al., 2018; Sivadas et al., 2008). However, H2a was rejected for all three measures when groups were defined by geographical regions as the factor structures were not comparable between the Asian and Western groups. H2b was also only partially accepted for the COS, where measurement equivalence was established for the groups defined by the individualism-collectivism dimensions (Hofstede, 2017). The lack of equivalence could be attributed to overly narrow or broad statements that introduce inconsistencies (Dowd & Artistico, 2016; Hardin et al., 2004; Levine et al., 2003). Indeed, several items in the AHS were found to load highly onto factors contrary to the constructs they were designed to measure. These findings are consistent with Lux et al.'s (2021) assertion that the AHS lacks a clear dimensional structure due to redundant items, low reliability, and crossover items (variables cross-loading on different dimensions). Therefore, group comparisons based on the scale measures should be interpreted cautiously to avoid the misattribution of cultural values to cognition and behaviours (Boer et al., 2018). Furthermore, culture and social structures are implicit; people may not be aware of how their thoughts and behaviours are shaped by micro and macro level environmental influences (e.g., demographic factors). As such, responses on self-report measures may not always be a complete and accurate reflection of cultural attitudes and beliefs.

The conceptualisation of culture can also encompass geographic (e.g., country of origin, nationality), associative (e.g., family, living arrangements), and demographic (e.g., ethnicity, age, gender) factors (Brewer & Venaik, 2011; Chao & Moon, 2005; Goodwin et al., 2020; Heu et al., 2019; Taras et al., 2016; Vignoles et al., 2016). However, the null hypothesis was accepted for H3 as the demographic variables were not predictive of scores on the three measures. Collectivistic backgrounds, living arrangements, and ethnicity contributed to the COS and SCS models. Nonetheless, the lack of overall significance in the regression models highlights the need to revise existing measures or develop new instruments that account for economic, social, and political shifts (Brandt et al., 2014; Wong et al., 2008; Zhou et al., 2018). Indeed, the supplementary analyses revealed that the COS, SCS, and AHS did not effectively differentiate the individualistic and collectivistic groups (see Appendix N). Furthermore, although some value differences were observed between Asian and Western groups on the SCS and AHS, it is estimated that the scales may not be measuring the intended constructs within different populations (Boer et al., 2018; Hardin et al., 2004; Soh & Leong, 2002). The conflicting results from the present study suggest a need for further development and validation of methods to assess the multidimensional features of culture (Lux et al., 2021; Martín-Fernández et al., 2022; Sivadas et al., 2008).

It is also vital to examine and evaluate the concurrent and predictive validity of existing and future cultural measures, particularly within the current context of rapid globalisation and sociocultural shifts (Chen et al., 2020; Vignoles et al., 2016). Establishing predictive validity ensures the practicality of a psychological measure as it enables an extension of significant outcomes from the scale to other cognitive or behavioural manifestations (Barrett et al., 1981; Bergkvist & Rossiter, 2007). H4 was partially accepted for the present study as positive correlations were observed between the COS collectivism, SCS interdependence, and AHS holism scores. Furthermore, the SCS interdependence scores predicted greater holism scores, thus demonstrating its predictive validity. The COS, in contrast, appeared to lack predictive validity as the COS collectivism scores did not predict holism scores. Nevertheless, since the cultural dimensions of the COS and SCS were correlated and informed each other to some extent, concurrent validity was established for both measures. These findings provide useful evidence of the relationship between these cultural constructs consistent with previous literature (Koo et al., 2018; Masuda et al., 2008; Na et al., 2020; Oyserman et al., 2002; Oyserman & Lee, 2008; Senzaki et al., 2014; Yu et al., 2021).

The inconsistencies observed in the present chapter also aligns with previous research (Dowd & Artistico, 2016; Hardin et al., 2004; Levine et al., 2003; Na et al., 2020; Wang, 2000). As such, the efficacy of these instruments for differentiating cultural groups based on values and beliefs may present limitations due to their capacity to fully capture the complexity of culture (Hardin, 2006). For example, clear patterns sometimes do not emerge in cross-cultural research as the samples may not represent distinct cultural systems (Gudykunst & Lee, 2003). Replication studies in this domain should thus engage highly diversified samples as it is important to establish an accurate representation of cultural constructs across different nations, societies, and individuals (Boer et al., 2018). Indeed, the issue of generalisability in cross-cultural studies is difficult to circumvent. There is a need to move beyond cross-cultural comparisons involving only two countries (Boer et al., 2018; Vignoles et al., 2016). A large and diverse sample representative of the population of different countries as well as from varying age groups, SES, ethnicity, lifestyle, education, amongst others, is recommended to improve the generalisability of findings when comparing groups at a macro level (Germani et al., 2020; Li & Aksoy, 2007). Notably, future research should account for these multidimensional cultural features at the micro level when making inferences and deductions about behavioural differences observed across cultures (Boer et al., 2018).

As discussed earlier, individual levels of analyses, in addition to a collective one, is essential in cross-cultural research to provide an insight into the nature and function of the individual in the transmission of cultural values, behaviours, and norms (Fischer, 2009). Individuals act as carriers of culture, although cultural expressions can manifest at the micro and macro levels (Erez & Gati, 2004). However, a lack of consensus of a universal theoretical conceptualisation makes it challenging to establish a measure that can effectively capture the thoughts and behaviours informed by cultural influences (Caprar et al., 2015). Therefore, future research can use more complex methods such as a standardised econometric approach (Fiebig et al., 2010). This approach provides a flexible estimation of complex aggregate models that incorporates distributions of individual heterogeneity. A Bayesian modelling approach functions similarly: constructing individual models that operate under varying assumptions and circumstances based on information that is unique to the individual and information commonly associated with the population (Vidaurre et al., 2013). The breadth provided by such models would further our understanding of the multilevel and bidirectional patterns of culture (Ringle et al., 2010). These are highly advantageous methods that can be applied to future research to establish a holistic multilevel approach to understanding cultural differences (Boer et al., 2018; Brewer & Venaik, 2011, 2012; Chen et al., 2020; Goodwin et al., 2020; Steel & Taras, 2010; Van De Vijver & Leung, 2000; Vignoles et al., 2016).

2.5 Chapter Summary

In conclusion, the moderate internal reliabilities and the concurrent validity tests provided some evidence of the utility of the COS, SCS, AHS. However, the inconsistent factor structures for the COS, SCS, and AHS when used on varying macro level differentiations indicate a need to revise these instruments to parallel with current cultural trends across nations, societies, and individuals. Nevertheless, at the macro level, the individualism-collectivism dimension remains a significant and influential explanatory construct for describing collective and aggregated features of a nation (Brewer & Venaik, 2012; Schimmack et al., 2005; Venaik & Brewer, 2013; Venkateswaran & Ojha, 2019). Similarly, considering individual-level variances at the micro level can offer valuable insight into the dynamic and complex nature of cultural conceptualisations (Boer et al., 2018). Taken together, the use of a multilevel cultural framework is advantageous since it considers cultural characteristics at both macro and micro levels (Boer et al., 2018; Brewer & Venaik, 2011, 2012; Chen et al., 2020; Goodwin et al., 2020; Steel & Taras, 2010; Van De Vijver & Leung, 2000; Vignoles et al., 2016). Additionally, the findings have established the importance of ensuring measurement equivalence in future cross-cultural comparative research. The present study provides an important foundation of knowledge for deciphering the subsequent behavioural studies in this thesis.

Chapter 3: Cultural Differences in Visual Perceptual Learning of Global Forms

This chapter presents the first examination of cultural differences in VPL using some features of the multilevel cultural framework assessed in Chapter 2. Specifically, Chapter 3 examines how people from individualistic or collectivistic backgrounds (macro level) learn to differentiate global forms embedded in noise. Singelis' (1994) SCS was also used to assess if differences in performance could be attributed to independent and interdependent values at the micro level. As mentioned previously, despite presenting certain limitations, existing cultural measures remain valuable tools for attributing differences in cognition to specific cultural values (Han & Humphreys, 2016; Lux et al., 2021; Martín-Fernández et al., 2022). Only the SCS was first employed in this study to ensure that the investigation parallels with the widespread use of self-construals in previous culture and cognition research (e.g., Haberstroh et al., 2002; Kitayama et al., 2017; Kitayama & Park, 2014; Kraus & Kitayama, 2019; Kühnen & Oyserman, 2002; Ng et al., 2010; Sui & Han, 2007). This chapter will begin with a review of how the differentiation mechanism of VPL could vary as a function of cultural differences in cognitive styles. It will focus on the differences between individualistic and collectivistic cultures despite the GPE and how the present study can investigate these in the context of VPL. Results are then reported and discussed. The outcomes of this study could present compelling evidence for using specific cultural constructs (e.g., individualism-collectivism and independence-interdependence) within a multilevel framework to explain VPL differences.

3.1 Background

As discussed in Chapter 1, VPL represents the acquisition of visual skills through training to allow individuals to perform an initially difficult visual task relatively precisely (Sagi, 2011; Song et al., 2007; Watanabe & Sasaki, 2015). One of the ways VPL can occur is through differentiation. The *differentiation* mechanism of VPL describes how people learn to distinguish useful specifying variables from irrelevant nonspecifying variables in complex visual environments (Gibson, 1963; Goldstone, 1998; see Section 1.1.1 for review). Accordingly, the visual system can focus attention on the most pertinent elements of a scene following training (Dosher et al., 2010; Gibson, 1963; Maniglia & Seitz, 2018; Moore & Zirnsak, 2017; Qu et al., 2017; Rop & Withagen, 2014). Training and practice support improvements in one's ability to detect, differentiate and categorise initially ambiguous visual objects based on specific features and properties (Gibson, 1963; Mayhew et al., 2012; Pylyshyn, 1999). However, individual and cultural differences in attentional and processing styles could impact the VPL trajectories in which people learn to discriminate visual stimuli. Cognitive style differences such as analytic and holistic thinking have been suggested to influence the informational variables that are detected during perception (Chua et al., 2005; Davidoff et al., 2008; Goh et al., 2009; Jacobs et al., 2001; Kitayama et al., 2003; Markus & Kitayama, 2010; McKone et al., 2010; Petrova et al., 2013; van der Kamp et al., 2013).

Western civilizations are generally predisposed to more analytic systems of thought which relate to more localised and focal attentional patterns, while Asian traditions advocate holistic thinking and a propensity towards both local features and global contexts during visual perception (Choi et al., 2007; Masuda et al., 2016; Masuda & Nisbett, 2006; McKone et al., 2010). Cultural differences in these attentional processes could subsequently support VPL by selecting relevant sensory information during training. As such, people could exhibit faster improvements within specific culturally preferred tasks where they have a perceptual advantage. For example, the analytic processing tendencies amongst Westerners were proposed to support their ability to ignore irrelevant information to overcome illusory biases. In contrast, East Asians with more holistic tendencies could not overlook the contextual information that caused the illusory bias during training (Van der Kamp et al., 2013). Therefore, cultural differences in VPL trajectories could be linked to differential strategies in information processing as described by the analytic and holistic systems of thought (Choi et al., 2016; Kim et al., 2010; Masuda & Nisbett, 2006; Nisbett et al., 2001).

Although visual scenes typically contain both global and local information, people tend to exhibit increased sensitivity to global information, as described by the GPE (Mills & Dodd, 2014;

Navon, 1977; Rezvani et al., 2020). Nevertheless, some populations demonstrate a prevailing tendency for either local or global processing due to cultural mediation (Blais et al., 2021; Davidoff et al., 2008; Trémolière et al., 2021). Therefore, cultural differences in cognitive styles such as analytic and holistic thinking may still manifest despite the GPE, especially during culturally preferred or nonpreferred tasks (Goh et al., 2013; Hedden et al., 2008). An evidence-based selection of tasks is thus essential; selecting tasks that engage specific culturally mediated cognitive processes could present robust evidence of prevailing cultural influences on information processing (Cramer et al., 2016; Lao et al., 2013; Petrova et al., 2013; Ueda et al., 2018). For instance, investigating VPL trajectories using tasks that compel people to engage in global processing could reveal whether global precedence is a stable phenomenon across cultures. Alternatively, it could reveal if cultural variations in thinking styles have a dominating influence on behaviour. Importantly, the information or cues in the task stimuli should be neutral and uninformative to minimise biases such as language or education levels that could impact task performance (Brants et al., 2016; Doherty et al., 2008; Dosher et al., 2010; Dosher & Lu, 1998; Kourtzi et al., 2005; Mayhew et al., 2010; McKone et al., 2010; Millar et al., 2013; Savani & Markus, 2012; Westheimer & Lavian, 2013).

The Glass (1969) pattern discrimination task is an example of a visual categorisation task that requires global processing to overcome sensory uncertainty (Frangou et al., 2019; Garcia et al., 2013; Li et al., 2012; Mayhew et al., 2012; Wang et al., 2017). Radial and concentric patterns are embedded in noise, and observers must extract relevant features to effectively discriminate these global patterns. Observers learn how to translate sensory inputs into meaningful categories despite the perceptual uncertainties induced by noisy backgrounds through the process of differentiation. However, cultural differences in visual processing styles may impact how people perceive and discriminate these patterns during learning (Caparos et al., 2012, 2020; Davidoff et al., 2008; van der Kamp et al., 2013). Specifically, the analytic and holistic processing differences between cultures described above could influence sensitivity to informational variables in the stimuli and impact VPL trajectories. Therefore, cultural differences in how people process global information could manifest during training when people learn to effectively differentiate ambiguous visual stimuli such as the Glass (1969) patterns.

To recap, the general emphasis of collectivism in East Asian cultures encourage interdependent self-concepts at the individual level. In contrast, the emphasis on individualism in Western societies encourage independent self-concepts (see Chapter 1 for further details). These cultural and self-construal variations can also be associated with differential processing styles (e.g., Grossmann & Jowhari, 2018; Han & Humphreys, 2016; Kitayama et al., 2017; Kitayama & Park, 2010, 2014; Kraus & Kitayama, 2019; Kühnen & Oyserman, 2002; Kuwabara & Smith, 2012; Lin & Han, 2009; Ng et al., 2010; Sui & Han, 2007; Zhu et al., 2016). Therefore, it is essential to consider both individual and group level cultural differences as they may differentially impact VPL. The individualism and collectivism constructs (Hofstede, 2017) discussed in Chapter 2 will be used as a macro level distinction to provide a generalized view of cultural group characteristics (Daniels & Greguras, 2014). The independence and interdependence self-construals (Singelis, 1994) will be applied as micro level differentiation to allow the attribution of behaviours to independent and interdependent self-construals (Kim & Sasaki, 2014; Kitayama & Uskul, 2011; Li et al., 2018; Voyer & Franks, 2014). Due to the novelty of the research on culture and VPL, self-construals were employed as the micro level characteristic in the first experimental study to ensure consistency in the interpretation of findings with previous literature (e.g., Kitayama & Park, 2010).

The underlying cultural influences on VPL remain an enigma; there is a lack of research on how differential analytic and holistic tendencies across individualistic and collectivistic cultures may influence VPL. Culture shapes our perceptions, cognitions, and behaviours consistent with unique cultural systems and conventions (Bang, 2015; Park & Huang, 2010; Wang, 2016). Indeed, the human brain is sensitive to environmental and ecological demands (Boyke et al., 2008; Morishita & Hensch, 2008; Park & Huang, 2010). Therefore, experience, socialisation, or identification with a cultural system has been proposed to regulate cognitive, behavioural, and brain responses that are observable even in simple and abstract tasks (Hedden et al., 2008). The present study thus aims to identify if cultural backgrounds – represented by the individualism-collectivism constructs and independent and interdependent self-construals – can mediate VPL in the Glass (1969) pattern discrimination task. Any differences in performance when differentiating these global patterns during training can be attributed to the analytic and holistic processing tendencies prevalent in individualistic and collectivistic cultures.

3.1.1 Aims of Study

The Glass (1969) pattern discrimination task will be employed to identify cultural differences in VPL through comparisons of perceptual accuracy. The Glass (1969) patterns are neutral and cannot be associated with any semantic meaning (Doherty et al., 2008; McKone et al., 2010; Savani & Markus, 2012). Therefore, participants have an equal advantage as differences in skills, expertise, and qualifications should not interfere with task performance. Singelis' (1994) self-construal scale will be used to assess the differences in independent and interdependent self-construal held by the participants. As mentioned above, collectivists and those with interdependent self-construal tend to perceive holistically compared to individualists or those with independent self-construal. Therefore, it is hypothesised that the collectivistic group and those with interdependent self-construal would exhibit greater accuracy improvements in the global pattern discrimination task. The present study would broaden our knowledge of prevailing cultural influences on VPL despite the GPE (Bang, 2015).

3.2 Method

3.2.1 Participants

Participants were recruited through opportunity sampling in a UK university. Eighty-three participants were recruited for the present study. Among these, 41 were international students (18 Malaysians, 13 Chinese, 7 South Asians, 1 Vietnamese, 1 Emirati, and 1 Azerbaijani) who were studying in the UK and had lived in the UK for less than five years (M = 18.44 months; SD = 16.18) representing the collectivistic group, while 42 were British or European students representing the individualistic group. The European students from countries such as Spain, Romania, Sweden, Bulgaria, Cyprus, and Denmark had been in the UK for 18 months to 17 years. Two students, both aged 22, who were native English speakers, reported that they were not born in the UK; one participant who was born in Jamaica had been living in the UK for 13 years, while the other who was born in Tanzania had been living in the UK for 20 years. Both have spent most of their youth in the UK, so they were assigned to the individualistic group.

Due to the difficulty of the task, participants who scored two standard deviations from the mean of the first run (Run 1) were excluded from the analysis. Additionally, one participant was further excluded for performing below chance level throughout training, suggesting they did not understand the task instructions. Therefore, six participants were excluded, and the analysis was conducted on seventy-seven participants who had a mean age of 21.31 (*SD* = 2.55) from individualistic (*n* = 40) and collectivistic (*n* = 37) backgrounds based on their nationalities. All participants had normal or corrected-to-normal vision and did not use special-coated eyewear.

3.2.2 Design

The present study employed a between-subjects design comparing two groups from different cultural backgrounds defined by nationalities; half originated from collectivistic backgrounds, while the other half were from individualistic backgrounds. Response accuracy was recorded following previous work on the glass patterns (Frangou et al., 2019; Garcia et al., 2013; Mayhew et al., 2012; Mayhew & Kourtzi, 2013). Response accuracy was compared between individualistic and collectivistic cultures to investigate cultural differences in VPL trajectories. The experiment also adopted a cued-response design with a delay between stimuli presentation and response. This standardisation feature ensured similar RTs when participants were making a response (Li et al., 2012). Therefore, although RTs were recorded, these were not a reflection of learning ability but rather a measure of participant’s motor response (keypress) to the cue. Taken together, the independent variables in the present study are individualism-collectivism cultural backgrounds and independent-interdependent self-construals, while the dependent variable is performance accuracy and learning rates in the Glass (1969) pattern discrimination task.

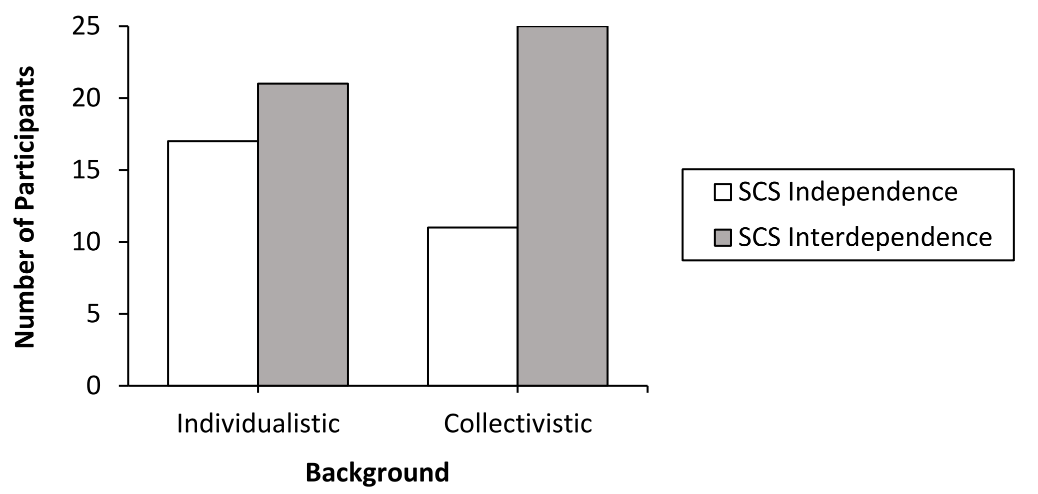
3.2.3 Materials

Demographics Questionnaire. The questionnaire identified background information such as nationality, gender, age, language, ethnic background, birthplace, and years lived in the UK (Lawrence et al., 2020; Yeh, 2003). Birthplace and years lived in the UK were used to assign participants to the corresponding experimental groups (individualistic or collectivistic backgrounds).

Singelis' (1994) SCS. The SCS was used to identify self-construal differences between the individuals of both experimental groups (see Appendix F). Cronbach's reliabilities for the overall scale were .732. Specifically, α values for the 12 independent and 12 interdependent items were .785 and .665, respectively. These were comparable to the α values reported in Chapter 2 for the SCS. Figure 3.1 shows that the individualistic group of participants were equally likely to hold independent or interdependent self-construal, whereas the collectivistic group appeared more likely to hold interdependent self-construal. However, there was no statistically significant association between the SCS and background variables, χ^2 (1, N = 74) = 1.58, p = .209, thus indicating that both individualists and collectivists were equally likely to possess independent and interdependent self-construal. Nevertheless, past studies have similarly reported inconsistent findings between independent and interdependent self-construal constructs (Kitayama et al., 2019; Magid et al., 2017; Marquez & Ellwanger, 2014; Na et al., 2020), and these can be attributed to factors that will be detailed further in the discussion (see Section 3.4).

Figure 3.1

Self-Construal of Participants from Individualistic and Collectivistic Backgrounds

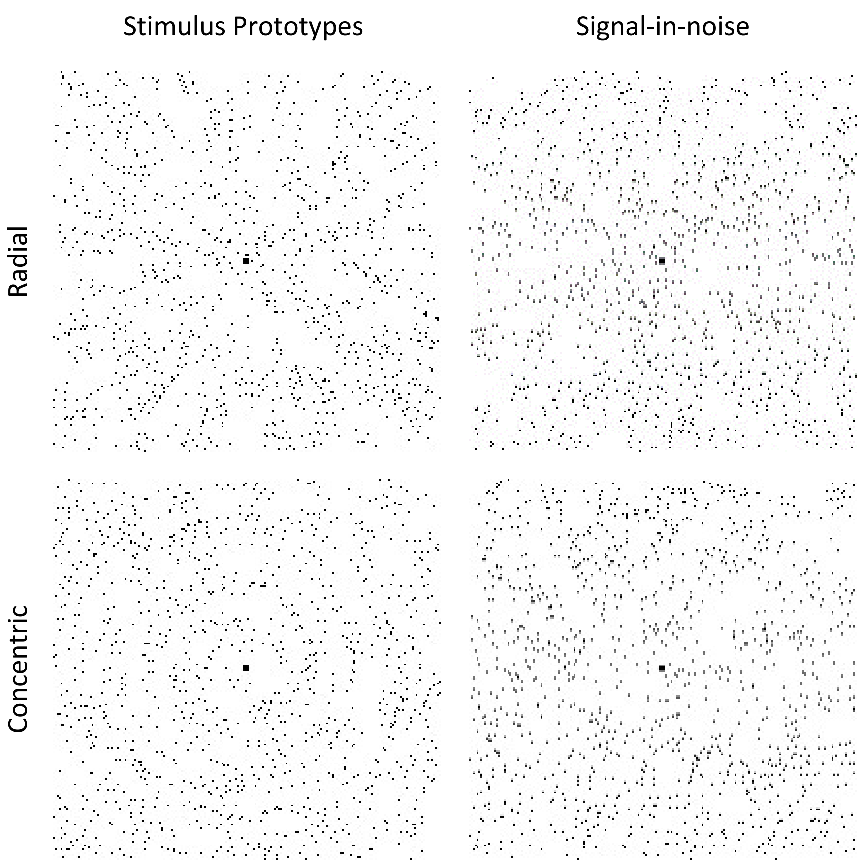


Note. The collectivistic group were more likely than the individualistic group to hold interdependent self-construals. However, these differences were not significant.

Stimuli. MATLAB 2015a (The MathWorks Inc., 2015) was used in conjunction with Psychtoolbox-3 (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997) for stimulus generation and presentation. Participants were tasked with discriminating radial and concentric Glass (1969) patterns to identify the cultural differences in perceptual learning processes. Specifically, the discrimination task was adapted from (Mayhew et al., 2012) experimental paradigm to assess how observers learn to extract global shapes embedded in cluttered backgrounds. Each stimulus consisted of pairs of dots (2.3 × 2.3 arc min^2) or dot dipoles that were aligned according to the specified spiral angle (signal dipoles), displayed within a square aperture (7.9°×7.9°) against a black background (100% contrast). Dot density was set at 3%, and the distance between the dot dipoles was 16.2 arc min (Frangou et al., 2019). The spiral angle for each dot dipole is characterised by the angle between the dot dipole orientation and the radius from the centre of the dipole to the centre of the stimulus aperture (Frangou et al., 2019). Concentric patterns were formed by tangentially placed dipoles, while radial patterns were constructed by orthogonally placed dipoles. In the present study, radial patterns were generated using a spiral angle of ±0°, whereas concentric patterns were generated using a spiral angle of ±90°. These patterns had 35% or 40% signal (i.e., aligned dot dipoles) and were embedded in a background of randomly positioned and oriented dipoles (noise). Patterns were rotated clockwise or anticlockwise across trials in a randomised order (see Figure 3.2). Spiral angles were jittered across stimuli (±3°) to control for potential local adaptation and ensure that participants would learn to discriminate global shapes rather than just local features during stimulus categorisation (Garcia et al., 2013).

Figure 3.2

Example of Radial and Concentric Glass (1969) Patterns

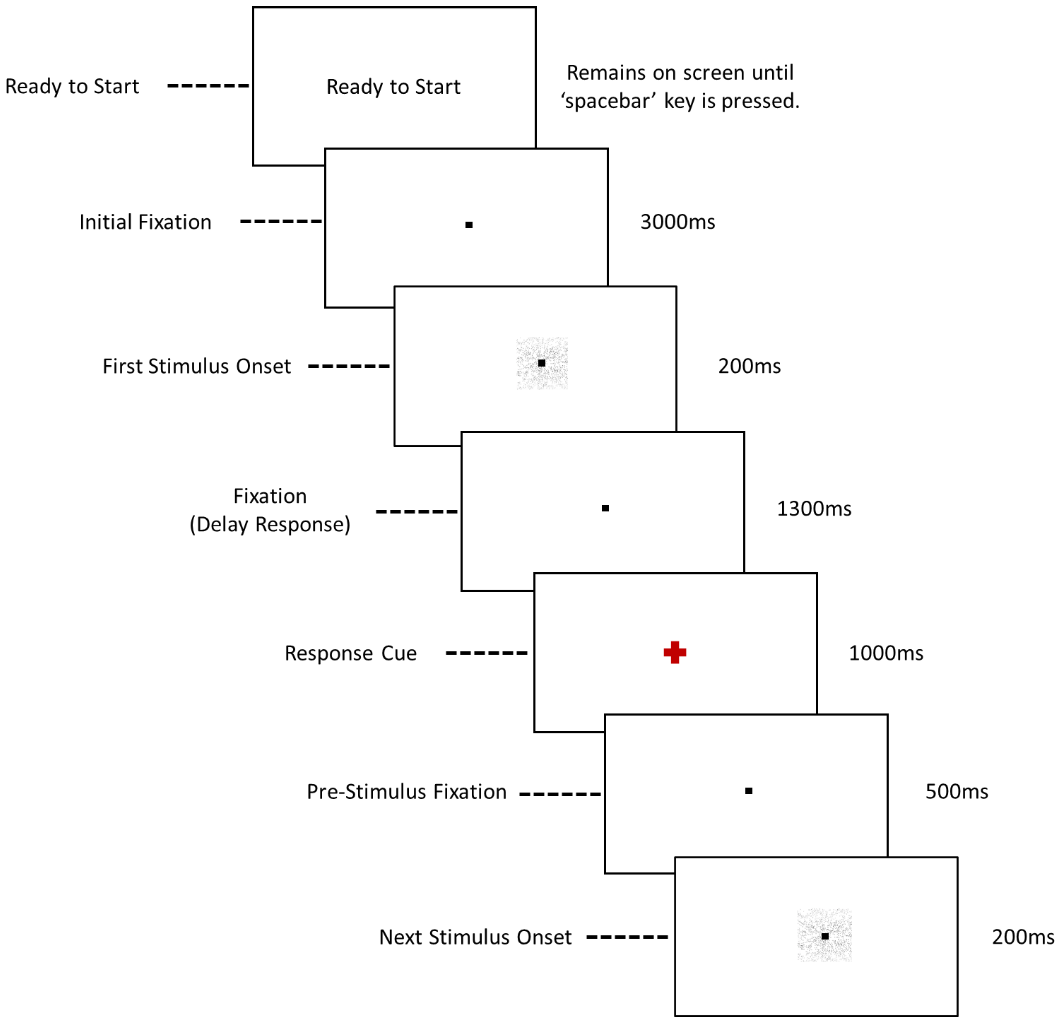


Note. The radial (top) and concentric (bottom) patterns are presented with inverted contrast for illustration purposes. The stimulus prototypes with 100% signal are also shown for comparison purposes only. The signal-in-noise patterns are generated with 37.5±2.5% signal.

A total of four experimental runs were administered for each participant. Each run constituted 108 trials that were randomised between two stimulus conditions (radial and concentric). Figure 3.3 presents the sequence of events for each trial in the Glass (1969) pattern discrimination task. Each trial consisted of a 200 ms stimulus presentation followed by a 1300 ms fixation. A response cue then appeared for 1000 ms to prompt participants to identify the pattern by pressing key ‘1’ for radial patterns and key ‘2’ for concentric patterns. The fixation between stimulus presentation and the response cue ensures that RTs are standardised across participants and groups. A 500 ms fixation dot was displayed on the screen before the next trial onset.

Figure 3.3

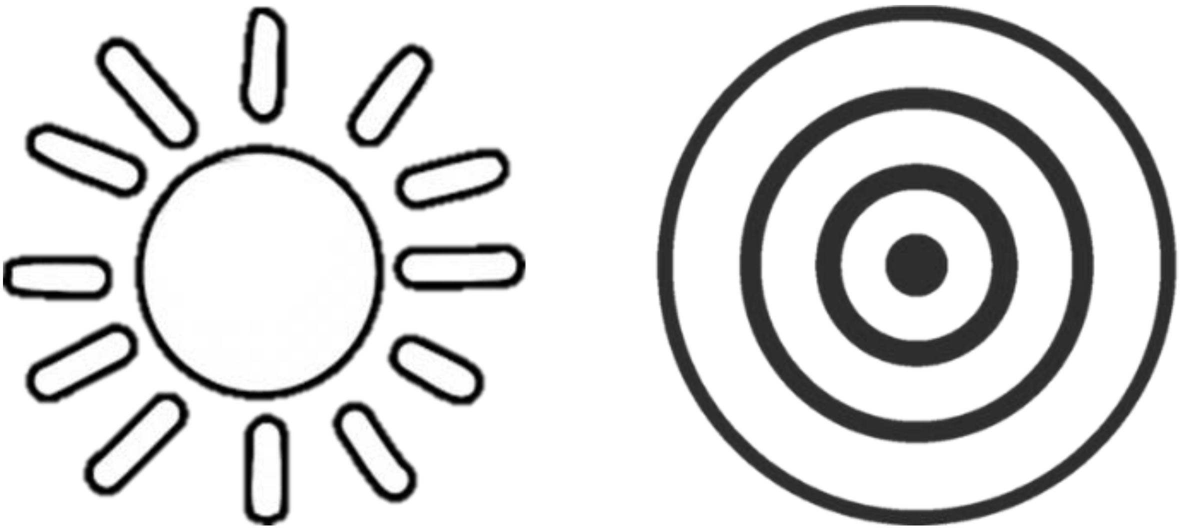
Glass (1969) Pattern Discrimination Task Sequence of Events



The experiment also consisted of a familiarisation phase that was time-constrained in the same way as the experimental phase to ensure that participants were aware of the actual speed of the experimental trials and familiarised themselves with the response keys. The trials in the familiarisation phase consisted of an image of the sun to represent radial patterns and an image of a target to represent concentric patterns (see Figure 3.4).

Figure 3.4

Stimuli Presented During the Familiarisation Phase



Note. The image of the sun represents radial patterns, while the image of the target represents concentric patterns. The trials in the familiarisation phase were time-constrained in the same way as the experimental trials.

Equipment. The experiments were carried out on a 22” Lenovo ThinVision coloured monitor with a 1920×1080-pixels resolution and a frame refresh rate of 60Hz.

3.2.4 Procedure

Once informed consent was obtained, participants were instructed to complete the demographics questionnaire and SCS. Participants were assigned to either the collectivistic condition or the individualistic condition, depending on the background information provided in the demographic questionnaire. The computer task began with an initial familiarisation phase consisting of 15 mock presentation trials of the sun (representative of radial patterns) and a target (representative of concentric patterns) to familiarise participants with the keypresses. Results were not recorded during the familiarisation phase. Participants then completed four experimental runs with breaks in between each run. Response accuracy (number of correct pattern identifications) for each participant was recorded. Participants were debriefed upon completion of the study. All the experiments were conducted in a dark room.

3.2.5 Data Analysis

The data, which met parametric assumptions, was analysed in four steps. First, an analysis was conducted to test the hypothesis and identify if participants from collectivistic backgrounds had greater response accuracy than participants from individualistic backgrounds across each run. The second analysis examined cultural group differences in learning rates to substantiate the findings of the initial analysis. *Learning rates* in the present study was defined as the slope of the linear line fitted for accuracy across four runs. A third analysis was then carried out to identify whether accuracy differences could be attributed to independent or interdependent self-construals. Three participants whose scores were equal on both subscales were excluded from the third analysis as these participants could not be classified into either category. Lastly, a regression analysis revealed if cultural background and SCS values were predictive of overall accuracy and learning rates. Overall accuracy and learning rates (slope) represent different learning indices; the former reflects the general ability of participants to engage in global processing to support overall learning, while the latter reflects the rate at which participants learned to discriminate the patterns. The background and SCS categories were coded into dummy variables for this analysis.

3.2.6 Ethical Considerations

Ethical approval was granted by the university's research ethics committee (Reference: PSY_BSc_OCT17_001; see Appendix H2). Written consent was needed, and participants could leave at any time without consequence. Participants were looking at the computer screens for at least 60 minutes. Therefore, they were advised to refrain from participating in the experiment if they could not look at computer screens for extended periods. Participants are allowed breaks of 60 seconds per experimental block (there are four blocks in total) with a longer break of 180 seconds halfway through the experiment to avoid fatigue. The experimenter was always present to address any concerns or issues participants may have.

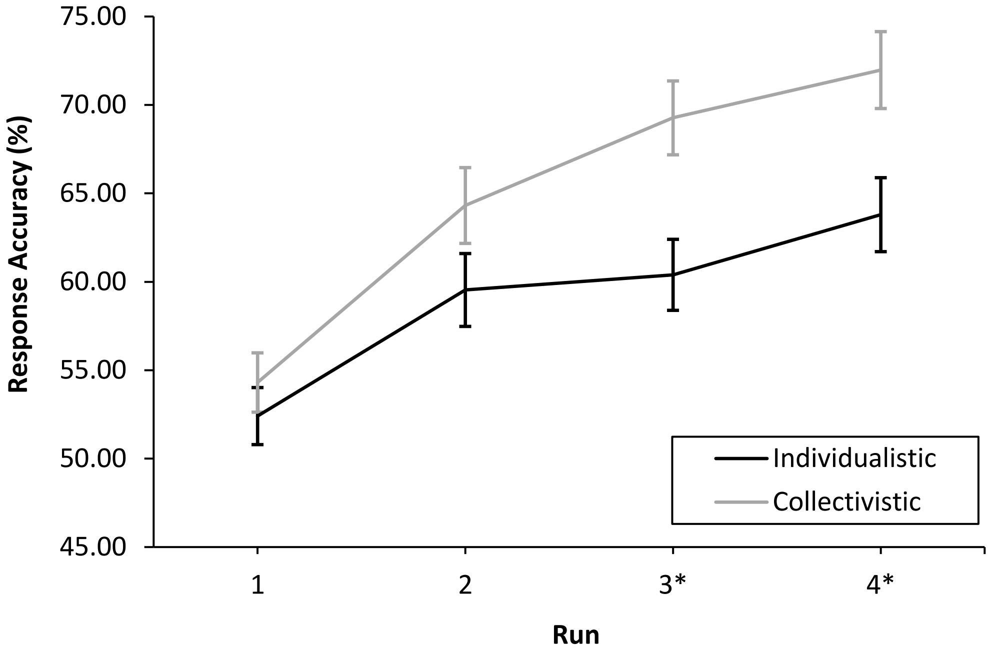
3.3 Results

3.3.1 Macro Level Comparison of Response Accuracy for Individualistic and Collectivistic Groups

A 2 (Background: Individualistic or Collectivistic) × 4 (Run: 1, 2, 3 and 4) mixed-measures ANOVA was first run to compare response accuracy between the individualistic (n = 40) and collectivistic (n = 37) groups. The results revealed an interaction between background and runs (F(2.58, 193.72) = 3.95, p = .013, η^2_p = .050, Greenhouse-Geisser Corrected), suggesting learning differences between the individualistic and collectivistic groups. A main effect of runs (F(2.58, 193.72) = 59.19, p < .001, η^2_p = .441, Greenhouse-Geisser Corrected) indicated that both groups improved during training, while a main effect of cultural background (F(1,75) = 7.30, p = .009, η^2_p = .089) indicated that individualistic and collectivistic groups differed significantly in performance accuracy (see Figure 3.5). Importantly, post-hoc t-tests with multiple comparison adjustments (Bonferroni corrections) revealed that although both groups initially exhibited similar accuracy performance at Run 1 (p = .381) and Run 2 (p = .087), the collectivistic group subsequently exhibited significantly better performance than the individualistic group at Run 3 (t(75) = 9.59; p = .001; *Cohen's d* = .756) and Run 4 (t(75) = 8.83; p = .005; *Cohen's d* = .664). These results suggest that the collectivist group had greater improvements during training compared to the individualistic group.

Figure 3.5

Response Accuracy of Individualistic and Collectivistic Groups



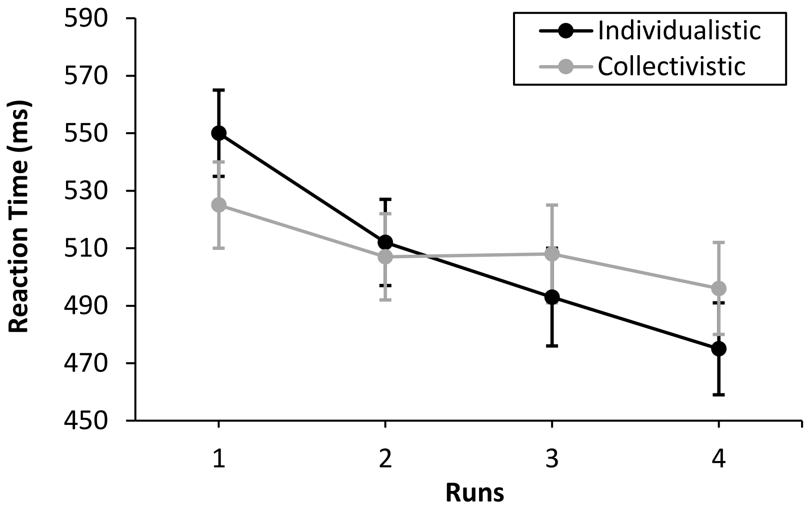
Note. The performance of the collectivistic (*n* = 37) group were consistently better than the individualistic group (*n* = 40). Response accuracy data is presented in percentages. The error bars represent standard errors.

3.3.2 Macro Level Comparison of Learning Rates between Individualistic and Collectivistic Groups

Learning rates (slope of accuracy across runs) were also examined to further explore cultural group differences in improvement during training. A Welch's t-test for unequal variances conducted on the learning rates revealed a significant difference between the individualistic (*M* = 3.78; *SD* = 3.44) and collectivistic (*M* = 6.26; *SD* = 4.72) groups, *t*(75) = 7.00; *p* = .011; *Cohen's d* = .600, where the collectivistic group exhibited higher learning rates. These findings validate the interaction reported for the ANOVA above and illustrate the influence of culture on VPL. Indeed, the absence of cultural group differences in RTs across all runs suggest that the cultural variations in task performance are not confounded by the effects of differential RTs (*p* = .926; see Figure 3.6). It can thus be presumed that the behavioural differences in accuracy performance and learning rates can instead be attributed to cultural group differences in global processing strategies.

Figure 3.6

Reaction Times of Individualistic and Collectivistic Groups Across all Runs



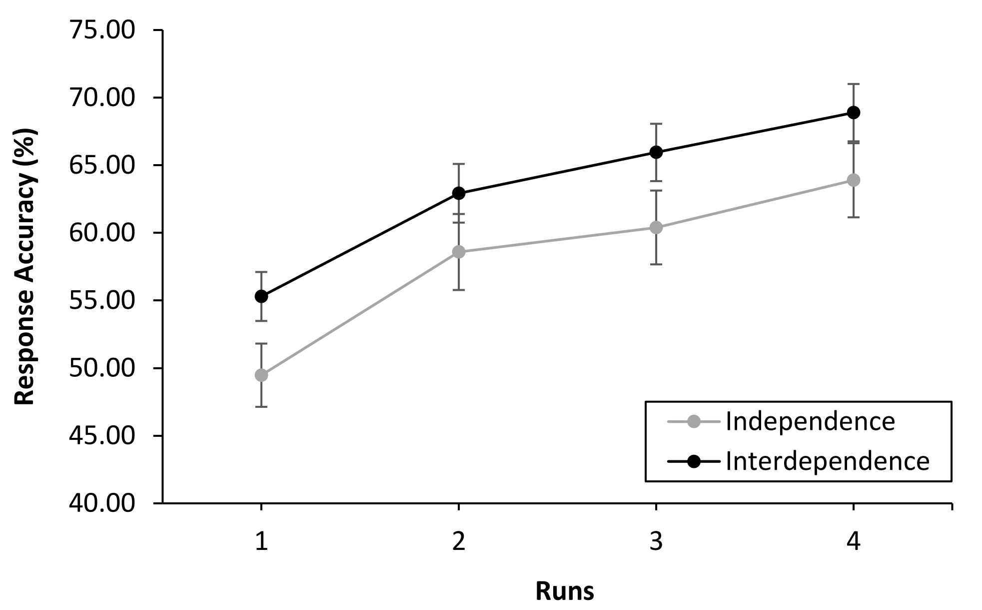
Note. The absence of group differences in RTs suggest that the cultural variations in performance are not confounded by the effects of differential RTs. The error bars represent standard errors.

3.3.3 Micro Level Comparison of Response Accuracy and Learning Rates Between Individuals with Independent or Interdependent Self-Construal

The following analysis of participants' responses on Singelis' (1994) self-construal scale revealed that more participants identified with an interdependent self-construal (*n* = 46) than with an independent self-construal (*n* = 28), while three participants identified with both categories. A mixed-measures ANOVA revealed a non-significant interaction between self-construal and response accuracy (*p* = .792; see Figure 3.7), while the between-subjects effect only approached significance (*p* = .091). A Welch's t-test on learning rates also revealed no significant difference between the independent (*M* = 4.43; *SD* = 4.29) and interdependent (*M* = 5.08; *SD* = 4.25) groups (*p* = .524).

Figure 3.7

Comparison of Response Accuracy Between Those with Independent or Interdependent Self-Construal



Note. There were no group differences in response accuracy between those with independent (n = 46) and interdependent self-construals (n = 28). The error bars represent standard errors.

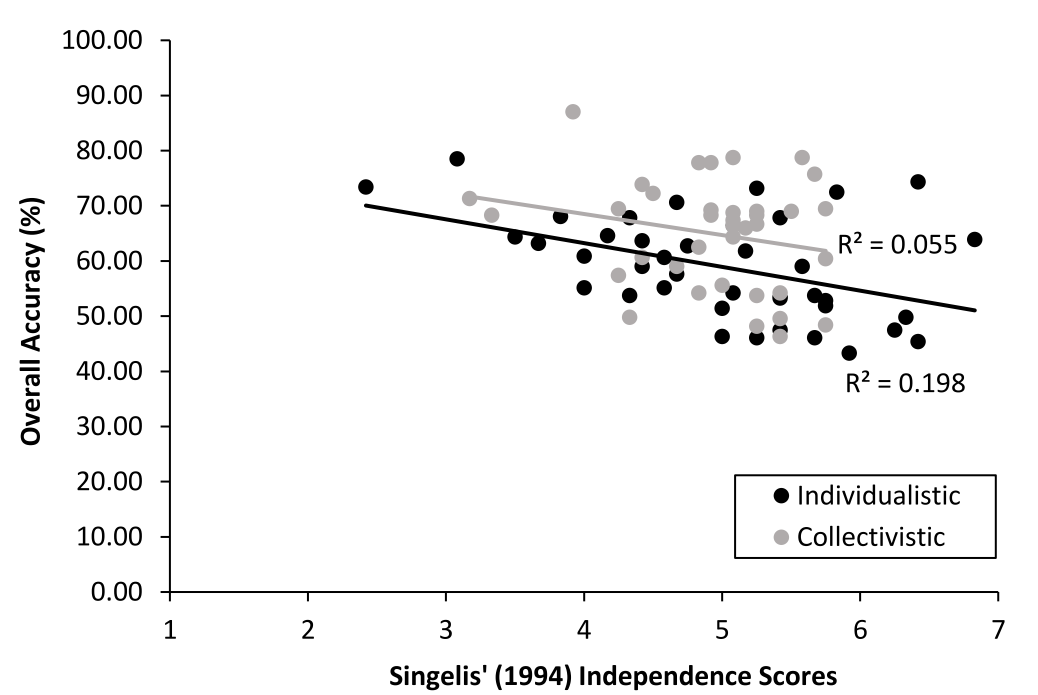
Taken together, it appears that the SCS cannot be used as dichotomous categories to explain the cultural differences in VPL. However, since independent and interdependent SCS constructs can also be analysed as continuous value dimensions rather than categorical traits at the individual level (Oyserman et al., 2002), people can adhere to both values in varying degrees on a continuum. A regression analysis was thus carried out to identify if variability in independent and interdependent scores, used as continuous rather than binary regressors, in addition to cultural background, could be associated with overall performance and learning rates.

3.3.4 Examining the Influence of Sociocultural Variables on Task Performance

For the first regression analysis, accuracy scores across all runs were collated to determine overall accuracy. Using the enter method, a multiple regression was run to predict the variability in overall accuracy (M = 267.25; SD = 43.36) using cultural background (individualistic or collectivistic), as well as independent (M = 4.96; SD = .808) and interdependent self-construal (M = 5.16; SD = .637) as predictor variables for the model (see Figure 3.8 and Figure 3.9). The assumptions relating to multicollinearity and independence of observations were met. Together, the predictor variables explained 17.2% (*Adjusted* R^2 = .172) of the variability in overall accuracy. The overall association between the predictor variables and accuracy performance was significant, $F(3, 76) = 6.28$, $p = .001$. Specifically, the individualistic (b = - 23.97; p = .011) and independence (b = - 18.32; p = .002) variables had a significant and negative association with overall accuracy. Since both variables have been linked to analytic thinking (Choi et al., 2007), the lower predicted accuracy could be due to conflicting thought processes during VPL of global patterns. However, the interdependent scores were not predictive of overall accuracy (b = 3.97; p = .585).

Figure 3.8

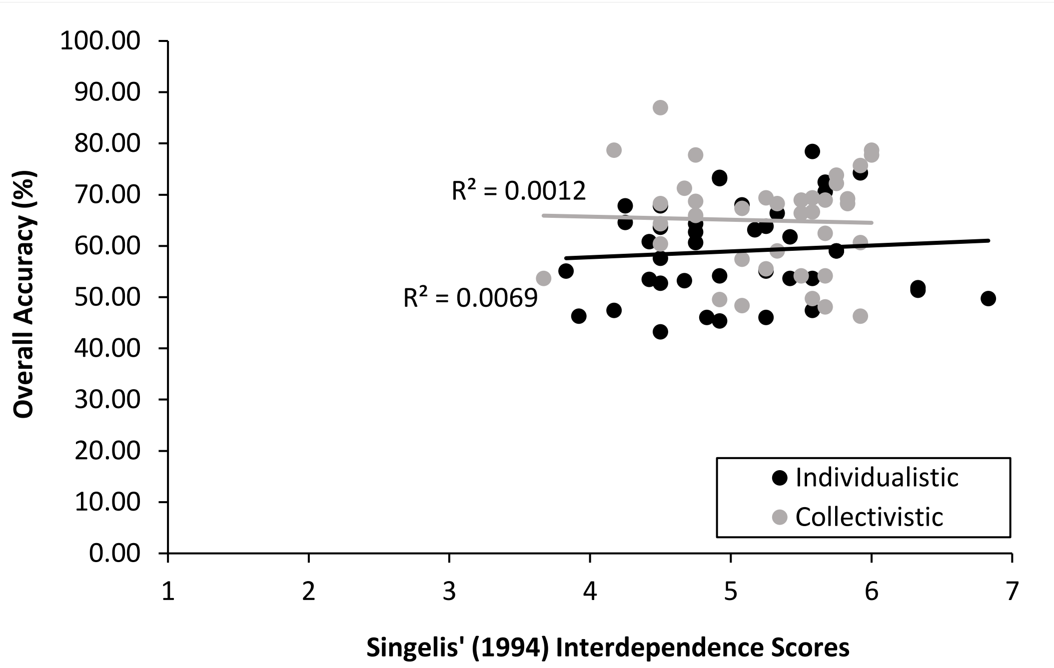
Scatterplot Depicting the Relationship between SCS Independence Scores, Cultural Background, and Overall Response Accuracy



Note. Individualistic cultural backgrounds and independence SCS scores were significant and negative predictors of overall accuracy.

Figure 3.9

Scatterplot Depicting the Relationship between SCS Interdependence Scores, Cultural Background, and Overall Response Accuracy



Note. SCS interdependent scores were not predictive of with overall accuracy.

The second regression analysis on learning rates revealed that the predictor variables explained 8.2% (*Adjusted* R^2 = .082) of the variability in learning rates, *F*(3, 76) = 3.26, *p* = .026. However, only individualistic backgrounds had a significant and negative association with learning rates (*b* = - 2.23; *p* = .021). Singelis' (1994) independence (*b* = -.635; *p* = .279) and interdependence scores (*b* = .995; *p* = .188) did not contribute significantly to this model. The inconsistent predictive influence of independent self-construal on different learning indices, i.e., overall accuracy and learning rates, will be considered in the discussion.

3.4 Discussion

The present study aimed to identify the influence of macro and micro cultural characteristics on VPL using the Glass (1969) pattern experimental paradigm. As hypothesised, the collectivistic group had greater performance accuracy in this discrimination task than the individualistic group.

These findings are compelling as cultural differences in VPL emerged despite evidence of the GPE (Gerlach & Starrfelt, 2018; Liu & Luo, 2019; Mills & Dodd, 2014; Navon, 1977; Rezvani et al., 2020). Although all participants learned to differentiate the global visual forms, the learning trajectory eventually diverged as the experiment progressed. There were clear differences in VPL trajectories between both cultural groups. Therefore, these findings are consistent with the notion that culture can shape cognition and behaviours (Caparos et al., 2012, 2020; Davidoff et al., 2008; Trémolière et al., 2021; van der Kamp et al., 2013). Indeed, the VPL differences in the present study can be associated with previous cross-cultural findings that suggest collectivists are more holistic and attuned to the relationships between objects and events in the environment (e.g., Caparos et al., 2020; Jenkins et al., 2010; Kim et al., 2009; Koo et al., 2018). It is thus proposed that differential cognitive strategies resulted in the divergence in performance between both cultural groups.

The outcomes of the present study are significant as it demonstrates that culture can indeed underlie VPL abilities. Specifically, the macro level cultural conceptualisation using the individualism and collectivism framework has revealed a fundamental processing difference between cultures that inform VPL under specific task conditions. The group differences in the learning of the global Glass (1969) patterns support the proposition that collectivists, represented by the international student sample, are indeed more holistic (Jenkins et al., 2010; Masuda & Nisbett, 2006). In contrast, the individualists, represented by European students, could be impeded in their learning due to greater propensities for analytic thinking (Kitayama et al., 2019; Kitayama & Uskul, 2011; Nisbett et al., 2001). As such, this study suggests that individualistic and collectivistic environments can inform the cognitive and behavioural strategies that people from different cultures adopt (Caparos et al., 2020; Davidoff et al., 2008; Markus & Kitayama, 2010; Trémolière et al., 2021). However, although these results indicate that collectivists are more holistic than individualists, there was no direct assessment of analytic or holistic tendencies to link performance to these cognitive styles. Future studies should thus utilise other measures to capture the multiple facets of culture that could influence VPL. Taken together, the individualism and collectivism dimensions are useful for group analysis at the macro level of culture. However, macro level analyses may be reductive as it assumes that all members of a culture share similar abilities and motivations (Rogoff & Gutierez, 2003; Taras et al., 2016). Therefore, a micro level of analysis was also applied in the present study to examine the dynamic influence of individuals on cultural systems, cognition, and behaviour.

A standardised individual-level measure at the micro level of culture can account for individual variations in goals, abilities, attitudes, and beliefs (Singelis et al., 1995). For example, self-construal influences have been observed in physiological and psychological manifestations (Chiao et al., 2013). However, contrary to previous research (Goto et al., 2010; Han & Ma, 2014; Hedden et al., 2008; Ma et al., 2014), the present study did not find differences between participants with independent or interdependent self-construal as measured using Singelis (1994) SCS. As discussed in Chapter 2, this could first be due to limitations of the SCS and its possible insensitivity in measuring cultural distinctions (Levine et al., 2003). Additionally, more participants in the present study had inclinations towards interdependent values regardless of cultural backgrounds. It is estimated that participants in cross-cultural research are often highly susceptible to confounding variables such as cultural shifts, sociohistorical backgrounds, linguistic abilities, and ecological differences (Chen et al., 2018; Grossmann et al., 2012). Future studies should thus employ alternative individual level differentiations such as cognitive style measures (e.g., Choi et al., 2007) or visual tests (e.g., Kitayama et al., 2003) that may be more representative of individual level distinctions of culture.

There could also be a deficiency of cultural influences at the individual level on VPL abilities (Magid et al., 2017; Marquez & Ellwanger, 2014). The international student sample, for instance, may have influenced the results of the present study, as individuals who voluntarily immigrated to another culture may have psychological affinities to the culture that they chose to live in (Kitayama et al., 2003). They may also amass multiple cultural identities through acculturation and exposure to varying sociocultural contexts (Hong et al., 2000; Mok & Morris, 2012; Xi et al., 2018). Contradictory evidence of cultural differences should thus be interpreted with caution. Nevertheless, the present study still serves as an intriguing foundation for expanding research in this interdisciplinary domain of culture and VPL, as the value of independence was observed to be a predictor of poorer task performance. To circumvent some individual level confounds, future investigations could be directed on people who have lived in more than one culture (i.e., bicultural individuals). This population may internalise multiple cultural identities due to the integration of values from their early cultural experiences with the values adopted from the host country. Consequently, these internalised cultural systems can be activated at different times and contexts through primes or environmental triggers such as language (Mok & Morris, 2012; Ng et al., 2010; Xi et al., 2018).

Since population samples may not always represent distinct cultural systems (Gudykunst & Lee, 2003), individual-level analyses thus remain indispensable for examining the dynamic nature of culture (Matsumoto et al., 2001). For example, although individuals may have stronger inclinations towards a specific cultural orientation to guide behaviour, these values can shift according to varying social environments (Grossmann & Jowhari, 2018; Hong et al., 2000; Kühnen & Oyserman, 2002; Wang et al., 2013). As mentioned previously, individuals can internalise multiple cultural identities and mental representations that are dynamic and can manifest differentially under varying contexts (Brewer & Gardner, 1996; Mok & Morris, 2012; Ng et al., 2010; Xi et al., 2018). Priming self-construal could thus allow for a causal examination of the relationship between specific cultural characteristics and VPL processes (Han et al., 2013). Interdependence priming, for instance, has been found to induce broader attention scopes (Lin & Han, 2009). Wang (2008) also reported that Asian Americans primed to identify more strongly as Americans recalled more self-oriented memories, whereas those primed to identify as Asians recalled more socially oriented memories. Clearly, priming techniques are an important commodity for cross-cultural research as it allows researchers to make direct inferences about how cultural characteristics such as self-construals can influence behaviour and neural responses (Lin et al., 2008; Ng et al., 2010; Sui & Han, 2007; Xi et al., 2018). Studies using priming methodologies could reveal the intricate interaction of social, individual, and situational factors that govern the manifestation of culture in human behaviour and cognition.

The present study adds to our knowledge of cultural diversity in the community (Santamaria, 2009). Research that seeks further knowledge and acceptance of cultural distinctiveness in cognition and behaviours represents an important foundation for establishing universal training programmes and interventions that ensure learning success for all (Weber et al., 2015). Acknowledging learning barriers could encourage the accommodation of more diverse needs within multicultural learning environments (Sharma et al., 2019).

3.5 Chapter Summary

Despite considerable reports of individual differences in perceptual learning trajectories (Hansen et al., 2012; Rop & Withagen, 2014; Withagen & Caljouw, 2011; Withagen & van Wermeskerken, 2009), there is a lack of research within this domain in the context of culture. Due to the complexity of culture and its differential impact on human psychological processes, there is a great theoretical interest in exploring if the processes underlying VPL can also vary as a function of culture. Information processing strategies can vary significantly due to cultural mediation (Blais et al., 2008, 2021; Caparos et al., 2020; Davidoff et al., 2008). Indeed, the present study reported greater improvements in response accuracy for the collectivistic group in differentiating complex stimuli, reflecting their increased tendency to attend to global information. Notably, it provides compelling preliminary evidence that culturally informed cognitive strategies could influence VPL trajectories despite the GPE. Nevertheless, the lack of differences between individuals with independent and interdependent self-construal reflects a need for further research employing priming procedures or neural measures to explore the dynamic multilevel influence of culture that could impact VPL. Based on the outcomes of the present study and its limitations, the following study will employ a priming procedure to enable a causal examination into the impact of micro level cultural characteristics on VPL in the Glass (1969) pattern discrimination task.

Chapter 4: The Influence of Self-Construal Priming on Visual Perceptual Learning

Based on the findings in Chapter 3, further exploration of micro level influences on VPL is needed to address the limitations associated with the representativeness of participant samples. Indeed, culture is dynamic (Briley et al., 2014); people can internalise multiple cultural identities and value structures based on their exposure to varying sociocultural contexts (Hong et al., 2000; Mok & Morris, 2012; Xi et al., 2018). These identities can be made salient through priming manipulations to examine the influence of specific cultural values on cognition, behaviours, and neural processes (Brewer & Gardner, 1996; Kühnen & Oyserman, 2002; Matsumoto & Kupperbusch, 2001; Mok & Morris, 2012; Ng et al., 2010; Wang et al., 2013; Xi et al., 2018). Therefore, extending on the finding that independence values are predictive of poorer performance on the Glass (1969) pattern discrimination task (see Section 3.3.4), this chapter presents a causal examination into the influence of independence-interdependence cultural values on VPL processes using a cultural priming procedure. This chapter will begin with an overview of the dynamicity of culture and the importance of this dynamic view in examining cultural differences in cognition and behaviour. Past research will be evaluated, with a specific focus on priming methodologies designed to investigate the dynamic nature of culture. The justifications for a priming study are then presented. The study outcomes are reported and discussed in the final section of this chapter.

4.1 Background

Cultures evolve and transform in response to globalisation and environmental changes at micro and macro levels (Erez & Gati, 2004). Traditional static views of culture such as Hofstede's (1980) national cultural index assume that cultural values are stable structures that remain consistent across time and space. However, there is a progressive shift of research from static to dynamic views to account for our increasingly diverse societies (Gelfand et al., 2017; Greenfield, 2018; Kwon et al., 2021; Kashima et al., 2019). The dynamic view contrasts with traditional static approaches that assume culture to be composed of discrete and rigid constructs rather than integrated and domain-general constructs (Bruner, 1990). An individual could thus embody multiple cultural identities that become operative in guiding behaviour and the construction of meaning in different contexts (Hong et al., 2001; Oyserman & Lee, 2008). According to the dynamic view of culture, these cultural knowledge and identities are accessible, flexible, and dynamic (Briley et al., 2014). Therefore, researchers can identify the circumstances in which cultural differences may arise or disappear (Briley et al., 2014).

As discussed in Chapter 1, the dynamic view of culture is supported by two cognitive models that describe culture as a diffused network of knowledge structures that can be activated according to situational or environmental demands to influence cognition and behaviour (Briley et al., 2014). The situated cognition model (Oyserman & Sorensen, 2009) and the dynamic-constructivist model (Chiu & Hong, 2006; Hong & Chiu, 2001) contributes to a compelling avenue for research on the dynamic influence of culture in different contexts (see Section 1.2.4). Indeed, the priming techniques derived from the cognitive approach are important as it assumes that people can dynamically integrate or dissociate from some features of their cultures (Benet-Martínez et al., 2002; Hong et al., 2000). Priming has thus been widely used in cross-cultural research to allow the experimental isolation of cultural influences on psychological processes (Flinkenflogel et al., 2019).

Priming allows the attribution of cultural values to a wide range of behaviours such as relational and categorical thinking (Ji et al., 2000, 2004), perceptual processing styles (Lin et al., 2008; Miyamoto et al., 2006), as well as in neural representations of the self and others (Ng et al., 2010; Wang et al., 2013). During priming, individuals are exposed to stimuli related to a specific cultural construct, thereby making salient the knowledge structures of specific cultural systems to temporarily identify its influence on cognition or behaviour (Briley et al., 2014). An essential feature of the priming procedure is that the task is typically presented as an independent and unrelated exercise. Participants are usually unaware of its true purpose in shifting cultural identities. It is anticipated that priming will induce a spread of activation from one construct to another within a psychologically linked network of constructs (Chiu & Hong, 2006; Hong & Chiu, 2001; Oyserman & Sorensen, 2009). Priming effects can then be assessed using a dependent measure to establish causal links between cultural values and psychological manifestations (Han, 2015).

To further illustrate priming methodologies within cross-cultural research (see Section 1.2.4 for additional examples), Hong et al. (2001) used an “I” or “we” manipulation adapted from the twenty-statement task (Kuhn & McPartland, 1954) to activate the cultural identities of bicultural Chinese Americans. Participants made a comparable number of collective and individualistic statements when their American identity was made salient. However, participants generated more collective statements when primed with cues related to their Chinese cultural identity. Evidently, priming is useful for studying culture as a dynamic construct.

Bicultural individuals exposed to Chinese or Western pictorials also exhibited changes in brain activity linked to the inclusiveness of the self with significant others, thereby providing neural evidence for the prominence of interdependent cultural values (Ng et al., 2010). Using the pronoun circling task (Gardner et al., 1999), Lin et al. (2008) further reported significant neural differences in ERPs amongst Chinese participants primed with independence versus interdependence in a global and local target discrimination task. These studies provide neural evidence for Markus and Kitayama’s (1991) independent and interdependent self-construal constructs. However, Ng et al. (2010) and Lin et al. (2008) did not report significant behavioural differences following priming. Therefore, the apparent neural difference remains speculative. Indeed, the inconsistencies across methodologies and findings necessitate further research on the efficacy of a priming approach in linking sociocultural orientations to cognition and behaviours (Grossmann & Jowhari, 2018; Li et al., 2018; Magid et al., 2017; Marquez & Ellwanger, 2014; Oyserman & Lee, 2008; Xi et al., 2018).

Regrettably, the replication crisis in social psychology research has cast doubts on the efficacy of priming despite the priming effects identified in past studies (Aarts et al., 2015; Wiggins & Christopherson, 2019). For example, Magid et al. (2017) observed that neither solitary nor collective settings, replicating herding and rice-farming practices within laboratory conditions, could prime social orientations and cognitive styles. Working alone or together did not induce the independence-analytic or interdependence-holistic tendencies held by different cultural groups. It was proposed that priming may be insufficient for simulating subsistence-related behaviours as laboratory conditions do not mirror the intensity of real-world scenarios. Furthermore, historical determinants may not generalise to the contemporary populations. Climate and differential pathogen exposure (Fincher et al., 2008), socioeconomic disparities (Grossmann & Varnum, 2015), or shifts in learning systems (Chang et al., 2011) could influence modern-day variations in social orientations or cognitive styles. Therefore, cultural influences may not always manifest behaviourally, as they may operate on distinct processes which are not yet identified. Future research should administer systematic approaches in exploring the dynamicity of culture and its specific impact on implicit and manifested psychological processes. Specifically, in the context of the present thesis, furthering research in this domain could offer causal evidence of micro level cultural influences on VPL.

This chapter seeks to expand existing research on cultural priming into the domain of VPL and address inconsistencies in the efficacy of priming (Grossmann & Jowhari, 2018; Li et al., 2018; Magid et al., 2017; Marquez & Ellwanger, 2014; Oyserman & Lee, 2008; Xi et al., 2018). The proposed research will present a novel investigation into the link between independent-interdependent cultural values and analytic and holistic tendencies that could impact VPL in the Glass (1969) pattern discrimination task. Research is needed to supplement the dynamic models of culture to identify the specific characteristics of culture which influence VPL. Behaviours can stem from conscious and unconscious processes, and culture can govern these processes in different ways (Briley et al., 2014). Therefore, it is worthwhile to employ priming techniques to identify the explanatory constructs that inform cross-cultural differences. Since Chapter 3 reported evidence of macro level cultural influences on VPL, the present study will focus on micro level characteristics of independence and interdependence and how these can inform VPL trajectories.

4.1.1 Aims of Study

The present study builds on Chapter 3 and aims to further explore the influence of self-construals (micro cultural characteristics) on VPL. The priming of independent and interdependent self-construal can temporarily alter an individual's perception of the self, thus revealing the manifestation of thoughts and behaviours characteristic of independent and interdependent values (Hong et al., 2000; Kühnen & Oyserman, 2002; Oyserman & Lee, 2008). As a priming manipulation check, Singelis' (1994) SCS will be used to assess the differences in independent and interdependent self-construal held by the participants following priming. The AHS (Choi et al., 2007) and COS (Triandis & Gelfand, 1998) were also used as manipulation checks to assess if responses on these constructs could be linked to the priming procedure. The Glass (1969) pattern discrimination task was used to examine the effects of independence and interdependence on VPL. The endorsement of independence in mainstream Western cultures has been associated with more analytic thinking, whereas the widespread interdependence in Asian cultures has culminated in holistic thinking styles (Kitayama et al., 2009). Therefore, it is hypothesised that those primed with interdependence would exhibit greater accuracy and RT improvements in the global pattern discrimination task that requires holistic processing compared to those primed with independence. To minimise the confounding effects associated with diverse participant samples (Matsumoto & Kupperbusch, 2001; Wang et al., 2013; Wang et al., 2017), all participants recruited for this study were Westerners.

4.2 Method

4.2.1 Participants

A power analysis on G*Power estimated that a sample size of 45 participants is needed for an effect size of .250 (Faul et al., 2007; see Appendix S). Subsequently, sixty-one participants with a mean age of 22.17 (*SD* = 6.12) were recruited through a UK institution's Research Participation Scheme. Credits were rewarded to participants upon completion of the study. Participants in this study were British or European students who were randomly assigned to one of three experimental groups: independence priming, interdependence priming, or the control condition. The European students (*n* = 6) who were from countries such as Lithuania, Romania, Portugal, and Germany had been in the UK for between 1 month to 20 years. A further four participants (2 Indians, 1 Zimbabwean, 1 Zambian, 1 Nigerian) were British nationals who were born elsewhere but had lived in the UK for 7 to 17 years. One participant born in India had been in the UK since they were 11, while the participant born in Nigeria had been in the UK since they were 14. All participants had normal or corrected-to-normal vision. Table 4.1 presents a breakdown of participant demographics. One participant was excluded from all subsequent analyses as the participant made the same keypress for 98% of the trials.

Table 4.1

Sociodemographic Characteristics of Participants

Characteristics	*n*
Gender	
Female	56
Male	4
Handedness	
Right	53
Left	7
Living Arrangement	
Alone	3
Significant Others	33
Housemates	22
Other	2
Language	
English	54
Other	6
Ethnicity	
White	32
Black	5
Asian	21
Mixed	1
Other	1

4.2.2 Design

The present study employed a between-subjects design comparing three groups of participants; two groups were differentially primed with independence (n = 20) or interdependence (n = 20) values, while a third group was assigned to the control (n = 20) condition. Brewer and Gardner's (1996) pronoun circling task was used to prime values of independence or interdependence. Additionally, three measures – Singelis' (1994) SCS, Triandis and Gelfand's (1998) COS, and Choi et al.'s (2007) AHS – served as manipulation checks to assess the value systems held by participants following priming (see Chapter 2 for a review of these measures). Response accuracy and RTs of correct pattern discriminations were recorded for each participant to compare VPL differences between the three experimental groups. The cued-response design (delay between stimuli presentation and response) was removed from the present study to enable a comparison of RTs. The RTs could represent an additional indicator of VPL. Taken together, the independent variable in the present study is cultural priming, while the dependent variables are performance accuracy and RTs in the Glass (1969) pattern discrimination task.

4.2.3 Materials

Demographics questionnaire. The questionnaire identified background information such as nationality, gender, age, language abilities, ethnic background, and birthplace (Lawrence et al., 2019; Yeh, 2003). This information was collected to identify the influence of variables that could confound the results.

Singelis (1994) SCS. The SCS was used to identify self-construal differences between the individuals of the different experimental groups after the priming procedure. One participant had equal scores on both subscales. Cronbach's reliability for the overall scale was .622; Specifically, α values for the 12 independent and 12 interdependent items were .638 and .792, respectively. The α values were comparable to those identified in Chapters 2 and 3 for the SCS.

Triandis and Gelfand's (1995) COS. The COS assessed individualism and collectivism on four dimensions: HI, VI, HC, and VC (see Chapter 2). Cronbach's reliability for the overall scale in the present study was .700. Specifically, α values for the HI, VI, HC, or VC dimensions were .620, .421, .767, and .742, respectively. The reliability of the VI dimension was within an unacceptable range. Removing one item (VI 3: "Competition is the law of nature.") increases reliability to .565, which still constitutes poor reliability. Similarly, for the composite individualism (sum of HI and VI) dimension, reliability was .454. The collectivism (sum of HC and VC) dimension had reliabilities of .809. These reliabilities are inconsistent with those reported in Chapter 2. As such, the individualism constructs could not be consistently identified from the responses of the current sample, thereby presenting implications for the interpretation of findings associated with this scale.

Choi et al.'s (2004) AHS. The AHS measures holistic thinking on four dimensions (see Chapter 2). Cronbach's reliability for the overall scale was .628, consistent with the values reported in Chapter 2. Alpha values were .614, .608, .660, and .699 for the dimensions of causality, contradiction, change perception, and attention, respectively.

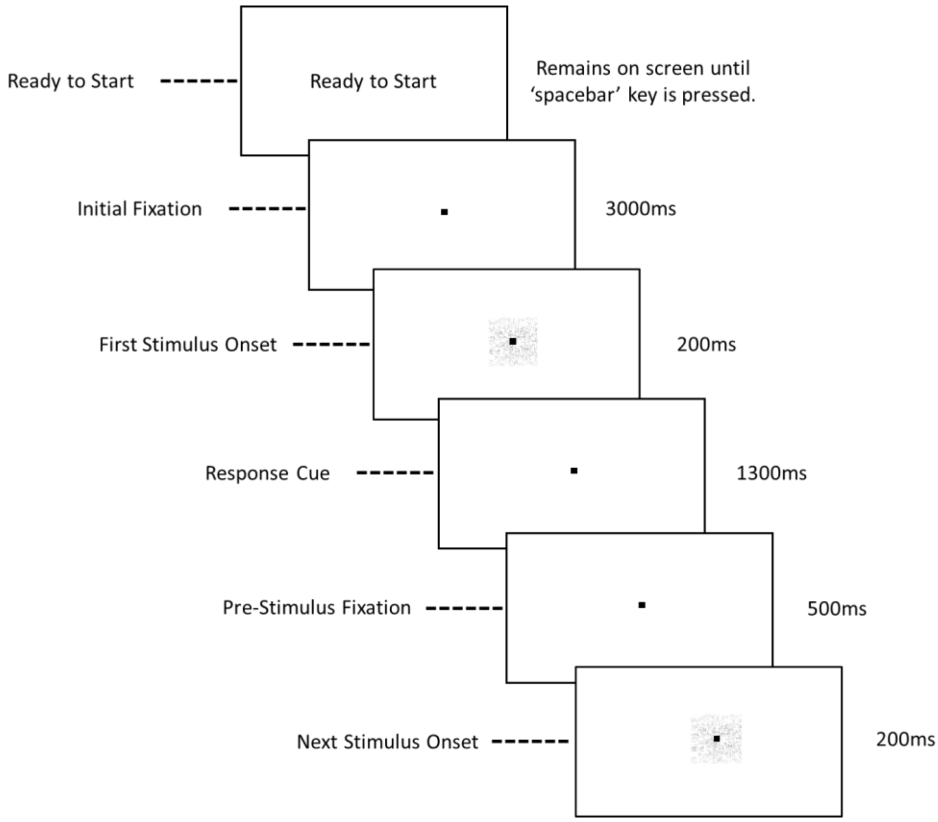
Pronoun Circling Task. The pronoun circling task is a cultural priming tool whereby participants count the number of pronouns within a descriptive paragraph about a trip to the city to prime independent or independent cultural values (Brewer & Gardner, 1996). The paragraph contained 19 pronouns that were varied according to the priming conditions. Singular pronouns such as 'me', 'I', or 'mine' were used to prime independence, while plural pronouns such as 'we', 'our', or 'us' were used to prime interdependence. An additional control condition that primed neither value required participants to identify 'it' pronouns within the paragraph.

Stimuli. MATLAB 2015a (The MathWorks Inc., 2015) was used in conjunction with Psychtoolbox-3 (Brainard, 1997; Pelli, 1997; Kleiner et al., 2007) for stimulus generation and presentation. Participants were tasked with discriminating radial and concentric Glass (1969) patterns to identify the cultural differences in perceptual learning processes. Specifically, the discrimination task was adapted from Mayhew et al.'s (2012) experimental paradigm to assess how observers learned to extract global shapes embedded in cluttered backgrounds. Each stimulus consisted of pairs of dots (2.3 × 2.3 arc min^2) or dot dipoles that were aligned according to the specified spiral angle (signal dipoles), displayed within a square aperture (7.9°×7.9°) against a black background (100% contrast). The spiral angle for each dot dipole is characterised by the angle between the dot dipole orientation and the radius from the centre of the dipole to the centre of the stimulus aperture (Frangou et al., 2019). Concentric patterns were formed by tangentially placed dipoles, while radial patterns were constructed by orthogonally placed dipoles. In the present study, radial patterns were generated using a spiral angle of ±0°, whereas concentric patterns were generated using a spiral angle of ±90°. These patterns had either 35% or 40% signal and were rotated clockwise or anticlockwise across trials in a randomised order (see Figure 3.2). Spiral angles were jittered across stimuli (±3°) to control for potential local adaptation and ensure that participants would learn to discriminate global shapes rather than just local features during stimulus categorization (Garcia et al., 2013).

The main experimental design consisted of four experimental runs. Each run had a total of 108 trials that were randomised between two stimulus conditions (radial and concentric). The order of trials was matched for history, such that each trial was equally likely to be preceded by any of the conditions. Two initial trials were added in each run to balance the history of the second trial; these were excluded in the final analysis. Each trial consisted of a 200 ms stimulus presentation followed by a 1300 ms fixation dot which was a cue for response. Participants made a response on key '1' for radial patterns and key '2' for concentric patterns. A 500 ms fixation dot was displayed on the screen before the next trial onset. Each experimental run began and ended with a 3000 ms fixation (see Figure 4.1). The study also consisted of a familiarisation phase where participants were presented with an image of the sun to represent radial patterns, and an image of a target to represent concentric patterns (see Figure 3.4). The trials in the familiarisation phase were time-constrained in the same way as the experimental trials to ensure that participants were aware of the actual speed of the experimental trials and familiarised themselves with the response keys.

Figure 4.1

Glass (1969) Pattern Discrimination Task Event Sequence



Note. The experimental design in the present study did not include a cued-response design (delay between stimuli presentation and response). Therefore, unlike the experiment in Chapter 3, participants were asked to make an immediate judgement following stimulus presentation.

Equipment. The experiments were carried out on a 22" Lenovo ThinVision coloured monitor with a 1920×1080-pixels resolution and a frame refresh rate of 60Hz. A chin rest was used to ensure that participants were constantly at 47 cm from the monitor to ensure that distance from the screen was not a confounding variable which would impact participant's performance in the computer task (Garcia et al., 2013; Mayhew et al., 2012).

4.2.4 Procedure

Once informed consent was obtained, participants were randomly assigned to either the independent or interdependent priming condition or the control condition. Participants were then instructed to complete the pronoun circling priming task (Brewer & Gardner, 1996) as a part of a proofreading and word search activity. Next, participants completed the familiarisation phase for the main experiment, followed by the four experimental phases with breaks in between each run. Response accuracy and RTs for each participant were recorded. The demographics questionnaire and three cultural measures (SCS, COS, and AHS) were then completed, and participants were debriefed. All experiments were carried out in a dark room.

4.2.5 Data Analysis

The data, which met parametric assumptions, were analysed using the IBM SPSS Statistic for Windows, Version 25.0 (IBM, 2017). First, a manipulation check was conducted to assess the value systems held by participants following the priming procedure. Next, an analysis was conducted to identify if participants primed with interdependence had greater response accuracy following training than the control group or those who were independently-primed. Overall accuracy was also calculated (sum of correct responses across four runs) and compared between the different priming conditions. As mentioned in Chapter 3 (see Section 3.2.5), the overall accuracy score represents the general ability of participants to engage in global processing to support accurate discrimination of the global forms. The third analysis examined group differences in RTs when making correct responses. Overall RTs were also calculated (average RTs for correct responses across four runs) for comparison between groups. The overall RT index also represents the average time for participants to differentiate the global patterns and make accurate perceptual judgements. Lastly, a regression analysis explored the predictive influence of sociodemographic variables on overall accuracy and overall RTs. All categorical variables were coded into dummy variables for the analysis.

4.2.6 Ethical Considerations

Ethical approval was granted by the university's research ethics committee (Reference: Chua #011.18; see Appendix H1). Participants were advised to refrain from participating in the experiment if they could not look at computer screens for prolonged periods. The chin rest was disinfected between each use. Participants are allowed breaks of 60 seconds per experimental block (there are four blocks in total) with a longer break of 180 seconds halfway through the experiment to avoid fatigue. The experimental procedure was explained thoroughly to participants before they provided written consent, and the experimenter was always present to address any concerns or questions. Contact details of the primary researcher, supervisors, and the ethics committee were provided to participants during the debrief. Participants could withdraw their data at any time, although data analysed collectively cannot be removed as they can no longer be identified individually.

4.3 Results

4.3.1 Priming Manipulation Checks

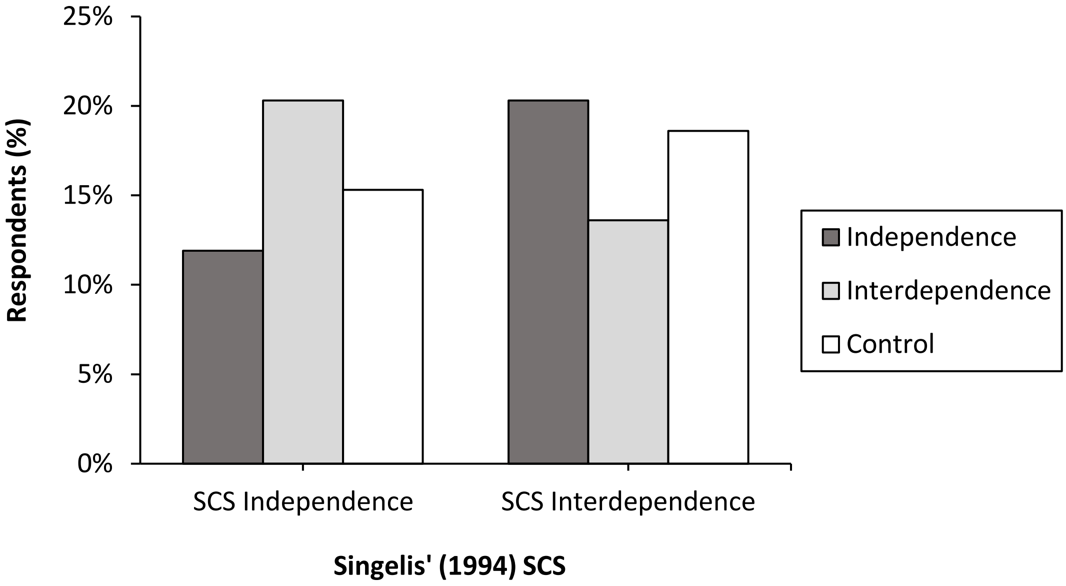
Before conducting the primary analyses, manipulation checks were performed to assess if the cultural values held by participants were consistent with their respective priming conditions. Although participants were primed with either independence or interdependence values, the SCS, COS, and AHS that measured self-construal, cultural orientation and holistic thinking were administered. Chapter 2 had established concurrent and predictive validity for these measures. Therefore, examining responses on all three measures were estimated to provide a more comprehensive insight into the influence of priming.

Singelis (1994) SCS. Participants who had been independently primed were more likely to hold interdependent self-construal. In contrast, interdependently primed participants were more likely to hold independent self-construal according to the SCS (see Appendix T1). However, as seen in

Figure 4.2, there was no statistically significant association between SCS self-construals and priming conditions, $\chi^2(2, N = 59) = 2.17, p = .338$, thus indicating that those primed with independence, interdependence, as well as the control group were equally likely to possess independent and interdependent self-construal as measured by the SCS.

Figure 4.2

Self-Construals (Singelis, 1994) of Participants According to Priming Conditions



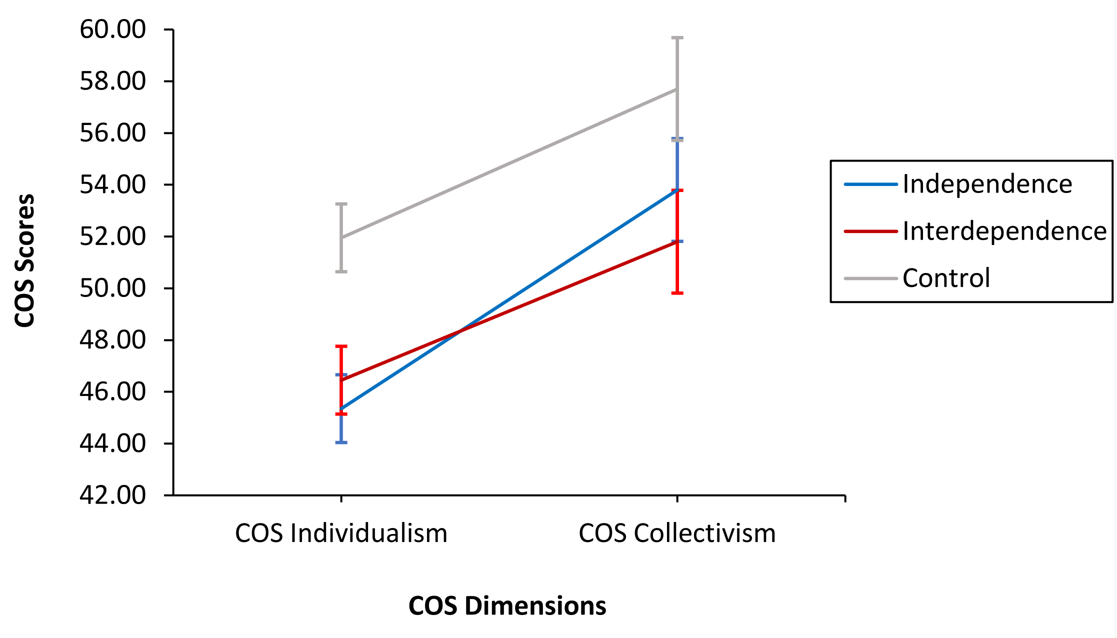
Note. Participants were equally likely to hold independent and interdependent self-construal regardless of priming conditions.

Triandis and Gelfand's (1995) COS. Separate scores were calculated for an individualism (sum of HI and VI) and collectivism (sum of HC and VC) dimension. The aggregated scoring procedure reduced the number of uncategorised participants from 13.3% ($n = 8$) to 3.3% ($n = 2$). However, a chi-square analysis revealed that participants regardless of priming condition were equally likely to hold individualistic or collectivistic values, $\chi^2(2, N = 58) = 1.32, p = .517$ (see Appendix T2). A further examination of the data by priming condition revealed a significant difference between the priming groups in individualism scores, $F(2, 57) = 7.29, p = .002, \eta^2_p = .204$. Participants in the control group

(*M* = 51.95; *SD* = 7.01) were significantly more individualistic than the independently (*M* = 45.35; *SD* = 4.85) and interdependently- (*M* = 46.45; *SD* = 5.50) primed groups (see Figure 4.3).

Figure 4.3

Cultural Orientation (Triandis & Gelfand, 1998) of Participants According to Priming Conditions



Note. Participants were equally likely to hold independent and interdependent self-construal regardless of priming conditions.

Choi et al.'s (2004) AHS. The mean score on this measure was 118.50 (*SD* = 9.81). The interdependently-primed group had lower scores (*M* = 116.60; *SD* = 10.14) than the independently-primed group (*M* = 119.40; *SD* = 9.59) and the control group (*M* = 119.50; *SD* = 9.91). However, there were no significant differences in holism scores between the priming conditions (*p* = .577).

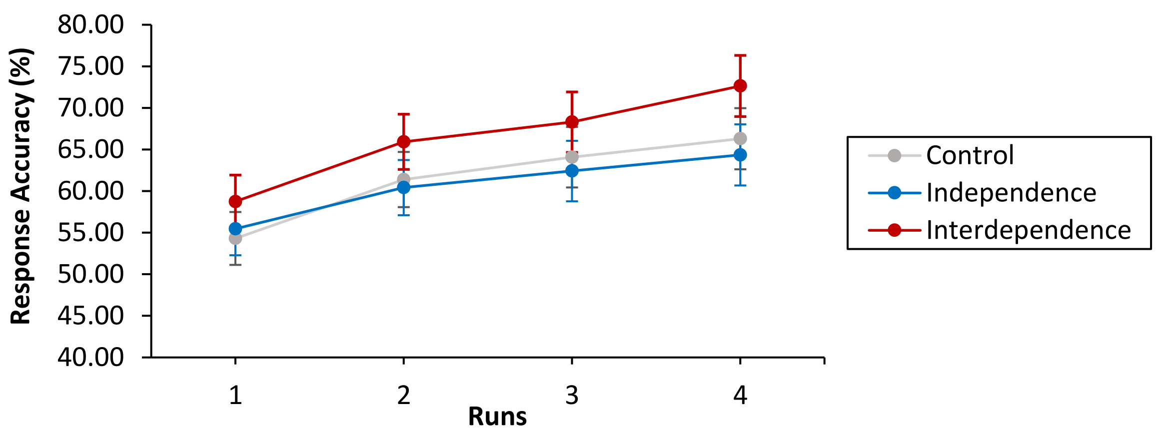
The manipulation checks revealed that the independence-interdependence priming procedure did not impact participants' responses on all three measures (SCS, COS, and AHS). Although the control group demonstrated significantly greater individualistic orientations on the COS than the experimental groups, these findings should be interpreted cautiously due to the poor reliabilities reported for the COS individualism dimension. Taken together, the lack of significant differences in the value orientations between the experimental groups following priming presents implications for the interpretation and validity of findings related to the main experimental data (see Section 4.4 for a detailed discussion).

4.3.2 Comparison of Performance Accuracy Between Priming Groups

A 3 (Priming: Independence, Interdependence, or Control) × 4 (Run: 1, 2, 3, and 4) mixed-measures ANOVA was run to compare response accuracy between the independent (n = 20), interdependent (n = 20), and control (n = 20) groups. As seen in Figure 4.4, all participants exhibited learning as the experiment progressed from the first to the last run, $F(2.36, 134.57) = 28.05$, $p < .001$, $\eta^2_p = .330$ (Greenhouse-Geisser Corrected).

Figure 4.4

Response Accuracy of Participants Across Four Runs



Note. No significant group differences were observed. The error bars represent standard errors.

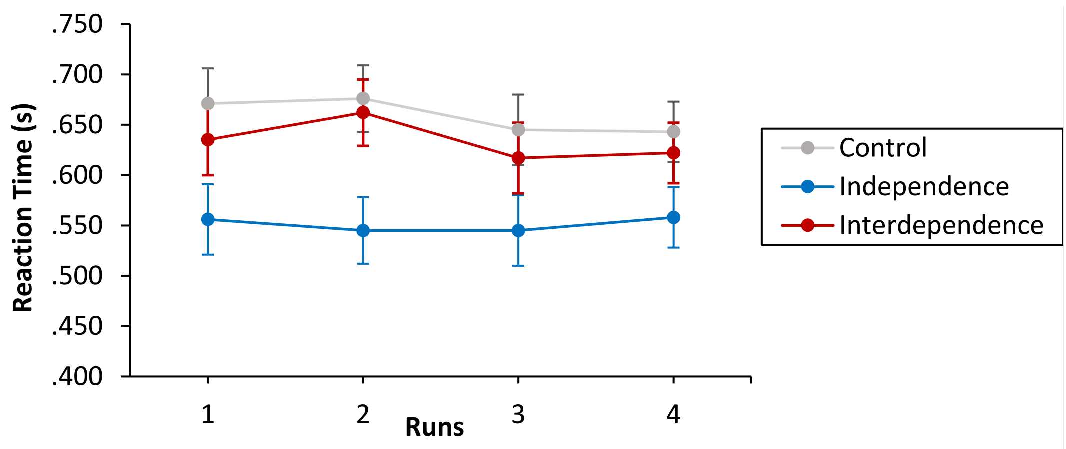
Generally, the interdependently-primed group had better response accuracy in the discrimination task than the other groups (see Appendix T3 for scores in each run). However, there were no significant interactions between the effects of priming and response accuracy (p = .798), indicating that the priming manipulation was not effective in influencing performance in the discrimination task. Indeed, a one-way ANOVA on the overall accuracy scores (sum accuracy across four runs) revealed no significant differences between the three conditions (p = .322), indicating a lack of group differences in the general ability to discriminate the global patterns. As no interaction effects or group differences were observed, learning rates were not analysed in the present study.

4.3.3 Comparison of Reaction Times for Correct Responses Between Priming Groups

The third analysis consisted of a 3 (Priming: Independence, Interdependence, or Control) × 4 (Run: 1, 2, 3 and 4) mixed-measures ANOVA to identify group differences in RT for correct responses. RTs did not change between runs (p = .246), suggesting consistency in making correct responses throughout the experiment. Interestingly, as seen in Figure 4.5, the independently-primed group had consistently faster RTs than the interdependently-primed and control group across the four runs (see Appendix T4 for RTs in each run). There was a main effect of priming (F(2,57) = 3.60, p = .034, η^2_p = .112), indicating a group difference between the priming conditions. The post-hoc analysis with Bonferroni corrections revealed that the independently-primed group had significantly faster RTs than the control (p = .021) and interdependently-primed (p = .046) groups in Run 2. However, there were no significant interactions between the priming conditions and RTs across the four runs, F(4.38, 124.81) = .622, p = .662, η^2_p = .021 (Greenhouse-Geisser Corrected).

Figure 4.5

Reaction Times of Correct Responses Across Four Runs for Priming and Control Groups

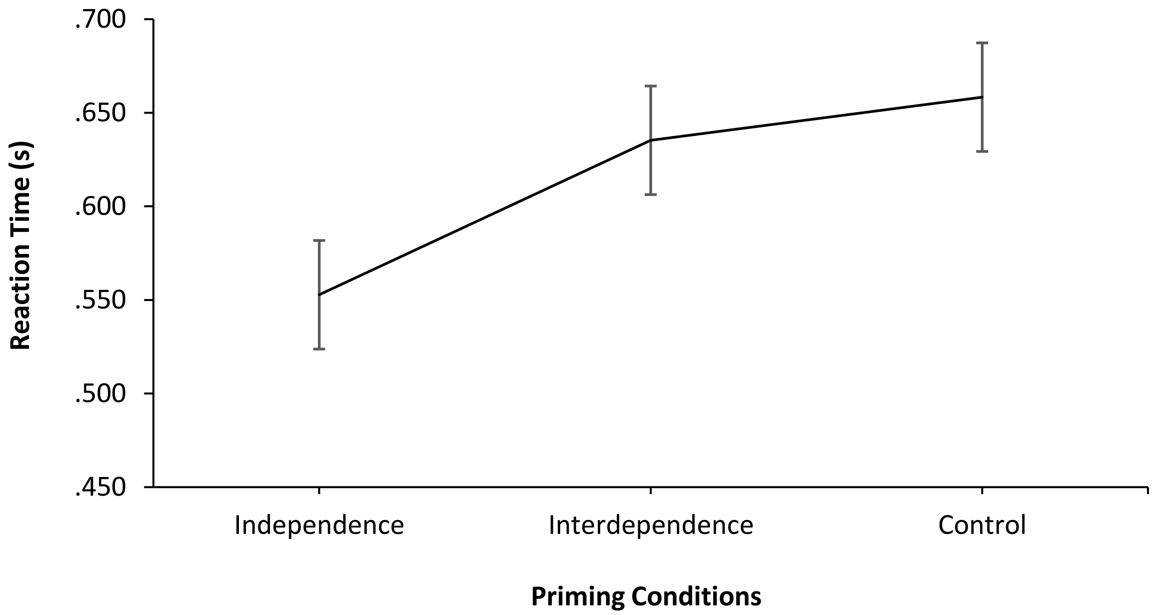


Note. The independently-primed group had significantly faster RTs in Run 2 compared to the interdependently-primed and control groups. The error bars represent standard errors.

The overall RTs for all correct responses across the four combined runs was thus calculated to assess the general time taken for each group to make accurate judgements of the global patterns. A one-way ANOVA revealed a statistically significant effect of priming on the overall RTs, $F(2, 57) = 3.59$, $p = .034$, $\eta^2_p = .112$. The effect size was medium to large. A post-hoc test with multiple comparison adjustments (Bonferroni corrections) revealed that the independently-primed group ($M = .553$; $SD = .163$) was significantly faster than the control group ($M = .658$; $SD = .113$) when making correct responses in the task ($p = .041$; see Figure 4.6). The interdependently-primed group ($M = .635$; $SD = .110$) also appeared to make slower responses compared to the independently-primed group. However, these differences were not significant ($p = .154$). There were also no differences between the interdependently-primed group and the control group ($p < .999$).

Figure 4.6

Overall RTs of Correct Responses for Priming and Control Groups



Note. The independently-primed group had significantly faster RTs than the control group when making accurate perceptual judgements. The error bars represent standard errors.

4.3.4 Examining the Influence of Sociocultural Variables on Task Performance

Table 4.2 shows the relationship between the dependent variables (overall accuracy and RT) and the cultural values measured by the COS, SCS, and AHS following the priming procedure. Independence priming was found to be significantly associated with shorter overall RTs and lower COS individualism and SCS independence scores. In contrast, the control condition was associated with longer overall RTs and increased COS individualism and COS collectivism scores. Correlations between the cultural scales generally replicated the findings from Chapter 2, whereby COS individualism scores were positively associated with SCS independence scores (see Section 2.3.3). Likewise, the COS collectivism scores were positively correlated with SCS interdependence scores and AHS holism scores.

An analysis was then carried out to identify if group differences in accuracy and RTs could be predicted by the priming manipulations, the values measured by the COS, SCS, and AHS, and the demographics of participants. Data for overall accuracy was normally distributed, while overall RT data were skewed (*Skewness* = -.919; *SE* = .309). A preliminary regression analysis (enter method) indicated that demographic predictors including age, handedness, living arrangements, language, and ethnicity did not contribute significantly to the model for both overall accuracy (p = .349) and overall RTs (p = .129). Therefore, the subsequent regression analyses focused on the main effects of priming and the cultural measures.

Table 4.2

Correlation Matrix of Task Performance, Priming Conditions, and Cultural Variables

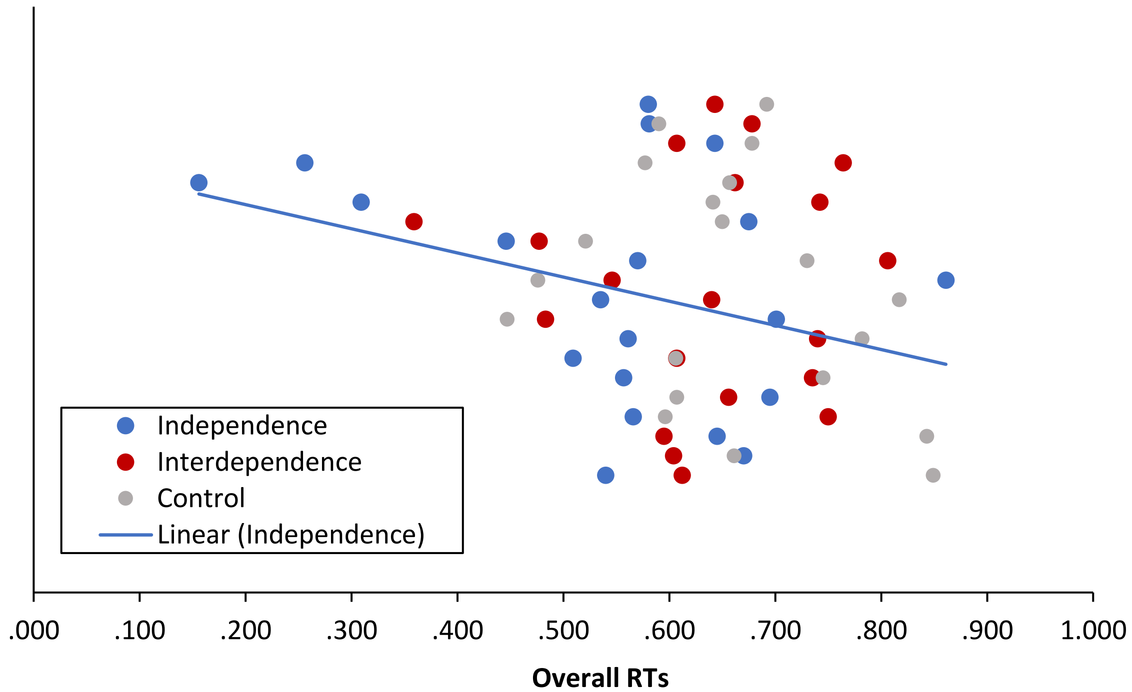
	Independence Prime	Interdependence Prime	Control Prime	COS Individualism	COS Collectivism	SCS Independence	SCS Interdependence	AHS Holism
Overall RT	-.327*	.103	.224*	.079	.160	-.049	.064	.172
Overall Accuracy	-.121	.196	-.074	-.154	-.167	.180	.071	-.097
Independence Prime	–							
Interdependence Prime	-.500**	–						
Control Prime	-.500**	-.500**	–					
COS Individualism	-.284*	-.162	.446*	–				
COS Collectivism	-.050	-.207	.257*	.205	–			
SCS Independence	-.221*	.124	.097	.376*	-.011	–		
SCS Interdependence	.046	-.013	-.033	-.058	.562**	-.169	–	
AHS Holism	.065	-.138	.073	.009	.347*	-.196	.445**	–

* significance at <.05, ** significance at <.001

A multiple regression using the enter method was first applied to predict the variability in overall accuracy as a function of priming and responses on the COS (individualism and collectivism scores), SCS (independence and interdependence scores), and AHS (holism score). However, these variables were not predictive of better response accuracy in the Glass (1969) pattern discrimination task (p = .277). A second multiple regression (enter method) using the same variables also did not reveal a significant model for overall RTs (p = .375), although independence priming was found to be a significant predictive variable (p = .034; M = .615; SD = .137). These findings could be attributed to the unsuccessful manipulation checks related to the three measures. Therefore, a separate regression analysis on only the priming conditions revealed a significant model, $F(2, 59) = 3.59$, p = .034. Specifically, there was a significant negative association between the independence priming variable and RT (b = - .327; p = .014). The model explained 8.2% (*Adjusted* R^2 = .081) of the variability in overall RT in the task (see Figure 4.7).

Figure 4.7

Scatterplot Depicting the Relationship between Priming Conditions and Overall RT



Note. The trendline of the interdependent and control group are not displayed in the figure above as these variables did not contribute significantly to the regression model.

4.4 Discussion

The present study employed a priming methodology to establish a causal link between independent or interdependent self-construal and VPL processes in the Glass (1969) pattern discrimination task. The endorsement of independence in mainstream Western cultures has been associated with more analytic thinking, whereas the widespread ideology of interdependence in Asian cultures has culminated in a tendency for holistic cognition and more global distributions of attention (Han & Humphreys, 2016; Kitayama et al., 2009). Therefore, the interdependently-primed group was hypothesised to exhibit greater accuracy and faster RTs in differentiating global forms due to an increased tendency for global processing. However, the priming manipulation did not impact response accuracy. Furthermore, the manipulation checks revealed that the priming conditions did not align with responses on the SCS, COS, and AHS, thereby casting doubt on the efficacy of the priming manipulation on shifting participants' cultural identities. These findings are inconsistent with previous reports that cultural priming can provide direct evidence of cultural influences on different psychological processes (Benet-Martínez et al., 2002; Choi et al., 2016; Hoersting et al., 2021; Lin et al., 2008; Ng et al., 2010; Sui & Han, 2007; Wang et al., 2013, 2014).

Contrary to the hypothesis, the independently-primed group also had significantly faster RTs than the control group, and independent priming was predictive of faster RTs when making correct responses in the discrimination task. Since the manipulation checks were unsuccessful, the RT differences could be attributed to other factors. For one, the significantly faster responses indicate an underlying cultural mechanism or construct linked to independence priming that was not assessed. For example, faster RTs could be associated with increased confidence in judgements (Ratcliff & Starns, 2013; Voskuilen & Ratcliff, 2016). Indeed, independent self-construal has been linked to the need for autonomy and competence (Tanaka, 2020). It is also predictive of greater expressions of confidence and competence (Lalwani & Shavitt, 2009) and a greater pursuit of achievement to demonstrate proficiency (Luo et al., 2011; Wang et al., 2021). Therefore, increasing the saliency of the independent self through priming could enhance confidence which contributed to faster RTs. Alternatively, slower RTs have previously been attributed to wider attentional spread (Boduroglu & Shah, 2017; Lawrence et al., 2019). Therefore, the faster RTs exhibited by the independently-primed group indicates a narrower attentional spread consistent with analytic thinking styles (Choi et al., 2007; Koo et al., 2018). Since VPL trajectories were consistent across priming conditions, it is estimated that the analytic thinking style induced by independence priming only manifested in RTs differences. However, these explanations are speculative and warrant further research to identify the role of self-construal, confidence, and cognitive styles on task performance, as these were not captured or assessed in the measures used in the present study.

Finding behavioural variations even within a single culture would provide compelling evidence of the psychological processes which vary as a function of underlying sociocultural characteristics (e.g., Choi et al., 2016; Han & Humphreys, 2016; Lin et al., 2008; Wang et al., 2013). The recruitment strategy in this study (i.e., recruiting participants from only Western backgrounds) mirrors previous approaches of treating independent and interdependent values as an individual difference variable within a single culture (Matsumoto & Kupperbusch, 2001; Wang et al., 2013; Wang et al., 2017). Since recruitment was focused on the UK and Europe, participants were assumed to be inclined towards values associated with Western cultures, such as independence and analytic thinking. Therefore, the control group should exhibit similar behavioural patterns as the independently-primed group. However, the control group were instead significantly slower than the independently-primed group, with RTs being more like the interdependently-primed group. The discrepancy in RTs could be due to minor performance deteriorations, as small processing errors are magnified over repeated interactions with the stimuli (O'Reilly, 2001; O'Reilly et al., 2013). The slower RTs could also be attributed to more conscientious perceptual decision-making (Hansen et al., 2012). The inability to link the behavioural findings to any of the administered cultural measures once again illustrates the need for further research investigating the underlying characteristics of culture that could inform VPL processes (e.g., conscientiousness; Chen et al., 2014).

The present study has revealed the limitations of the COS, SCS, and the AHS, which could not be meaningfully associated with priming or task performance. Due to unprecedented rates of globalisation and an expansion of multiculturalism (Chen et al., 2020; Hong & Cheon, 2017; Vignoles et al., 2016), a dynamic transaction occurs between individuals and their changing environments (Wang et al., 2017). People who have been exposed to multiple cultural environments can internalise different cultural frames and dispositions. The means by which populations navigate local ecologies may then transfer to how they navigate the social realm through specific scripts of thinking and doing that are consistent with the values in their respective cultures (Kitayama et al., 2009). Indeed, the micro-macro contexts of culture that are embedded in multiple dynamic layers of values and practices can mediate information processing (Bruner, 1990; Wang & Brockmeier, 2002). The self and cultural systems thereby become mutually constitutive (Wang et al., 2017). However, this dynamic interaction has yet to be captured by a cultural instrument that can provide a holistic, accurate, and consistent reflection of the values that people from different cultures may hold.

Future research should seek to identify the circumstances in which the effect of activating cultural knowledge and concepts may persist as a long-term or short-term implication (Briley et al., 2014). The lack of behavioural differences in accuracy indicates a deficiency in priming efficacy. For instance, the Glass (1969) patterns that were degraded with noise may lead to perceptual uncertainty, thus demanding more attention for accurate identification. A lack of focused attention may disrupt the contents of visual memory or increase susceptibility to stimuli replacement (Pylyshyn, 1999). Consequently, priming could be insufficient in the context of the present study due to the task difficulty, and differences in VPL may not be immediately evident. Indeed, situationally induced knowledge accessed using cultural primes decays more quickly than chronically accessible knowledge that is more frequently accessed (Briley et al., 2014; Chiu & Hong, 2006; Hong & Chiu, 2001; Oyserman & Sorensen, 2009). The long experiment duration may thus have weakened the efficacy of priming; this could further explain the lack of behavioural differences and the poor associations between independence or interdependence priming with the cultural measures.

However, the speculative nature of these considerations necessitates additional research to identify a prime that can directly activate self-construal to influence VPL. Priming in cross-cultural research remains an intriguing avenue for future research as the effects of priming could instead manifest in implicit neural and physiological responses (Han & Ma, 2014; Lin et al., 2008; Ng et al., 2010).

The priming of independent and interdependent self-construal has been found to initiate changes in brain activation rather than manifested behaviours (e.g., Lin et al., 2008; Ng et al., 2010; Sui & Han, 2007). As mentioned in the introduction, individuals exposed to a different host culture may adopt distinct cultural identities that can be activated in varying contexts (Brewer & Gardner, 1996). Priming procedures thus allow researchers to infer a causal relationship between culture and brain activity rather than simple correlational approaches typically used in cross-cultural research (Han & Humphreys, 2016). Therefore, future research could advance the present study from the functional neural level to identify our sensitivity to cultural processes at an implicit level. The systematic application of cultural priming methodologies in research still has the potential to provide invaluable evidence of culturally influenced neural and psychological responses (Han et al., 2013).

To summarise, the present study has provided some evidence that priming cultural values of independence can be associated with VPL processes as reflected in the RTs. At the individual (micro) level, although it is assumed that people have a dominant identity that presents itself in normal circumstances, these cultural identities can be adapted in response to the environment and context (Benet-Martínez et al., 2002; Lin et al., 2008; Ng et al., 2010; Wang et al., 2014; Wang, 2008). Priming techniques thus present important opportunities to examine how social, individual, and situational factors interact to govern behaviours and attitudes (Syed & Azmitia, 2010). The present study represents an extension to Chapter 3, and it highlights the importance of examining the multilevel influence of culture on behaviour (Wang, 2008). The present study contributes important findings to the thesis as it delves into the influence of culture on behaviour at the individual level.

4.5 Chapter Summary

In conclusion, the present study represents a critical investigation into the link between independent-interdependent cultural values on VPL in the Glass (1969) pattern discrimination task. The outcomes of this chapter contribute to the existing literature on the efficacy of cultural priming (e.g., Grossmann & Jowhari, 2018; Ji et al., 2000, 2004; Li et al., 2018; Ng et al., 2010; Wang et al., 2013; Xi et al., 2018), and presents some implications for future research. The limitations associated with priming, such as the observed inconsistencies in behavioural manifestations (accuracy and RTs), indicates the need for further research (Aarts et al., 2015; Wiggins & Christopherson, 2019). For example, the differential RTs between the experimental groups following priming could be attributed to external cultural factors which were not assessed in the present study. Indeed, the poor relationship between independence and interdependence priming with the values measured by the COS, SCS, and the AHS suggests that an alternative measure could more accurately explain the cultural differences in RTs. Additionally, the lack of manifested behavioural differences in response accuracy reflects a need to extend the investigation to other VPL domains or employ neuroscientific techniques such as EEG or fMRI. Nevertheless, as demonstrated in the present study, although the efficacy of cultural priming remains debatable, unexpected, or discrepant outcomes within the cross-cultural domain could still contribute evidence for the dynamic nature of culture and its influence on people’s thoughts and behaviours.

Chapter 5: Examining the Unitisation Component of VPL using a Symbol Sequence Learning Task

Following the change in research direction (see COVID-19 Impact Statement), the scope of the investigation was expanded to include the unitisation mechanism of VPL to achieve the aim and objectives of the present thesis (see Chapter 1). The unitisation mechanism of VPL was incorporated to ensure continuity as it could also be affected by cognitive style variations. To this end, a symbol sequence learning task (SLT; Wang et al., 2017) that engages global processing mechanisms like the Glass (1969) pattern discrimination task was used to investigate cultural differences in VPL. Unlike the discrimination task that engaged the differentiation mechanism of VPL (ambiguous stimuli become distinguishable following training), the SLT implicates the unitisation mechanism whereby complex event configurations are integrated into perceptual wholes to inform accurate predictions. Furthermore, the SLT engages perceptual processes related to both spatial contexts and temporal sequences, contributing further novelty to the present investigation. This chapter will begin with a review of the unitisation mechanism of VPL and how culture could be implicated during training to impact learning trajectories. The experimental design of the SLT and the study outcomes will then be presented and evaluated in the later sections of the chapter. The present study aims to expand on previous findings of how culture can operate on VPL within a different task domain.

5.1 Background

The unitisation mechanism of VPL describes the integration of complex sequences or configurations into a singular unitised representation following an extended period of training (Goldstone, 1998, 2000; Liang et al., 2020). Indeed, people can learn to detect the contingencies of co-occurring stimuli by identifying repetitive patterns or associative pairings (Wang et al., 2017). There is an increase in task efficiency as people learn to perceive complex visual events or structures by detecting only a single unit within the composite stimuli. For instance, Pevtzow and Goldstone (1994) reported that observers were significantly quicker at recognising specific parts of a stick figure following training involving different combinations of three contiguous lines. The increasing familiarity with specific stimuli features or dimensions following training allowed observers to carry out tasks in a relatively automatic manner, as reflected in their decaying RTs (Cock & Meier, 2007; Pevtzow & Goldstone, 2019; Schyns et al., 1998). Therefore, frequent exposure and experience with visual objects through training can enhance perceptual abilities by shifting the direction of attention towards more specific and relevant components in the stimuli (Schyns et al., 1998).

People can exploit previous knowledge to inform learning of higher-order structures (Wang et al., 2017). For example, despite the absence of trial-by-trial feedback during training, observers learned to extract the relevant temporal statistics and probabilistic structure underlying a sequence of unfamiliar symbols to inform their predictions about upcoming symbols in the sequence (Wang et al., 2017). Consistent with the unitisation mechanism, it is proposed that observers had, either implicitly or explicitly, formed an integrated configural representation of apparently single events (i.e., unfamiliar symbols) to inform their predictions about the overall sequence of events. Indeed, the accumulated experience with the stimuli was reflected in increased prediction accuracy and decaying RTs. Since learning often occurs incidentally (Cock & Meier, 2007), it is vital to establish clear learning indicators (Nissen & Bullemer, 1987). Experiments such as the SLT would thus be a valuable assessment of learning as it can reveal accuracy and RT improvements in predicting event sequences following training (Robertson, 2007; Wang et al., 2017).

RT measures provide a trial-by-trial index of predictive and statistical learning in tasks such as the SLT, where stimuli are presented in a probabilistic sequence (Bornstein & Daw, 2012). People can track the co-occurrence of stimulus elements through mere observations. Consequently, the recurring configuration of the stimuli increases its subjective similarity (Welham & Wills, 2011), thus supporting statistical learning of event sequences and improving RTs. Indeed, faster RTs for more probable stimuli is representative of predictive learning. The delta rule explains the mechanisms underlying this learning process; there is a gradual decaying influence of previously observed stimuli (Bayer & Glimcher, 2005; Lau & Glimcher, 2005). These exponentially decaying weights are characteristic of an error-driven learning procedure (Danielmeier & Ullsperger, 2011). Therefore, the errors that occur when people learn the underlying conditional probabilities of events are part of the unitisation process that enhances the accuracy of future predictions (Bar, 2009; Dale et al., 2012).

There are individual differences in strategies for learning predictive structures; faster learners were proposed to employ a probability-maximisation strategy to extract the most probable outcomes from a complex structure of events (Wang et al., 2017). In contrast, others may attempt to learn all possible statistical contingencies to match the exact sequence statistics during predictive learning. However, there is a lack of research on the process of unitisation in learning predictive structures within the context of culture. It is hypothesised that cultural differences in analytic and holistic cognitive styles could also impact the process of unitisation processes during VPL in the SLT, as evidenced in the previous studies within this thesis.

An analogy that can relate unitisation processes to analytic and holistic thinking styles is in word perception. A combination of letters become unitised through learning as one becomes more familiar with different letter arrangements that form coherent words (Allen et al., 1995, 2002; Ganayim, 2015; Johnson et al., 1986; Tao et al., 1997). Increased familiarity results in an increased redundancy of the letters within words. Consequently, words are often identified faster than its letters (Johnson, 1975). This word-level processing represents holistic or global processing. However, disrupting the higher-level appearance of words by using mixed-cased letters, for instance, leads to slower processing at the letter level (Allen et al., 1995, 2002; Ganayim, 2015; Johnson et al., 1986; Tao et al., 1997). This letter-level processing reflects analytic processing. Taken together, the unitisation process that occurs during VPL could be impacted by differences in analytic and holistic thinking. Similarly, the sequence of events (i.e., stimuli) in the SLT becomes uninformative if perceived analytically as independent occurrences. It needs to be perceived holistically as a series of interconnected elements consistent with global perceptual processes. Therefore, the present study would examine the unitisation mechanism of VPL while accounting for the analytic-holistic cognitive style variations between cultures (Choi et al., 2007; Koo et al., 2018).

The utility of the SLT for examining cultural differences in VPL is consistent with the previous investigations in this thesis, as it also compels participants to engage in global or holistic processing. Consequently, any observed differences between people from varying cultural backgrounds would present further evidence of the dominant influence of culture in varying task domains despite the GPE. Indeed, in contrast to the Glass (1969) pattern discrimination task which engages low-level percepts in a top-down manner, the SLT engages processes related to the formation of high-order associations (unitisation) in a bottom-up fashion (Chafee & Ashe, 2007; Keele et al., 2003). Therefore, the present study contributes diversity to the investigations in this thesis as the SLT engages the unitisation mechanism of VPL using a task that implicates both spatial contexts and temporal sequences (i.e., participants must configure the spatial relationships of distinct events that manifest based on underlying temporal statistics). Examining both temporal and spatial modalities has important implications for understanding higher-order cognitive functions and the meaningful integration of complex event structures (Liang et al., 2020; Powers et al., 2016; Shin & Ivry, 2002; Wang et al., 2017). The outcomes could translate into real-world training paradigms that require sequential and ordered execution, such as linguistics, reading, musical ability, and sports activities (Polat, 2009; Shin & Ivry, 2002; Smyth & Naveh-Benjamin, 2018; Wang et al., 2017).

Collectively, in addition to the real-world applications, employing the SLT to test implicit learning is significant because automatic cognition depends on covert or implicit cultural knowledge structures such as analytic-holistic thinking (Chua et al., 2005; Park & Huang, 2010). Park et al. (2016) have also proposed that cultural groups were better differentiated by implicit rather than explicit tendencies. Therefore, measures such as RTs and accuracy may reduce artefacts like demand characteristics, social desirability, and reference group effects that manifest in explicit measures such as questionnaires (Han, 2015; Park et al., 2016). Although the design of the SLT appears relatively simple, it could represent the processing of short-term event sequences or structures that cognitive systems may encounter during daily activities (Botvinick & Plaut, 2004; Dale et al., 2012). The present study is thus a simplified representation of this ecological context where learning manifests through the detection of regularities in the environment (Dale et al., 2012).

5.1.1 *Aims of Study*

The present study aimed to examine implicit multilevel cultural influences on the unitisation mechanism of VPL. Learning will be represented by performance index following training, RT improvements, and learning rates in predicting context-dependent event sequences. The SLT is a test of implicit memory and statistical learning, as reflected in participants' speed of predicting patterns in a structured sequence of stimuli (Wang et al., 2017). In the present study, participants from individualistic and collectivistic cultural backgrounds (the macro level of culture) were trained to predict upcoming stimuli as accurately as possible based on learning from previously presented stimuli sequences. Unbeknownst to participants, set probabilities govern the sequence in which specific stimuli may appear. Performance index and improvements in RTs would thus reveal if participants learned the implicit probabilities of the presented stimuli. Performance index should progressively increase, while RTs should decrease as participants learn the governing probabilities underlying the sequence of events through a unitisation process. Additionally, it would be intriguing to examine if cultural differences at the micro level as defined by holistic thinking (Choi et al., 2007), social orientation (Singelis, 1994), and cultural orientations (Triandis & Gelfand 1998) could also be linked to the unitisation mechanism of VPL. Participants from collectivistic backgrounds where holistic thinking is prevalent and those with interdependent self-construal are predicted to be better at integrating the underlying probabilities of single events into whole configural units. It is estimated that participants would make faster and more accurate predictions following unitisation, as indicated by increasing performance indices and decaying RTs, compared to their individualistic counterparts and those who have independent self-construal.

5.2 Method

5.2.1 Participants

Sixty-four participants were recruited using Prolific (www.prolific.co) – an online participant recruitment platform. The sample size was determined based on a power analysis on G*Power (Faul et al., 2007; see Appendix U), and based on previous research (Wang et al., 2017). A custom pre-screening feature available on Prolific was applied to recruit Western individualist and Eastern collectivist participants. Specifically, for the collectivistic group, the study was made available to users who were nationals were from Bangladesh, Cambodia, China, Hong Kong, India, Indonesia, Japan, Korea, Macau, Malaysia, Myanmar, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam. An additional screening criterion was applied to only include participants who identified as monocultural individuals. The remaining pool of eligible participants following the custom pre-screening was 322 individuals. Similarly, the monocultural criterion was applied for the individualistic group. Users who reported nationalities from the UK, Ireland, Germany, France, Belgium, Denmark, Finland, Italy, Netherlands, Norway, Poland, Sweden, and Switzerland were invited to participate in the study. The pool of eligible participants following the monocultural and nationality pre-screening for the individualistic sample was 20,469 individuals. Participants recruited on Prolific were reimbursed £6.00 for their participation in the hour-long experiment.

Of the 64 participants, two participants – one from the individualistic group and one from the collectivistic group – were excluded from analysis as they did not engage in the instructional call for the main learning task. Therefore, they may present as outliers due to a lack of understanding of the task requirement. The mean age of the remaining participants (33 females, 29 males) was 28.05 ± 9.34 years. Among these, 44 spoke English as their first language, while the remaining 18 participants had spoken English for 13.89 ± 7.15 years with an average confidence of 4.14 (*SD* = .723) out of a score of five. Additionally, 44 participants reported playing games (*M* = 10.48 hours per week; *SD* = 10.56). Table 5.1 below shows further details of participant demographics.

Table 5.1

Participant Demographics

Descriptors	*n*
Handedness	
Right	53
Left	7
Ambidextrous	1
Living Arrangement	
Alone	9
Significant Others	39
Housemates	14
Ethnicity	
White	26
Black	3
Asian	32
Mixed	1
Educational Attainment	
Higher Education	43
College	12
High School	7
Household Income	
Below £10,000	7
£10,001 - £20,000	16
£20,001 - £30,000	4
£30,001 - £40,000	4
£40,001 - £50,000	10
£50,001 to £150,000	13
Above £150,000	3
Prefer not to say	5

Participants were categorised into two experimental groups based on their self-reported nationalities. The individualistic group consisted of 32 participants, while the collectivistic group consisted of 30 participants. Table 5.2 below shows the breakdown of participants based on self-reported nationalities. For the collectivistic group, participants consistently reported that they spent most of their youth in their birth country and the places where they held citizenship (see Appendix V for further details). However, some reported that they were currently residing in other countries. Nonetheless, as these participants had reportedly spent most of their youth in their birth countries, they were categorised into the collectivistic group for the purposes of the present experiment (Chen et al., 2021). Implications of the diversity in the sample are considered in the Discussion (see Section 5.4) and in Chapter 7 (see Section 7.3.2).

Table 5.2

Nationalities of Participants

Nationalities	*n*
Collectivistic	
India	11
Malaysia	8
Vietnam	4
China	3
South Korea	3
Taiwan	1
Individualistic	
United Kingdom (UK)	26
Europe	6

Note. The European category includes countries such as the Netherlands (*n* = 1), Belgium (*n* = 1), Finland (*n* = 2), France (*n* = 1), and Italy (*n* = 1).

5.2.2 Design

The present study employed a between-subjects design comparing two groups from individualistic and collectivistic groups based on their self-reported nationalities. RTs and performance index were recorded and calculated for each participant to compare VPL differences in sequence learning between participants from individualistic and collectivistic cultures. Additionally, participants were also categorised based on their responses on the SCS (independence-interdependence), COS (horizontal and vertical individualism-collectivism), and AHS (analytic-holistic thinking) to compare performance at the individual level. Collectively, the independent variables in the present study are individualism-collectivism cultural backgrounds (macro level) and individual level differentiations measured by the SCS, COS, and AHS (micro level). The dependent variable is the performance index and RTs across five runs in the symbol SLT.

5.2.3 Materials

The self-report measures from earlier chapters were also used in the present experiment, including the demographics questionnaire, Singelis' (1994) SCS, Triandis and Gelfand's (1998) COS, and Choi et al.'s (2007) AHS (see Appendix E to G). Cronbach's reliabilities for each measure are reported below. Some additional questions were included in the demographic questionnaire (see Appendix W) to ascertain SES (based on household income), educational attainment, dominant hand, video gaming habits, and where participants had spent most of their youth. These factors could add an unaccounted source of variance to the data (Boer et al., 2018), and were thus examined as predictor variables in the regression analyses (see Section 5.3.6).

Singelis (1994) SCS. The SCS was used to identify self-construal differences between the individuals of the different experimental groups. Cronbach's reliability for the overall scale was .669; Specifically, α values for the 12 independent and 12 interdependent items were .768 and .702, respectively. These were comparable with the reliabilities reported in Chapter 2.

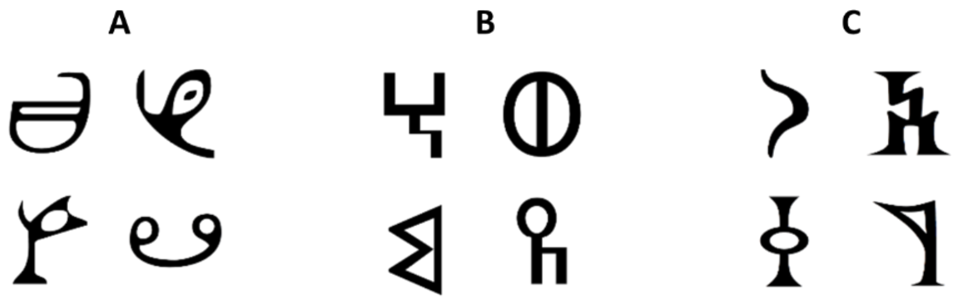
Triandis and Gelfand's (1998) COS. The COS assessed cultural orientation values on four dimensions: VI, HI, VI, and VC. Cronbach's reliability for the overall scale was .703. Specifically, α values for the HI, VI, HC, or VC dimensions were .667, .764, .676, and .776, respectively, and these were also comparable with the reliabilities reported in Chapter 2. As 10 participants could not be categorised due to similar scores on more than one subscale, separate scores were calculated for the individualism (sum of HI and VI) and collectivism (sum of HC and VC) dimensions. The number of uncategorised participants following the aggregated scoring procedure was reduced to two. The individualism and collectivism dimensions had reliabilities of .697 and .778, respectively.

Choi et al.'s (2007) AHS. The AHS assessed thinking styles on four dimensions: causal perception, attitude towards contradiction, perception of change, and locus of attention. Cronbach's reliability for the overall scale was .631. Alpha values for the four dimensions (causality, contradiction, change perception, and attention) were .611, .667, .585, and .690, respectively.

Sequence Learning Task. The symbol SLT was administered on the i-ABC online website (Adaptive Brain Lab, University of Cambridge, UK). In this task, participants were exposed to a sequence of four symbols and were subsequently asked to predict which symbol should appear next. The SLT employed in this chapter was adapted from Wang et al.'s (2017) study. The stimuli consisted of Ndjuká syllabary (Turk-Browne et al., 2009), and the symbols were presented against a mid-grey background to ensure discriminability. Three sets of the stimuli, each consisting of four symbols, were randomly assigned to participants to ensure that any cultural differences did not stem from effects of familiarity (see Figure 5.1). The random set selection assigned to each participant at the beginning was maintained across all runs.

Figure 5.1

Experimental Stimuli (Ndjuká syllabary; Turk-Browne et al., 2009)

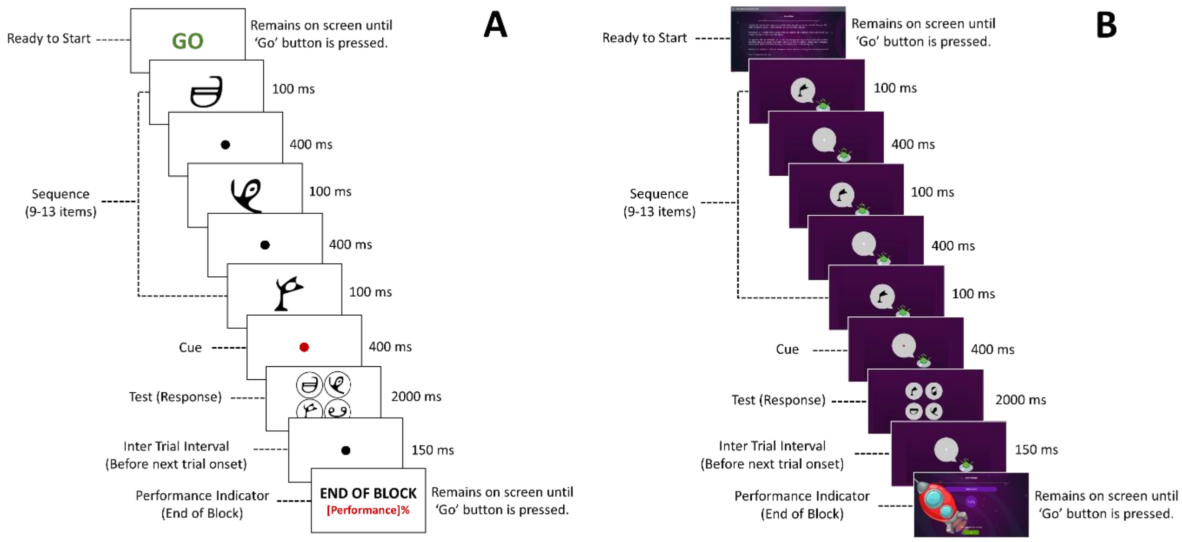


Note. Participants were randomly one of the three sets of stimuli (set A, B, or C). Each stimulus set consisted of four Ndjuká symbols.

For the current experiment, participants completed five test runs, and each run consisted of 60 trials (approximately eight minutes per run). Each trial consisted of a variable sequence length (9 to 13 symbols). The variable length was to sustain the participant's attention in the task (Wang et al., 2017). Figure 5.2 shows the sequence of events for the SLT.

Figure 5.2

The Sequence of Events for the SLT



Note. Figure 5.2(A) shows the sequence of events presented on a white background for illustration purposes. Figure 5.2(B) shows the sequence of events presented to participants on the i-ABC platform (Adaptive Brain Lab, University of Cambridge, UK).

Each symbol (item) appeared one at a time and remained on the screen for 100 ms. There was a 400 ms interstimulus gap between each item. Following presentation of the symbol sequence, a small red circle appeared on the screen for 400 ms as a cue for participants to make a response. The response screen then displayed all four symbols randomly in a two-by-two grid for 2000 ms or until participants indicated using a mouse press which symbol should appear next in the sequence. A white highlight around the chosen stimuli appeared for 300 ms following participant's responses. Alternatively, the response screen would time-out after 2000 ms if no stimuli were selected and a null response was recorded. There was a 150 ms interval before the next trial onset. Following Wang et al.'s (2017) study, trial-by-trial feedback was not provided. Instead, block feedback was presented to participants at the end of each test run.

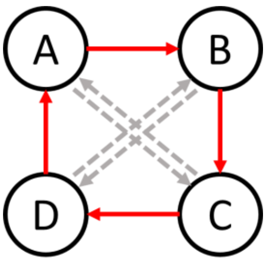
Unbeknownst to participants, the sequence of events was generated using a first-order (Level 1) Markov model that manipulated the probabilistic order in which the symbols appeared (Karlaftis et al., 2019; Wang et al., 2017). Specifically, the memory order of the symbol sequence, also called the context length, was manipulated to generate the statistics that determine which symbol should appear next based on the immediately preceding symbol. This underlying Markov model can be defined by the following formula (Wang et al., 2017), where i refers to time, k refers to the order of the model ($k = 1$ in the present study), and $s(i)$ refers to the target symbol at time i

$$P(s(i)|s(i-1), s(i-2), \dots, s(1)) = P\big(s(i)\big|s(i-1), s(i-2), \dots, s(i-k)\big), k < i.$$

As seen in the formula, the preceding k-tuple of symbols ($s(i-1), s(i-2), \dots, s(i-k)$) represents the context. For a level-1 model, this would mean that the target participants needed to identify was conditional on the previous symbol. Indeed, the context-based statistic generated stipulates that the participants could either select the high probability target (80%) or the low probability target (20%). For example, as seen in Figure 5.3, if symbol A was presented, symbols B or C could follow, with symbol B being 80% more likely to occur than symbol C, which has a 20% occurrence probability.

Figure 5.3

First-Order Markov Model (Wang et al., 2017)



Level-1		Target			
		A	B	C	D
Context	A		0.8	0.2	
	B			0.8	0.2
	C	0.2			0.8
	D	0.8	0.2		

Note. The four symbols (assigned with letters A, B, C, and D) have different conditional probabilities based on the immediately preceding symbol.

5.2.4 Procedure

All participants provided informed consent and completed all the self-report measures (demographics, SCS, COS, and AHS). Upon completing the questionnaires, participants were provided with a link to a Microsoft Teams call with the researcher. The researcher then instructed participants to set up an account on the i-ABC experimental platform using their anonymised Prolific code. Once logged onto the i-ABC, participants were provided with instructions for the SLT. All participants then familiarised themselves with the task procedure by completing a mandatory practice phase that consisted of five trials of a randomised stimuli sequence. Participants could then choose to complete additional practice phases. Following the practice, participants proceeded to the test phase of the SLT, which consisted of five experimental runs. Responses were made using the left button on the mouse while all responses and RTs were recorded. The test phase took approximately 40 minutes, with short breaks between each run to prevent fatigue. The researcher remained on the call to resolve any issues or address any questions throughout the study. Participants were thanked, debriefed, and reimbursed for their time upon completion of the experiment.

5.2.5 Data Analysis

MATLAB 2020a (The MathWorks Inc., 2020) and IBM SPSS Statistic for Windows, Version 25.0 (IBM Corp., 2017) were used for data analysis. The data which met parametric assumptions were analysed in six steps. The first analysis was to examine individual-level differences on the SCS (Singelis, 1994), COS (Triandis & Gelfand, 1998), and AHS (Choi et al., 2007) measures. Next, a set of three analyses were conducted to identify if there were any group and individual level differences in performance in the task. Macro level group differences were defined by individualistic and collectivistic backgrounds (Hofstede, 2017), while individual-level differences were defined by the SCS (independence-interdependence) and COS (individualism-collectivism) categories.

A performance index (PI) was calculated to quantify performance for each participant. The contingency table (context-target frequency) of responses were compared to the context-target frequency table for the presented trial sequences (see Figure 5.3). The absolute Euclidean distance was first computed across 60 trials per run using the following formula, where the distribution of participant responses was subtracted from the distribution of the presented sequence:

$$AbDist(context) = \sum_{target} |P_{resp}(target|context) - P_{pres}(target|context)$$

Next, PI for each context was calculated to identify the minimum overlap between the response distributions ($AbDist$) and presented sequence distributions using the following formula:

$$PI(context) = \sum_{target} min\ (P_{resp}(target|context),\ P_{pres}(target|context))$$

Note that the formula can also be represented by:

$$PI(context) = 1 - AbDist(context)/2.$$

Finally, overall PI in each run was calculated by averaging the performance indices across contexts, $PI(context)$, weighted by the corresponding stationary context probabilities:

$$PI = \sum_{Context} PI(context) \cdot P(context)$$

Each participant thus had an absolute PI for all runs. The calculations above show that the PI reflects the match between response distributions with the presented symbol distributions. This method of computing performance accounts for the probabilistic nature of the event sequences instead of using just a simple correct or incorrect measure of accuracy (Wang et al., 2017). Additionally, to account for possible confounding effects of random-guesses, a relative PI was computed by subtracting random-guess baselines ($PI_{rand} = 0.45$) from the absolute PI. The relative PI represents a normalised PI measure that reflects performance relative to random guessing in each run.

Collectively, one analysis was used to compare task performance as defined by absolute PI and relative PI between individualistic and collectivistic groups at the macro level of culture (see Section 5.3.2). Consistent with the micro (individual) level analysis procedure in Chapter 3 (see Section 3.3.3), performance was also compared between those with independent and interdependent self-construals (see Section 5.3.3), and those with individualistic or collectivistic cultural orientations (see Section 5.3.4). RTs between groups were also reported for each analysis to assess if participants' responses varied as a function of cultural differences.

The third analysis examined cultural group differences in overall PI and learning rates. *Learning rates* are defined as the slope of the linear line fitted for the absolute PI across five runs for each participant. Alternatively, to account for the non-linear changes in performance amongst participants, an integral curve difference (ICD) between absolute PI and random PI was also calculated. The integral of the random-guess baseline curve was subtracted from the integral of each participant's PI curve to obtain the overall PI for each participant.

The fourth and final analysis was a regression analysis to examine the relationship between overall PI and learning rates on the SLT with variables such as SCS, COS, and AHS scores. Additional predictor variables such as SES, educational attainment, years lived in a different country, and ethnicity, were also included in the model to identify if these moderated the effects of learning. Categorical data were coded into dummy variables for the regression analysis.

5.2.6 Ethical Considerations

Ethical approval was granted by the university's research ethics committee (Reference: Chua/#7658/sub2/R(A)/2020/Dec/BLSS FAEC; see Appendix H3). Written consent was required for participation. Participants were advised to refrain from participating if they could not look at computer screens for extended periods. There were breaks between each experimental block (every 8 minutes) to avoid fatigue, but participants could leave the study at any time. The study was explained thoroughly to participants before they provided consent. The experimenter was also present on a Microsoft Teams call to address any concerns or questions throughout the study. Contact details of the research team and the ethics committee were provided to participants in the debriefing. Participants could withdraw their data at any time, although data analysed collectively cannot be removed as they can no longer be identified individually.

5.3 Results

5.3.1 Comparison of Responses on the Self-Report Measures

The following analyses were carried out to identify if participants from individualistic and collectivistic cultures held values consistent with their cultural backgrounds as measured by the SCS, COS, and AHS (i.e., independence-interdependence, individualism-collectivism, holism).

Singelis (1994) SCS. More participants in the individualistic group had independent self-construals, while the collectivistic group consisted of more participants who had interdependent self-construals (see Table 5.3). However, a chi-square analysis revealed that the association between SCS self-construal and cultural group only approached significance, $\chi^2(1, N = 62) = 3.14$, $p = .076$. The individualistic group ($M = 4.95$; $SD = .873$) had generally higher scores on the SCS independence subscale than the collectivistic group ($M = 4.71$; $SD = .682$), although this difference was not significant ($p = .236$). Additionally, the differences between the individualistic ($M = 4.65$; $SD = .709$) and collectivistic ($M = 4.98$; $SD = .597$) group on the SCS interdependence subscale only approached significance ($p = .051$).

Table 5.3

Participant's Self-Construals (Singelis, 1994) According to Cultural Groups

Self-Construal	*n*	Percentage (%)
Individualistic Group		
Independence	20	62.5
Interdependence	12	37.5
Collectivistic Group		
Independence	12	40.0
Interdependence	18	60.0

Triandis and Gelfand's (1998) COS. Table 5.4 shows a breakdown of the cultural orientations held by participants from different cultural backgrounds. However, a chi-square analysis revealed that participants, regardless of background, were equally likely to hold individualistic or collectivistic values on the COS (p = .795). A further examination of the data revealed no significant differences in the aggregated individualism (p = .619) or collectivism (p = .073) scores between both groups.

Table 5.4

Participant's Cultural Orientations (Triandis & Gelfand 1998) According to Cultural Groups

Cultural Orientation	*n*	Percentage (%)
Individualistic Group		
Individualism	14	43.8
Collectivism	16	50.0
Missing	2	6.3
Collectivistic Group		
Individualism	13	43.3
Collectivism	17	56.7

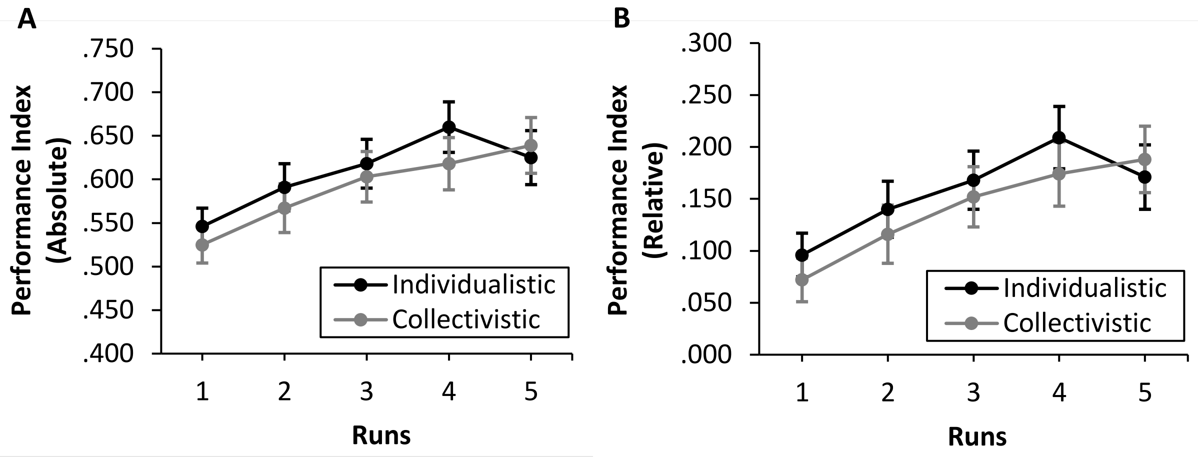
Choi et al.'s (2007) AHS. The mean score of respondents on this measure was 118.13 (SD = 10.38). There was no significant difference in holism scores between both groups (p = .661).

5.3.2 Comparison of Performance Index and RT at the Macro Level

First, a 2 (Culture: Individualistic or Collectivistic) × 5 (Run: 1, 2, 3, 4, and 5) mixed-measures ANOVA was run to compare the absolute PI between the individualistic (n = 32) and collectivistic (n = 30) groups. All participants exhibited learning as the experiment progressed from the first to the last run, $F(2.66, 159.34) = 15.46$, $p < .001$, $\eta^2_p = .205$ (Greenhouse-Geisser Corrected). However, as seen in Figure 5.4(A), there were no significant interactions between the cultural groups and absolute PI across five runs *(p* = .432; see Appendix X1 for detailed scores). These findings indicate no differences in performance between the individualistic and collectivistic groups at the macro level.

Figure 5.4

Absolute and Relative Performance Index of Participants Across Five Runs



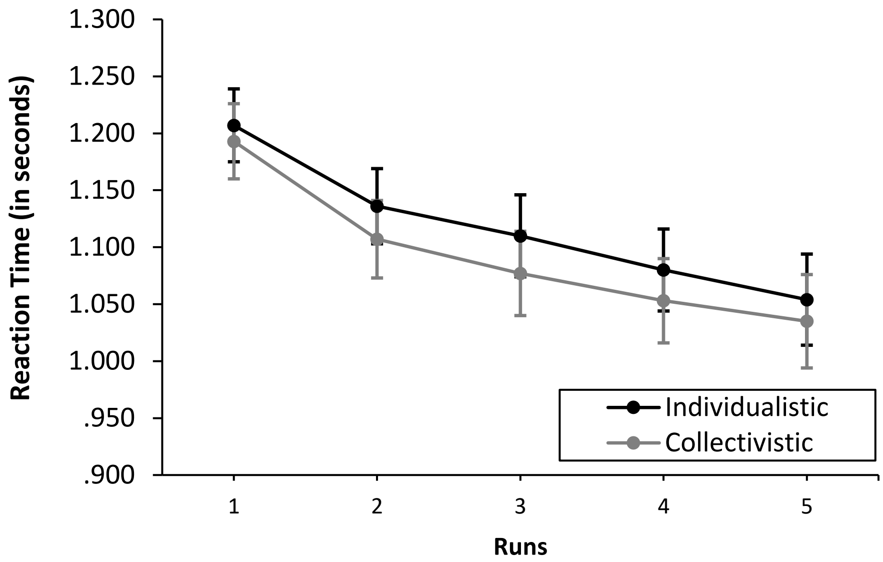
Note. Figure 5.4(A) presents the data for absolute PI, while Figure 5.4(B) presents the data for relative PI. Relative PI reflects performance relative to random guessing. All participants exhibited learning as the experiment progressed from the first to the last run. However, there were no group differences in both absolute and relative PI. The error bars represent standard errors.

A 2 (Culture: Individualistic or Collectivistic) × 5 (Run: 1, 2, 3, 4, and 5) mixed-measures ANOVA was also run to compare the relative PI between the individualistic and collectivistic groups (see Figure 5.4(B)). As mentioned previously, the relative PI reflects a normalised indicator of task performance relative to random guessing (Relative PI = Absolute PI – Random Guess; Wang et al., 2017). All participants exhibited learning as the experiment progressed from the first to the last run, $F(2.81, 168.39) = 16.46$, $p < .001$, $\eta^2_p = .215$ (Greenhouse-Geisser Corrected). Like the absolute PI, there were no significant interactions between the cultural groups and relative PI across the five runs ($p = .466$), thereby indicating a lack of cultural groups differences at the macro level in the SLT (see Appendix X2 for detailed scores).

The third analysis consisted of a 2 (Culture: Individualistic or Collectivistic) × 5 (Run: 1, 2, 3, 4, and 5) mixed-measures ANOVA to identify if there was a group difference in RTs for making responses (see Figure 5.5 or Appendix X3). RTs significantly decreased across runs, $F(2.58, 154.64) = 22.04$, $p < .001$, $\eta^2_p = .269$ (Greenhouse-Geisser Corrected). However, there were no significant interactions between the cultural groups and RTs across the five runs ($p = .948$).

Figure 5.5

Reaction Times of Individualistic and Collectivistic Groups Across Five Runs



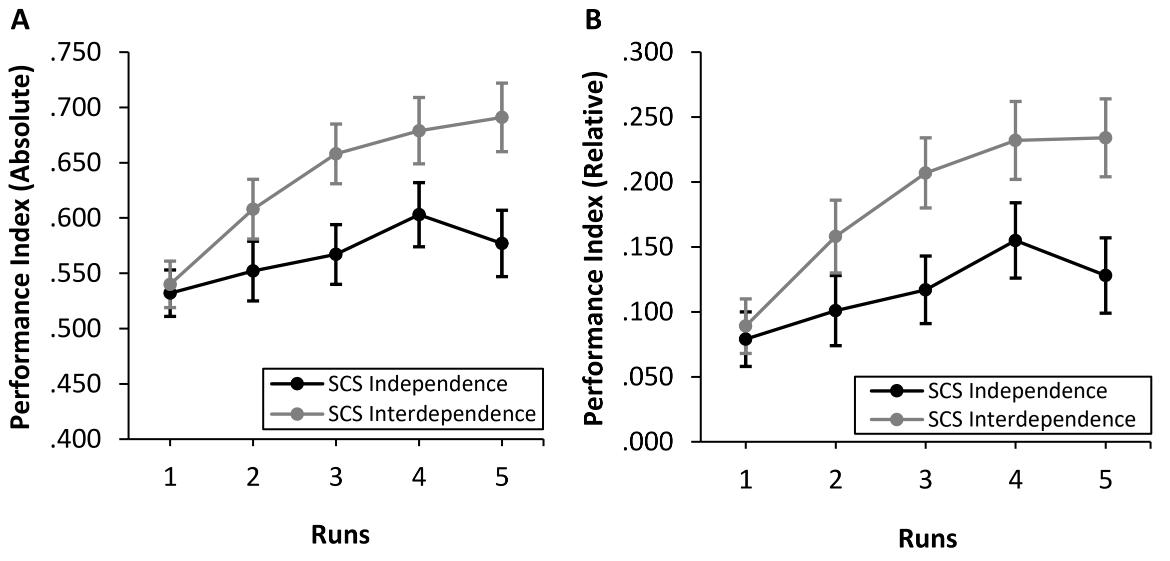
Note. RTs significantly decreased across runs, but no group differences were observed. The error bars represent standard errors.

5.3.3 Comparison of Performance Index and RT at the Micro Level: Independent and Interdependent Self-Construals (Singelis, 1994)

A 2 (Self-Construal: Independence or Interdependence) × 5 (Run: 1, 2, 3, 4, and 5) mixed-measures ANOVA was run to compare the absolute PI between those with independent ($n = 32$) and interdependent ($n = 30$) self-construal as measured on the SCS. Levene's test for equality of variances was met. All participants exhibited learning as the experiment progressed from the first to the last run, $F(2.78, 166.90) = 16.56$, $p < .001$, $\eta^2_p = .216$ (Greenhouse-Geisser Corrected). Importantly, there was a significant interaction between self-construal distinctions and absolute PI across the five runs, $F(2.78, 166.90) = 3.58$, $p = .018$, $\eta^2_p = .056$ (Greenhouse-Geisser Corrected). As seen in Figure 5.6(A), those with interdependent self-construal had significantly better performance in the SLT than those holding independent self-construal (see Appendix X4 for detailed scores). Specifically, performance began to diverge from the third run. Post-hoc t-tests revealed group differences in Run 3, $t(60) = 2.39$, $p = .020$, $d = .606$ (medium effect size), and Run 5, $t(60) = 2.66$, $p = .010$, $d = .676$ (medium effect size). However, the p-value was adjusted to .010 (Bonferroni corrections) to control for errors related to multiple comparisons (Lee & Lee, 2018). As such, the group differences were not significant. Alternative learning indices (overall PI and learning rate) were thus compared between the independent and interdependent groups (see Section 5.3.5).

Figure 5.6

Absolute and Relative Performance Index of Participants with Independent and Interdependent Self-Construal (Singelis, 1994) Across Five Runs



Note. Figure 5.6(A) presents the absolute PI, while Figure 5.6(B) presents the data for relative PI. There were significant interactions between self-construal distinctions and absolute PI ($p = .018$), as well as relative PI ($p = .048$). The error bars represent standard errors.

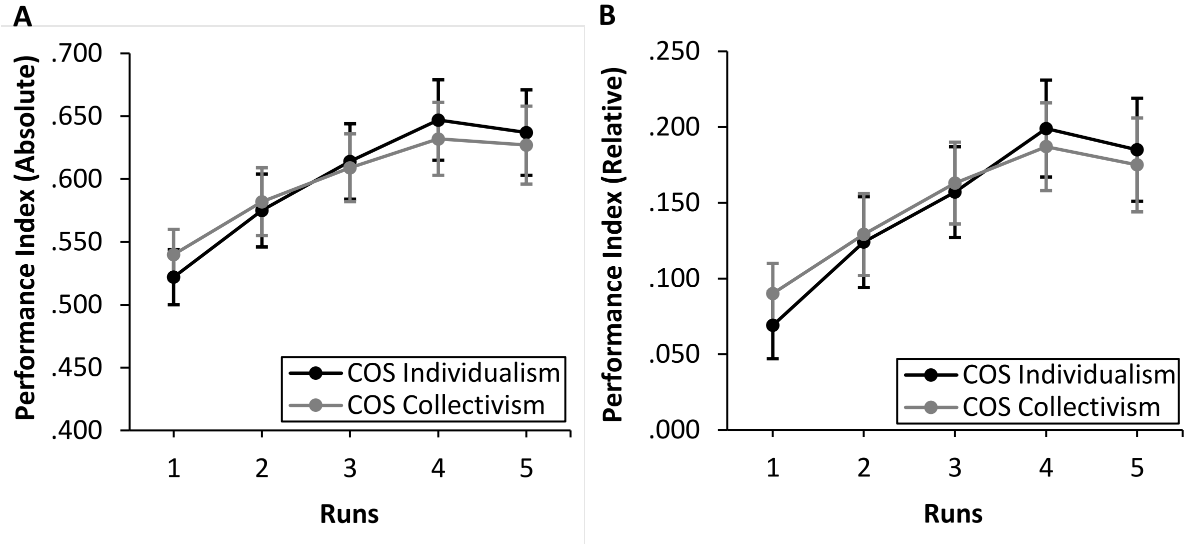
A 2 (Self-Construal: Independence or Interdependence) × 5 (Run: 1, 2, 3, 4, and 5) mixed-measures ANOVA was also run to compare the relative PI between the independent and interdependent groups. Levene's test for equality of variances was met. Like the absolute PI, all participants exhibited learning as the experiment progressed from the first to the last run, $F(2.92, 174.89) = 17.41$, $p < .001$, $\eta^2_p = .225$ (Greenhouse-Geisser Corrected). There was also a significant interaction between self-construal distinctions and relative PI across the five runs, $F(2.92, 174.89) = 3.02$, $p = .033$, $\eta^2_p = .048$ (Greenhouse-Geisser Corrected). As seen in Figure 5.6(B), those with interdependent self-construal had better performance in the SLT than those with independent self-construal (see Appendix X5 for detailed scores). However, post-hoc t-tests with multiple comparison adjustments revealed group differences that only approached significance in Run 3, $t(60) = 2.36$, $p = .022$, $d = .598$, and Run 5, $t(60) = 2.50$, $p = .015$, $d = .636$. To control for Type 1 errors related to multiple comparisons (Lee & Lee, 2018), the statistical significance for the post-hoc analyses were also set at $p = .010$ (Bonferroni corrections). A third mixed-measures ANOVA analysis revealed no significant interactions between the self-construal groups and RTs across the five runs ($p = .831$; see Appendix X6 for RTs in each run). Nonetheless, RTs significantly decreased across runs, $F(2.58, 154.80) = 21.96$, $p < .001$, $\eta^2_p = .268$ (Greenhouse-Geisser Corrected), indicating learning across all participants as the study progressed.

5.3.4 Comparison of Performance Index and RT at the Micro Level: Individualism and Collectivism Cultural Orientations (Triandis & Gelfand, 1998)

A 2 (Cultural Orientation: Individualism or Collectivism) × 5 (Run: 1, 2, 3, 4, and 5) mixed-measures ANOVA was run to compare the absolute PI between those with individualistic ($n = 27$) and collectivistic ($n = 33$) cultural orientation as measured by the COS (see Appendix X7 for detailed scores). All participants exhibited learning as the experiment progressed from the first to the last run, $F(2.73, 158.11) = 15.71$, $p < .001$, $\eta^2_p = .213$ (Greenhouse-Geisser Corrected). However, there were no significant interactions between cultural orientation distinctions and absolute PI across the five runs ($p = .781$). As seen in Figure 5.7(A), there were no differences in absolute PI between those with individualistic and collectivistic cultural orientations. Figure 5.7(B) shows a similar pattern of findings for relative PI across the five runs (p = .776; see Appendix X8).

Figure 5.7

Absolute and Relative Performance Index of Participants with Individualistic and Collectivistic Cultural Orientations (Triandis & Gelfand, 1998) Across Five Runs



Note. Figure 5.7(A) presents the data for absolute PI, while Figure 5.7(B) presents the data for relative PI. All participants exhibited learning as the experiment progressed from the first to the last run. However, there were no absolute and relative PI differences between groups defined by cultural orientation distinctions. The error bars represent standard errors.

A third mixed-measures ANOVA analysis revealed no significant interactions between groups distinguished by cultural orientations and RTs (p = .254; see Appendix X9 for RTs in each run). Nonetheless, like the previous analyses, RTs significantly decreased across runs, F(2.64, 153.24) = 22.97, p < .001, η^2_p = .284 (Greenhouse-Geisser Corrected), indicating learning across all participants as reflected by the decaying RT following training.

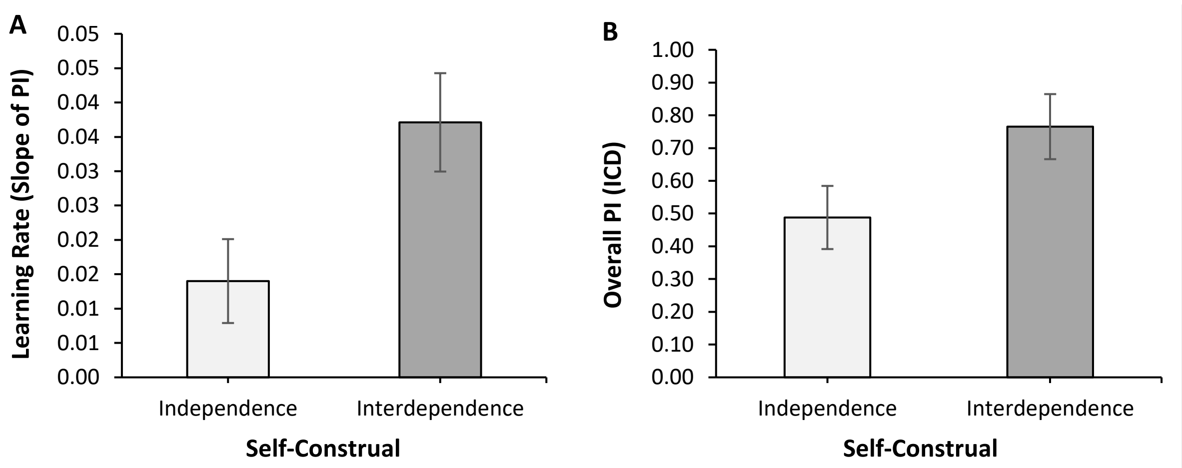
5.3.5 Comparison of Overall Performance Index and Learning Rates (Slope of Performance Index)

This part of the analysis examined group differences in overall PI and learning rates. As detailed in the Methods (see Section 5.2.5), *overall PI* is defined by the ICD between the PI curve and the random-guess baseline curve. In contrast, *learning rates* were defined as the slope of the linear line fitted for PI across five runs. A t-test conducted on the overall PI (p = .514) and learning rates (p =.601) revealed no significant difference between the individualistic and collectivistic cultural groups. Similarly, no significant differences were found for the groups distinguished by the COS on overall PI (p = .993) and learning rates (p = .459).

A t-test comparing groups with independent (M = .014; SD = .014) and interdependent (M = .037; SD = .039) self-construal as defined by the SCS revealed significant differences in learning rates, $t(60)$ = 2.47, p = .017, d = .625 (see Figure 5.8(A)). There was also a significant difference in overall PI between both groups, $t(60)$ = 2.00, p = .0495, d = .509. As seen in Figure 5.8(B), the interdependent group (M = .765; SD = .544) had higher overall PI than the independent group (M = .488; SD = .545).

Figure 5.8

Differences in Learning Rates and Overall Performance Index for Individuals with Independent and Interdependent Self-Construal (Singelis, 1994)

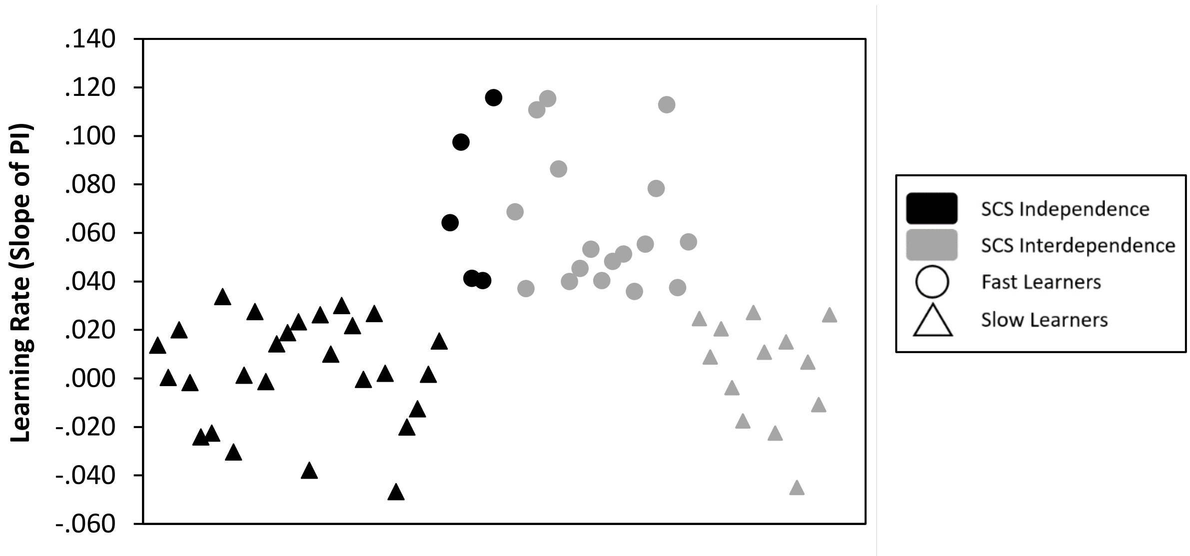


Note. There was a significant difference in learning rates and overall PI between independent and interdependent groups. The error bars represent standard errors.

To further explore the relationship between the SCS groups and learning on the SLT, a k-means cluster analysis was applied to the data on learning rates to classify participants as fast or slow learners. A chi-square test for association revealed a statistically significant association between SCS self-construals and learning rates, $\chi^2(1) = 11.39$, $p = .001$, *Cramer's V* = .429. The strength of association between the variables is medium to large. Specifically, individuals with independent self-construal were more likely to be slow learners than those with interdependent self-construal (see Figure 5.9). A supplementary analysis was conducted to identify if the differences in task performance were attributed to variations in individual learning strategies instead of the independence and interdependence cultural constructs (see Appendix Y). The findings revealed that most participants ($n = 50$) adopted a similar matching strategy for completing the task. Therefore, the observed behavioural differences are attributed to values of independence-interdependence rather than differences in individual learning strategies.

Figure 5.9

Learning Rate Data Clusters for Participants with Independent and Interdependent Self-Construal



Note. A k-means cluster analysis categorised the independent and interdependent participants into a fast learner or slow learner category. Individuals with independent self-construal were more likely to be slow learners compared to those with interdependent self-construal.

5.3.6 Examining the Influence of Sociocultural Variables on Task Performance

The final analysis was used to identify if group differences in overall PI (ICD between absolute PI and random PI) and learning rates (slope of PI) in the SLT could be predicted by the values measured by the COS, AHS, SCS, and demographics of participants. Data for the overall PI and learning rates were normally distributed. Preliminary analysis of the correlation matrix (see Appendix Z) revealed that there was a significant negative association between overall PI and SCS independence scores, $r(60) = -.293$, $p = .010$ (moderate effect size). However, the negative association between learning rates and SCS independence scores only approached significance ($p = .053$). There was also a significant negative association between COS individualism score and learning rates, $r(60) = -.217$, $p = .045$ (small to medium effect size).

The first regression analysis (enter method) examined if demographic predictors including age, gender, living arrangements, years lived in a different country, language, ethnicity, dominant hand, gaming habits, education level, and household income level were predictors of overall PI. These variables accounted for 15.4% (*Adjusted* $R^2 = .154$) of variation in the model. However, the regression model was not significant ($p = .115$). A separate regression analysis (enter method) to predict learning rates based on the same demographic variables was also not significant ($p = .445$)

A second regression analysis (enter method) with predictors such as SCS independence and interdependence scores (Singelis, 1994), COS individualism and collectivism scores (Triandis & Gelfand, 1998), AHS holism scores (Choi et al., 2007) was conducted to identify if these cultural measures contributed to the model predicting overall PI and learning rates. Collectively, these scores contributed 8.3% (*Adjusted* $R^2 = .083$) of variation for overall PI, with SCS independence scores observed to be a significant predictor for the model ($B = -.244$; $p = .026$). However, the regression model was not significant ($p = .079$). Similarly, the regression model for learning rates with the SCS, COS, and AHS scores as predictor variables was not significant ($p = .350$).

5.4 Discussion

As part of the overarching aim of this thesis, the present study examines the unitisation component of VPL using the multilevel cultural framework. The use of the SLT to examine the unitisation process differs from the Glass (1969) pattern discrimination task as it evaluates participants' abilities to perceive and integrate separate events into perceptual wholes. Instead of learning to discriminate global patterns embedded in noise, participants learned to integrate the underlying probabilities of single events presented sequentially to inform their predictions for an upcoming stimulus. The use of the SLT adds novelty to the investigation in the present thesis as it represents a task that incorporates both spatial contexts and temporal sequences. Examining these processes within a cultural context contributes important insights into how people from different backgrounds integrate complex event structures and detect regularities in the environment despite the GPE (Liang et al., 2020; Powers et al., 2016; Wang et al., 2017).

At the macro group level, it was hypothesised that people from collectivistic cultures would exhibit better task performance due to their increased tendency for global and holistic processing compared to people from individualistic cultures (Koo et al., 2018). At the micro individual level, those with interdependent self-construal (SCS; Singelis, 1994) and collectivistic cultural orientations (COS; Triandis & Gelfand, 1998) were also predicted to exhibit faster learning trajectories than those with independent self-construal and individualistic cultural orientations. Other sociodemographic variables such as ethnicity, living arrangements, education, and holistic thinking styles (AHS; Choi et al., 2007) were also examined to assess their influence on VPL. Of these, only one hypothesis was accepted, that is, micro level variations in independent and interdependent self-construals were associated with differences in task performance.

Generally, although there was a decay in RTs following training, there were no group differences at the macro and micro levels. RTs are an important behavioural index that can reflect processing differences; however, RTs do not always correlate with accuracy performance

(Danielmeier & Ullsperger, 2011). Therefore, the comparable RTs between the different cultural groups suggest that the differences in PI could be attributed to an underlying variation in participants' unitisation abilities rather than processing speed differences. Furthermore, task performance could not be attributed to holistic thinking, demographic variables, or individual learning strategies, thus providing further support for the micro level self-construal influence on VPL.

Holistic and global processing tendencies have been associated with interdependent self-construal (Koo et al., 2018; Masuda et al., 2008; Na et al., 2020; Nisbett et al., 2001; Oyserman et al., 2002; Oyserman & Lee, 2008; Senzaki et al., 2014; Yu et al., 2021). Holistic tendencies are proposed to support the learning of the complex event sequences in the SLT due to differences in loci of attention towards the 'big picture' compared to its individual parts. On this basis, the interdependent participants may have unitised the probabilistic pattern of seemingly distinct events early in training due to their holistic processing tendencies. Indeed, there was a divergence in performance between those with independent and interdependent self-construal despite the GPE. Furthermore, independent self-construal was linked to slower learning rates and was predictive of poorer performance on the SLT. Interestingly, besides locus of attention, the linear versus cyclical change perception mechanisms of holistic thinking could also explain the differences in task performance (Choi et al., 2007; Koo et al., 2018). A cyclical view relates to an expectation of fluctuations in interacting events, while a linear view assumes a consistent trajectory of events that do not deviate over time (Ji et al., 2001; Lu & Xie, 2019; Votruba & Kwan, 2018; Yama & Zakaria, 2019). Therefore, the cyclical view, typically preferred by collectivists and interdependent individuals, could support the VPL of complex event structures. In contrast, those with linear change perceptions may inherently expect stable patterns when predicting future events, thus explaining the slower learning trajectories. However, the influence of these thinking styles on VPL is speculative as the AHS did not predict learning rates or overall PI.

The inconsistency of behavioural findings when culture is differentially defined (micro versus macro level) suggests the need for further examining the complex interaction of cultural processes implicated during VPL. For instance, unlike the SCS, the COS and AHS scores were not predictive of overall performance or learning rates in the SLT. Indeed, despite the correlations between the COS and SCS subscales, which suggest some degree of overlap between both measures, the cultural constructs assessed by the COS and AHS could be insufficient for explaining performance differences due to the measurement limitations discussed in Chapter 2. Similarly, although the Western individualistic group were generally more independent, there was a lack of association between the SCS self-construals and the individualistic and collectivistic cultural groups. Generally, the lack of significant findings suggests that experimental settings may be insufficient for replicating real-world learning conditions in different cultures (Magid et al., 2017). Nonetheless, the medium effect sizes in task performance between those with independent and interdependent self-construals should not be neglected as this would discount potentially important cultural findings (Kitayama et al., 2019; Na et al., 2020; Tanaka, 2020). It is thus essential to consider alternative sociocultural variables accounting for the differences in performance on the SLT.

The present study, which was administered online, allowed for the recruitment of a more representative sample beyond the student population sampled in the other studies in this thesis. The sample thereby increases the generalisability of findings. However, cultural shifts may also contribute to a more homogenous sample when participants from different nations are grouped under Hofstede’s (2017) individualistic and collectivistic cultural umbrella. Consequently, these shifts may introduce sampling errors (i.e., representativeness) that limit the attribution of culture as a moderating factor in observed psychological differences (Boer et al., 2018; Field et al., 2021). As demonstrated in the present study, independent and interdependent micro level attributes were better predictors of VPL trajectories in the SLT than macro level attributes (individualism-collectivism) that were better predictors of VPL in the Glass (1969) pattern discrimination task. These findings indicate a complex interaction of sociocultural variables that manifest under varying contexts and task conditions. Indeed, social orientations and cognitive styles could change following sociopolitical upheavals resulting from differential pathogen exposure (Fincher et al., 2008; Rotella et al., 2021; Thomson et al., 2018), socioeconomic disparities (Grossmann & Varnum, 2015), modernisation (Hamamura et al., 2021; Hamamura, 2012), or shifts in learning systems (Chang et al., 2011). Once again, it is evident that advancing research using a dynamic multilevel cultural framework is important to better capture the complex interactions of sociocultural variables that inform cognition and behaviour under varying contexts and situations (Kwon et al., 2021).

Research on the multilevel influence of culture on the unitisation mechanism of VPL could establish an important foundation of knowledge that considers the various cultural constructs and determinants that differentiates individuals and societies. These findings could then translate into more inclusive training programmes that require sequential and ordered execution such as linguistics, reading, musical ability, and sports activities (Polat, 2009; Shin & Ivry, 2002; Smyth & Naveh-Benjamin, 2018; Wang et al., 2017). Indeed, examining both temporal and spatial modalities using the SLT could reveal the learning process which occurs when people from different cultural backgrounds integrate information into superordinate concepts or how they meaningfully integrate complex event structures (Liang et al., 2020; Powers et al., 2016; Wang et al., 2017). Notably, to provide further evidence of these behavioural observations (or the lack of it), it would be beneficial to supplement research findings in this domain with neurobiological evidence (Kwon et al., 2021).

Consistent with the micro level differences observed in the present study, neural activations in specific brain regions may depend on the cultural values held at the individual level (Hedden et al., 2008). Reduced cortical volume in the orbitofrontal cortex was linked to interdependent tendencies whereby individuals holding interdependent self-construal exhibited a greater attunement towards surrounding information and a reduced self-interest in pursuing goals (Kitayama et al., 2017). Interestingly, this study also found that self-interest was lowered automatically for those holding interdependent self-construal, suggesting that the act of reducing self-interest was an implicit disposition. These findings demonstrate that cultural values can manifest in neural functions, behaviours, and self-representations. Within the context of unitisation, Liang et al. (2020) also observed neural changes in the posterior ventral visual stream and perirhinal cortex in response to learning. These changes were associated with more rapid processing of familiar features in multifeatured conjunctions. Collectively, neuroscientific methods could be helpful for corroborating cross-cultural evidence of how people learn to identify spatial and temporal regularities.

There is little work exploring the explicit role of VPL in the acquisition of higher-level expertise and skills in the context of culture. Therefore, cross-cultural research in the unitisation domain of VPL presents opportunities for expanding knowledge in this field using more advanced methodologies or neuroscientific methods. Indeed, learning is often isolated into perceptual, attentional, or procedural components, which results in the neglect of potentially critical links between the three divisions (Goldstone, 1998, 2000). Research on unitisation is thus crucial as perceptual learning can influence behaviour by shaping early information processing mechanisms as well as subsequent cognitive and procedural processes. Specifically, VPL enables one to overcome inherent limitations and acquire expertise by forming meaningful configurations from a complex set of features (Chase & Simon, 1973; Pevtzow & Goldstone, 2019; Smyth & Naveh-Benjamin, 2018). Accordingly, research in this domain has real-world applications as it represents an analogue for the proceduralisation of a task whereby practice induces a more economical and efficient sequence of responses and actions.

5.5 Chapter Summary

Although further research is needed to strengthen the overall evidence, the attribution of independent and interdependent self-construals on learning in the SLT has provided novel evidence for a micro level cultural influence on VPL despite the GPE. Notably, as discussed in Section 5.1, this chapter extends the cross-cultural investigation on VPL by examining the unitisation mechanism. As such, the SLT, which incorporates both temporal and spatial modalities, has contributed further novelty to the investigation. However, the inconsistency in findings for cultural groups defined at the macro and micro levels suggest the need for further research in this domain. The rise of more globalised communities in line with widespread immigration and technological advances has made it increasingly challenging to define culture while accounting for key cultural features that evolve as people navigate through the new social realms (Kitayama et al., 2009; Schaller & Muthukrishna, 2021; Sheetal & Savani, 2021; Votruba & Kwan, 2018; Wang et al., 2017; Wang & Brockmeier, 2002). It is thus increasingly pertinent to adopt a dynamic multilevel cultural framework to reflect the evolution of culture and how it operates differentially within varying cognitive and task domains. To this end, future studies examining the unitisation component from a cross-cultural perspective could examine alternative cultural characteristics and employ neuroscientific methods to provide more robust evidence of cultural influences on VPL (Kwon et al., 2021). Further research in this area is necessary as the outcomes could reveal the prevailing influence of culture on VPL within different task domains. These findings could subsequently inform real-world training paradigms that involve detecting and integrating spatial and temporal regularities (Polat, 2009; Shin & Ivry, 2002; Smyth & Naveh-Benjamin, 2018; Wang et al., 2017).

Chapter 6: Towards a Cultural Neuroscience Perspective – Exploring an EEG Study Design for Examining Cultural Differences in VPL

As discussed in Chapter 5, neuroscientific methods could reveal the neurobiological underpinnings of culture (see Section 5.4), especially when behavioural differences are inconsistent or absent (Ng et al., 2010; Sasaki & Kim, 2017). Indeed, cultural influences on behaviour and cognition have a biological basis that can manifest in psychophysical and neuroscientific measures (Kim & Sasaki, 2014; Kitayama et al., 2019; Sasaki & Kim, 2017). Therefore, this chapter aims to explore and develop an EEG study for examining cultural differences in the temporal dynamics of global shape processing during VPL. The chapter begins with a recap of the literature on the early or late processing differences identified under varying task conditions (see Section 1.3.2). Next, the importance of systematic task selection is discussed in the context of analytic-holistic thinking and the GPE (Alotaibi et al., 2014; Mills & Dodd, 2014; Navon, 1981; Rezvani et al., 2020). Three pilot studies were then conducted as a preliminary exploration into the design of an EEG study. The Glass (1969) pattern discrimination task parameters were adapted to ensure that its design aligns with the aim of the present chapter. Due to the interruptions to data collection (see COVID-19 Impact Statement), the findings and outcomes of the pilot studies are reported and discussed at face value to avoid broad generalisations. An overview of the insights and future directions derived from the mini exploratory studies are presented at the end of this chapter.

6.1 Background

The application of neuroscientific techniques such as EEG has provided evidence of neural plasticity culminating from exposure to cultural systems and experiences (Han et al., 2013; Kitayama & Park, 2014; Kitayama & Uskul, 2011). As mentioned in Chapter 1 (see Section 1.3.2), the P1 ERP component, which peaks at 70 – 120 ms after stimulus presentation, is associated with attentional processes as the magnitude of P1 is larger for attended rather than unattended information (Luck et al., 2000). In cross-cultural research, differences in the magnitude of P1 when Asians and Westerners perceive global or local features indicates an underlying difference in attention modulation (e.g., Han et al., 2000; Lao et al., 2013; Lin et al., 2008; Lin & Han, 2009). Furthermore, the occurrence of the P1 coincides with the distinct temporal component reported by Mayhew et al. (2012) at 105 ± 16.1 ms poststimulus presentation following training in the Glass (1969) pattern discrimination task. The early latency identified in Mayhew et al.'s (2012) study was linked to global form processing and integration (Ostwald et al., 2008). Collectively, the cross-cultural evidence observed for the P1 and the neural findings observed by Mayhew et al. (2012) indicates an important opportunity for investigating how cultural differences in global perceptual biases can inform early sensory processing changes in the discrimination task following VPL.

The second temporal component reported by Mayhew et al. (2012) at 242 ± 19.2 ms poststimulus presentation has been related to perceptual classification judgements (Das et al., 2010; Ohla et al., 2005; Tanskanen et al., 2008). Notably, the later latencies around the second component identified by Mayhew et al. (2012) coincide with the P3 component, which reflects task-relevant processing (Risto, 2018). Indeed, the P3 ERP component reflects cultural differences in later stages of perceptual processing (Goto et al., 2010; Lewis et al., 2008; Na & Kitayama, 2011). For example, Lewis et al. (2008) reported that Asian Americans exhibited enhanced novelty P3 amplitudes for perceptually discrepant events compared to European Americans, indicating that Asian Americans were more sensitive to contextual information. Interestingly, the effects were also mediated by interdependent self-construal, thereby suggesting an individual level influence on perceptual and neural processes. Cumulatively, like the early component, the Glass (1969) pattern discrimination task could also reveal if cultural influences at macro and micro levels can operate in later stages of global form processing following VPL (Mayhew et al., 2012).

Further research in this domain could provide neurobiological indications of how cultural differences impact the distribution of processing resources during VPL, particularly if there is inconsistent behavioural evidence. To this end, appropriate task selection and experimental designs are especially crucial for reconciling the inconsistent and contradictory evidence from past research (Dale & Arnell, 2014, 2015). Indeed, although it seems easy to make population comparisons using the cultural modes of thought assumed to operate pervasively across different psychological domains, researchers should continuously adapt or advance existing research methods (Cole & Packer, 2019). Within a cross-cultural context, careful consideration of experimental methodologies is especially pertinent due to the extraneous impact of cultural factors such as language, familiarity, skills, and expertise that could affect task performance (Ueda et al., 2018).

Evidence for cultural differences in visual cognition has been inconsistent (e.g., Rayner et al., 2009), especially across different measures (Hakim et al., 2017). For example, Hakim et al. (2017) reported no cultural differences in the Navon task, which contradicts McKone et al.'s (2010) study that observed a stronger global advantage amongst East Asians. Additionally, a replication of Boduroglu et al.'s (2009) study revealed that native Chinese participants consistently outperformed American participants in a colour change detection task that assesses global/local processing (Hakim et al., 2017). These findings suggest an underlying mechanism supporting the global and local advantage of native Chinese participants in this task (Dale & Arnell, 2014; Lewis et al., 2009). Americans also outperformed Asian international students in the 'expand' condition that engages global processing, again contradicting Boduroglu et al.'s (2009) findings that Westerners had a greater tendency for local processing. Generally, the inconsistent evidence of cultural differences in visual cognition suggests that behavioural manifestations are not always observed due to internal (e.g., age, gender, culture) and external (e.g., nature of tasks and stimuli) factors (Lawrence et al., 2020; Poirel et al., 2008; Rezvani et al., 2020). Appropriate experimental designs are thus needed to better capture cultural influences on VPL processes.

In the context of the present thesis, stimuli and task parameters and the experimental procedure need to be carefully designed to ensure that it can examine cross-cultural differences in the early and late processing mechanisms of VPL. For example, employing stimuli that engages global processing could contribute important knowledge of the dominant influence of culture on perceptual processing despite the GPE. Notably, the use of stimuli such as Navon figures revealed that the global advantage described by the GPE could manifest in early perceptual mechanisms and later identification processes (Flevaris et al., 2011; Mills & Dodd, 2014; Navon, 1977; Poirel et al., 2008). Similarly, the Glass (1969) pattern discrimination task that compels participants to engage in global processing could reveal the time course of early perceptual processes and later perceptual judgments that vary across cultures.

To this end, varying the signal-to-noise ratios (SNRs) of the Glass (1969) pattern discrimination task will allow an examination into the time course of VPL. Faster perceptual processing and integration of the signal embedded within easy patterns (high SNR) would reveal the fundamental difference in how people preferentially attend to global information. Indeed, more cognitive resources are needed for participants to process visual features that contradict their preferred processing styles (Goh et al., 2013; Hedden et al., 2008). Therefore, participants with greater tendencies for holistic thinking should process the global features of the stimuli faster than those with analytic thinking styles during initial perception, as reflected in early ERP components.

To examine the later processing mechanism underlying VPL, the design of the Glass (1969) pattern discrimination task should further incorporate difficult (low SNR) stimuli with easy (high SNR) ones. Priming participants to engage in global processing using the easy stimuli would lower the detection thresholds for the difficult stimuli and facilitate learning transfer (Flevaris et al., 2011). This top-down effect operating on perceptual sensitivity following priming could thus reveal how the GPE induced by the Glass (1969) patterns can also operate on later perceptual processing (Flevaris et al., 2011). Furthermore, resistance to priming (as reflected in slower VPL trajectories) would reveal trait-like dispositional biases for local processing strategies. Clearly, cross-cultural experimental studies should be carefully designed to align with research aims and address inconsistencies in previous research (Alotaibi et al., 2014; Hakim et al., 2017). Importantly, incorporating neuroscientific methods such as EEG could supplement any behavioural findings and provide neural evidence of the time course in which cultural differences may arise during VPL (see Chapter 3; Sasaki & Kim, 2017).

6.1.1 Aims of Study

This chapter presents a series of pilot experiments with varying task parameters to build an EEG experiment that would reconcile the discourse surrounding the time course of VPL within a cross-cultural context. Chapter 3 reported cultural differences in manifested behaviour following VPL. Building on these findings, the use of EEG would provide further cross-cultural evidence of the temporal dynamics of global shape processing during VPL. This chapter thus explores the feasibility and design of the proposed EEG study. Experiment 1 aimed to identify if cultural differences in VPL would manifest under conditions of greater perceptual uncertainty. The Glass (1969) pattern discrimination task parameters were adapted to include only difficult stimuli with low SNRs. It was hypothesised that although greater cognitive resources are needed for participants to learn how to differentiate difficult patterns, cultural differences in global or holistic processing tendencies would support VPL of the difficult stimuli. Experiment 2, built upon the outcomes of Experiment 1, aimed to establish the occurrence of VPL when three stimuli conditions (easy, difficult, and control) were combined during training. It was estimated that the easy condition could prime global processing and induce learning transfer to the difficult stimuli. A control condition, which had stimuli with no signal, was included as a baseline comparison for keypresses between the stimuli conditions. Finally, Experiment 3 employed the experimental paradigm of Experiment 2 while EEG recordings were obtained. The method, results, and discussion of each experiment is discussed below.

6.2 Experiment 1

Chapter 3 presented evidence of the prevailing influence of culture on VPL despite the GPE when participants learned to discriminate global patterns under relatively easy task conditions. Therefore, the aim of Experiment 1 was to identify if cultural differences in VPL would still manifest under conditions of greater perceptual uncertainty. The Glass (1969) pattern discrimination task parameters were adapted to include only difficult stimuli with low SNRs. It was hypothesised that although greater cognitive resources are needed for participants to learn how to differentiate the global forms, cultural differences in global or holistic processing tendencies would support VPL despite the increased task difficulty. The outcomes of this pilot study would also inform the design of an EEG study for investigating cross-cultural differences in the time course of VPL.

6.2.1 Method

Participants. Thirty participants were recruited for Experiment 1, and the sample had a mean age of 21.13 ± 4.04 (3 males, 27 females). Twenty-two participants in this study had British or European (EU) nationalities, while eight were international students from countries such as Malaysia (*n* = 6), India (*n* = 1), and Indonesia (*n* = 1). The international sample had been in the UK for a mean duration of 1.45 years. One EU participant from Portugal had been in the UK for 1.5 years, while the three British nationals who were not born in the UK were from Zimbabwe (in the UK for 15 years), Bangladesh (in the UK for 19.5 years), and Pakistan (in the UK for nine years since age 10). Non-native English speakers (*n* = 7) have spoken English for 11.57 ± 5.65 years and rated their confidence in the language at 3.85 ± .690 out of a score of 5. Due to a disruption in data collection (see Covid-19 Impact Statement), there was an unequal sample size for the individualistic and collectivistic experimental groups. Therefore, eight participants were randomly selected from the individualistic (UK/EU) sample to match the collectivistic sample.

Design. Experiment 1 employed a between-subjects design comparing participants from individualistic and collectivistic cultural backgrounds. Participants from the UK and Europe were categorised as the individualistic group, while those from countries such as Malaysia, Indonesia, and India were categorised as the collectivistic group. Response accuracy and RTs were recorded to enable a comparison of VPL differences between the individualistic and collectivistic groups. The Glass (1969) patterns generated for this experiment were more difficult than those employed in Chapters 3 and 4 as these had low SNRs (23-25%). Taken together, the independent variables in the present study are cultural backgrounds as defined by individualism and collectivism at the macro level, as well as social orientations (independence-interdependence; Singelis, 1994), cultural orientations (individualism-collectivism; Triandis & Gelfand, 1998) and analytic-holistic distinctions (Choi et al., 2007; Kitayama et al., 2003) at the individual level. The dependent variables are performance accuracy and RTs of correct responses.

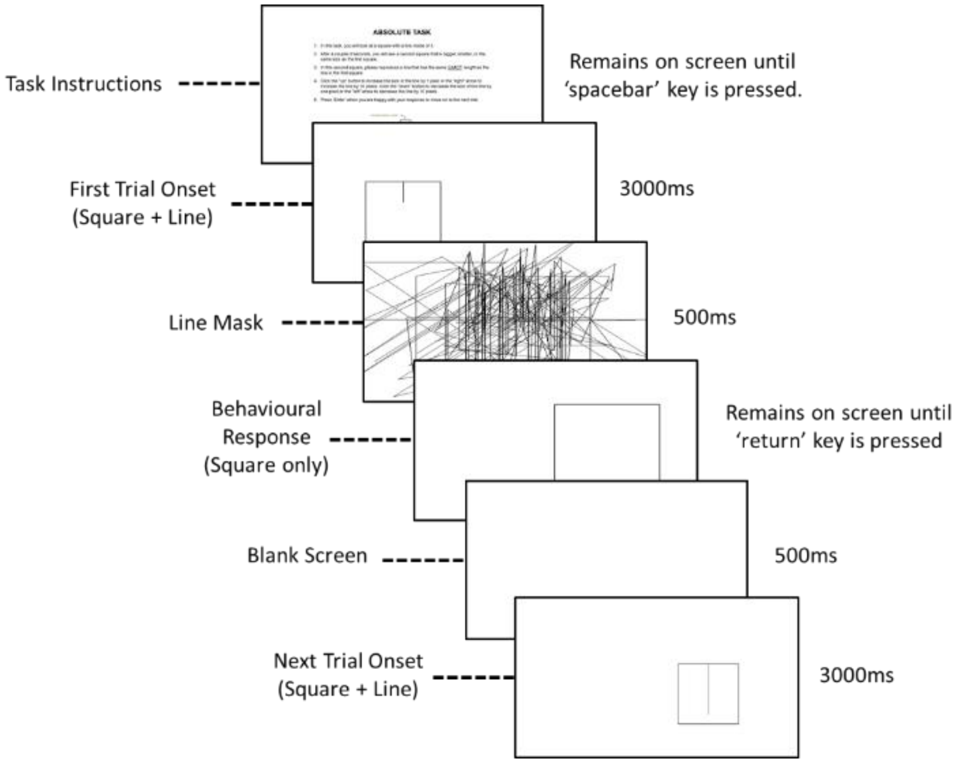
Materials. The self-report measures described in the earlier chapters were also used for the experiments in the present chapter; this included the demographics questionnaire, Singelis' (1994) SCS, Triandis and Gelfand's (1998) COS, and Choi et al.'s (2007) AHS (see Appendix D to G). The experiment was carried out on a 22" Lenovo ThinVision coloured monitor with a 1920 × 1080-pixels resolution and a frame refresh rate of 60Hz.

Framed-Line Test (FLT). The FLT was an additional measure employed in Experiment 1 to assess dispositional tendency for global or local processing based on ability to estimate line lengths embedded within frames of variable sizes (Kitayama et al., 2003). The response format of the FLT (participant-generated drawing) compared to the Likert-type responses to the cultural questionnaires (SCS, COS, and AHS) allows researchers to assess the behavioural profiles of participants (Na et al., 2019). Performance on the FLT could thus be used to associate analytic-holistic cognitive styles to performance in the Glass (1969) pattern discrimination task. The FLT, adapted from Hakim et al.'s (2016) task protocol, was coded in Python version 3.7 and implemented with PsychoPy toolbox version 3.2.4 (Peirce et al., 2019).

Figure 6.1 shows the sequence of events for the FLT. The FLT consisted of 12 trials – six absolute trials and six relative trials. Participants were shown two squares in each trial: the first square contained a vertical line drawn within it from the top centre, and the second square without a line was either bigger, smaller, or the same size as the first square. The squares and lines were drawn in black against a white background. For the absolute condition, participants were instructed to reproduce a line in the second square which had the same absolute (exact) length as the line from the first square. For the relative condition, participants were asked to reproduce a line with the same relative (proportional) length as the line in the first square. The absolute and relative conditions were presented in a randomised order.

Figure 6.1

Sequence of Events for the Framed-Line Test



Note. The FLT was presented to participants to estimate analytic or holistic tendencies through their performance on absolute and relative trials. Participants with greater error scores on the absolute condition (estimating exact line lengths within varying contexts) were proposed to possess more holistic thinking styles, while participants with greater error scores on the relative condition (estimating line lengths proportional to the context) are more analytic (Kitayama et al., 2003).

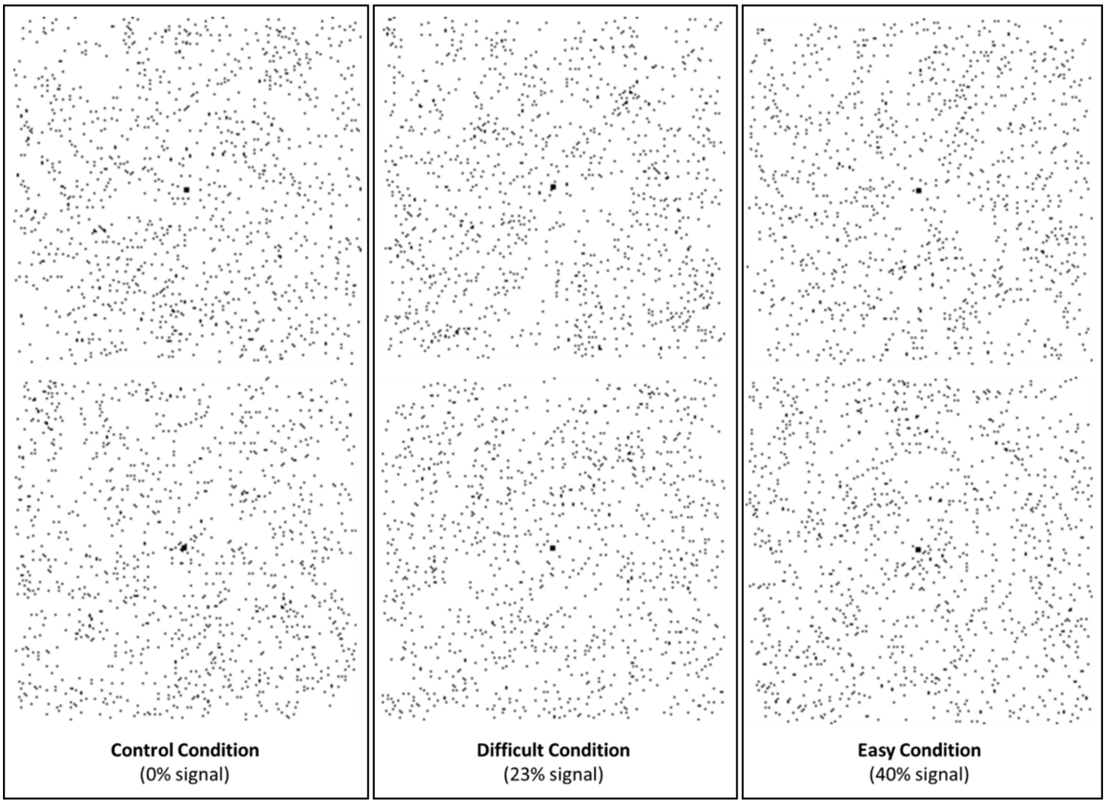
Participants were first presented with illustrated examples of the stimuli to ensure that they fully understood the response requirements (see Appendix AA). The 'up' and 'down' arrow keys on the keyboard increased and decreased the line length by one pixel, while the 'right' and 'left' arrow keys increased and decreased the length by ten pixels. Participants pressed the ‘space’ bar to begin the task. Six trials of each task (absolute and relative) were presented in a randomised order. For each trial, a square with a line first appeared on the screen for 3000 ms, followed by a distractor mask composed of arbitrary lines that lasted for 500 ms. The second square then appeared in one of the four quadrants of the screen. This design was an adaptation of the original study where participants moved across the room between stimuli presentations to ensure iconic memory did not impact performance (Kitayama et al., 2003). The size of the second square was determined based on the dimensions of the previous square and line combination (see Appendix BB).

When the second square appeared, participants adjusted the line length drawn from the top centre of the square. Once satisfied with their estimations, participants pressed on the ‘return’ key to move on to the subsequent trial. A blank screen was presented for 500 ms before the next trial onset. Participants’ responses were recorded, and the absolute and relative errors were calculated. Performance was assessed based on two outcomes: differences in relative judgment errors and differences in absolute judgment errors. Participants with greater error scores on the absolute task (estimating exact line lengths within varying contexts) were proposed to possess more holistic thinking styles. In comparison, participants with greater error scores on the relative task (estimating line lengths proportional to the varying context) are more analytic (Kitayama et al., 2003).

Glass (1969) Pattern Discrimination Task. MATLAB 2015a (The MathWorks Inc., 2015) was used in conjunction with Psychtoolbox-3 (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997) for stimulus generation and presentation. Stimuli features such as the dot dipoles and pattern rotations were consistent with those generated for Chapter 3 (see Section 3.2.3). The only change in task parameter for the present study was the lower SNR (23-25% signal) compared to the easy patterns (35-40% signal) used in Chapters 3 and 4 (see Figure 6.2). Participants were tasked with discriminating the radial and concentric patterns across several runs to investigate the perceptual learning processes that occur through training in difficult task conditions. All experiments were carried out in a dark room, and the viewing distance was maintained at 47 cm.

Figure 6.2

Different Signal Levels of Radial and Concentric Glass (1969) Patterns

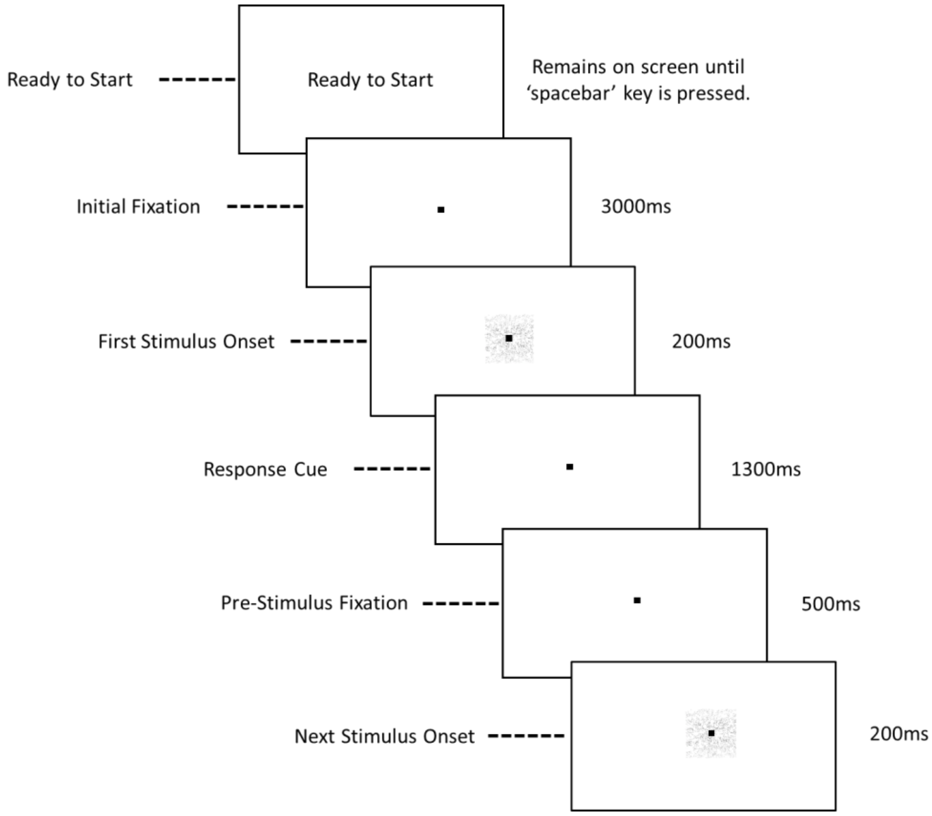


Note. The control condition stimuli do not contain any signal as these were used as baseline comparisons of random guesses. The difficult condition stimuli had 23% signal, while easy condition stimuli had 40% signal. The top row represents radial patterns, while bottom row represents concentric patterns. The stimuli are presented in inverted contrast for illustration purposes only.

Participants completed four experimental runs. Each run had 108 trials randomised between radial and concentric patterns. The order of trials was matched for history; each trial was equally likely to be preceded by any of the conditions. Two initial trials were added in each run to balance the history of the second trial; these were excluded in the final analysis. Figure 6.3 shows the sequence of events for Experiment 1. Each trial consisted of a 200 ms stimulus presentation followed by a 1300 ms fixation dot representing a response cue. Participants made a response on key '1' for radial patterns and key '2' for concentric patterns. A 500 ms fixation dot was displayed on the screen before the next trial onset. Each run began and ended with a 3000 ms fixation.

Figure 6.3

Glass (1969) Pattern Discrimination Task Event Sequence for Experiment 1 (Chapter 5)



Procedure. All participants completed an initial familiarisation phase to familiarise themselves with the task procedure and sequence of events (see Figure 3.4). Following this, participants completed the Glass (1969) pattern discrimination task while response accuracy and RTs were recorded. The demographics questionnaire and the cultural measures (COS, SCS, AHS, and FLT) were subsequently completed and followed by a debrief.

Data Analysis. IBM SPSS Statistic version 25.0 (IBM Corp., 2017) was used to analyse the data. As mentioned earlier, eight participants were randomly selected from the individualistic sample to match the sample size of the collectivistic group. The data which was normally distributed were analysed in two steps. The first analysis was a descriptive and reliability analysis of responses on the cultural measures (SCS, COS, AHS, and FLT). Due to the small sample and the lack of power, the outcomes of the first analysis revealed unequal sample sizes when groups were categorised based on the cultural measures. Therefore, individual level analyses were not conducted for Experiment 1. A second analysis was conducted to identify individualistic and collectivistic macro group level differences in response accuracy and RTs.

Ethical Considerations. Ethical approval was granted by Birmingham City University's research ethics committee (Reference: Chua #011.18; see Appendix H1). The ethical considerations of Experiment 1 were consistent with those Chapter 3 (see Section 3.2.6).

6.2.2 Results

The following analysis presents data of 16 participants – eight of whom were from collectivistic backgrounds and eight who were randomly selected from a sample of 22 participants from individualistic backgrounds.

COS. Cronbach's reliabilities for the overall scale was .827. Specifically, α values for the HI, VI, HC, or VC dimensions were .625, .696, .764, and .654, respectively. Three participants were categorised into the HI dimension, ten on the HC dimension, and two on the VC dimension. Separate individualism and collectivism scores were also calculated, and the α values for these dimensions were .723 and .792, respectively. The resulting scores revealed that two participants were categorised as individualistic, 13 were collectivistic, and one could not be categorised.

SCS. Reliability for the overall scale was .737, while the 12 independent and 12 interdependent items had α values of .587 and .687, respectively. Five participants had independent self-construal, and ten had interdependent self-construal according to the SCS scores. One participant could not be classified due to equal scores on both subscales. Specifically, the individualistic group had three participants with independent self-construal and five with interdependent self-construal. The collectivistic group had two participants with independent self-construal, five with interdependent self-construal, and one who could not be classified.

AHS. Reliability for the overall scale was .719. Alpha values for the four dimensions of causality, change perception, contradiction, and attention were .449, .602, .398, and .652, respectively. The reliability for the attitudes towards contradiction dimension was in an unacceptable range.

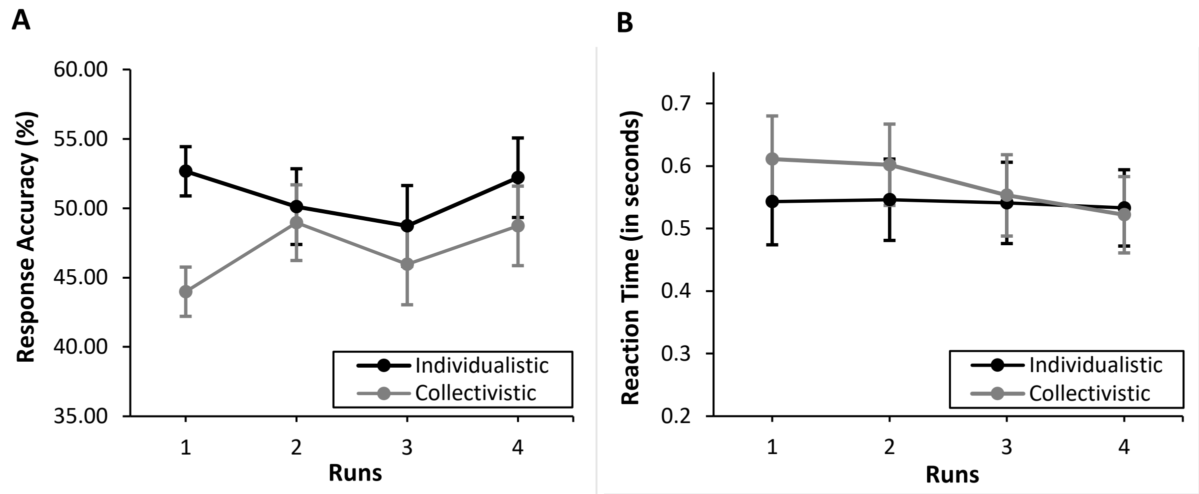
FLT. Each participant had six relative error and six absolute error scores in this task. The mean absolute and relative error scores were calculated for each participant by averaging the six trial scores in each condition. Additionally, to standardise the error scores, a ratio was calculated by dividing the error score by the correct line length of each trial. The individualistic group had greater absolute error scores (M = 23.98; SD = 14.53) and lower relative errors (M = 4.06; SD = 41.27). These findings indicate that they had more holistic thinking styles, which is consistent with the GPE but contradicting previous cross-cultural research (Choi et al., 2007; Kitayama et al., 2003). In contrast, the collectivistic group exhibited similar patterns of error in both the absolute (M = 6.96; SD = 39.66) and relative (M = 8.98; SD = 21.67) tasks. However, between and within-group differences in absolute and relative error scores were not significant. The implications of these findings will be discussed further in the General Discussion (see Section 6.5).

Generally, the unequal and small sample sizes informed by the cultural measures in the present study (COS, SCS, AHS, and FLT) indicate that individual level analyses could not be conducted due to violations of assumptions and lack of power.

Response Accuracy. A 2 (Culture: Individualistic or Collectivistic) × 4 (Run: 1, 2, 3, and 4) mixed-measures ANOVA was first carried out on response accuracy data of individualistic and collectivistic participants. The interaction between cultural backgrounds and runs were not significant (p = .271). As seen in Figure 6.4(A), there were no significant differences between the runs (p = .422) or between the cultural groups (p = .106), thereby indicating that participants did not improve in the task following training, and this was consistent for both groups.

Figure 6.4

Task Performance for Individualistic and Collectivistic Groups Across Runs



Note. There were no group differences in response accuracy (A) and RTs (B) between those from individualistic and collectivistic backgrounds. The error bars represent standard errors.

Reaction Times. A 2 (Culture: Individualistic or Collectivistic) × 4 (Run: 1, 2, 3, and 4) mixed-measures ANOVA was also conducted for the RTs. There were no significant interactions between the experimental groups and runs ($p = .621$). As seen in Figure 6.4(B), there were no observed differences between cultural groups ($p = .693$) or runs ($p = .487$).

6.2.3 Discussion

Experiment 1 was a pilot study that followed the experimental design of Chapter 3, whereby task performance was compared between participants of different cultural backgrounds (individualistic versus collectivistic). However, the task presented in this study employed difficult stimuli with lower SNRs. Since the collectivistic group had previously been identified to perform better than the individualistic group in the Glass (1969) pattern discrimination task, this experiment aimed to identify if the cultural differences in VPL would still manifest under conditions of greater perceptual uncertainty. The results of this study could be used to inform the design of the EEG study as previous research has often reported conflicting behavioural and neural outcomes (e.g., Ng et al., 2010). However, the accuracy and RT findings indicate an absence of cultural differences in the learning of difficult patterns with low SNRs. Contrary to the findings in Chapter 3, the collectivistic group did not perform better than the individualistic group, and task performance remained at a chance level across all runs as the experiment progressed.

It is estimated that learning did not occur in the present study due to the increased task difficulty. Consistent with the RHT and GPE, VPL could occur in a top-down fashion whereby learning of easy task conditions supports learning in difficult tasks (Ahissar & Hochstein, 1997, 2002, 2004; Ding et al., 2003). For example, eureka or priming presentations whereby easy stimuli are first administered before more complex stimuli are presented have been found to facilitate learning of the difficult stimuli through generalisations (Ahissar & Hochstein, 1997; Dale & Arnell, 2014). Learning transfer occurs considerably faster within these easy task conditions due to modifications within the generalised receptive fields of higher cortical areas. In contrast, difficult task conditions demand more learning specificity both in terms of spatial position and orientation, which has been related to changes in the localised receptive fields of lower cortical regions. Therefore, if training is administered with only difficult stimuli in the absence of feedback, there may be a lack of behavioural improvements due to the specificity of learning. On this basis, the outcomes of Experiment 1 suggest a need to incorporate easy stimuli with difficult ones to enable learning in a top-down fashion. Training with easy conditions could decrease the learning thresholds to inform learning in more difficult conditions as supported by previous priming studies (e.g., Dale & Arnell, 2014; Flevaris et al., 2011) and the RHT (Ahissar & Hochstein, 1997, 2002, 2004; Ding et al., 2003).

6.3 Experiment 2

Experiment 2 (the EEG behavioural pilot), built upon the outcomes of Experiment 1, was aimed at establishing the occurrence of VPL when three stimuli conditions (easy, difficult, and control) for the discrimination task were combined during training. It was estimated that the easy condition could prime participants to perceive global patterns and induce learning transfer for the difficult stimuli. The control stimuli condition with no signal was also included as a baseline comparison reflecting random guesses.

6.3.1 Method

Participants. Eleven participants with a mean age of 20.73 ± 3.58 (six females) were recruited for the EEG behavioural pilot study. All participants were British nationals (6 White, 5 Asians) and native English speakers.

Design. The experiment employed a within-subjects design comparing task performance on three different stimuli conditions: easy (high SNRs), difficult (low SNRs), and a control condition (no signal). The control condition served as catch trials and provided a baseline marker of comparison for participants' keypresses. Response accuracy and RTs of correct pattern discriminations were recorded for each participant to compare VPL differences between the stimuli conditions. Taken together, the independent variable in the present study was the stimuli conditions (easy, difficult, control), while the dependent variables are performance accuracy and RTs of correct responses.

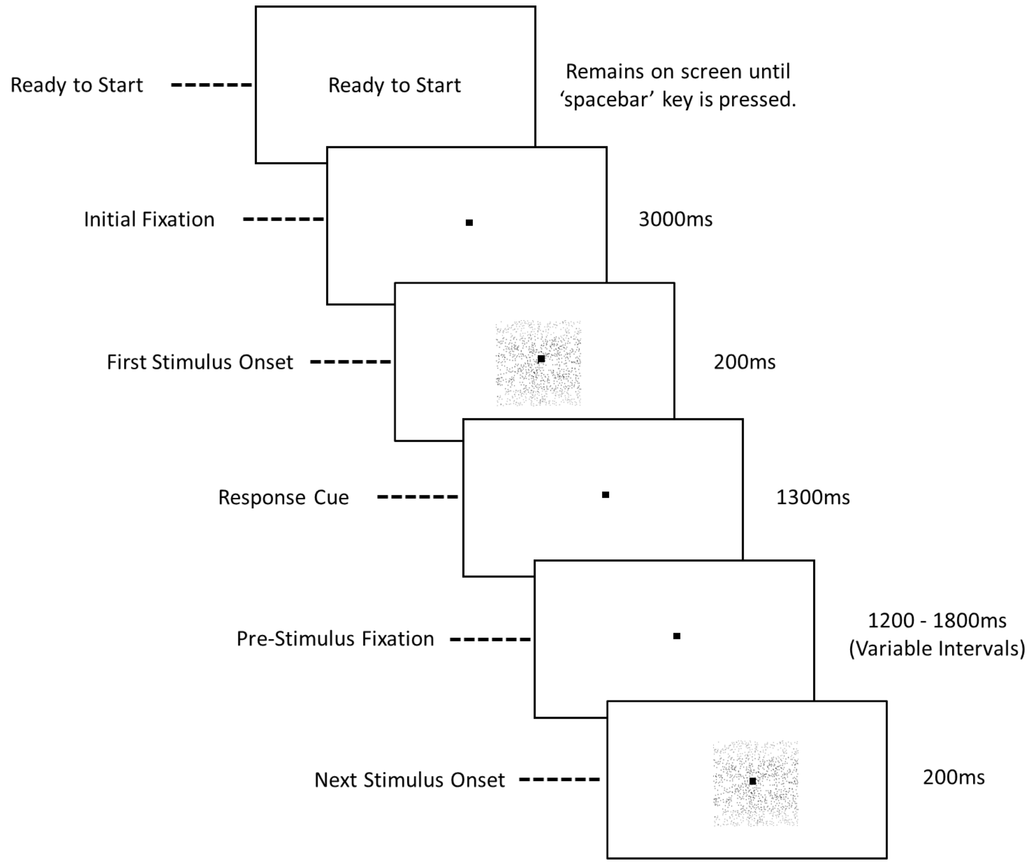
Materials. The self-report measures described in Experiment 1 was also used for the present study. This included the demographics questionnaire, Singelis' (1994) SCS, Triandis and Gelfand's (1998) COS, Choi et al.'s (2007) AHS, and the FLT (see Appendix D to G). The experiment was carried out on a 22" Lenovo ThinVision coloured monitor with a 1920 × 1080-pixels resolution and a frame refresh rate of 60Hz. All experiments were carried out in a dark room at a viewing distance of 47 cm.

Glass (1969) Pattern Discrimination Task. MATLAB 2015a (The MathWorks Inc., 2015) was used in conjunction with Psychtoolbox-3 (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997) for stimulus generation and presentation. In addition to the difficult stimuli (23-25% signal) employed in Experiment 1, the present study also integrated an easy (35-40% signal) and control (0% signal or 100% noise) condition. Each experimental run consisted of 48 trials per stimuli condition (see Figure 6.2). The order of trials was matched for history, and two initial trials were added in each run (excluded from analysis). Collectively, participants completed 864 trials carried out over six experimental runs (144 trials per run). As this experiment was a behavioural pilot for an EEG study, the number of trials was increased to ensure sufficient data quality and statistical power (Boudewyn et al., 2018). Participants were tasked with discriminating the radial and concentric patterns across several runs to investigate the perceptual learning processes that occur through training under varying task conditions. Each trial consisted of a 200 ms stimulus presentation, followed by a 1300 ms fixation dot representing a response cue (see

Figure 6.5). Participants made a response on key '1' for radial patterns and key '2' for concentric patterns. A variable intertrial interval of 1200-1800 ms was displayed before the next trial onset. Each run began and ended with a 3000 ms fixation.

Figure 6.5

Glass (1969) Pattern Discrimination Task Event Sequence for Experiment 2 and 3



Procedure. All participants completed the initial familiarisation phase to familiarise themselves with the task procedure and sequence of events (see Figure 3.4). Following this, participants completed the Glass (1969) pattern discrimination task while response accuracy and RTs were recorded. The demographics questionnaire and the cultural measures (COS, SCS, AHS, and FLT) were subsequently completed and followed by a debrief.

Data Analysis. IBM SPSS Statistic for Windows, Version 25.0 (IBM Corp., 2017) was used to analyse the data. The first analysis was a descriptive and reliability analysis of responses on the cultural measures (SCS, COS, AHS, and FLT). The small sample and the poor reliabilities indicated that the individual level data are not suitable for further analysis. The second analysis aimed to identify response accuracy and RT differences between the easy and difficult stimuli conditions. Data for the control condition (no signal stimuli) were also analysed to identify the participant's pattern of responses. Response accuracy in run 3 (*Skewness* = .996; *SE* = .661) and overall accuracy for the easy condition (*Skewness* = .941; *SE* = .661) were slightly skewed and kurtotic but it does not differ significantly from normality (Cramer & Howitt, 2011).

Ethical Considerations. Ethical approval was granted by Birmingham City University's ethics committee (Reference: Chua/1877/R(A)/2019/Mar/BLSS FAEC; see Appendix H4). **E**thical considerations for this behavioural pilot were consistent with Experiment 1 (see Section 6.2.1).

6.3.2 Results

Building on the previous study, Experiment 2 employed a combination of easy (high SNR) and difficult (low SNR) stimuli, as well as an additional control condition whereby the stimuli had no signal (100% noise). The stimuli in the control condition were included for random guess baseline comparison purposes with the other signal conditions. It also served as catch trials to identify if participants were making unbiased responses (e.g., making an equal number of responses using both keys). This experiment was informed by Experiment 1, which did not find VPL when only difficult stimuli were administered to participants. Importantly, the present study was implemented as an

EEG behavioural pilot to establish the occurrence of VPL for the experimental paradigm involving three stimuli conditions (easy, difficult, and control).

COS. Cronbach's reliability for the overall scale was .408. Specifically, α values for the HI, VI, HC, or VC dimensions were .680, .522, .513, and .158, respectively. Six participants were categorised into the HI dimension, four on the HC dimension, and one on the VC dimension. The low alpha reliabilities on the COS could be attributed to the small sample size. Therefore, participants' scores on the COS will not be used in subsequent analyses.

SCS. Alpha reliability for the overall scale was .665. Specifically, α values for the 12 independent and 12 interdependent items were .673 and .345, respectively. Five participants were categorised as independent on the SCS, while six had interdependent self-construal.

AHS. Reliability for the overall scale was .684. Alpha values for the four dimensions of causality, contradiction, change perception, and attention was .699, -.214, .866, and .674, respectively. The respondents' mean score on this measure was 116.55 (*SD* = 10.80). However, the negative reliability score on the contradiction scale violates reliability model assumptions. Therefore, participants' holism scores were not used in subsequent analyses.

FLT. The mean absolute and relative scores and a standardised ratio of these scores were calculated for each participant. The sample in the present study made greater relative errors (*M* = 26.12; *SD* = 30.28) than absolute errors (*M* = 16.08; *SD* = 41.67) in the task. A paired-samples t-test[4] revealed the difference between both error scores were significant, $t(10) = 2.42$, $p = .036$. As the present sample consisted of a British sample, these findings are consistent with research that suggest a greater prevalence of analytic thinking amongst Westerners who may exhibit poorer performance in estimating the proportion of line lengths in the relative task (Choi et al., 2007; Kitayama et al., 2003).

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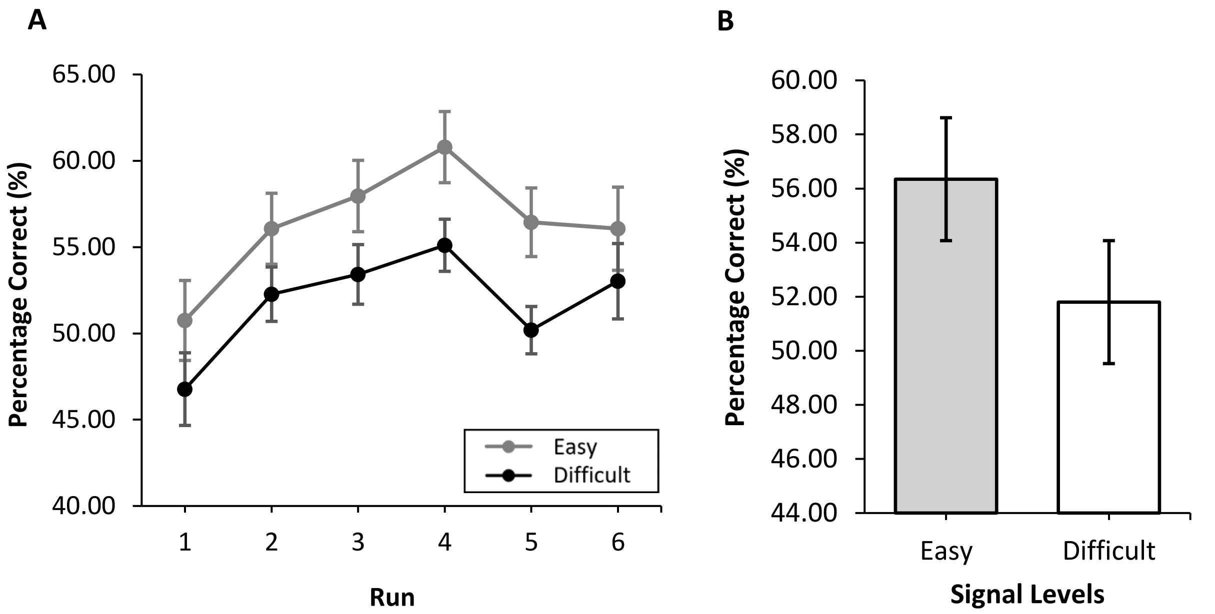
[4] A Wilcoxon signed-rank test (non-parametric equivalent to account for the small sample size) also showed a significant difference ($Z = -2.05$, $p = .041$) between the relative and absolute task conditions.

Response Accuracy. A 2 (Signal Level: Easy and Difficult) × 6 (Run: 1, 2, 3, 4, 5, and 6) within-measures ANOVA was run to compare the response accuracy of all participants (n = 11). As seen in Figure 6.6(A), there were no significant interactions between signal levels and response accuracy across the six runs (p = .226). There were also no significant differences in accuracy between each run (p = .261; see Appendix CC1). However, there was a significant difference between the signal levels, $F(1, 10) = 314.14$, $p < .001$, $\eta^2_p = .969$, whereby response accuracy was greater for the easy condition than the difficult condition. Therefore, as seen in Figure 6.6(B), a paired-samples t-test[5] was carried out on overall response accuracy (sum accuracy across six runs), $t(10) = 3.72$, p = .004, d = .440. The effect size was small to medium.

Figure 6.6

Response Accuracy for Easy and Difficult Stimuli Conditions Across Runs



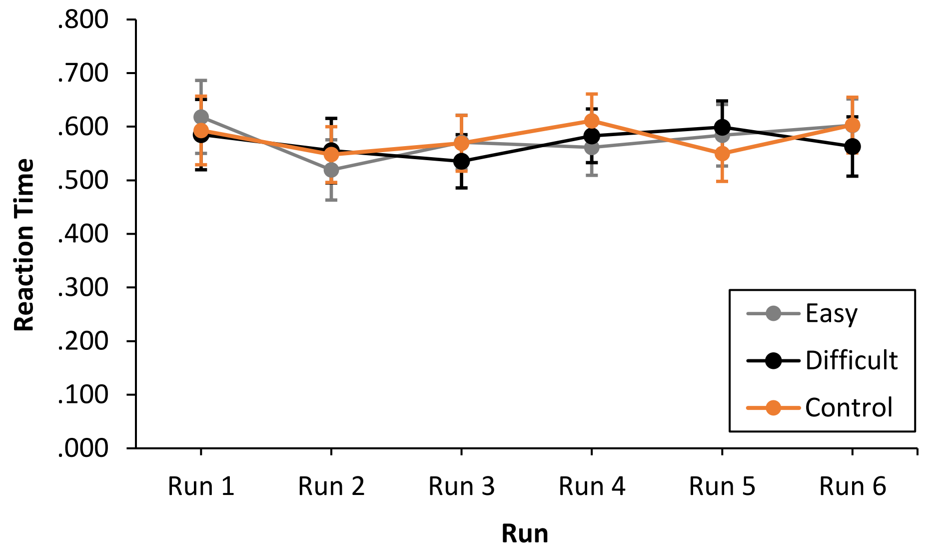
Note. There were no differences across runs between both stimuli conditions (A). However, a consolidation of the scores across the 6 runs revealed a significant difference between easy and difficult conditions (B).

[5] A Wilcoxon signed-rank test (non-parametric equivalent to account for the small sample size) also showed a significant difference (Z = -2.71, p = .007) between the easy and difficult stimuli conditions.

Reaction Times. A 2 (Signal Level: Easy and Difficult) × 6 (Run: 1, 2, 3, 4, 5, and 6) within-measures ANOVA was run to compare RTs. There were no significant interactions (p = .069) or differences between signal levels (p = .296) or runs (p = .501). There were also no differences in RTs across runs for all participants (see Figure 6.7), suggesting that differences in RTs did not contribute to the differences in performance for the easy and difficult stimuli conditions.

Figure 6.7

Reaction Times for Easy, Difficult, and Control Stimuli Condition Across Runs



Note. The were no significant difference in RTs between all stimuli conditions. RTs of the control condition was calculated as the average RT of all responses made with nonresponse trials excluded.

Control Condition. For the control condition consisting of no signal trials (288 trials in total), a paired-samples t-test revealed that participants were significantly more likely to press on Key 1 compared to Key 2 throughout the experiment, $t(10) = 3.49$, $p = .006$ (see Table 6.1).

Table 6.1

Key Presses in the Control (No Signal) Condition

Keys	*M* (%)	*SD*	95% Confidence Interval	
			Lower Bound	Upper Bound
Missed	20.27 (7.04)	13.69	3.00	44.00
Key 1	169.09 (58.71)	32.97	114.00	226.00
Key 2	35.58 (34.12)	104.98	48.00	162.00

While the response bias for the control condition could be attributed to an increased likelihood for participants to misidentify the patterns in the noise as radial patterns, participants could also be biased to make a response on a particular key more frequently. This form of response bias is typically reflected in faster RTs (Starns & Ma, 2018). Therefore, further analysis of the overall RTs for the control trials was carried out to assess this keypress bias. The analysis revealed that there were no significant differences (p = .144) in RTs between Key 1 (M = .568; SD = .144) and Key 2 (M = .591; SD = .16). Furthermore, as seen in Figure 6.7, the RTs for the control trials were comparable to the easy and difficult trial conditions across all six runs (p = .462).

Based on these findings, it could be implied that the participants were more inclined to perceive radial patterns instead of concentric patterns, hence the greater occurrences of keypress 1. RTs are expected to be quicker for nondecisions or movements consistent with the keypress bias (Starns & Ma, 2018). However, as seen in the analyses here, participants had comparable RTs for all stimuli conditions throughout the experiment. It is estimated that the short time window (200 ms), in addition to the noisy backgrounds, increased the perceptual uncertainty that participants faced in decision-making during VPL. Nevertheless, future studies should employ a counterbalancing methodology for key presses to reduce order effects (Larcombe et al., 2017; Tan et al., 2019). For instance, in the context of the present study, a randomised counterbalancing strategy could be used for participants to first identify radial patterns on key 1 for half of the experiment (three runs) and switch to key 2 for radial patterns for the other half (three runs).

6.3.3 Discussion

In summary, the behavioural findings reported in Experiment 2 suggest that the present design could be implemented as an EEG study to examine cross-cultural differences in the time course of learning. As VPL was not observed in Experiment 1 when only difficult stimuli were administered, the addition of the easy stimuli condition in the present study was intended to operate as an anchor for learning transfer (Ahissar & Hochstein, 1997). The administration of easy stimuli with more difficult ones could act as a prime and facilitate learning through learning generalisation in a top-down fashion (Dale & Arnell, 2014). Indeed, the present study revealed a significant difference between easy and difficult stimuli conditions. Additionally, the results showed that the control condition could be used as a baseline marker reflecting random guesses as determined by keypresses. The observations from the control condition also a provided valuable recommendation for improving future studies which could benefit from employing a counterbalancing methodology. Taken together, the experimental paradigm assessed in Experiment 2 was an essential foundation for informing the EEG pilot study (Experiment 3).

6.4 Experiment 3

Experiment 3 employed the experimental paradigm of Experiment 2, while EEG responses were measured to assess the time course of VPL.

6.4.1 Method

Participants. The EEG pilot experiment consisted of two British male participants aged 24 and 29. Both participants were native English speakers, right-handed, had normal or corrected-to-normal vision, and reported no history of neurological disorders.

Design. The experimental design of Experiment 2 was employed in the present study while EEG signals were recorded. Within a cultural context, the independent variables of an EEG study based on the design of Experiment 2 would be stimuli conditions (easy, difficult, control) and cultural backgrounds (individualistic and collectivistic). The dependent variables would be behavioural performance (response accuracy and RTs) and ERP signal differences between the stimuli conditions. However, since the present study was piloted on only two participants, these independent and dependent variables were not applicable. Instead, the pilot study reported here aimed to explore the implementation of an EEG study. The outcomes could then be used to inform future studies that compare the time course of VPL when people from different cultural groups learn to differentiate global forms embedded in varying levels of noise.

Materials. Participants completed the demographics questionnaire, Singelis' (1994) SCS, Triandis and Gelfand's (1998) COS, Choi et al.'s (2007) AHS (see Appendix D to G). The experiment was carried out on a 22" Lenovo ThinVision coloured monitor with a 1920 × 1080-pixels resolution and a frame refresh rate of 60Hz.

EEG Data Acquisition. The EEG pilot study was conducted using a BioSemi Active Two system with 32 channels using silver chloride electrodes configured to the 10–20 electrode system (http://www.biosemi.com; BioSemi B.V., Amsterdam, Netherlands). EEG data were recorded at 1024 Hz. Electrooculogram (EOG) was also recorded to monitor eye movements; electrodes were placed above and below both eyes and at a position lateral to the left outer canthus. Two electrodes were also placed on the left and right mastoids. Participants were asked to minimize blinking and movements. Impedances during data collection were kept under 10 kΩ. The detected stimulus and response onsets were saved alongside the EEG signals.

Glass (1969) Pattern Discrimination Task. The task parameters used in the present study were obtained from Experiment 2 (see Section 6.3.1). Similar to Experiment 2, MATLAB 2015a (The MathWorks Inc., 2015) was used in conjunction with Psychtoolbox-3 (Brainard, 1997; Kleiner et al., 2007; Pelli, 1997) to present the experiment, which consisted of six experimental runs. Each run consisted of 144 trials made up of the three stimuli conditions - the easy (35-40% signal), difficult (23-25%), and control (0% signal) conditions. Figure 6.5 shows the sequence of events for each trial. All experiments were carried out in a dark room, and the viewing distance was maintained at 47 cm.

Procedure. Once informed consent was obtained, participants were prepared for EEG data acquisition. All participants then completed the initial familiarisation phase to familiarise themselves with the task procedure and sequence of events. Following this, participants completed the Glass (1969) pattern discrimination task while response accuracy, RTs, and neural activity were recorded for each participant as a measure of VPL across all runs. The demographics questionnaire, FLT, and the cultural measures (COS, SCS, and AHS) were completed at the end of the study.

Data Analysis. MATLAB 2015a (The MathWorks Inc., 2015) and IBM SPSS Statistic for Windows version 25.0 (IBM Corp., 2017) were used to process and analyse the behavioural data. For the EEG data, pre-processing was first carried out on EEGLAB. ERPs were time-locked to the stimulus onset and averaged within each trial type across a 4000ms epoch relative to a 200ms prestimulus baseline. The raw data for each participant was then visually inspected for artefacts caused by signal loss or blocking as well as for manual rejection. The EEG data was then bandpass filtered at 0.1–40 Hz offline, and trials were averaged across conditions. Independent Component Analysis (ICA) was subsequently applied to remove ocular and motor artefacts and inform the selection of appropriate components (Makeig et al., 2004; Knyazev, 2013). After data pre-processing, the EEG recordings were matched to the behavioural data (correct responses). The behavioural and EEG data for each stimulus condition (easy, difficult, control) is presented individually for participants below.

Ethical Considerations. Ethical approval was granted by Birmingham City University's research ethics committee (Reference: Chua/1877/R(A)/2019/Mar/BLSS FAEC; see Appendix H4). For this EEG study, in addition to the ethical considerations of the previous studies using the Glass (1969) pattern discrimination task (see Section 3.2.6), additional steps to minimise risks were considered. The cap and electrodes are washed thoroughly after each participant. Clean towels, hairbrushes, shampoo, and a hairdryer were also prepared in advance. Participants were briefed thoroughly on the experimental set-up, the length of each experimental phase, and the task instructions. For instance, participants were informed in advance of when and why the EEG cap and electrodes would be placed on them before any contact to minimise discomfort. The researcher was present throughout the experiment to monitor the session and answer any questions or concerns.

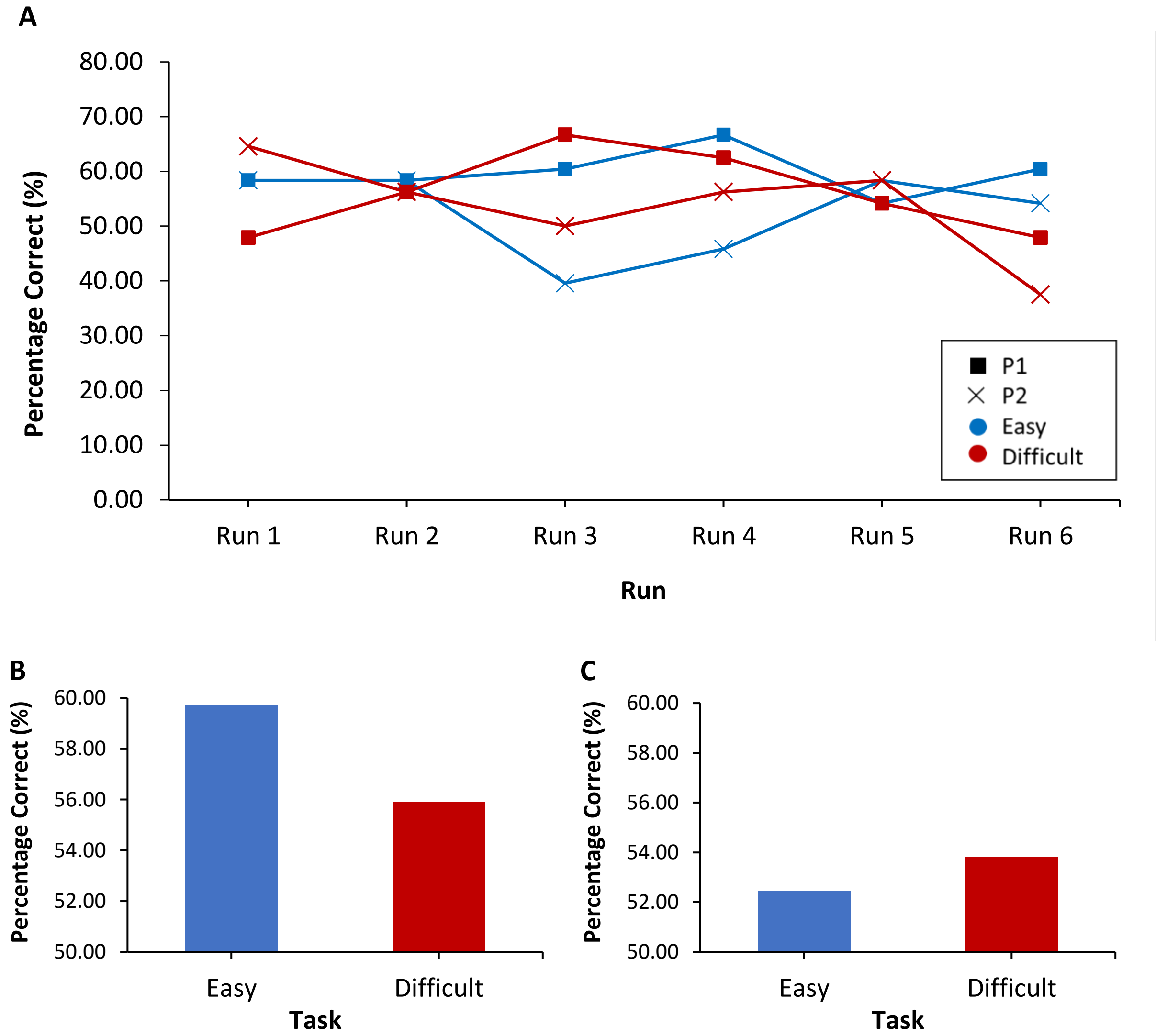
6.4.2 Results

This pilot aimed to test if the EEG methodology was appropriate for comparing cultural differences in electrophysiological responses when discriminating between easy and difficult Glass (1960) patterns. Furthermore, the EEG pilot was used to inform an analysis plan for cross-cultural comparisons. However, it is important to note that these data are preliminary and cannot be generalised due to the limited sample.

Behavioural data. The behavioural results of the participants (n = 2) are presented individually. As seen in Figure 6.8(A), both participants exhibited consistent performance across runs. Correct responses across six runs were thus consolidated to represent overall learning of easy and difficult patterns. Figure 6.8(B) and 6.8(C) shows that Participant 1 (P1) had better performance for both the easy and difficult task conditions compared to Participant 2 (P2).

Figure 6.8

Response Accuracy for Participants Across Runs for Easy and Difficult Stimuli

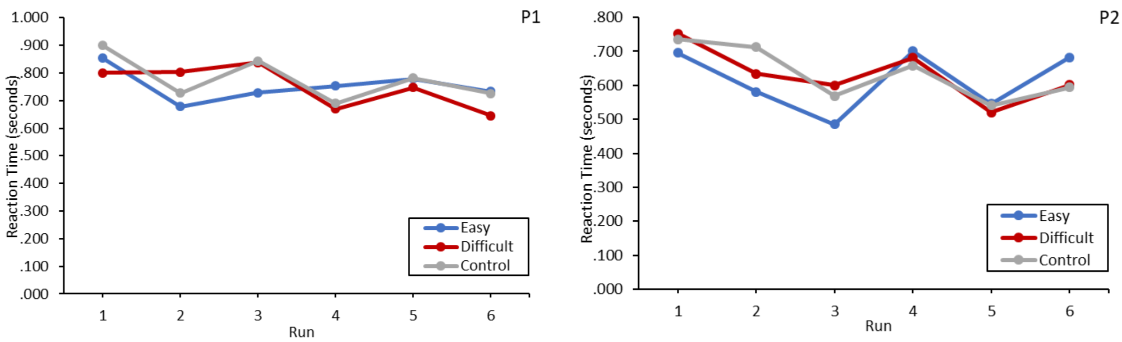


Note. The percentage accuracy scores in (A) were calculated based on the participant's accuracy in each stimuli condition (44 easy, 44 difficult, and 44 control stimuli). Participant 1 exhibited greater response accuracy in both the easy and difficult stimuli conditions (B) compared to Participant 2 (C).

Consistent with the RT findings of Experiment 1 and 2, Figure 6.9 shows that the RTs of participants were consistent across runs and for all stimuli conditions. Therefore, signal differences in EEG component amplitudes cannot be attributed to RT differences.

Figure 6.9

Reaction Times for Easy, Difficult, and Control Stimuli Condition Across Runs



Note. There were no RT differences across conditions for both P1 and P2.

For the control condition (288 no signal trials in total), participants did not exhibit the keypress bias identified in the previous experiment, as seen in Table 6.2. These findings suggest that the participants completed the task as instructed.

Table 6.2

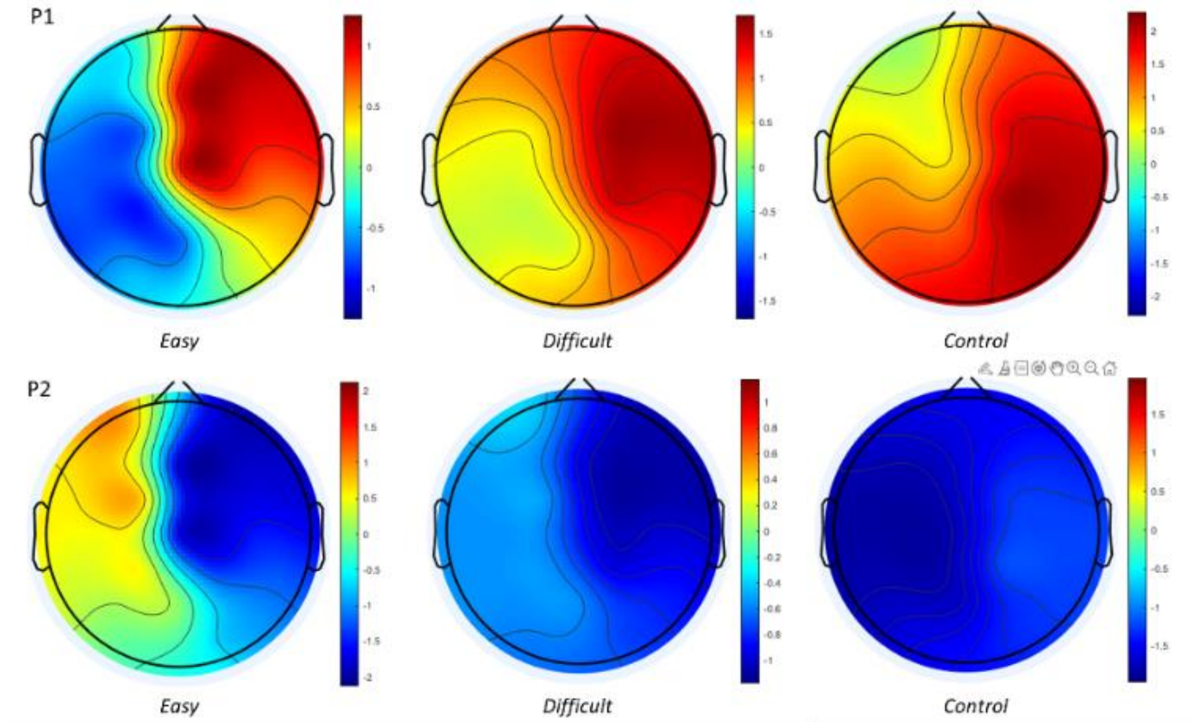
Key Presses in the Control (No Signal) Condition

	Missed (%)	Key 1 (%)	Key 2 (%)
P1	8 (2.78)	152 (52.78)	128 (44.44)
P2	9 (3.13)	116 (40.28)	163 (56.60)

EEG data. Figure 6.10 presents the topographical components averaged from all channels for the easy, difficult, and no signal conditions for P1 and P2. The topography of the difficult and control conditions was comparable, suggesting that neural activity underlying the learning process of stimuli with very low or no signal levels were similar.

Figure 6.10

Topographical Components of the Easy, Difficult, and Control Conditions for Each Participant

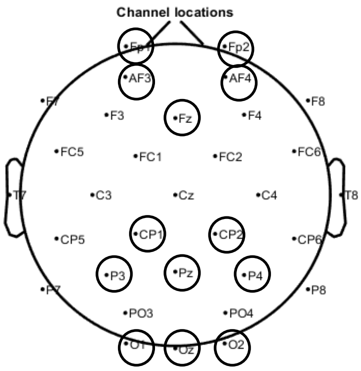


Note. The topography for the difficult and control conditions appeared comparable, suggesting that activity underlying the processing of stimuli with low or no SNRs were similar.

Topographical mapping is an important precursor for source localisation to inform subsequent analyses (Murray et al., 2008). Furthermore, Mayhew et al. (2012) reported changes in the occipitotemporal and frontoparietal areas following learning in the Glass (1969) pattern discrimination task. Therefore, the channel locations selected for the subsequent analyses in this chapter were based on these topographical maps and previous research (Mayhew et al., 2012). Based on the mapping in Figure 6.10 and Mayhew et al.'s (2012) study, channels surrounding the occipital and frontoparietal areas were selected to generate participants' averaged electrical activity for the easy, difficult, and control conditions, respectively (see Figure 6.11).

Figure 6.11

Channels Selected for Generating Averaged Electrical Activity

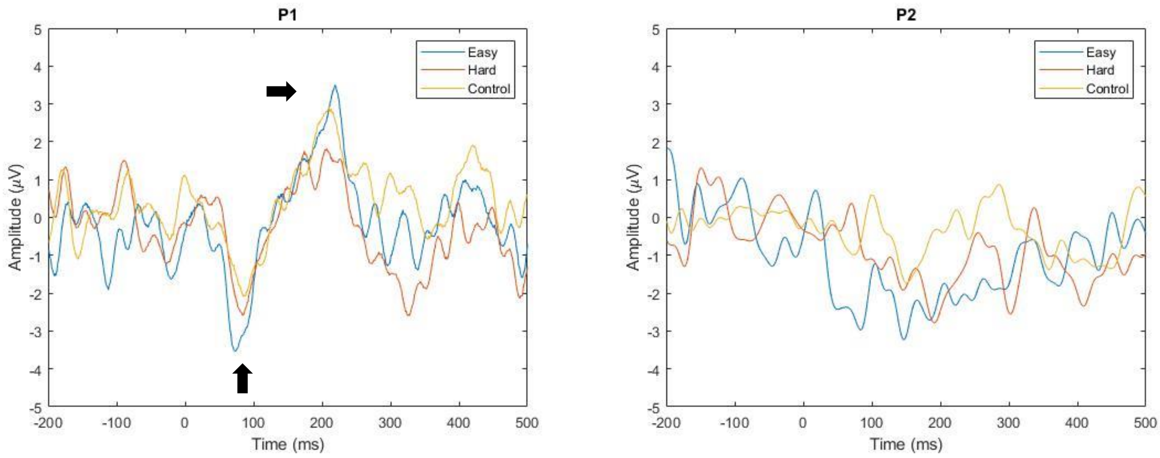


Note. Channels surrounding the occipital and frontoparietal areas were selected for generating the averaged electrical activity of participants for the easy, difficult, and control conditions.

Figure 6.12 shows the averaged electrical activity for both participants 200 ms before stimuli presentation and 500 ms post stimuli presentation. The black arrows in Figure 6.12 (left) for P1 point to two different peaks at approximately 90 ms and 200 ms, which interestingly, correspond with the components reported by Mayhew et al. (2012) at 86-119 ms and 229-249 ms following VPL. However, these findings were not observed in the data of P2.

Figure 6.12

Averaged ERPs Extracted for Each Participant



Note. Channel locations selected were Fp1, Fp2, AF3, AF4, Fz, CP1, CP2, P3, P4, Pz, O1, O2, and Oz.

6.4.3 Discussion

The present EEG pilot employs the experimental paradigm of Experiment 2, whereby participants completed six experimental runs with three stimuli conditions (easy, difficult, and control). Due to the limited sample size, differences in task performance or neural activity will not be discussed as it would be speculative and inaccurate. Nevertheless, the EEG study is an important avenue for further research within a cultural context. Behavioural improvements in the discrimination task after training were associated with neural changes in early and later processes (Mayhew et al., 2012). Therefore, despite the limitation relating to the lack of generalisability, this experiment is an important foundation for an EEG study that reveals the time course of VPL when people of different cultures learn to discriminate global patterns embedded in noisy backgrounds.

6.5 General Discussion

The experiments presented in this chapter aimed to build a foundation for an EEG study to examine the neurobiological underpinnings of cultural differences in VPL. The use of EEG in with the Glass (1969) pattern discrimination task that includes varying stimuli parameters (as defined by SNRs), could provide cross-cultural evidence of the temporal dynamics of VPL during global form processing. Experiment 1 utilised the experimental design of Chapter 3 with difficult patterns (low SNRs). However, the results did not replicate the earlier findings as cultural differences in accuracy and RTs were not observed. The outcomes of Experiment 1 indicated that VPL did not occur when only difficult stimuli were used in training. The greater cognitive resources needed to differentiate the global forms may have masked participants' default global/local processing strategies. Therefore, to assist in the VPL process, a priming design using easier task conditions was used to facilitate the learning of more difficult stimuli through generalisation and learning transfer (Ahissar & Hochstein, 1997, 2004; Dale & Arnell, 2014, 2015; Ding et al., 2003; Hochstein & Ahissar, 2002).

Both easy and difficult stimuli were subsequently employed in Experiment 2, while an additional no-signal control condition was included as a baseline for behavioural (keypresses) comparisons. Experiment 2 revealed a significant difference between easy and difficult stimuli conditions. The control condition also served as a useful baseline for analysing participants' responses (keypresses) relative to the experimental conditions. Lastly, Experiment 3 incorporated the use of EEG with the experimental design of Experiment 2 to assess an EEG study design that could compare behavioural and neural responses of different cultural groups. The EEG pilot was also used to establish a pre-processing and analysis strategy for the EEG data. The present chapter demonstrates the importance of adapting task parameters to establish an EEG study design that allows further investigation into the time course of VPL within a cross-cultural context. Indeed, the dispositional tendency for attending to the global properties depends on the experimental design as well as stable individual processing strategies (Dale & Arnell, 2014).

The outcomes of Experiment 1 and Experiment 2 suggest that priming using easy patterns could support the discrimination of difficult stimuli by conditioning participants to focus on the global features of the stimuli (Dale & Arnell, 2014). These findings support the RHT as the combined use of easy stimuli with difficult ones appeared to facilitate learning through transfer and generalisation (Ahissar & Hochstein, 1997; Burgoon et al., 2013; Flevaris et al., 2011). Therefore, integrating three stimuli conditions could be a reasonable avenue for cultural neuroscientific research that examines VPL differences. Indeed, the use of Glass (1969) patterns in the present thesis have narrowed the research focus to holistic processing. Incorporating the easy and difficult stimuli conditions within a single study could reveal if the GPE induced by the stimuli operates on early or later cognitive mechanisms (Dale & Arnell, 2014; Flevaris et al., 2011; Poirel et al., 2008). For instance, faster RTs to the easy stimuli would indicate early perceptual processing. In contrast, the learning transfer for the difficult stimuli condition suggests a later top-down influence during holistic processing of the global forms. Importantly, these early and late processes could also be reflected in neural activity (Mayhew et al., 2012), thus supporting the need to advance research in this domain using neuroscientific methods.

As discussed in Chapter 1 (see Section 1.3.2) and the introduction (see Section 6.1), cultural differences have been observed in both early and late perceptual processing (e.g., Goto et al., 2010; Lao et al., 2013; Lewis et al., 2008; Lin et al., 2008), and the ERPs identified can be extended to VPL processes (e.g., Ding et al., 2003; Shoji & Skrandies, 2006; Skrandees et al., 1996; Song et al., 2007). For instance, cultural differences in the early and late stages of information processing can be mapped to the two distinct task-relevant temporal components following training in the Glass (1969) pattern discrimination task (Mayhew et al., 2012). These components are notable as the earlier latency has been linked to visual form detection and integration (Ostwald et al., 2008), while the later latency has been associated with perceptual classification judgements (Das et al., 2010; Duncan, 2001; Johnson & Olshausen, 2003; Ohla et al., 2005; Tanskanen et al., 2008). Collectively, the temporal components and learning-dependent changes identified at early and later stages of global form processing following VPL, and the implication of cultural influences in early and later attentional mechanisms, necessitates further research to unify these findings. Extending the findings from both domains could reveal if culture acts upon the earlier or later perceptual systems during VPL. Indeed, as observed in the pilot studies here, the use of the Glass (1969) pattern discrimination task consisting of both easy and difficult stimuli conditions would support this investigation. Systematic task selection is clearly an important consideration in cross-cultural research designs (Alotaibi et al., 2014).

Self-report cultural measures are often subject to limitations such as demands characteristics (Na et al., 2020). Therefore, implicit measures of behaviours such as RTs, accuracy, or memory may reduce these artefacts (Na et al., 2020; Poirel et al., 2008). However, these measures could still be subject to biases and unaccounted sources of noise that could mask cultural or individual differences depending on the tasks used (e.g., Dale & Arnell, 2014, 2015; Evans et al., 2009; Hakim et al., 2017; Ueda et al., 2018). For instance, the FLT was proposed as an objective alternative for measuring individual differences in analytic or holistic processing (Choi et al., 2007). Indeed, the FLT was used to supplement the use of self-report cultural measures (SCS, COS, and AHS) that had varying accounts of validity and consistency (see Chapter 2). Western individualists have previously been reported to be more analytic, as demonstrated by their ability to estimate absolute line lengths more accurately (Kitayama et al., 2003). However, this chapter's adaptation of the FLT presented contradictory evidence as the Western individualistic sample in Experiment 1 were more holistic, while the sample in Experiment 2 appeared to be more analytic.

The contradictory findings and variances observed in the FLT could be attributed to the small samples that may be unrepresentative of the Western individualistic population. Alternatively, another explanation for the contradictory evidence relates to the dominance of the GPE in the FLT (Mills & Dodd, 2014; Navon, 1981; Rezvani et al., 2020). These findings indicate the importance of task selection when researching cultural differences in cognition and behaviour. Cultural differences do not always manifest consistently, as the tasks used may not be appropriate for examining the psychological processes which may vary across cultures (Rezvani et al., 2020; Dale & Arnell, 2013). For example, natural scenes are more complex and susceptible to biases like colour perception (Elliot & Maier, 2012) or preferences (Simonic, 2003). Therefore, the use of simple figure should reveal differences that are motivated by attention to stimulus elements rather than endogenous processing goals such as familiarity with stimuli (Kitayama & Murata, 2013). Importantly, the task selection should also be consistent with the research aims and objectives (Alotaibi et al., 2014).

The specific biocultural interaction that cultivates visual and learning differences remains an enigma (Khan et al., 2017). Therefore, contemporary cultural neuroscience research that departs from mere comparative behavioural studies are essential to uncover and understand the psychophysiological similarities and differences across cultures while also addressing the inconsistencies across existing literature (Khan et al., 2017). In the context of the present thesis, EEG research could provide unique cross-cultural evidence on the temporal dynamics of VPL (Goto et al., 2013). Since cultural influences have been implicated in early attentional systems and low-level perceptual encoding (e.g., Kitayama & Murata, 2013), as well as later mechanisms (e.g., Goto et al.

2010; Lewis et al. 2008), it is crucial to examine these temporal processes using appropriate methodologies and tasks systematically. For example, the nature of the Glass (1969) patterns that do not carry any semantic meaning also allows for more control over confounds as it consists of only low-level perceptual features (Petrova et al., 2013). The outcomes would indicate that culture is ingrained and could impact stimulus-driven attention and perception during learning.

6.6 Chapter Summary

Advances in the field of cultural neuroscience have provided considerable insight into our understanding of how culture influences the underlying mechanisms of perceptual processing (Ishii et al., 2009; Kitayama & Murata, 2013; Kitayama & Uskul, 2011; Lewis et al., 2008). In the same way, it could reveal if the differences in VPL between cultures stem from a divergence in early perception or later decision-making processes. As culturally acquired behaviour is considered semantic knowledge and involves automatic processes, a time-sensitive measure such as EEG would contribute novel neurobiological insights into the stages and components of perceptual processing that differ between cultures (Kitayama & Murata, 2013). The prevalence of contradictory results in the field when varying tasks and experimental methods are used also necessitates further research in this domain to address divergent findings (e.g., Hakim et al., 2017). Indeed, the present chapter presents an EEG experimental design to examine both the cultural and biological aspects of VPL. The use of EEG alongside the Glass (1969) patterns would provide further insight into the implicit cultural influences on VPL within the context of a multilevel cultural model (Lewis et al., 2008). Future research could also extend the investigation beyond the differentiation mechanism of VPL (e.g., unitisation) to account for the task- and context-variations in which culture can manifest.

Chapter 7: General Discussion

A multilevel cross-cultural examination of VPL is a novel area of research that has yet to receive greater scrutiny (Morris et al., 2015; Simko & Olick, 2021; Tsui et al., 2007). Therefore, the overarching aim of the present thesis was to identify if cultural differences contribute to variability in VPL processes. Specifically, the differentiation and unitisation mechanisms of VPL were examined using a dynamic multilevel cultural framework. The thesis builds upon previous cross-cultural research that examined differences in perception (e.g., Kastanakis & Voyer, 2014), attention (e.g., Correa-Chávez & Rogoff, 2009; Lufi et al., 2017), memory (e.g., Alea & Wang, 2015; Leger & Gutchess, 2021), and learning (e.g., Mayhew et al., 2012; van der Kamp et al., 2013; Wang et al., 2017). Indeed, to narrow the focus of the investigation into this expansive interdisciplinary area of culture and cognition, it was important to first examine the influence of global or holistic processing on VPL processes in the present thesis due to the GPE (Mills & Dodd, 2014; Navon, 1981; Rezvani et al., 2020). Consistent with the thesis aim, the collective outcomes of all the studies presented here offer a compelling insight into the fundamental cross-cultural differences in cognitive styles that manifest despite the common global advantage observed in the general population (see Section 1.1.2). Notably, these processing differences influence VPL trajectories within varying task domains despite the GPE. As such, this thesis contributes significant knowledge to existing research and provides an original contribution to the literature on VPL within a cross-cultural context. This chapter will first present a summary and evaluation of the findings in previous chapters (Chapters 2 to 6) and how they align with the aims and objectives of the thesis. The implications of this research for theory and practice will then be reviewed, followed by a discussion of the limitations and future directions.

7.1 Overview: Aims and Objectives of Thesis

According to the GPE, people have a general tendency to engage in global processing as the perceptual system often prioritises global information over a more fine-grained analysis of local objects during visual perception (Gerlach & Starrfelt, 2018; Liu & Luo, 2019; Mills & Dodd, 2014;

Navon, 1981; Rezvani et al., 2020). Therefore, any behavioural differences identified when people from different cultural backgrounds complete global tasks would present substantial evidence of a fundamental cultural difference in visual perception despite the GPE. To this end, the Glass (1969) pattern discrimination task (Mayhew et al., 2012) and the SLT (Wang et al., 2017) were employed to examine the differentiation and unitisation mechanisms of VPL, respectively (see Section 1.1.2). Both tasks compel participants to engage in global processing. Additionally, a multilevel framework with both macro and micro features at the national and individual level was used in the present investigation to account for the multiplexity of culture and how it could differentially impact VPL processes (Boer et al., 2018; Brewer & Venaik, 2011, 2012; Chen et al., 2020; Goodwin et al., 2020; Oyserman et al., 2002; Steel & Taras, 2010; van de Vijver & Leung, 2000, 2021; Vignoles et al., 2016).

The objectives of this thesis are thus as follows: defining and assessing a multilevel model of culture that can function as an explanatory framework for behavioural differences (see Chapter 2); investigating if micro and macro level cultural influences could modulate global processing in the Glass (1969) pattern discrimination task that implicates the differentiation mechanism of VPL (see Chapter 3); using priming techniques to explore the dynamic nature of culture and how individual-level variations in self-construal could influence VPL (see Chapter 4); investigating if micro and macro level cultural influences could also govern global processing differences in the SLT that implicates the unitisation mechanism of VPL (see Chapter 5); and lastly, exploring and establishing an EEG study designed to assess for cultural differences in the temporal dynamics of global shape processing during VPL (see Chapter 6). The key findings of each research objective will be explored further in the next section.

7.2 Key Findings

Chapter 2 presented essential preliminary findings for the thesis as it established a multilevel explanatory framework for investigating cross-cultural differences in VPL. The macro level of culture was defined by the individualism-collectivism distinctions, which differentiated groups based on their nationalities (Hofstede, 1980, 2001, 2011). The individualism-collectivism dimension is a significant explanatory construct for describing collective and aggregated features of a nation (Brewer & Venaik, 2012; Schimmack et al., 2005; Venaik & Brewer, 2013; Venkateswaran & Ojha, 2019). Micro level cultural features were also integrated with the macro system to account for individual variations that may define or inform cultural norms, practices, and behaviours (Fischer, 2009). As such, the micro level of culture examined in Chapter 2 was defined by social orientations (SCS; Singelis, 1994), cultural orientations (COS; Triandis & Gelfand, 1998), and cognitive styles (AHS; Choi et al., 2007). Considering these individual level variances, alongside participant demographics (e.g., living arrangements, ethnicity, etc.), can offer valuable insight into the dynamic and complex nature of cultural conceptualisations (Boer et al., 2018; Hong et al., 2000; Steel & Taras, 2010).

Although the cultural instruments (COS, SCS, AHS) examined in this chapter were limited by their lack of measurement equivalence, these could nonetheless be used to inform the multilevel cultural framework for examining cultural differences in VPL. Considering the interaction between the multiple facets of culture as defined by these cultural instruments could account for the error variances associated with the typical convention of comparing WEIRD populations in cross-cultural research (Varnum et al., 2008). Collectively, the integration of macro and micro levels to define a multilevel cultural framework provides an important explanatory function for understanding the behavioural observations in the subsequent experimental chapters of this thesis. Beyond this, the multilevel framework could also be extended to other psychological domains as it considers the broad influence of cultural systems at both macro and micro levels on cognition and behaviour (Boer et al., 2018; Chen et al., 2020; Goodwin et al., 2020; Steel & Taras, 2010; Van De Vijver & Leung, 2000, 2021; Vignoles et al., 2016).

Chapter 3 presented the first novel evidence of cultural differences in VPL. The experiment in this chapter employed the multilevel framework to examine the macro and micro cultural systems which may influence VPL in the Glass (1969) pattern discrimination task. Although the Glass (1969) patterns do not carry semantic meaning, these are representative of the abundance of information we are exposed to in the environment. The present study's findings have important theoretical and real-world implications (see Section 7.3). Notably, the outcomes of this chapter contributed critical knowledge about the influence of culture on VPL as it extends from previous research that is predominantly focused on individual differences VPL (e.g., Hansen et al., 2012; Rop & Withagen, 2014; Withagen & Caljouw, 2011; Withagen & van Wermeskerken, 2009). Specifically, the study provides novel and compelling evidence of how people from individualistic and collectivistic cultures learn to discriminate complex stimuli. This differentiation mechanism of VPL was assessed as participants learned to distinguish radial and concentric Glass (1969) patterns embedded in noise (Frangou et al., 2019; Garcia et al., 2013; Li et al., 2012; Mayhew et al., 2012; Wang et al., 2017). The ambiguity induced by the noise compels participants to engage in global or holistic processing to support learning and accurate discriminations.

Consistent with the GPE, all participants exhibited improvements in the task following training (Mills & Dodd, 2014; Navon, 1981; Rezvani et al., 2020). However, a subsequent divergence in performance during training indicates a fundamental processing difference between cultures, whereby the greater tendency for holistic thinking within collectivistic cultures was proposed to support faster learning trajectories (e.g., Han & Humphreys, 2016; Kitayama et al., 2009; Peng & Nisbett, 1999; van der Kamp et al., 2013; Wan et al., 2016). Additionally, at the micro level, independence, as measured on Singelis' (1994) SCS was also predictive of poorer overall performance in the discrimination task, indicating that self-construals could also represent a different cultural system at the individual level that may impact VPL. Nonetheless, the lack of group differences between those holding independent versus interdependent self-construal warrants further research to better indicate how these values influence perceptual accuracy and learning rates. Therefore, the next chapter employed a priming methodology to examine the causal impact of self-construals on VPL processes.

Chapter 4 presented a causal examination into how primed values of independence and interdependence can influence the global processing and VPL of ambiguous Glass (1969) patterns. The outcomes of this chapter had significant implications for the overarching aim of the present thesis, as cultural priming allows the experimental isolation of the behaviours induced by specific cultural values (Kühnen & Oyserman, 2002). Notably, the dynamic nature of priming further contributes to the multilevel cultural framework for investigating VPL, as it considers the intricate interaction of social, individual, and situational factors that govern the manifestation of culturally congruent behaviours (Briley et al., 2014; Hong et al., 2000; Syed & Azmitia, 2010; Xi et al., 2018). Indeed, the faster RTs induced by independence priming indicates a narrower attentional spread consistent with independent self-construals and analytic thinking styles (Choi et al., 2007; Koo et al., 2018). Evidently, priming methodologies can present some intriguing insights into the dynamic influence of self-construals on behavioural indices such as RTs.

However, priming effects were not reflected in performance accuracy. It is possible that the salience of the GPE overshadowed the effects of priming (Mills & Dodd, 2014; Navon, 1981; Rezvani et al., 2020). The lack of group differences in VPL trajectories suggests the need for more robust priming manipulations that can sufficiently induce culturally consistent behaviours (beyond the GPE). Alternatively, since the efficacy of priming was also not reflected in the priming manipulation checks, the observed RT differences could be attributed to other mechanisms such as confidence or conscientiousness that were not assessed in this study (Chen et al., 2014; Tanaka, 2020; Wang et al., 2021). These findings provide important insight into the complexity of cultural manifestations at the individual level during VPL. The inconsistencies in behavioural manifestations following priming warrant additional research within other VPL domains (i.e., unitisation) or using neuroscientific measures such as EEG (Han & Ma, 2014; Lin et al., 2008; Ng et al., 2010). Expanding the scope of the investigation would provide further evidence of the dynamic multilevel influence of culture that can manifest differentially under varying contexts.

Chapter 5 subsequently presented an investigation to examine the unitisation mechanism of VPL using the multilevel cultural framework (see COVID-19 Impact Statement). This chapter offered significant insight into the impact of micro level cultural mediation on VPL, which extends beyond the differentiation mechanism assessed in the earlier chapters. A symbol SLT was employed to assess participants' ability to perceive and integrate a complex configuration of separate events into perceptual wholes (Wang et al., 2017). Importantly, the SLT, despite implicating a different VPL mechanism, engaged global processing like the Glass (1969) pattern discrimination task to ensure continuity in assessing the dominant influence of culture despite the GPE. The SLT also contributes further novelty to the investigation as it represents a task that incorporates learning of both spatial contexts and temporal sequences (i.e., configuring distinct events that manifest based on underlying temporal statistics). Although there were no behavioural differences at the macro level, micro level differences were observed between those with independent and interdependent self-construal, once again providing evidence for the dynamic multilevel influence of culture on VPL mechanisms.

The divergence in performance during training provides support for previous research that have linked interdependent self-construal to greater tendencies for global or holistic processing (Koo et al., 2018; Masuda et al., 2008; Na et al., 2020; Nisbett et al., 2001; Oyserman et al., 2002; Oyserman & Lee, 2008; Senzaki et al., 2014; Yu et al., 2021). The increased tendency for global processing amongst those with interdependent self-construals was proposed to enhance learning. In contrast, slower learning trajectories amongst those with independent self-construals could be attributed to more analytic processing. Together, these findings present compelling evidence that cultural manifestations are contingent on task domains. However, to reconcile the inconsistent macro and micro level evidence observed across studies, further research is needed to examine the prevailing influence of culture on VPL within varying task domains and stimuli conditions (Wang et al., 2017). Additionally, incorporating neuroscientific methods such as EEG would provide more robust and novel evidence of cultural influences on VPL processes (Kwon et al., 2021).

Chapter 6 was a culmination of the collective outcomes reported in the present thesis (see COVID-19 Impact Statement). Specifically, the outcomes of the three pilot studies presented in this chapter contribute to an EEG experimental design that could reconcile the discourse surrounding the time course of VPL within a cross-cultural context. To this end, the parameters of the Glass (1969) pattern discrimination task were adapted and evaluated systematically to inform an EEG study design that can investigate the neurobiological underpinnings of culture. Experiment 1 revealed that cultural differences did not manifest under conditions of significant perceptual uncertainty. Regardless of cultural background, participants did not learn when trained using only difficult stimuli with low SNRs. Therefore, easy patterns were combined with difficult patterns in Experiment 2 to enable learning transfer and generalisation (Ahissar & Hochstein, 1997, 2004; Dale & Arnell, 2014, 2015; Ding et al., 2003; Hochstein & Ahissar, 2002). A control condition was also included as a baseline comparison for keypresses between the stimuli conditions. As predicted, response accuracy was greater for the easy condition than the difficult one. An EEG pilot was subsequently conducted with the same task parameters to explore the experimental design further while EEG responses were recorded. Taken together, the outcomes of the exploratory studies in this chapter inform an EEG experimental design that can examine the multilevel influence of culture on VPL during global shape processing. An EEG study could provide neural evidence of how cultural differences in global or holistic processing operates on early or later cognitive mechanisms (e.g., Goto et al., 2010; Han et al., 2000; Lao et al., 2013; Lewis et al., 2008; Lin et al., 2008; Lin & Han, 2009; Na & Kitayama, 2011), particularly when there is a lack of behavioural findings (e.g., Ng et al., 2010).

In summary, the empirical evidence reported in the present thesis indicates that the dynamic multilevel nature of culture is domain-specific and operates differentially on VPL processes under varying task conditions. Indeed, the present thesis has made novel and compelling contributions to the existing literature on the interdisciplinary area of culture and cognition by integrating the micro and macro systems of systems of culture into a dynamic multilevel framework (see Chapter 2). Hofstede's (1980, 2001, 2011) individualism-collectivism construct was used to define groups at the macro level, while independent and interdependent self-construals (Markus & Kitayama, 1991; Singelis 1994) were used as the primary micro level constructs examined in the present thesis. This integrative framework established an explanatory framework for the subsequent experimental chapters. Specifically, the individualism-collectivism constructs and the independent-interdependent self-construal informed VPL trajectories for differentiating ambiguous global forms (see Chapter 3). Since the Glass (1969) pattern discrimination task requires global processing, observed cultural differences in performance despite the GPE demonstrates the dominant influence of culture on VPL. To further supplement these findings, enhancing the saliency of independent self-construals through priming was also attributed to significantly faster RTs during VPL (see Chapter 4). The micro (individual) level influences on VPL persisted even within a different task domain (see Chapter 5). Therefore, self-construals are not only implicated when people learn to differentiate ambiguous global forms but also during unitisation when people learn to integrate complex event sequences to make accurate predictions about future events. These findings then informed three pilot studies that explored an EEG experimental design that would reveal cultural differences in the temporal dynamics of global shape processing during VPL (see Chapter 6). Taken together, it is apparent that the present thesis has contributed compelling observations of the dynamic multilevel influence of culture on VPL within varying contexts and situations.

7.3 Implications of Research

Although further research is needed to validate this dynamic multilevel cultural framework, especially from a neuroscientific perspective, the present thesis has provided a substantial foundation of knowledge for research in this interdisciplinary area of culture and cognition (Atkins et al., 2016). First, the present thesis has provided compelling evidence of a multilevel cultural framework that can account for variances in VPL abilities at both micro and macro levels of culture (Morris et al., 2015; Simko & Olick, 2021; Tsui et al., 2007). Second, the proposed framework also highlighted the prominence of the dynamic nature of culture and the circumstances under which culture-specific cognition and behaviours may manifest (Gelfand et al., 2017; Greenfield, 2018b;

Kashima et al., 2019; Kwon et al., 2021; Wang et al., 2017; Yamazakia & Kayes, 2010). Third, the present thesis has presented novel evidence of how cultural differences in cognitive styles can moderate VPL processes despite the common global advantage typically observed in the population (Mills & Dodd, 2014; Navon, 1977; Rezvani et al., 2020). Culturally distinct perceptual styles could eclipse the GPE to reveal the dominant influence of culture on VPL processes, and this was indeed identified in the present thesis. Fourth, the two global tasks employed – namely the Glass (1969) pattern discrimination task (Mayhew et al., 2012) and SLT (Wang et al., 2017) – contributed diversified evidence of how cultural influences can operate on the differentiation and unitisation mechanisms of VPL (Chamberlain et al., 2017). Fifth, the stimuli used in both tasks cannot be associated with any semantic meaning (Doherty et al., 2008; McKone et al., 2010; Savani & Markus, 2012). As such, prior knowledge, skills, and expertise cannot interfere with the VPL process, thereby providing more distinct evidence of how specific cultural constructs can influence task performance. The design and methodology of the present thesis contribute new knowledge on the intricate ways that culture can shape VPL, which has significant implications for theory and practice.

7.3.1 Implications for Theory

Despite multiple reports of individual differences in perceptual learning trajectories (e.g., Hansen et al., 2012; Rop & Withagen, 2014; Withagen & Caljouw, 2011; Withagen & van Wermeskerken, 2009), there is a lack of research in the context of culture. Indeed, due to the complexity of culture and its differential impact on human psychological processes, there is a great theoretical interest in exploring if the processes underlying VPL can also vary as a function of culture. It is important to emphasise that differences in perceptual biases, illusions, and visual preferences do not stem from racial distinctions but to differences in experience and perceptual inference habits that are likely to differ across societies (Briley et al., 2014; Segall et al., 1963). Increases in the frequency of interaction between members of different cultures and the environment have prompted research exploring cultural differences to avoid misconceptions around the perceptual and learning abilities of people from different sociocultural backgrounds.

From a theoretical perspective, a multilevel cultural framework that considers both the macro and micro level features of culture to explain differences in VPL processes is highly advantageous for reducing inconsistencies that are pervasive in cross-cultural research (Amer et al., 2017). Considering the dynamic features of culture at both levels offers a more holistic picture of how micro and macro level cultural systems operate to inform each other and psychological processes such as VPL (Kashima et al., 2019). Furthermore, establishing links between the macro-micro levels provides valuable information about cultural change and how these could subsequently impact cognition and behaviours (Chen et al., 2020; Goodwin et al., 2020; Vignoles et al., 2016; Wang et al., 2017). For example, as demonstrated in the present thesis, macro-level differences in individualism and collectivism and micro-level differences in self-construal operated differentially on the differentiation and unitisation mechanisms of VPL. Evidently, the dynamic multilevel cultural framework offers a comprehensive and integrated overview of the mechanisms underlying cultural transmission, retention, transformation, and manifestation (Kashima et al., 2019).

Generally, the present thesis has revealed that the configuration of learning patterns may vary at individual and cultural levels (Trigwell & Ashwin, 2006). However, little theoretical work has examined the neurobiological underpinnings of VPL within a cross-cultural context. Eye-tracking, EEG, and fMRI technology are thus essential for identifying the psychophysiological mechanisms underlying VPL (Amer et al., 2017), especially within diverse educational domains (Martínez-Fernández & Vermunt, 2015; Sharma et al., 2019). Accordingly, advancing research in this domain would contribute further theoretical evidence and present significant implications for practice.

7.3.2 Implications for Practice

The outcomes of the present thesis provide compelling evidence that different cognitive strategies can be developed and enhanced through training (Jacobs et al., 2011; Rop & Withagen, 2014; van der Kamp et al., 2013). As such, research in this domain could reveal the effectiveness of VPL in allowing individuals of different cultural backgrounds to acquire visual skills that help reduce perceptual uncertainty (Dosher & Lu, 1998; Dosher & Lu, 2017; Frangou et al., 2019; Lu et al., 2011; Pylyshyn, 1999; Sagi, 2011). Therefore, the present thesis adds to our knowledge of cultural diversity in the community (Santamaria, 2009). Early identification of culturally specific learning needs could allow early interventions (Deveau et al., 2014a, 2014b). These findings can then translate into training programmes that consider the diverse needs of individuals whose daily activities require significant visual demands, such as athletes (Deveau et al., 2014a, 2014b). Such training programmes could also be adapted to induce a more efficient sequence of responses and actions such as playing musical instruments, reading, and linguistics (Polat, 2009; Shin & Ivry, 2002; Smyth & Naveh-Benjamin, 2018; Wang et al., 2017). Further research is thus essential to reveal the neural basis of VPL within a cross-cultural context as it could also incite innovations and interventions for improving visual acuity for visual disabilities such as amblyopia, cortical blindness, or vision declines (Bower et al., 2013; DeLoss et al., 2015; Lu et al., 2011; Polat, 2009; Zhang et al., 2014).

Taken together, from a practical perspective, research on culture and cognition can reveal the learning strategies adopted by individuals from different cultures and backgrounds. As such, researchers can establish a knowledge base of the disparities that exist across individuals, societies, and nations (Ma et al., 2016). This knowledge base can help inform key policies that ensure equal learning opportunities and advocate the development of training paradigms that account for cultural variances in learning (Brants et al., 2016; Tanaka, 2020). Similarly, the present thesis and future research outcomes could contribute significant implications for policymakers, academic institutions, and organisations. For example, research that reveals how contextual information guides visual processing can be applied to spatial configuration planning of landmarks or objects that act as informative navigation and orienting cues for inhabitants of the city (Chun, 2000). Considering culturally universal or -distinct differences in visual perception and information processing will ensure more careful planning and implementation of inclusive developmental plans that recognise the diverse needs that people from different cultures may have. Alternatively, understanding the dynamic factors that mediate VPL could also inform the development and delivery of practical support programmes for learning (Tanaka, 2020). Continuous research in this domain is thus crucial to reveal how cultures converge or diverge in our increasingly interconnected world, thereby impacting the relevance of existing policies, curricula, and training programmes.

7.4 Limitations and Future Directions

Previous research has established that cultural influences can shape attentional and perceptual processes (e.g., Correa-Chávez & Rogoff, 2009; Lufi et al., 2017; Ueda et al., 2017. The present thesis has contributed further knowledge in this domain within the context of VPL. Indeed, cultural differences in global processing can inform VPL trajectories within different contexts (e.g., differentiation versus unitisation tasks). These information-processing biases are informed by environmental affordances that may drive changes in the brain, cognition, and behaviours (Nguyen-Phuong-Mai, 2017). For example, Miyamoto et al. (2006) proposed that the busy and ambiguous landscapes of Japan in comparison to American sceneries stimulate the development of more holistic thinking styles. Hence, as the cultural environment varies, the manifestation of culture-specific brain activity, cognition, and behaviour also change dynamically (Nguyen-Phuong-Mai, 2017). In the same way, it is estimated that culturally informed cognition and behaviours acquired early in life such as cognitive styles can persist across varying situations (Chiao, 2018; Greenfield, 2018b; Uskul et al., 2008; Varnum et al., 2010), and this has been demonstrated in the research presented here. However, some limitations must be considered and examined in future research.

7.4.1 Static vs Dynamic Multilevel Measures of Culture

The first limitation that will be reviewed is the static conceptualisation of cultural constructs represented by the self-report questionnaires used in the present thesis. Chapter 2 has extensively discussed the limitations of existing cultural measures such as inconsistent reliabilities, weak construct validities, lack of measurement equivalence (Boer et al., 2018), issues with terminologies

(Li & Aksoy, 2007), and poor sensitivity (Levine et al., 2003). Furthermore, static conceptualisations of culture do not account for individual differences and the dynamic changes in social processes within a society (Hong et al., 2000). Indeed, demographic variables such as language, educational attainment, living arrangements and ethnicity could contribute to differences in attitudes and behaviours (see Section 2.3.3; Brewer & Venaik, 2011; Heu et al., 2019; Vandello & Cohen, 1999). These demographic characteristics need to be considered within cross-cultural research, as they may dynamically influence attentional biases (Shaki et al., 2012; Shaki & Fischer, 2008). For instance, despite the innate evolutionary propensity for a left to right spatial bias observed amongst infants (Heilman & Van Den Abell, 1980), an accumulation of reading and writing experience can shape directional spatial biases (Dehaene et al., 1993; McCrink et al., 2018; Previtali et al., 2011). Caregivers appear to be the early cultural transmitters of spatial attentional orientation as children often exhibit behaviours consistent with their dominant language even from an early age (McCrink et al., 2014; Shaki et al., 2012). Clearly, cultural measures need to have sufficient validity and reliability to reflect the dynamic nature of cultural characterisations that evolve following changing contexts (Brandt et al., 2014; Wong et al., 2008). These considerations will allow researchers to maintain rigorous experimental control for clearer attributions of specific cultural constructs to cognition and behaviour.

Reliable and valid measures that can assess the multidimensional features of culture is essential for allowing researchers to explain the observed differences in attitudes, beliefs, and behaviours of those from different cultural backgrounds (Chiao et al., 2013). For example, it may be difficult to systematically define the cultural backgrounds of people with complex migration histories based on nationality or geographical distinctions. Therefore, using Hofstede's (1980, 2001, 2011) individualism-collectivism differentiations would minimise the likelihood of excluding data that could provide valuable information about the nuanced features of our multicultural societies at individual and group levels (e.g., Singelis et al., 1995). Furthermore, an objective measure of basic cognitive performance would help verify if all participants are matched in terms of abilities such as processing capacity and working memory to account for differences that may otherwise be neglected by static measures like questionnaires (Park & Huang, 2010). Therefore, future research could identify the feasibility of using tools such as the Glass (1969) pattern discrimination task as a psychometric measure of information processing that allows direct behavioural comparisons rather than the traditional use of static self-report cultural instruments (Pedraza & Mungas, 2008). Such tasks could be used as standardised psychoeducational measures to ensure consistency in assessing cognitive abilities, thereby minimising the possibility of specific groups being misclassified as cognitively disadvantaged due to their responses on self-report measures (Pedraza & Mungas, 2008).

Taken together, to circumvent the limitations associated with the measures used in the present thesis, additional tools such as RTs and accuracy measures can be used to make explicit links between specific cultural constructs and the psychological differences observed between cultures (Poirel et al., 2008). However, it is important to note that these objective and implicit measures should be context-dependent to minimise unaccounted sources of noise that could mask actual cultural or individual differences (e.g., Dale & Arnell, 2013; Hakim et al., 2017; Rayner et al., 2009). The measures should thus be selected based on research aims and objectives (Alotaibi et al., 2014; Mills & Dodd, 2014; Navon, 1981; Rezvani et al., 2020; Ueda et al., 2018). For instance, tasks that are too easy or difficult, or are highly susceptible to the GPE like the FLT, may not reveal distinct cultural group differences (see Section 6.2; Hakim et al., 2017). Therefore, future research should administer standardised and objective behavioural measures that can act as supplementary tools for defining groups based on cognitive styles. The use of computerised testing can also reduce response biases or demand characteristics and tester errors (Lufi et al., 2017). Besides that, existing cultural measures should also be consistently reviewed to assess their measurement equivalence across populations (Li & Aksoy, 2007; Lux et al., 2021; Martin-Fernandez et al., 2022). As seen in the next section, there is an increasing imperative for careful considerations of the samples recruited within cross-cultural research. These samples are often susceptible to confounding variables such as global cultural shifts, migration history, linguistic abilities, cognitive abilities (e.g., memory, attention, intelligence), and ecological differences that can impact the generalisability of findings (Grossmann et al., 2012).

7.4.2 Generalisability of Findings

Within cross-cultural research, there is a risk of making widespread generalisations about the psychological functioning of specific populations based on samples that are limited to certain demographics or backgrounds (Caparos et al., 2020). The student sample used in the present thesis, excluding the online study (see Chapter 5), represents a key limitation, particularly within the context of cross-cultural research (Wang, 2000). International student samples are often susceptible to biases (e.g., socioeconomic advantages, intellectual abilities, psychological affinities for host culture). Furthermore, with the increasing ease and preference for studying abroad in recent years (Healey, 2008; Russell, Rosenthal, & Thomson, 2010), the importance of more representative population samples afforded by online studies cannot be understated. Indeed, increasing globalised societies and communities have made static measures impractical as these do not typically account for nuances in other cultural features such as beliefs, values, routines, and practices that evolve with time and space (Greenfield, 2018a, 2018b). Consequently, large and diverse samples beyond typical student populations are needed to account for these dynamic meaning systems in addition to features such as SES, ethnicity, educational background, and age, amongst others to address the issue of generalisability in cross-cultural studies (Germani et al., 2020; Li & Aksoy, 2007).

Unrepresentative samples often impart large variances in the data, leading to contradictory evidence and a lack of significant findings. For instance, the widespread use of WEIRD populations in cross-cultural research often fails to consider the diversity within and across societies (Henrich et al., 2010). The WEIRD population in cross-cultural research only represents 12% of the world’s population (Henrich et al., 2010). As such, more representative samples from diverse backgrounds and demographics must be included in future research to account for the circumstances and variances that inform perceptual processing and learning styles (Joy & Kolb, 2009; Martínez-

Fernández & Vermunt, 2015; Tempelaar et al., 2012; Toyama & Yamazaki, 2018; Yamazakia & Kayes, 2010). Age is another example that illustrates the issue with generalisability, particularly within the interdisciplinary domain of culture and cognition (Lufi et al., 2017). Cultural orientations are not merely a cross-national phenomenon but can also differ across generations within a country as it progresses and gains greater exposure to foreign ideologies and concepts (Cohen, 2009; J. Ma et al., 2016; Parry & Urwin, 2011; Zhou et al., 2018). Conducting research across different age groups could thus increase the generalisation of findings and provide a deeper insight into the effect of cultural differences on attention. Further research in this domain could inform training paradigms that are fairer not only across cultures but across generations.

To summarise, it is essential to recruit participants beyond the student populations to ensure the generalisability and representativeness of the research findings (Wang, 2000). Further research is also needed to test the multilevel cultural framework proposed in the present thesis within various culturally diverse settings and populations. The broadly accepted definition for culture can relate to the enduring traditions, beliefs, and values that ethnic, religious, and social groups transmit from one generation to the next (Guiso et al., 2006; Hong & Cheon, 2017). Therefore, it is important to consider varying cultural features, perspectives, and viewpoints to establish a dynamic and all-encompassing explanatory framework (Chiu et al., 2010; Schwartz & Bilsky, 1990). This dynamic and multilevel meaning system could subsequently inform how and when culture could manifest in cognition and behaviour. Indeed, cultural influences in cognition and behaviour are often context- or task-dependent (Alotaibi et al., 2017; Hakim et al., 2017; Rezvani et al., 2020; Ueda et al., 2018). Therefore, an alternative method for increasing the generalisability of findings relates to priming techniques that account for the dynamic nature of culture. As discussed in the next section, despite presenting limitations, priming techniques could provide some compelling insights into the link between specific cultural constructs and VPL mechanisms.

7.4.3 Priming Cultural Values

Priming techniques operate under the assumption that the cultural identities an individual embodies can be activated or switched in response to specific social contexts and interactions (Hong et al., 2000; Brewer & Gardner, 1996). However, the replication crisis in social psychology research has cast doubts on the efficacy of priming despite the priming effects identified in past studies (Wiggins & Christopherson, 2019). Indeed, the efficacy of cultural priming remains debatable as it has presented varied results and outcomes across different methods and studies (Oyserman & Lee, 2008). For instance, priming tasks that appear unrelated to the actual experiment may activate an area of the brain that is irrelevant for processing in the main experimental task. It is also estimated that some cultural constructs cannot be primed or temporarily shifted within experimental and laboratory settings (Magid et al., 2017). Alternatively, situationally induced (primed) knowledge may not always manifest in behaviour as the primed constructs typically decay more quickly than the knowledge that is frequently accessed (Briley et al., 2014). As such, long experiments could weaken the efficacy of self-construal priming, especially if the primed construct is incompatible with the cultural values that the individual typically holds. Consequently, priming procedures may not always present clear cultural comparisons in behaviour (Oyserman & Lee, 2008). Further research is needed to systematically explore the dynamicity of culture and its specific impact on psychological processes (Han & Ma, 2016; Lin et al., 2008).

Cultural neuroscientific research is an example of an increasingly important methodology used within the interdisciplinary domain of culture and cognition as it can supplement traditional self-report and objective behavioural measures (Briley et al., 2014; Kitayama & Salvador, 2017; Rule et al., 2013; Shkurko, 2020). Similarly, it could be used in conjunction with priming procedures to provide insights into the dynamic influence of culture on our brains, cognition, and behaviour (Han & Ma, 2016; Lin et al., 2008). For instance, independence and interdependence self-construal priming have been linked to neural activity differences rather than behaviours (e.g., Harada et al., 2010; Lin et al., 2008; Ng et al., 2010; Sui et al., 2009; Sui & Han, 2007). Ng et al. (2010) employed a meticulous experimental design involving priming, fMRI, and a bicultural-self questionnaire to ensure that the bicultural participants possessed both Chinese and Western cultural identities. Participants performed a personality trait judgement task involving the self, mother, non-identified person such as a classmate or supervisor, and a control task involving font judgement. Despite the lack of behavioural differences, fMRI scans revealed neural evidence that indicated that self-inclusiveness for significant others and even strangers were associated with primed interdependent cultural values. Future research could advance research on culture and VPL using priming techniques and neuroscientific measures to identify how culture can manifest at the neural level. This methodology becomes especially pertinent as human behaviour often adapts to new conditions and environments (Greenfield, 2018b). Furthermore, as discussed in the following section, replicability is not always possible in cultural research due to rapid social changes and shifts in policies, norms, and practices within a society (Gelfand et al., 2017).

7.4.4 Globalisation and the Rise of Multiculturalism

The continuous evolution of culture across time and space drives the psychological variations observed at macro and micro levels of culture (Briley et al., 2014; Erez & Gati, 2004; Hong et al., 2000; Kashima et al., 2019; Sedikides et al., 2011; Xi et al., 2018). These changes could subsequently mediate information processing and learning differently, as demonstrated in the present thesis (see Chapters 3 and 5). However, the inconsistency in findings from existing measures (e.g., SCS, COS, and AHS) suggest that cultural shifts across nations and societies are not accurately reflected on these measures. Indeed, advancements in communication technologies and the increasing value placed on individual uniqueness have shifted interdependence values to more independent and individualistic ones (Gentile et al., 2012; Zhang & Shavitt, 2003). As such, shyness, previously seen as a positive trait in Chinese culture, is now associated with maladjustment in the current society where extraversion is needed for success (Chen et al., 2005). Young learners in

Zinacantec Maya communities are also becoming more skilled at abstract representations of novel rather than familiar patterns due to rapid economic development (Maynard et al., 2015), thereby supporting how the changes in sociocultural environments can shape visual representations. Interestingly, widespread globalisation and multiculturalism have also been associated with a convergence of collectivistic values in some cultures (Hong & Cheon, 2017; Ma et al., 2016). These findings indicate the need for cultural constructs and measures that can provide an accurate and consistent reflection of the dynamic nature of culture and how it can manifest differentially under varying contexts (i.e., during differentiation and unitisation).

The self and the environment are mutually constitutive – whereby individuals within a society can inform the cultural environment, while cultural environments can also shape an individual's values (Wang et al., 2017). To avoid any dissonance from inconsistencies between the entrenched cultural values of the society and individual values, people may adapt their attitudes, values, or behaviours to restore cognitive equilibrium (Aronson, 2009). For example, China has experienced widespread sociocultural, political, and economic changes (Brandt et al., 2012; Wong et al., 2008). Consequently, there is a shift in cultural orientations in China, particularly for the younger generations (Sabet, 2011). For instance, the Chinese X-Generation who have been subject to rapid modernisation are more individualistic and accommodating towards the concept of modernity (Zhang & Shavitt, 2013). Yi et al. (2010) also found that the younger post-1980s generation are more confident and self-promoting than the earlier generations, revealing individualistic behaviours that contradict the mainstream collectivistic norm prevalent in Chinese society (Morris et al., 2015). Additionally, the one-child policy in China has reshaped the deeply rooted values of gender equality, filial piety, and patrilineality. Families with daughters being the only child are expected to bear the responsibilities typically assumed by male roles, such as providing financial support (Sudbeck, 2012). Collectively, there is an erosion of traditional cultural values due to globalisation, multiculturalism, and an increasing acceptance of western and individualistic values in typically collectivistic nations (Hong & Cheon, 2017; Ma et al., 2016; Yi et al., 2010; Zhang & Shavitt, 2003).

Future studies need to consider the dynamic and constantly evolving nature of cultural environments and their influence on norms, values, beliefs, and behaviours (Gelfand et al., 2017; Kashima et al., 2019). Indeed, changes in the natural environment could shift existing values and practices as society adapts to the challenges and changes afflicting a country or society (Grossmann & Varnum, 2015; Kashima et al., 2019; Santos et al., 2017). However, some researchers have also argued that globalisation induces homogeneity rather than heterogeneity (Cserni, 2020; Dąbrowski & Środa-Murawska, 2021), thereby contributing to a lack of observed cultural differences in cognition and behaviour. Therefore, to reconcile these inconsistencies, the dynamic multilevel cultural framework proposed in the present thesis has even greater relevance as it considers dynamic changes and cultural influences at micro and macro levels. Variations in these values can then be associated with manifested attitudes and behaviours within varying contexts and task domains (Kashima et al., 2019; Kitayama et al., 2019). Naturally, demographic features of the sample population in cross-cultural research such as age, gender, and social class should be considered in addition to assessing cultural constructs at micro and macro levels as this would broaden the generalisability of findings (see Section 7.3.2).

7.4.5 Reconciling Inconsistent Behavioural Findings: Methods in Cultural Neuroscience

Cultural differences in visual cognition do not always manifest in research (Hakim et al., 2017). These inconsistencies can be attributed to the conditions in which the culturally associated thoughts and behaviours are being examined (Kitayama et al., 2019). As discussed above, cultural differences can be observed under varying task conditions depending on the cultural constructs activated within the specific context (e.g., Ueda et al., 2018). Therefore, examinations using cultural neuroscientific methods are needed to investigate changes in the structure and function of the brain that arise from the sociocultural environments (Nguyen-Phuong-Mai, 2017; see Chapter 6). Neuroscientific methods such as EEG and fMRI can reveal specific brain and neural activity that differentiate the biological processes of people from different cultures (Ma et al., 2014). These methods have also been used to explain underlying cultural differences in cognition and behaviour (Chiao et al., 2013; Ma et al., 2014). Integrating neuroscientific methods alongside the dynamic multilevel cultural framework is thus a promising direction for future research that extends beyond social and cognitive psychology (Kitayama & Uskul, 2011; Zhou & Cacioppo, 2010).

Advancements in cultural neuroscience have revealed the malleability of the brain for adapting to changes in the sociocultural environment (Han et al., 2013; Kitayama et al., 2015; Kitayama & Uskul, 2011). Indeed, cognitive processes that are heavily dependent on culturally dependent knowledge structures are often rapid and implicit (van Gog & Scheiter, 2010). Thus, measures obtained from EEG or fMRI may provide further validations of evidence relating to cultural differences in VPL as these can capture relatively automatic or unconscious behaviour (van Gog & Scheiter, 2010). Future research should thus advance the findings of the present thesis at the functional neural level (e.g., Mayhew et al., 2013). The ERP waveform elicited by one trial type (easy signal patterns) in the Glass (1969) pattern discrimination task can be subtracted from the waveform of another trial type (difficult signal patterns) to eliminate concurrent brain processes that do not differ between trial types. This methodology could reveal cross-cultural differences in the temporal dynamics underlying perception and discrimination of global forms during VPL (Goto et al., 2013). Similarly, neuroimaging techniques such as fMRI could provide more localised spatial information of the observed effects to offer more substantial evidence of cultural differences in VPL.

Supplementing neurobiological evidence to support behavioural findings allow a more comprehensive understanding of behaviour and psychological processes (Khan et al., 2017; Kim & Sasaki, 2014). Indeed, the combination of cultural psychology and neurobiological perspectives can provide compelling insight into how cultural environments and experiences interact dynamically with human neural systems to shape cognitive processes such as perceptual learning (Ames & Fiske, 2010; Chiao & Ambady, 2007; Chiao et al., 2013; Costa & Sebastián-Gallés, 2014; Galvan, 2010; Han et al., 2013; Han & Ma, 2014; Li et al., 2014). Notably, Goh et al. (2013) observed that the ventral-visual and frontoparietal regions of the brain were implicated in cultural-related visual processing. Activations in these brain regions were consistent with the behavioural difference in a visuospatial judgement task. The faster RTs exhibited by East Asians compared to Westerners reflected the relative ease of the task for the East Asian group. In contrast, Westerners exhibited greater suppression of the default network and greater neural engagements within frontal, parietal, and occipital regions in response to the challenging cognitive task, which may be incongruent with their preferred thinking styles (also known as a culturally nonpreferred task). Therefore, the initial evidence of Goh et al.'s (2013) study warrants further investigations to identify the cultural brain regions involved in cognitive processes such as VPL.

The neural changes resulting from VPL remains widely debated as learning has been proposed to alter early sensory processing (Adini et al., 2002; Teich & Qian, 2003), while others have argued that it shapes the neural circuits of later decision-related processes (e.g., Dosher & Lu, 1999; Jacobs, 2009; Law & Gold, 2008; Sigman et al., 2005). Further research is thus needed to reconcile these findings, particularly in the context of culture. Indeed, the psychophysiological underpinnings of cultural differences in VPL remains a relatively unexplored domain despite recognition of how specific cultural systems can shape cognitive styles and influence VPL processes (see Chapters 3 and 5). Therefore, contemporary cultural neuroscience research that departs from mere comparative behavioural studies are essential to uncover and understand the psychophysiological similarities and differences that vary as a function of culture, especially when inconsistent behavioural findings are observed (Kamienkowski et al., 2012). Exploring and understanding the underlying neural and cognitive mechanisms can provide a detailed account of how people perceive and learn new information (Gutchess et al., 2006). Furthermore, as discussed in Section 7.3.3, neuroscientific methods could also be used in conjunction with priming procedures to provide insights into the dynamic influence of culture (Han & Ma, 2016; Lin et al., 2008). Advancements in cultural neuroscience contribute novel insights into the dynamic nature of culture and its changeability in response to situational and contextual factors (Christopoulos & Hong, 2013).

7.4.6 Cultural Influences in Varying Task Domains

As demonstrated in the present thesis, the behavioural differences observed for tasks with varying perceptual field variables demonstrate the importance of using appropriate experimental designs to examine cultural differences in VPL (see Chapters 3 and 5). A cautious approach is needed when interpreting the implication of global perceptual biases on higher-order cognitive functioning (Gao et al., 2011). For example, inconsistencies in findings could reflect motivational differences or general awareness rather than differences in attentional processing (Chamberlain et al., 2017). It is thus important to ensure that the tasks used are indicative of the perceptual organisational and learning processes that vary as a function of culture. Indeed, the outcomes of the experiments in the thesis have revealed that the GPE is not universal nor absolute (Dale & Arnell, 2014). Task parameters were manipulated to alter the saliency of global forms to compel participants to engage in global processing (Dale & Arnell, 2014). Cultural differences that manifest despite the GPE would provide evidence of the prevailing influence of culture on perceptual processing and learning (Poirel et al., 2008; Mills & Dodd, 2014; Flevaris et al., 2011). As predicted, micro and macro level cultural influences were observed to differentially operate on VPL depending on the task domains, thereby highlighting the importance of task and stimuli selection to achieve research aims and objectives (Alotaibi et al., 2014; Ueda et al., 2018).

The stimuli used in different tasks could facilitate the GPE and how it manifests (Poirel et al., 2008; Rezvani et al., 2020). To illustrate, the accuracy and RTs induced by the GPE could reveal analytic or holistic processing tendencies (Mills & Dodd, 2014; Navon, 1977). Faster RTs to local targets suggest more analytic processing, while longer RTs reflect wider attentional spread and holistic processing (Alotaibi et al., 2017; Boduroglu & Shah, 2017; Lawrence et al., 2020; McKone et al., 2010). In the same way, divergences in the GPE can stem from the meaningfulness of targets (Poirel et al., 2008). Familiar stimuli such as objects and letters, compared to unfamiliar non-objects, can activate semantic knowledge and pre-existing representations to increase RTs. In contrast, non-objects that carried no meaning did not impact RTs. Drawing on this, the lack of semantic meaning associated with the Glass (1969) patterns and the Ndjuká symbols in the SLT was thus a critical experimental feature in the present thesis. The neutrality of the stimuli minimises the confounding effects of familiarity and offers impartial evidence of VPL differences across cultures. Furthermore, it reconciles some of the conflicting findings in previous research where cultural differences may not manifest due to incompatible experimental designs (e.g., Evans et al., 2009; Hakim et al., 2017; Rayner et al., 2007). Indeed, perceptual field variables related to the nature of stimuli such as size, type, congruency, relevance, and spatial frequency can differentially impact information processing (Rezvani et al., 2020). Therefore, careful consideration of the experimental design is needed to address the inconsistency of previous cross-cultural evidence.

Future studies should also identify if the provision of feedback during VPL induces a convergence of performance between cultural groups. Although external feedback is not essential for the occurrence of VPL (Fahle et al., 1995), feedback provisions may result in the divergence of participants' perceptual performance due to variations in information detection and learning capacity (Withagen & van Wermeskerken, 2009). Both individualists and collectivists are expected to improve after receiving feedback; however, collectivists are hypothesised to improve faster than individualists as they are more likely to be quicker at identifying the specifying information within the stimuli. It is also important to note that the difference in processing strategies between the two groups of participants may only be apparent when their knowledge of the stimuli is subsequently tested in a pretest-training-posttest experimental paradigm (Amer et al., 2017). Feedback interventions should thus be further examined within the cross-cultural context to reveal how and if feedback can reduce response biases and performance variance (Liu et al., 2014a, 2014b).

To summarise, stimuli and task parameters can be altered to assess the processing strategies that people from different cultures adopt under varying experimental conditions (Dale & Arnell, 2014). The present thesis demonstrates that cultural differences in global and holistic processing strategies can manifest despite the GPE under varying task and stimuli parameters (Dale & Arnell, 2014). The Glass (1969) pattern discrimination task implicated the differentiation mechanism of VPL, while the symbol SLT (Wang et al., 2017) implicated the unitisation mechanism. Although both mechanisms assess distinct mechanisms, each revealed unique evidence of the dynamic multilevel influence of culture on VPL within varying contexts despite the GPE.

7.5 Conclusion

The present thesis employed a multilevel framework that considers macro and micro levels of culture to investigate how cross-cultural differences in global processing can impact VPL. Hofstede's (1980, 2001, 2011) individualism-collectivism constructs characterised culture at the macro level, while social orientations (Markus & Kitayama, 1991; Singelis, 1994) characterised culture at the individual level. Collectively, the present thesis has provided compelling evidence of how VPL can vary as a function of culture during differentiation and unitisation. Notably, these cultural differences manifested despite the common global advantage typically observed in the population as stipulated by the GPE, thereby revealing the dominant influence of culture on VPL processes (Mills & Dodd, 2014; Navon, 1977; Rezvani et al., 2020). Therefore, the present thesis has provided a substantial foundation of knowledge that considers both macro and micro levels of culture to account for variances in VPL abilities within diverse task domains. Specifically, (1) the use of a multilevel framework, (2) the use of global tasks which implicate two distinct mechanisms of VPL, and (3) the framing of culture as a dynamic construct that can be situationally induced, has contributed novel and intriguing evidence to the literature on culture and cognition.

The differential macro and micro cultural influences on VPL do have some limitations that must be acknowledged. Although the prominent influence of the independent and interdependent individual level constructs has been observed throughout the thesis, the findings are constrained by limitations such as inconsistent reliabilities and poor sensitivity in the SCS (Singelis, 1994). As such, the use of more recent and validated individual-level cultural measures is needed. Furthermore, as the influence of individualism and collectivism was only observed during the differentiation process of VPL, there is a need for a more in-depth exploration of the nuances of culture and how the macro-micro levels operate dynamically under varying task conditions and upon distinct cognitive processes. Indeed, the individualism-collectivism constructs (Hofstede, 1980) describe conceptually unique group characteristics that may not necessarily correlate at the individual level (Na et al., 2020). Additionally, global cultural and societal shifts could induce homogeneity in the individualism-collectivism values that people hold, thereby attenuating any effects of culture at the macro level. It is thus important to move beyond student samples and consider alternative macro level features that may be more representative of VPL differences across cultures.

Taken together, the rapid growth of cross-border movement across the globe alongside its associated transformations presents an exciting avenue for future research (Luo, 2016), especially from the cultural neuroscience perspective (see Chapter 6). Future research should investigate alternative macro and micro cultural features that dynamically influence how people detect and process information under varying task conditions during training (Jacobs et al., 2011; Rop & Withagen, 2014; van der Kamp et al., 2013). From a theoretical perspective, the integrative multilevel framework provides a holistic view of the dynamic and reciprocal relationship that exists between macro and micro cultural systems and how it can inform VPL trajectories (Brandt et al., 2014; Briley et al., 2014; Erez & Gati, 2004; Hong et al., 2000; Kashima et al., 2019; Sedikides et al., 2011; Wong et al., 2008; Xi et al., 2018). At the practical level, the outcomes of the present thesis revealed how people from different cultural backgrounds acquire visual skills that help reduce perceptual uncertainty in an informationally dense visual field (Frangou et al., 2019; Hansen et al., 2012; Jia et al., 2018; Lu et al., 2011; Mayhew et al., 2012; Pylyshyn, 1999; Sagi, 2011). Indeed, the focus of the investigation on global processing during VPL reflects a representation of reality whereby the human visual system is regularly exposed to an abundance of information. As such, the cross-cultural findings in this and future studies could be used to address learning disparities, inform inclusive training initiatives, and ensure equitable opportunities for all.

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Appendices

Appendix A

Dissemination Materials

Appendix A1

Abstract for poster presentation presented at the Vision Sciences Society 2018 Annual Conference

September 2018
Volume 18, Issue 10
ISSUE

OPEN ACCESS
Vision Sciences Society Annual Meeting Abstract | September 2018

Cross-cultural differences in perceptual learning

Eirini Mavritsaki; Stephanie Chua; Zoe Kourtzi; Maxine Lintern; Panagiotis Rentzelas

+ Author Affiliations

Journal of Vision September 2018, Vol.18, 277. doi:https://doi.org/10.1167/18.10.277

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Abstract

Cross-cultural studies have shown that independence in individualistic societies is associated with analytic systems of thoughts, whereas collectivistic societies which place greater emphasis on interdependence are generally predisposed to holistic thinking (Masuda & Nisbett, 2011; Bang, 2015). Further, cultural identity has been shown to effect picture perception and cognitive processes (Nisbett & Miyamoto, 2005). For example, Asians were shown to be more sensitive to contextual rather than focal information compared to Americans in a change-blindness task in which observers had to detect either a focal or contextual change within pairs of images (Masuda & Nisbett, 2006). Here, we build on previous work on perceptual learning (Mayhew, Li, & Kourtzi, 2012) and test the role of individualistic vs. collectivistic influences on learning ability. Eighty-three participants of different cultural backgrounds – consisting of Asian (collectivistic) and European (individualistic) students – were asked to discriminate between radial and concentric Glass patterns embedded in background noise. We employed the Singelis' (1994) self-construal scale (SCS) to examine whether differences in task performance due to training were influenced by independent or interdependent cultural values. Visual perceptual learning was evident in both groups; that is, all participants improved in accuracy and reaction times through training. Importantly, Asian participants showed higher performance before and during training than European participants, suggesting an advantage in learning to extract global shapes embedded in cluttered backgrounds. This is consistent with the previously reported tendency of collectivists for global processing under perceptual uncertainty. Our findings provide evidence for the role of cross-cultural influences on visual processes that relate to our ability to improve in making perceptual judgements through training and experience.

Meeting abstract presented at VSS 2018

Appendix A2

Accepted Manuscript for the International Journal of Psychology Based on Chapter 3 of the Thesis

International Journal of Psychology

International Journal of Psychology, 2021
DOI: 10.1002/ijop.12824

Cultural differences in visual perceptual learning

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Cultural differences in visual perceptual learning (VPL) could be attributed to differences in the way that people from individualistic and collectivistic cultures preferentially attend to local objects (analytic) or global contexts (holistic). Indeed, individuals from different cultural backgrounds can adopt distinct processing styles and learn to differentially construct meaning from the environment. Therefore, the present work investigates if cross-cultural differences in VPL can vary as a function of holistic processing. A shape discrimination task was used to investigate whether the individualistic versus collectivistic backgrounds of individuals affected the detection of global shapes embedded in cluttered backgrounds. Seventy-seven participants—including Asian (collectivistic background) and European (individualistic background) students—were trained to discriminate between radial and concentric patterns. Singelis's self-construal scale was also used to assess whether differences in learning could be attributed to independent or interdependent self-construal. Results showed that collectivists had faster learning rates and better accuracy performance than individualists following training—thereby reflecting their tendency to attend holistically when learning to extract global forms. Further, we observed a negative association between independent self-construal—which has previously been linked to analytic processing—with performance. This study provides insight into how socio-cultural backgrounds affect VPL.

Keywords: Culture; Self-construal; Visual learning; Perception; Glass patterns.

Visual perceptual learning (VPL) refers to the acquisition of visual skills through training to improve our ability to detect useful information in cluttered scenes (Dosher & Lu, 2017). Indeed, the perceptual experiences gained through training allows individuals to perform an initially difficult visual task relatively precisely (Gerlach & Starrfelt, 2018; Liu & Luo, 2019; Mayhew et al., 2012). The extensive literature on VPL has evidenced improvements in numerous tasks such as orientation discrimination, phase identifications, pattern discrimination and object identification following training (Dosher & Lu, 2017; Gerlach & Starrfelt, 2018; Liu & Luo, 2019; Mayhew et al., 2012; Mollon et al., 2017). Cumulatively, these studies have reported considerable evidence of individual differences in VPL. However, cross-cultural differences in VPL and how VPL could vary as a function of differential processing styles across cultures remains largely unexplored. Furthermore, since it is difficult to detach VPL processes from attentional mechanisms (Dosher & Lu, 2017), people may develop differential visual learning and perceptual strategies based on the attentional or processing styles dominant in their culture (van der Kamp et al., 2013).

Sustained exposure to cultural systems (as defined by frameworks such as individualism and collectivism or independent and interdependent self-construals) could influence how people attend to or process informational variables from the environment (Blais et al., 2021; Caparos et al., 2020; Davidoff et al., 2008). For instance, individualism and independent self-construals which

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This work was supported by Birmingham City University's PhD Classic Doctoral Training Grant (reference number PR0109).

Stephanie Y. P. Chua: Conception and design; collection, analysis and interpretation of data; drafting and revision. Panagiotis Rentzelas: Conception and design; analysis and interpretation of data; revision. Polytimi Frangou: Conception and design; revision. Zoe Kourtzi: Conception and design; revision. Maxine Lintern: Conception; revision. Eirini Mavritsaki: Conception and design; analysis and interpretation of data; revision.

are widespread in Western cultures, as well as collectivism and interdependence in Eastern cultures have been associated with analytic and holistic processing styles, respectively (Choi et al., 2007). These processing differences have been evidenced in how people from different cultural backgrounds detect visual changes or make categorical judgements (Boduroglu et al., 2009; Boduroglu & Shah, 2017; Hedden et al., 2008; Nisbett et al., 2001). Specifically, the individualism–collectivism framework has been used as a general descriptor of Western and Eastern cultures at national or group levels (Oyserman et al., 2002), while at the individual level, culture can be conceptualised by independent or interdependent self-construals (Singelis, 1994). Notably, these individual- and group-level cultural frameworks can be linked to differential distributions of attention (Choi et al., 2007).

To illustrate, the emphasis on individualism and independence in Western societies such as those in Europe have been linked to analytic thinking styles and more localised attentional patterns towards focal objects (Boduroglu et al., 2009; Boduroglu & Shah, 2017; Choi et al., 2007; Nisbett et al., 2001). In contrast, the emphasis on collectivism and interdependence in Eastern societies such as those in Southeast Asia have been associated with more holistic thinking styles and broader distributions of attention towards objects as well as the context in which the object is embedded (Jenkins et al., 2010; Nisbett et al., 2001). As an example, the persistent effect of cultural differences in attention towards irrelevant contextual information among East Asians (but not in Westerners) has clearly evidenced their tendency for holistic processing and a global attentional bias (Amer et al., 2017). Furthermore, there is also extensive empirical research evidence that further illustrates the influence of cultural-specific patterns of analytic and holistic processing (e.g., Boduroglu et al., 2009; Boduroglu & Shah, 2017; Choi et al., 2007; Jenkins et al., 2010; Nisbett et al., 2001). Given that VPL improves our ability to detect useful information in cluttered scenes (Dosher & Lu, 2017), cultural differences in the selection of relevant sensory information during analytic and holistic processing could similarly facilitate VPL processes.

During VPL, individuals learn to attend to the key visual features for interpreting a scene while ignoring ambiguous information (Dosher & Lu, 2017; Gerlach & Starrfelt, 2018; Liu & Luo, 2019; Mayhew et al., 2012; Mollon et al., 2017). However, following initial exposure to the visual stimuli, individuals from different cultural groups could first detect either local or global informational variables consistent with the analytic or holistic processing styles prevalent in their cultures (Boduroglu & Shah, 2017; Jenkins et al., 2010; Nisbett et al., 2001). For instance, East Asians—due to their increased tendency for global processing—were reported to be more susceptible to global illusory biases compared to Westerners (van der Kamp et al., 2013). This cultural difference further diverged as Westerners were significantly quicker than their East Asian counterparts at identifying the useful informational variables following feedback (van der Kamp et al., 2013). Nevertheless, performance converged post-training (van der Kamp et al., 2013), indicating that although differential processing styles across cultures may result in initially inaccurate perceptual judgements, individuals could learn to shift their focus to key features and improve performance through training.

van der Kamp et al.'s (2013) study provides an important foundation for advancing VPL research as East Asians initially appeared less flexible in changing their use of informational variables following feedback to reduce the illusory bias. It would thus be compelling to examine differences in VPL as a function of cultural differences in analytic and holistic processing. Furthermore, like Amer et al.'s (2017) study, van der Kamp et al. (2013) also did not assess participants' cultural inclinations. It would be useful to expand the investigation to examine how the individual-level (e.g., independent-interdependent self-construal) and group-level cultural constructs (e.g., individualism–collectivism) differentiating Western and Eastern cultures can be associated with VPL processes. To our knowledge, there is a lack of research on whether and how differential analytic and holistic tendencies across different cultures may influence VPL (e.g., van der Kamp et al., 2013).

It is important to select tasks that fulfil research objectives as cultural differences in information processing may manifest differentially (Hedden et al., 2008). The Glass (1969) pattern discrimination task is an example of a visual categorisation task that requires holistic or global processing to overcome sensory uncertainty (Mayhew et al., 2012). Radial and concentric patterns are embedded within noise in this task, and observers are required to extract and integrate relevant features into global forms to effectively discriminate the patterns. Observers learn how to translate sensory inputs into meaningful categories despite the perceptual uncertainties induced by noisy backgrounds (Mayhew et al., 2012). Therefore, they are likely compelled to focus on the global rather than local features of the stimuli during training. Notably, there is evidence to suggest a common global advantage during visual processing as stipulated by the global precedence hypothesis (Gerlach & Starrfelt, 2018; Liu & Luo, 2019). Despite this, it is estimated that the analytic and holistic processing differentiations between cultures could still impact how individuals perceive their environments and learn (Blais et al., 2021; Caparos et al., 2020; Davidoff et al., 2008; van der Kamp et al., 2013). The Glass (1969) pattern discrimination task could thus provide important evidence on the influence of culture on VPL as it can reveal if cultural differences in task performance

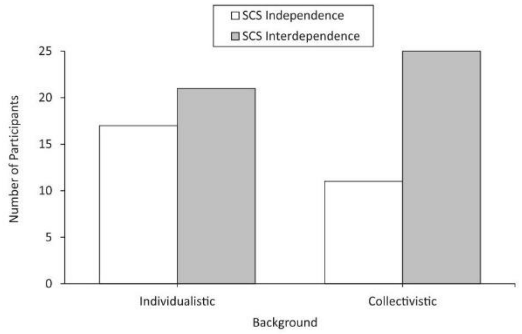

Figure 1. Self-construal of participants from individualistic and collectivistic backgrounds. *Note:* The collectivistic group were more likely to hold interdependent than independent self-construal, while the individualistic group were equally likely to hold independent or interdependent self-construal although these differences were not significant.

Self-construal scale

Singelis's (1994) 24-item SCS was used to identify self-construal differences between the individuals of both experimental groups. The SCS consisted of items that measured participants' independent self-construal (e.g., "I enjoy being unique and different from others in many respects") and interdependent self-construal (e.g., "I have respect for the authority figures with whom I interact"). Responses were measured on 7-point Likert scales which ranged from 1 (*strongly disagree*) to 7 (*strongly agree*). Each participant had two scores and was assigned with having either independent or interdependent self-construal depending on their scores in each subscale. Scores were calculated for each subscale by summing up the responses and dividing the sum by the number of questions in the subscale (n = 12). Three participants with equal scores on both subscales were excluded from this analysis as they could not be categorised. Cronbach's reliability (α) for the overall scale was .732; Specifically, α values for the 12 independent and 12 interdependent items were .785 and .665, respectively. Figure 1 shows that the individualistic group of participants were equally likely to hold independent or interdependent self-construal, whereas the collectivistic group appeared more likely to hold interdependent self-construal. However, there was no statistically significant association between the SCS and background variables, χ^2 (1, n = 74) = 1.58, p = .209, thus indicating that both individualist and collectivists were equally likely to possess independent and interdependent self-construal. Nevertheless, past studies have similarly reported inconsistent findings between independent and interdependent self-construal constructs (e.g., Na et al., 2019), and these can be attributed to factors that will be detailed further in Discussion section.

Stimuli

We used MATLAB 2015a in conjunction with Psychtoolbox-3 for stimulus generation and presentation. Participants were tasked with discriminating radial and concentric Glass (1969) patterns (Frangou et al., 2019; Mayhew et al., 2012) to identify the cultural differences in perceptual learning processes. Specifically, the discrimination task was adapted from (Mayhew et al., 2012) experimental paradigm to assess how observers learn to extract global shapes embedded in cluttered backgrounds. Each stimulus consisted of pairs of dots (2.3×2.3 arc minute^2) or dot dipoles that were aligned according to the specified spiral angle (signal dipoles), displayed within a square aperture ($7.9° \times 7.9°$) against a black background (100% contrast). Dot density was set at 3%, and the distance between the dot dipoles was 16.2 arc minute (Frangou et al., 2019). The spiral angle for each dot dipole is characterised by the angle between the dot dipole orientation and the radius from the centre of the dipole to the centre of the stimulus aperture (Frangou et al., 2019). Concentric patterns were formed by tangentially placed dipoles, while radial patterns were constructed by orthogonally placed dipoles. In the present study, radial patterns were generated using a spiral angle of $\pm 0°$ whereas concentric patterns were generated using a spiral angle of $\pm 90°$. These patterns comprised of 35% or 40% signal (i.e., aligned dot dipoles) and were embedded in a background comprising of randomly positioned and oriented dipoles. Patterns were rotated clockwise or anticlockwise across trials in a randomised order (see Figure 2). Spiral angles were jittered across stimuli ($\pm 3°$) to control for potential local adaptation and ensure that participants would learn to discriminate global shapes rather than just local features during stimulus categorisation.

Participants completed a total of four experimental runs. Each run constituted a total of 108 trials that were randomised between two stimulus conditions (radial and concentric). Each trial consisted of a 200-millisecond stimulus presentation followed by a 1300-millisecond fixation. A response cue then appeared for 1000 milliseconds to prompt participants to identify the pattern by pressing key "1" for radial patterns and key "2" for concentric patterns. The fixation between stimulus presentation and the response cue ensures that RTs are standardised across participants and groups. A 500-millisecond fixation dot was displayed on the screen before the next trial onset.

Procedure

Ethical approval was granted by the university's research ethics committee. Once informed consent was obtained, participants completed the demographics and SCS questionnaires. Participants were assigned to either the

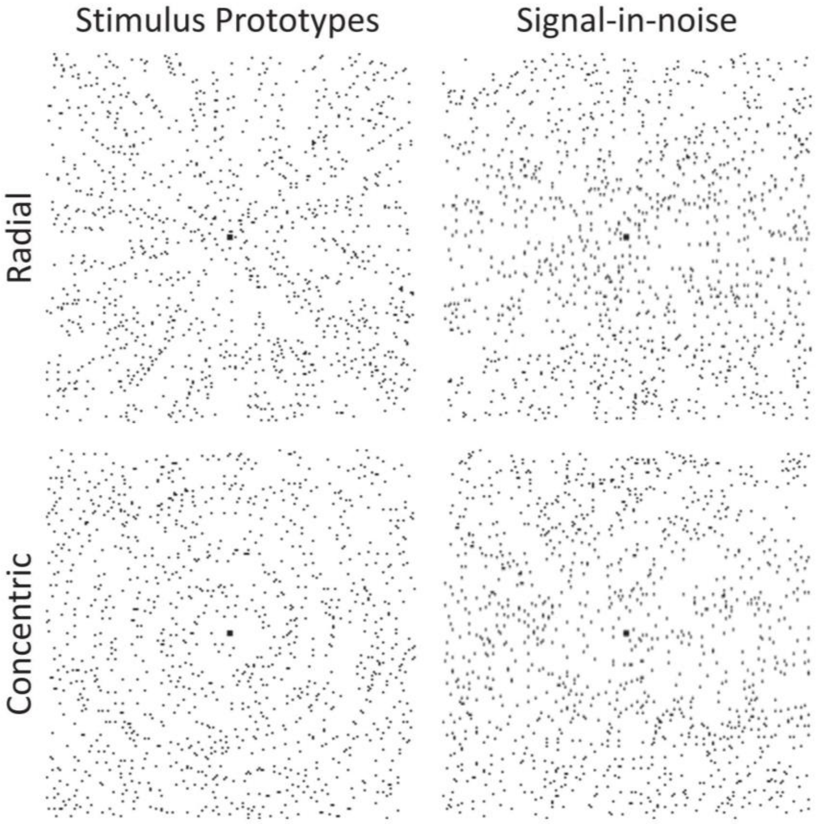

Figure 2. Example of radial and concentric Glass (1969) patterns. *Note:* The radial (top) and concentric (bottom) patterns are presented with inverted contrast for illustration purposes. The stimulus prototypes with 100% signal are also shown for comparison purposes only. The signal-in-noise patterns are generated with $37.5 \pm 2.5\%$ signal.

collectivistic or individualistic groups depending on the demographic information provided. The computer task began with an initial familiarisation phase which consisted of 15 mock presentation trials. Participants were shown an image of the sun (representative of radial patterns) and an image of a target (representative of concentric patterns) to allow them to familiarise themselves with the keypresses. Results were not recorded during the familiarisation phase. Following this, participants completed four experimental runs with breaks in between each run. Response accuracy (number of correct pattern identifications) and RTs for each participant was recorded. Participants were debriefed upon completion of the study.

Data analysis

The data, which met parametric assumptions, was analysed in four steps: first, an analysis was conducted to test the hypothesis and identify if participants from collectivistic backgrounds had greater response accuracy compared to participants from individualistic backgrounds across each run. The second analysis examined cultural group differences in learning rates to substantiate the findings of the preceding analysis. Learning rates in the present study is defined as the slope of the linear line fitted for accuracy across four runs. A third analysis was then carried out to identify if group differences in performance accuracy could be attributed to the independent or interdependent self-construal categories that participants adhered to. Three participants whose scores were equal on both subscales were excluded from the third analysis as these participants could not be classified in either category. Lastly, a regression analysis revealed if cultural background and SCS values were predictive of overall accuracy and learning rates. Overall accuracy and learning rates (slope) represent different learning indices; the former reflects the general ability of participants to engage in global processing to support overall learning, while the latter reflects the rate at which participants learned to discriminate the patterns.

RESULTS

We first compared response accuracy between the individualistic and collectivistic groups. A 2 (Background: Individualistic or Collectivistic) × 4 (Run: 1, 2, 3 and 4) mixed-measures analysis of variance (ANOVA) showed an interaction between background and runs ($F(2.58, 193.72) = 3.95, p = .013, \eta_p^2 = .050$, Greenhouse–Geisser corrected), suggesting learning differences between the individualistic and collectivistic groups. A main effect of runs ($F(2.58, 193.72) = 59.19, p < .001, \eta_p^2 = .441$, Greenhouse–Geisser corrected) indicated that both groups improved during training, while a main effect of cultural background ($F(1, 75) = 7.30, p = .009, \eta_p^2 = .089$) indicated that individualistic and collectivistic groups differed significantly in performance accuracy (see Figure 3). Importantly, post-hoc t tests with multiple comparison adjustments revealed that although both groups initially exhibited similar accuracy performance at Run 1 ($p = .381$) and Run 2 ($p = .087$), the collectivistic group subsequently exhibited significantly better performance than the individualistic group at Run 3 ($t(75) = 9.59$; $p = .001$; Cohen's $d = .756$) and Run 4 ($t(75) = 8.83$; $p = .005$; Cohen's $d = .664$). These results suggest that the collectivist group had greater improvements during training compared to the individualistic group.

To explore the difference in improvement during training further, we examined cultural group differences in learning rates (slope of accuracy across runs). A Welch's t test for unequal variances conducted on the learning rates revealed a significant difference between the individualistic ($M = 3.78$; $SD = 3.44$) and collectivistic ($M = 6.26$; $SD = 4.72$) groups, $t(75) = 7.00$; $p = .011$; Cohen's $d = .600$, where the collectivistic group exhibited higher learning rates. These findings provide further validation for the interaction reported for the ANOVA above and illustrates the influence of culture on VPL. Indeed, the absence cultural group differences in RTs across all runs also suggest that the cultural variations in task performance are not confounded by the effects of differential response times (see Figure S1). It can thus be presumed that the behavioural differences in accuracy performance and learning rates can instead be attributed to cultural group differences in global processing strategies.

The next analysis of participants' responses on Singelis's (1994) SCS revealed that more participants identified with an interdependent self-construal ($n = 46$) than with an independent self-construal ($n = 28$), while three participants identified equally to both categories. A mixed-measures ANOVA revealed a non-significant

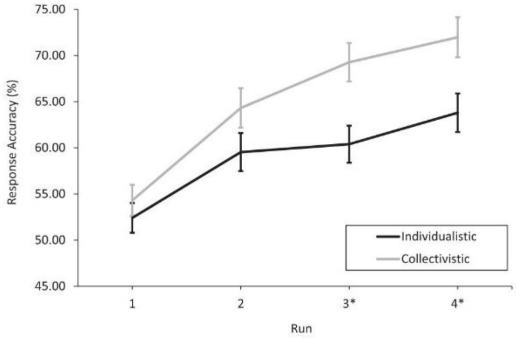

Figure 3. Line graph of response accuracy between individualistic and collectivistic groups. *Note:* Performance of the collectivistic ($n = 37$) group were consistently better than the individualistic group ($n = 40$). The '*' symbol indicates a statistically significant difference between both groups. Response accuracy data is presented in percentages. The error bars represent standard errors.

interaction between self-construal and response accuracy across four runs ($p = .792$), while the between-subjects effect only approached significance ($p = .091$). A Welch's t test on learning rates also revealed no significant difference between the independent ($M = 4.43$; $SD = 4.29$) and interdependent ($M = 5.08$; $SD = 4.25$) groups ($p = .524$). Taken together, it appears that the SCS cannot be used as dichotomous categories to explain cultural difference in VPL. However, since independent and interdependent SCS constructs can also be seen as continuous value dimensions rather than categorical traits at the individual level (Oyserman et al., 2002), people can adhere to both values in varying degrees on a continuum. A regression analysis was thus carried out to identify if variability in independent and interdependent scores, used as continuous rather than binary regressors, in addition to cultural background could be associated with overall performance and learning rates (see Figures 4 and 5).

For the first regression analysis, accuracy scores across all runs were collated to determine overall accuracy. Using the enter method, a multiple regression was run to predict the variability in overall accuracy ($M = 267.25$; $SD = 43.36$) using cultural background (individualistic or collectivistic), as well as independent ($M = 4.96$; $SD = .808$) and interdependent self-construal ($M = 5.16$; $SD = .637$) as predictor variables for the model. The assumptions relating to multicollinearity and independence of observations were met. Together, the predictor variables explained 17.2% (adjusted $R^2 = .172$) of the variability in overall accuracy. The overall association between the predictor variables and accuracy performance was significant, $F(3, 76) = 6.28$, $p = .001$. Specifically, the individualistic ($b = -23.97$; $p = .011$) and independence ($b = -18.32$; $p = .002$) variables had a significant and negative association with overall accuracy. Since both variables have been linked to analytic

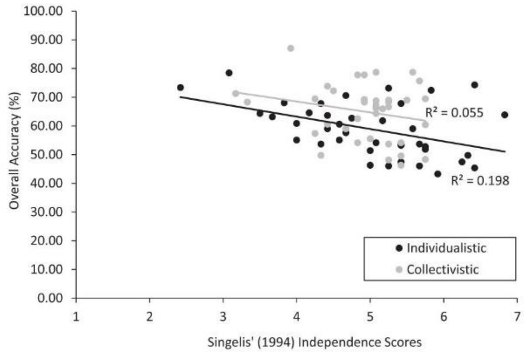

Figure 4. Scatterplot depicting the relationship between independence SCS scores, cultural background and overall response accuracy. *Note:* Individualistic cultural backgrounds and independence SCS scores were significant and negative predictors of overall accuracy.

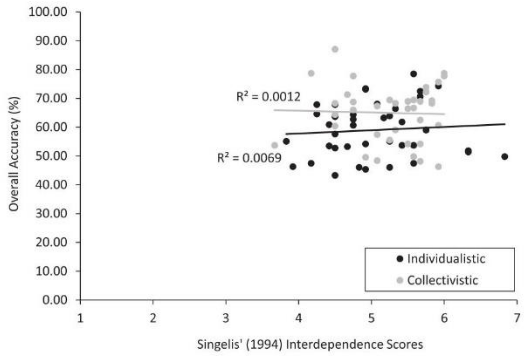

Figure 5. Scatterplot depicting the relationship between interdependence SCS scores, cultural background and overall response accuracy. *Note:* The positive association between interdependent scores with overall accuracy was not significant.

thinking (Choi et al., 2007), the lower predicted accuracy could be due to conflicting thought processes during VPL of global patterns. Conversely, interdependent values that are linked to holistic thinking was, as anticipated, positively associated with overall accuracy in the global processing task although it was not a significant predictor variable ($b = 3.97$; $p = .585$).

The second regression analysis on learning rates revealed that the predictor variables explained 8.2% (adjusted $R^2 = .082$) of the variability in learning rates, $F(3, 76) = 3.26$, $p = .026$. However, only individualistic backgrounds had a significant and negative association with learning rates ($b = -2.23$; $p = .021$). Singelis's (1994) independence ($b = -.635$; $p = .279$) and interdependence scores ($b = .995$; $p = .188$) did not contribute significantly to this model. The inconsistent predictive influence of independent self-construal on different learning indices, that is, overall accuracy and learning rates, will be considered in Discussion section.

DISCUSSION

The present study aimed to identify the influence of culture on VPL using training on a shape discrimination task. As hypothesised, the collectivistic group (Asian students) had greater performance accuracy and faster learning rates in this discrimination task compared to the individualistic group (European students). The greater learning rates and improvements in accuracy following training suggest an increased sensitivity to global forms among the collectivistic group despite the perceptual uncertainties evoked by embedded noise in the stimuli. These findings are in line with previous work in the area of cross-cultural research suggesting that collectivists are more holistic and attuned to the relationships between objects and events in the environment (Boduroglu et al., 2009; Boduroglu & Shah, 2017; Choi et al., 2007; Jenkins et al., 2010; Nisbett et al., 2001). To our knowledge, this is the first study to suggest cultural influences in VPL.

Interestingly, we observed cultural differences in VPL despite the global precedence effect (Gerlach & Starrfelt, 2018; Liu & Luo, 2019). Although both groups exhibited learning in the global pattern discrimination task, the learning trajectory appeared to diverge, with the collectivistic group showing greater accuracy by the end of the task. The group differences in the perception and learning of the global information in the shape discrimination task provide support for the proposition that Asians are more holistic (Jenkins et al., 2010; Nisbett et al., 2001). In contrast, it is possible that the propensity of Westerners to be more analytic and attentive to local information made it more difficult for them to improve in the perceptual learning task involving global forms. Our findings suggest that the analytic-holistic distinction between cultures influences VPL, particularly in tasks involving perceptual uncertainties. Furthermore, our results indicate that the behavioural differences observed between groups distinguished by their nationalities suggest that cultural influences may impact cognitive and behavioural processes (Blais et al., 2021; Caparos et al., 2020; Davidoff et al., 2008), although further research is needed to examine the specific cultural mechanisms underlying any differences in cognition and behaviour. While the individualism and collectivism dimensions are useful for cultural group analyses, it is also important to consider an individual level of analysis to examine the dynamic influence of cultural systems on an individual's cognition and behaviour (Taras et al., 2016).

A standardised individual-level measure accounts for individual variations in goals, abilities, attitudes and beliefs (Singelis, 1994). However, contrary to previous research (e.g., Hedden et al., 2008), we did not find significant cognitive or behavioural differences between participants with independent or interdependent self-construal as measured using Singelis's (1994) SCS. This could be due to limitations of the SCS and its possible insensitivity in measuring cultural distinctions. For instance, cross-cultural research participants are often highly susceptible to confounding variables such as socio-historical backgrounds, linguistic abilities, cognitive abilities (e.g., memory, attention) and ecological differences (e.g., Hakim et al., 2017). Alternatively, there could be a deficiency of cultural influences at the individual level on VPL abilities. The international sample, for example, may have skewed the results of the present study, as individuals who voluntarily immigrated may have psychological affinities to the culture they chose to live in (Morris et al., 2015). They may also amass multiple cultural identities through their exposure to varying sociocultural contexts (Morris et al., 2015). It is thus important to be cautious when generalising and interpreting contradictory evidence of cultural differences in cognition and behaviour.

Indeed, despite the lack of individual-level differences when self-construal was used as dichotomous traits, the regression outcomes for independence scores on the SCS still serves as an intriguing foundation for expanding research in this interdisciplinary domain of culture and VPL. For instance, independent self-construal, when applied as a continuous variable, was predictive of lower overall accuracy in the discrimination task. As mentioned earlier, independent and interdependent self-construal have been associated with distinct information processing strategies (Choi et al., 2007; Lin & Han, 2009; Nisbett et al., 2001). Therefore, independence, which is linked to analytic thinking, could affect the ways in which people perceive the global patterns as reflected in overall accuracy performance following training. However, independence was not predictive of significantly slower learning rates. The difference in the findings might have been observed because overall accuracy and learning rates represent different learning indices where the latter considers performance fluctuations over time. For example, group differences in learning rates could perhaps be better explained by other cultural variables that were not measured in the present study (Morris et al., 2015). Nonetheless, the self-construal findings should not be neglected as it would discount potentially important cultural findings. Future studies could instead employ further individual level differentiations such as cognitive styles (Choi et al., 2007) that could be more representative of individual-level cultural differences that impact VPL processes.

Although clear patterns sometimes do not emerge in cross-cultural research, individual-level analyses in future research remain indispensable for examining the dynamic nature of cultural systems (Na et al., 2019). For example, although individuals usually have stronger inclinations towards a specific cultural orientation to guide behaviours and cognitions, these values can shift according to varying social contexts (Grossmann & Jowhari, 2018; Kühnen & Oyserman, 2002). Consequently, there may be discrepancies in cross-cultural studies due to the ambiguity of which processes are susceptible to cultural influences (e.g., Hakim et al., 2017). That is, an individual exposed to different host cultures may develop seemingly conflicting self-construal and cultural mental representations that can be activated through primes to influence attentional and perceptual processes (Morris et al., 2015). Indeed, priming self-construal has previously been used to make cultural inferences on behaviour and neural responses (e.g., Lin & Han, 2009). Therefore, priming methodologies could be used in future studies to attribute cultural values and VPL abilities (Morris et al., 2015).

Cultural differences in VPL remains a relatively unexplored domain despite the recognition of how exposure to different cultural beliefs and social milieus can shape behaviours, cognition and the brain's functional organisation (e.g., Han, 2015; Hedden et al., 2008; Park & Huang, 2010). Our study adds to our knowledge of cultural diversity, and research seeking further knowledge and acceptance of cultural distinctiveness of cognition and behaviours promotes equal learning opportunities for all. Further research in this domain is essential to reveal the nature of socio-cultural influences on perceptual learning and brain plasticity.

CONCLUSION

To our knowledge, the present study provides the first compelling evidence of cross-cultural differences in VPL. Culture mediates information processing (Blais et al., 2021; Caparos et al., 2020; Davidoff et al., 2008); and extending these findings to the VPL research domain, our results demonstrate that cultural differences in global processing can indeed affect learning. Despite the perceptual uncertainties induced by noise in the global patterns, the collectivistic group (Asian sample) showed greater improvements in response accuracy in the perceptual learning task compared to the individualistic group (European sample). However, there was a lack of differences at the individual level as represented by independent and interdependent self-construal, suggesting that further research employing priming procedures, cognitive screening and neural measures are needed to explore the dynamic multilevel influence of culture on VPL. Nonetheless, our research offers novel insights into the role of socio-cultural influences on our ability to improve our perceptual decisions through training.

Manuscript received March 2021
Revised manuscript accepted November 2021

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Figure S1: Reaction time differences between individualistic and collectivistic groups across all runs.

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Appendix A3

Chua, S. Y. P., Rentzelas, P., Kourtzi, Z., Lintern, M., & Mavritsaki, E. (2019). The influence of self-construal priming on visual perceptual learning. *Journal of Vision, 19*(10), 185c. https://doi.org/10.1167/19.10.185c

September 2019
Volume 19, Issue 10
ISSUE

OPEN ACCESS

Vision Sciences Society Annual Meeting Abstract | September 2019

The influence of self-construal priming on visual perceptual learning

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+ Author Affiliations & Notes

Journal of Vision September 2019, Vol.19, 185c. doi:https://doi.org/10.1167/19.10.185c

SHARE TOOLS

Abstract

Culture is a dynamic construct composed of a network of diversified, but sometimes paradoxical knowledge structures which can be activated or suppressed according to situational demands (Briley, Wyer, & Li, 2014). The emphasis of independence and personal achievements within individualistic societies have been linked to an increased tendency for analytic thinking, whereas collectivistic societies which emphasize interdependence and group goals have been associated with more holistic thinking styles (Han & Humphreys, 2016). Clearly, adherence to these independent or interdependent values could influence cognitive styles; priming independent self-construal has been found to increase local processing tendencies, while priming interdependence increases global processing (Lin, Lin & Han, 2008). Priming procedures can temporarily shift independent or interdependent self-concepts to reveal the cognitive processes that are modulated by culture. The present study thus aims to identify if there are differences in perceptual learning abilities when specific cultural values are situationally activated. Forty-one British and European students were primed with either independent or interdependent self-construal using Brewer and Gardner's (1996) pronoun circling task. Participants primed with interdependent self-construal were expected to be better at extracting global forms in the Glass pattern discrimination task than those primed with independence. As predicted, a difference in reaction times was found between both groups during training. Those primed with interdependence made significantly slower responses, and this could be attributed to the additional time needed for perceptual decision-making in accurately identifying feature differences in the stimuli. Those primed with interdependence also had higher performance than those who were independently-primed despite perceptual uncertainties in the stimuli – revealing the increased tendency for global processing when interdependent self-concepts are activated, although the differences were not significant. These findings provide evidence that self-construals can be causally linked to differences in processing styles during visual learning.

Appendix B

Approval of PhD Registration Extension

Lovain Hynes
Mon 6/1/2020 10:05 AM
To: Stephanie Chua
Cc: Eirini Mavritsaki; Panagiotis Rentzelas; Maxine Lintern; BLSS Doctoral Research College

Dear all

Please see confirmed minute below from the FRDEC meeting held on 21 May 2020.

59.6 Stephanie Chua BFRDEC20.05.28

-

The Committee received and discussed the above application. Due to the nature of the changes to the project the Committee approved an extension to the stipend payments, fee waiver and registration for the maximum period of six months.

Should you have any queries please do not hesitate to contact me.

Kind regards

Lovain Hynes | Doctoral Research College Officer BLSS
Doctoral Research College
Research, Innovation, Enterprise, Employability (RIEE)
Birmingham City University
W: bcu.ac.uk/research

Appendix C

Respondents of Interest

	Participant	Description
CATEGORY 1: ASIAN	17	Chinese national lived in UK for 10 years
	27	Chinese national lived in Australia for 6 years
	181	Chinese national lived in UK for 14 years
	191	Jordanian, born in Qatar
	194	Chinese Taiwanese nationality born in Australia, never lived elsewhere
	195	Chinese national, born in USA, lived in Hong Kong for 11 years
	214	Taiwanese national, born in Taiwan, lived in the US for 7 years
	218	No nationality, Asian origin.
	282	Indian national, born in India but lived in the UK for 8 years
	298	Japanese national, lived in the US for 2.5 years and China for 5 years
	310	Pakistan national, born in Saudi Arabia, lived in Pakistan for only 7 months
	315	Born in Pakistan, Pakistan nationality, lived in UK 11 years
	338	Chinese national, born in China, lived in Singapore for 6 years
	341	Singaporean national, lived in Malaysia 7 years, UEA 7 years, and Czech Republic 2 years
	348	Taiwanese national, born in Taiwan, lived in the US for 8 years
	353	Korean national, born in Korea, lived in the US for 7 years
	356	Vietnamese born in Vietnam, lived in the US for 7 years
	367	Indian national, born in Oman, lived in UAE for 5 years
	381	Indonesian national, born in Indonesia, lived in Malaysia for 20 years
CATEGORY 2: WESTERN	**Participant**	**Description**
	37	European, born in Denmark, lived in the UK for 10 years
	38	British Canadian nationality, born in Canada, lived in the UK for 20 years
	42	Born in Yemen, British nationality, lived in the UK for 12 years
	45	European, born in Sweden, lived in the UK for 7 years
	48	European, born in Spain, lived in the UK for 6 years
	49	Mexico
	109	British national, born in HK, lived in the UK for 22 years
	112	British Canadian nationality, born in Canada, lived in the UK for 21 years
	114	European, born in Germany, lived in the UK for 19 years
	117	Born in Turkey with Canadian nationality, lived in UAE for 3 years
	130	Colombia
	136	Born in Iraq, British nationality, lived in the UK for 18 years
	137	Born in Malaysia, Finnish citizenship, lived in Finland 8 years
	139	Hungarian, born in Hungary, lived in the UK for 6 years
	164	Born in Saudi Arabia, with Canadian (17 years) and American Citizenship
	165	Polish nationality, born in Poland, lived in the UK for 6 years
	205	British, lived in UAE for 10 years
	222	British Cypriot nationality, born in Cyprus, lived in the UK for 4 years

	224	Bulgarian, born in Bulgaria, lived in the UK for 6 years
	226	Costa Rica
	233	American national lived in HK 14 years
	234	Born in Kenya, with British nationality, lived in Canada for 3 years
	241	American lived in China 13 years
	244	European, born in Italy, lived in Belgium for 15 years
	245	American lived in China for 7 years
	252	Born in India, Canadian national, lived in UAE for 18 years
	256	Born in Pakistan, British nationality, never lived elsewhere
	260	French British, born in France, lived in the UK for 22 years
	267	New Zealander, born in New Zealand, lived in Australia for 10 years
	270	German American dual nationality, lived in USA for 6 years
	273	Born in Iraq, Swedish national. Lived in Sweden 23 years and 4 years in the UK
	280	Russian, born in Kazakhstan
	286	British national, born in the Philippines, but never lived elsewhere
	287	Russian, born in Lithuania
	291	European, born in Italy, lived in the Netherlands for 7 years
	301	Russian nationality, born in Russia, lived in Germany for 8 years
	318	Scottish nationality, born in the UK, lived in Jersey for 7 years
	332	Italian and Canadian nationalities, born in Germany but never lived elsewhere
	377	Born in Malaysia with British nationality, lived in the UK 5 years
CATEGORY 3: OTHERS	**Participant**	**Description**
	44	South African, born in Angola
	79	South African lived in the UK for 14 years, nationality NA
	105	Born in Zimbabwe, lived in the UK for 14 years, nationality NA
	106	Born in Yemen, lived in the UK for 8 years, nationality NA
	116	Born in Pakistan, lived in the UK for 9 years, nationality NA
	124	Filipino national, born in Australia, lived in the Philippines for only 5 months
	128	Filipino national born in Canada, lived in the United States for 15 years
	129	South African national, born in South Africa, lived in Australia 20 years
	159	Latvian and Dane dual nationality, born in Latvia, lived in China (2 years), Spain (1 year), and Denmark (8 years)
	202	Born in Singapore, British and German nationalities, lived in India 11 years, NZ 8 years, and France for 7 months
	255	Born in China, China and USA nationalities, lived in USA 16 years
	299	European who lived in Indonesia for 6 years, nationality NA
	308	Egyptian national, lived in the Netherlands for 8 years, and USA for 5 years
	361	Born in China, Chinese Canadian, lived in Canada 16 years
	376	Hong Kong and America dual citizen, lived in USA 7.5 years

Appendix D

Demographics Profile

1. Age: ______________________________

2. Gender:
   - ☐ Female
   - ☐ Male
   - ☐ Prefer not to say
   - ☐ Other: __________________

3. Are you currently living:
   - ☐ On your own
   - ☐ With housemates
   - ☐ At home with family (e.g., parents, siblings, grandparents, partner, children etc.)
   - ☐ Other: __________________

4. Were you born in the United Kingdom?
   - ☐ Yes
   - ☐ No

5. If you were not born in the United Kingdom, where were you born?
   ____

6. What is your nationality/nationalities?
   ____

7. Have you lived in another country other than the one you were born in for more than 6 months?
   - ☐ Yes
   - ☐ No

8. If you have you lived in another country for more than 6 months:
   - ☐ Where : __________________________________
   - ☐ For how long : __________________________________

9. Primary language:
   - ☐ English
   - ☐ Spanish
   - ☐ Chinese
   - ☐ Arabic
   - ☐ Other: __________________

10. If you are not a native English speaker:
    - ☐ How long have you been speaking English: _______________ (years)
    - ☐ How confident are you about speaking English?

      Not at all *1 2 3 4 5* ***Very***

- ☐ What other languages do you speak?: ____________________

11. What is your primary ethnic identity?
    A. Caucasian/ White
        - ☐ British
        - ☐ European
        - ☐ Irish
        - ☐ Irish traveller
        - ☐ Other: ____________________

    B. Black or Black British
        - ☐ Black or Black British - Caribbean
        - ☐ Black or Black British – African
        - ☐ Other: ____________________

    C. Asian or Asian British
        - ☐ Asian or Asian British - Indian
        - ☐ Asian or Asian British - Pakistani
        - ☐ Asian or Asian British - Bangladeshi
        - ☐ Chinese
        - ☐ Filipino
        - ☐ Other: ____________________

    D. Multiple Ethnic Groups
        - ☐ Mixed – White and Black Caribbean
        - ☐ Mixed – White and Black African
        - ☐ Mixed – White and Asian
        - ☐ Other: ____________________

    E. Other Ethnic Group
        - ☐ Arab
        - ☐ Other: ____________________
        - ☐ Not Known
        - ☐ Prefer not to say

Appendix E

Triandis and Gelfand's (1998) Cultural Orientation Scale (COS)

Instructions: *We are interested in how you feel about the following statements. There are 16 items in this section. Please respond to every statement by dragging the slider to the value you most strongly believe to be the case as far as you are concerned. This is a measure of personal belief: there are no right or wrong answers. Thank you.*

Your answers can range from 1 = Never/Definitely No to 9 = Always/Definitely Yes

Never/ Definitely No	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	**Always/ Definitely Yes**

Horizontal individualism items:

1. I'd rather depend on myself than others.
2. I rely on myself most of the time; I rarely rely on others.
3. I often do "my own thing."
4. My personal identity, independent of others, is very important to me.

Vertical individualism items:

1. It is important that I do my job better than others.
2. Winning is everything.
3. Competition is the law of nature.
4. When another person does better than I do, I get tense and aroused.

Horizontal collectivism items:

1. If a coworker gets a prize, I would feel proud.
2. The well-being of my coworkers is important to me.
3. To me, pleasure is spending time with others.
4. I feel good when I cooperate with others.

Vertical collectivism items:

1. Parents and children must stay together as much as possible.
2. It is my duty to take care of my family, even when I have to sacrifice what I want.
3. Family members should stick together, no matter what sacrifices are required.
4. It is important to me that I respect the decisions made by my groups.

Appendix F

Singelis' (1994) Self-Construal Scale

Instructions: *We are interested in how you feel about the following statements. There are 24 items in this questionnaire. Please read and respond each statement carefully. Please select the select the answers you believe to be true rather than the one you think you should choose or the one you would like to be true. There are no right or wrong answers. Thank you.*

Your answers can range from 1 = Strongly Disagree to 7 = Strongly Agree

1	*2*	*3*	*4*	*5*	*6*	*7*
Strongly Disagree	**Disagree**	**Somewhat Disagree**	**Don't Agree or Disagree**	**Somewhat Agree**	**Agree**	**Strongly Agree**

Independent self-construal items:

1. I enjoy being unique and different from others in many respects.
2. I feel comfortable using someone's first name soon after I meet them, even when they are much older than I am.
3. I'd rather say "No" directly, than risk being misunderstood.
4. Having a lively imagination is important to me.
5. I prefer to be direct and forthright when dealing with people I've just met.
6. I am comfortable with being singled out for praise or rewards.
7. Speaking up during a class is not a problem for me.
8. I act the same way no matter who I am with.
9. I value being in good health above everything.
10. Being able to take care of myself is a primary concern for me.
11. My personal identity independent of others, is very important to me.
12. I am the same person at home that I am at school.

Interdependent self-construal items:

1. Even when I strongly disagree with group members, I avoid an argument.
2. I have respect for the authority figures with whom I interact.
3. I respect people who are modest about themselves.
4. I will sacrifice my self-interest for the benefit of the group I am in.
5. I should take into consideration my parents' advice when making education/career plans.
6. If my brother or sister fails, I feel responsible.
7. I often have the feeling that my relationships with others are more important than my own accomplishments.
8. I would offer my seat in a bus to my professor.
9. My happiness depends on the happiness of those around me.
10. I will stay in a group if they need me, even when I'm not happy with the group.
11. It is important to me to respect decisions made by the group.
12. It is important for me to maintain harmony within my group.

Appendix G

Choi et al.’s (2007) Analysis-Holism Scale

Instructions: *We are interested in how you feel about the following statements. There are 24 items in this questionnaire. Please respond to every statement by dragging the slider to the value you most strongly believe to be the case as far as you're concerned.*

Each item was rated on a scale ranging from 1 = Strongly Disagree to 7 = Strongly Agree

1	*2*	*3*	*4*	*5*	*6*	*7*
Strongly Disagree	**Disagree**	**Somewhat Disagree**	**Don’t Agree or Disagree**	**Somewhat Agree**	**Agree**	**Strongly Agree**

Factor 1: Causality

1. Everything in the universe is somehow related to each other.
2. Nothing is unrelated.
3. Everything in the world is intertwined in a causal relationship.
4. Even a small change in any element of the universe can lead to significant alterations in other elements.
5. Any phenomenon has numerous numbers of causes, although some of the causes are not known.
6. Any phenomenon entails a numerous number of consequences, although some of them may not be known.

Factor 2: Attitude Toward Contradictions

7. It is more desirable to take the middle ground than go to extremes.
8. When disagreement exists among people, they should search for ways to compromise and embrace everyone’s opinions.
9. It is more important to find a point of compromise than to debate who is right/wrong, when one’s opinions conflict with other’s opinions.
10. It is desirable to be in harmony, rather than in discord, with others of different opinions than one’s own.
11. Choosing a middle ground in an argument should be avoided.
12. We should avoid going to extremes.

Factor 3: Perception of Change

13. Every phenomenon in the world moves in predictable directions.
14. A person who is currently living a successful life will continue to stay successful.
15. An individual who is currently honest will stay honest in the future.
16. If an event is moving toward a certain direction, it will continue to move toward that direction.
17. Current situations can change at any time.
18. Future events are predictable based on present situations.

Factor 4: Locus of Attention

19. The whole, rather than its parts, should be considered in order to understand a phenomenon.
20. It is more important to pay attention to the whole than its parts.
21. The whole is greater than the sum of its parts.
22. It is more important to pay attention to the whole context rather than the details.
23. It is not possible to understand the parts without considering the whole picture.
24. We should consider the situation a person is faced with, as well as his/her personality, in order to understand one's behaviour.

Appendix H

Ethical Approval Letters

Figure H1

Ethical Approval Reference Number: Chua #011.18

BIRMINGHAM CITY
University

Faculty of Business, Law & Social Sciences Research Office
Birmingham City University
Curzon Building
4 Cardigan Street
Birmingham
B4 7BD
BLSSethics@bcu.ac.uk

Monday 8th January 2020

Stephanie Chua Yoke Ping
Stephanie.Chua@mail.bcu.ac.uk

Dear Stephanie,

Re: Chua #011.18e - Cultural Differences in Perceptual Learning

Thank you for your application for approval of amendments regarding the above study. I am happy to take Chair's Action and approve the amendments which means you may continue your research.

I can also confirm that any person participating in the project is covered under the University's insurance arrangements.

Please note that ethics approval only covers your activity as it has been detailed in your ethics application. If you wish to make any changes to the activity, then you must submit an Amendment application for approval of the proposed changes.

Examples of changes include (but are not limited to) adding a new study site, a new method of participant recruitment, adding a new method of data collection and/or change of Project Lead.

Please also note that the Committee should be notified of any serious adverse effects arising as a result of this activity.

If for any reason the Committee feels that the activity is no longer ethically sound, it reserves the right to withdraw its approval. In the unlikely event of issues arising which would lead to this, you will be consulted.

Keep a copy of this letter along with the corresponding application for your records as evidence of approval.

If you have any queries, please contact BLSSethics@bcu.ac.uk

I wish you every success with your activity.

Yours Sincerely,

Kyle Brown

On behalf of the Faculty Academic Ethics Committee
Business, Law & Social Sciences

Figure H2

Ethical Approval Reference Number: PSY_BSc_OCT17_001

BIRMINGHAM CITY
University

5th October 2017

Re: Cultural Differences in Perception and Learning (158_CHU_DEC16)
APPLICATION REFERENCE: PSY_BSc_OCT17_001

Dear Stephanie,

Thank you for applying to the Departmental Research Ethics Committee with details of your proposed study. As a result of the review process it has been concluded that your study meets our guidelines.

Ethical Approval of your study is therefore granted. Please proceed to collect your data when ready. Please note the new updated reference number for your application.

Best Wishes,

Dr Emma Bridger
Psychology Department Research Ethics Committee Chair

Dr Kyle Brown
BLSS Faculty Ethics Committee Chair

Professor Keith Horton Executive Dean
Business, Law and Social Sciences Birmingham City University, City North Campus, Perry Barr, Birmingham B42 2SU
W: www.bcu.ac.uk

Figure H3

Ethical Approval Reference Number: Chua/#7658/sub2/R(A)/2020/Dec/BLSS FAEC

BIRMINGHAM CITY University

Faculty of Business, Law & Social Sciences Research Office
Curzon Building, 4 Cardigan Street
Birmingham
B4 7BD

BLSSethics@bcu.ac.uk;

16/Dec/2020

Miss Stephanie Yoke Ping Chua

stephanie.chua@mail.bcu.ac.uk

Re: Chua /#7658 /sub2 /R(A) /2020 /Dec /BLSS FAEC - Cultural Differences in Visual Perceptual Learning - Serial Reaction Time Task [Online Experiment]

Dear Stephanie Yoke Ping,

Thank you for your application and documentation regarding the above activity. I am pleased to take Chair's Action and approve this activity.

Provided that you are granted Permission of Access by relevant parties (meeting requirements as laid out by them), you may begin your activity.

I can also confirm that any person participating in the project is covered under the University's insurance arrangements.

Please note that ethics approval only covers your activity as it has been detailed in your ethics application. If you wish to make any changes to the activity, then you must submit an Amendment application for approval of the proposed changes.

Examples of changes include (but are not limited to) adding a new study site, a new method of participant recruitment, adding a new method of data collection and/or change of Project Lead.

Please also note that the Business, Law and Social Sciences Faculty Academic Ethics Committee should be notified of any serious adverse effects arising as a result of this activity.

If for any reason the Committee feels that the activity is no longer ethically sound, it reserves the right to withdraw its approval. In the unlikely event of issues arising which would lead to this, you will be consulted.

Keep a copy of this letter along with the corresponding application for your records as evidence of approval.

If you have any queries, please contact BLSSethics@bcu.ac.uk;

I wish you every success with your activity.

Yours Sincerely,

Dr. Kyle Brown

On behalf of the Business, Law and Social Sciences Faculty Academic Ethics Committee

Figure H4

Ethical Approval Reference Number: Chua/1877/R(A)/2019/Mar/BLSS FAEC

BIRMINGHAM CITY
University

Faculty of Business, Law & Social Sciences Research Office
Curzon Building, 4 Cardigan Street
Birmingham
B4 7BD

BLSSethics@bcu.ac.uk;

22/Mar/2019

Miss Stephanie Yoke Ping Chua

stephanie.chua@mail.bcu.ac.uk

Re: Chua /1877 /R(A) /2019 /Mar /BLSS FAEC - Cultural Differences in Visual Perceptual Learning

Dear Stephanie Yoke Ping,

Thank you for your application and documentation regarding the above activity. I am pleased to take Chair's Action and approve this activity.

Provided that you are granted Permission of Access by relevant parties (meeting requirements as laid out by them), you may begin your activity.

I can also confirm that any person participating in the project is covered under the University's insurance arrangements.

Please note that ethics approval only covers your activity as it has been detailed in your ethics application. If you wish to make any changes to the activity, then you must submit an Amendment application for approval of the proposed changes.

Examples of changes include (but are not limited to) adding a new study site, a new method of participant recruitment, adding a new method of data collection and/or change of Project Lead.

Please also note that the Business, Law and Social Sciences Faculty Academic Ethics Committee should be notified of any serious adverse effects arising as a result of this activity.

If for any reason the Committee feels that the activity is no longer ethically sound, it reserves the right to withdraw its approval. In the unlikely event of issues arising which would lead to this, you will be consulted.

Keep a copy of this letter along with the corresponding application for your records as evidence of approval.

If you have any queries, please contact BLSSethics@bcu.ac.uk;

I wish you every success with your activity.

Yours Sincerely,

Dr. Kyle Brown

On behalf of the Business, Law and Social Sciences Faculty Academic Ethics Committee

Appendix I

Participant Information Sheet

Differences in Perception and Learning

Researcher: Stephanie Yoke Ping Chua

Supervisors: Prof. Eirini Mavritsaki, Dr. Panogiotis Rentzelas, Prof. Maxine Lintern, & Prof. Zoe Kourtzi

What is the purpose of this research?

The main research is looking to investigate the distinctiveness and universality of learning processes. This questionnaire is a preliminary study which aims to identify the most suitable scale which can be used to measure values and beliefs. The outcomes of this will inform the researchers the scale which will be used in future studies to study the main research question.

What does taking part involve?

You will complete a demographics profile followed by a 3-part questionnaire about your thoughts and behaviours in varying situations. You may withdraw at any time if you feel uncomfortable.

How long will the study last?

The questionnaire will take about 20 minutes to complete.

What are the risks in taking part?

You will be looking at computer screens for at least 20 minutes. Therefore, you are advised to refrain from taking part in the experiment if you cannot look at computer screens for long periods of time. You can withdraw at any time during the course of the research. This project has been approved by the BCU Research Ethics Committee.

What are the benefits of taking part?

There will be no direct benefits of taking part in this study. However, the data you have provided in this research could be used to promote understanding and acceptance of individual distinctiveness in cognition and behaviours to encourage equal educational success within learning environments.

Who else will know you are taking part*?*

Only the researchers will be aware of your participation in this research. All the information you provide will be anonymised and kept private and confidential. All forms which could potentially identify you as a participant will be kept separately from the data and stored securely. The data collected will be analysed and reported collectively as a group.

What if you change your mind?

You have the right to withdraw at any time. It is completely voluntary and of your own decision. You will not be penalised or unfairly treated whether you agree to participate or not.

Who should you contact for more information?

Please contact **Stephanie Chua** - Stephanie.Chua@mail.bcu.ac.uk

You may also contact the project supervisors, **Prof Eirini Mavritsaki** (Eirini.Mavritsaki@bcu.ac.uk) or **Dr Panagiotis Rentzelas (**Panagiotis.Rentzelas@bcu.ac.uk)

If you are unhappy at any point in the study, or if there is a problem, you may contact the Faculty of Business, Law & Social Sciences ethics committee directly: blssethics@bcu.ac.uk

Thank you very much for taking the time to read this information.

Appendix J

Participant Consent Form

Differences in Perception and Learning

Researcher: Stephanie Yoke Ping Chua
Supervisors: Prof. Eirini Mavritsaki, Dr. Panogiotis Rentzelas, Prof. Maxine Lintern, & Prof. Zoe Kourtzi

Prior to the study, it is required that you provide written consent to indicate your willing participation. By signing below, you are agreeing that:

(1) You have read and understood the participation information sheet which describes the present study.
(2) You understand that your participation in the study is voluntary (without coercion) and you have the right to withdraw from the study at any point without providing any explanations.
(3) You understand that you can withdraw any or all of the information collected from the study at any time.
(4) You consent for your data to be shared *(for research purposes only)* with any funding/awarding bodies, academic institutions or academic publishers that support this research.
(5) You consent for your personal data, including sex, age, marital status, ethnic origin, religion/belief to be used in the context of this research only.
(6) You have been provided with the contact details of the researcher should you require further information or clarification regarding the study.
(7) You understand that all the data collected from this study is anonymized and stored on a secure password-protected drive. You also understand that all the information collected will be used solely for research purposes.

Please create a unique participant code using:
(a) the first two letters of your last name
(b) the last three digits of your mobile number

Please fill in your unique code below to indicate your willing participation in this study.

Appendix K

Debrief Sheet

Cultural Differences in Perceptual Learning

This questionnaire is a preliminary study which aims to identify the most suitable scale which can be used to measure cultural values in Birmingham City University. The outcomes of this will inform the researchers which scale responses best corresponds to the participant's background of being either a British/EU citizen or an international student. Therefore, the most suitable scale will be used in future studies on cultural differences in learning.

If this questionnaire has made you realized that you require additional advice and support for your well-being, you can contact the ASK Enquiry Service at Birmingham City University.

Telephone : 0121 331 7777
Address : The Curzon Building Level 1, *4 Cardigan Street,* Birmingham, *B4 7BD.*

As mentioned in the information sheet, an analysis will be conducted collectively on all the data collected. You can withdraw any or all information you have provided at any time. You will not be penalised or unfairly treated whether you agree to participate or not. Please contact the researchers using the contact details below should you wish to withdraw, and your data will be promptly omitted from analysis.

If you have any further questions, please feel free to contact the researchers:

Stephanie.Chua@mail.bcu.ac.uk
Eirini.Mavritsaki@bcu.ac.uk
Panagiotis.Renztelas@bcu.ac.uk

If you have any problems related to the study, you may also contact blssethics@bcu.ac.uk

Thank you for your time and participation in this study.

Appendix L

Mandarin Chinese Translation of the Complete Questionnaire

Appendix L1

Participant Information Sheet

参与者信息表

研究题目：价值观，态度和信仰

研究者: Stephanie Yoke Ping Chua

主任: Prof. Eirini Mavritsaki, Dr. Panogiotis Rentzelas, Prof. Maxine Lintern, & Prof. Zoe Kourtzi

该调查问卷是一项初步研究，旨在确定最适合用于衡量价值观和信仰的调查问卷。 这调查结果将告知未来的研究规模。您将首先填写个人资料，后再填写三份调查问卷，为了了解您在不同情况下的想法和行为。 您可以随时停止填写问卷。调查问卷大约需要20分钟完成。该项目已获得BCU研究伦理委员会的批准。只有研究人员才会意识到您参与了这项研究。 您提供的所有信息都将匿名并保密。 所有可能将您识别为参与者的表格将与数据分开存放并安全存储。 收集的数据将作为一个整体进行分析和报告 。您有权随时退出。您可在一个月内通知研究人员您是否要撤回您提供的信息。 无论您是否同意参加，都不会受到处罚或受到不公平待遇。

如果您需要更多信息，请联系Stephanie.Chua@mail.bcu.ac.uk或研究者的主任 Prof Eirini Mavritsaki (Eirini.Mavritsaki@bcu.ac.uk) 或 Dr Panagiotis Rentzelas (Panagiotis.Rentzelas@bcu.ac.uk) 。如果您对研究中的任何一点感到不满，您也可以直接联系BCU研究伦理委员会(blssethics@bcu.ac.uk) 。非常感谢您抽出宝贵时间阅读这些信息。

Appendix L2

Participant Consent Form

参与同意书

研究题目：价值观，态度和信仰

研究者: Stephanie Yoke Ping Chua

主任: Prof. Eirini Mavritsaki, Dr. Panogiotis Rentzelas, Prof. Maxine Lintern, & Prof. Zoe Kourtzi

在填写调查问卷之前，您需要提供书面同意以表明您愿意参与。 您是否同意：

(一) 您已阅读并理解了描述本研究的参与信息表。
(二) 您了解您参与本研究是自愿的（没有强制），您有权在任何时候退出而不提供任何解释。
(三) 您了解您可以在完成调查后三周内撤回从研究中收集的任何或所有信息。
(四) 您同意与支持该研究的任何资助/授予机构，学术机构或学术出版商共享您的数据（仅用于研究目的）。您的数据将被匿名化，并且不会以任何方式与您联系。
(五) 您同意您的个人数据，包括性别，年龄，婚姻状况，种族，宗教/信仰，仅用于本研究。
(六) 如果您需要有关该研究的进一步信息或说明，您已获得研究人员的详细联系方式。
(七) 您了解从本研究中收集的所有数据都是匿名的，并存储在受密码保护的安全驱动器上。您还了解所收集的所有信息仅用于研究目的。

请使用姓氏的前两个英文字母和手机号码的最后三位数字创建一个特殊的参与者代码。

例如：我的姓氏是Chua(蔡)，我的手机号码是077 1234 5678，所以我的特殊代码是CH678。

请填写的特殊代码，表明您愿意参与本研究。

Appendix L3

Demographics Profile

个人资料

年龄：________________________________

性别:

- □ 女
- □ 男
- □ 不想说
- □ 其他：__________________________

您现在和谁住在一起:

- □ 独自生活
- □ 与室友住在一起
- □ 与亲人一起住（例如父母，兄弟姐妹，祖父母，伴侣，孩子等）
- □ 其他：__________________________

国籍：________________________________

种族：________________________________

你有没有生活在你出生地以外的国家(超过6个月)？

- □ 有
- □ 没有

如果你有住在不同的国家,

- □ 哪里？ _________________________
- □ 多久？ _________________________

Appendix L4

Triandis and Gelfand’s (1998) Cultural Orientation Scale

TRIANDIS & GELFAND (1998)

说明：本节共有16个项目。 就您所关注的情况而言，请根据你的信念做出回应。 这是个人信仰的衡量标准：没有正确或错误的答案。 谢谢。

你的答案范围从 1 =决不/绝对不是 至 9 = 总是/肯定是

决不/ 绝对不是	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	**总是/ 肯定是**

1. 我宁愿依赖自己而不是别人。
2. 我大部分时间都依赖自己; 我很少依赖别人。
3. 我经常做“我自己的事”。
4. 对我来说， 我的个人身份独立于他人是非常重要 。
5. 我必须在工作上比他人办得更好。
6. 获胜就是一切。
7. 竞争是自然法则。
8. 当另一个人做得比我更好时， 我会感到紧张和激动。
9. 如果我的同事获得奖品， 我会感到自豪。
10. 同事们的福利对我很重要。
11. 对我来说， 快乐是与他人共度时光。
12. 我与他人合作时感觉很好。
13. 父母和孩子必须尽可能地在一起相处， 而且越久越好。
14. 照顾我的家人是我的责任， 即使牺牲我想要的东西也没问题。
15. 无论做出什么样的牺牲， 家庭成员都应该团结在一起。
16. 对我而言， 尊重该团队做出的决定很重要。

Appendix L5

Singelis'(1994) Self-Construal Scale

SINGELIS (1994)

说明：本节共有24个项目。 就您所关注的情况而言，请根据你的信念做出回应。 这是个人信仰的衡量标准：没有正确或错误的答案。 谢谢。你的答案范围可从 1 =强烈反对 至 7 = 强烈同意

1	2	3	4	5	6	7
强烈反对	不同意	不太同意	既不赞同也不反对	有点同意	同意	强烈同意

1) 我喜欢在许多方面中与众不同。
2) 在我遇到他人后，我很快就会使用某人的名字，即使他们比我年长。
3) 我宁愿直接说 “不”，也不愿冒被误解的风险。
4) 拥有生动的想象力对我很重要。
5) 在与刚认识的人打交道时，我更倾向于直截了当。
6) 我很乐意被单独赞美或奖励。
7) 在课堂上说发出提问对我来说不是问题。
8) 无论我和谁在一起，我的行为和性格都是一样的。
9) 我认为健康的身体最重要。
10) 能够照顾好自己是我首要关心的问题。
11) 我的个人身份独立于他人，对我来说非常重要。
12) 我在家或学校都是是同一个性格的人。
13) 即使我强烈反对小组成员，我会避免争论。
14) 我尊重与我互动的权威人物。
15) 我尊重谦虚的人。
16) 我会为了我所在的团体的利益，牺牲自己的利益。
17) 在制定教育/职业规划时，我应该考虑父母的建议 。
18) 如果我的兄弟或姐妹失败，我需感到有一定的责任 。
19) 我常常觉得我与他人的关系比我自己的成就更重要。
20) 我会在公交车上让位给我的教授。
21) 我的幸福取决于我周围人的幸福。
22) 即使我对小组不满意，如果小组成员需要我，我依然会留在同一个小组。
23) 对我而言，尊重该团队的决定很重要。
24) 在我的团队中保持和谐对我来说很重。

Appendix L6

Choi et al.’s (2007) Analysis-Holism Scale

CHOI, KOO, & CHOI’S (2007)

说明：本节共有24个项目。 就您所关注的情况而言，请根据你的信念做出回应。 这是个人信仰的衡量标准：没有正确或错误的答案。 谢谢。

你的答案范围可从 1 =强烈反对 至 7 = 强烈同意

1	*2*	*3*	*4*	*5*	*6*	*7*
强烈反对	不同意	不太同意	既不赞同也不反对	有点同意	同意	强烈同意

1. 宇宙中的一切都以某种方式互相关联。
2. 没有什么是无关联的。
3. 世界上的一切都是因果关系交织在一起的。
4. 即使宇宙中任何元素的微小变化也可能导致其他元素发生重大变化。
5. 任何现象都会有很多因素，尽管有些原因尚不清楚。
6. 任何现象都会产生许多后果，尽管其中一些可能不为人所知。
7. 采取中间立场比走向极端更为适当。
8. 当人与人之间存在分歧时，他们应该了解每个人意见的方法并一致寻找妥协。
9. 当一个人的意见与他人的意见冲突时，找到妥协点比辩论谁是对错是更为重要。
10. 与其他不同意见的人相处，最好的方法是和谐而不是不和。
11. 应避免在争论中选择中间立场。
12. 我们应该避免走向极端。
13. 世界上的每一个现象都在可预测的方向上前进。
14. 过着成功人生的人将继续保持成功下去。
15. 一个诚实的人将来会保持诚实下去。
16. 如果某事件朝某个方向移动，它将继续向该方向进展。
17. 目前的情况随时都可能发生变化。
18. 根据目前情况，未来的事件都可被预测的。
19. 以便了解一种现象，应该考虑整体而不是其中的部分。
20. 注意整体而不是其各个部分更为重要。
21. 整体大于其各部分的总和。
22. 更重要的是要注意整个背景而不是专注于某个细节。
23. 如果不去考虑整体情况，就无法理解其他的小细节。
24. 我们应该考虑一个人面临的情况，以及他/她的性格，以便了解一个人的 行为。

Appendix L7

Debrief Sheet

说明

研究题目：视觉学习的文化差异

该调查问卷是一项初步研究，旨在确定可用于衡量伯明翰城市大学文化价值的最合适的量表。因此，最合适的量表将用于未来的学习文化差异研究。如果这份调查问卷让您意识到您需要额外的建议和支持，您可以联系伯明翰城市大学的ASK咨询服务。

电话：0121 331 7777
地址：Curzon Building Level 1,4 Cardigan Street，Birmingham，B4 7BD。

如信息表中所述，将对收集的所有数据进行集体分析。您可以一个月内撤回您提供的任何或所有信息。无论您是否同意参加，都不会受到处罚或受到不公平待遇。如果您想退出，请使用下面的联系方式联系研究人员，您的数据将立即从分析中删除。

如果您有任何其他问题，请随时联系研究人员：

- Stephanie.Chua@mail.bcu.ac.uk
- Eirini.Mavritsaki@bcu.ac.uk
- Panagiotis.Renztelas@bcu.ac.uk

如果您有任何与研究相关的问题，您也可以联系blssethics@bcu.ac.uk 。

感谢您抽出时间参与本研究。

Appendix M

Comparison of Cronbach's Alpha Reliabilities Between Scales Completed in English by the Asian or Collectivistic Groups vs Mandarin Translations of the Scales

Scale	**Sub-Scale**	**English Version (Asian Group)**	**English Version (Collectivistic Group)**	**Mandarin Translation**
COS	Overall (16-items)	.762	.744	.799
	Horizontal Individualism (HI)	.752	.746	.651
	Vertical Individualism (VI)	.660	.691	.648
	Horizontal Collectivism (HC)	.699	.698	.509
	Vertical Collectivism (VC)	.749	.702	.756
Alternative COS	Individualism (Sum of HI and VI)	.755	.753	.679
	Collectivism (Sum of HC and VC)	.795	.776	.781
SCS	Overall (24-items)	.774	.767	.750
	Independence	.700	.712	.730
	Interdependence	.747	.749	.812
AHS	Overall (24-items)	.665	.641	.540
	Causality	.698	.577	.871
	Contradiction	.578	.558	.505
	Change Perception	.651	.635	.689
	Locus of Attention	.734	.733	.677

Appendix N

Chapter 2 Exploratory Analysis Comparing Macro Group Level Scores on the SCS, COS, and AHS

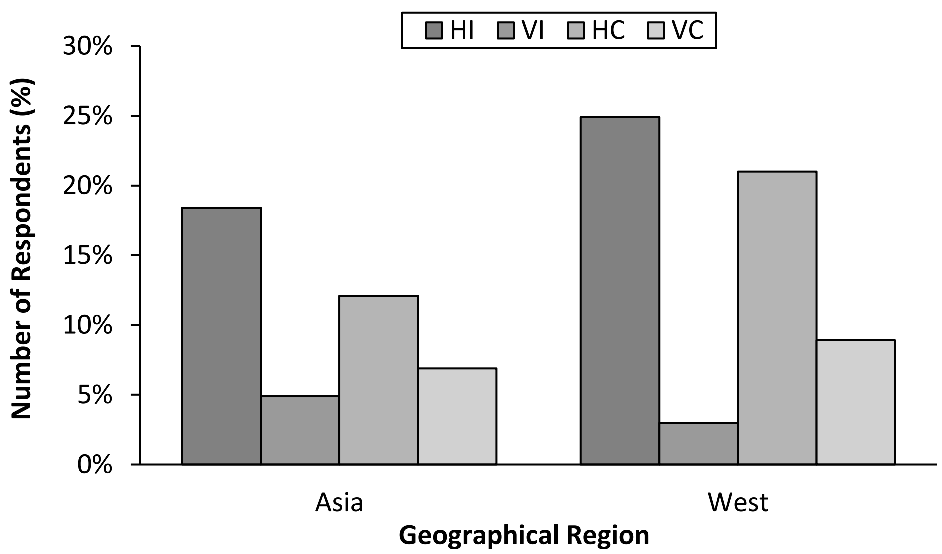
Group differences in adherence to values related to cultural orientations, independent and interdependent self-construal, and holistic thinking will be explored further here. However, due to the lack of measurement equivalence identified in Chapter 2 for the different instruments, any significant outcomes should be interpreted cautiously as extraneous factors (e.g., misinterpretation of items between cultural groups) could impact the comparability of findings (Boer et al., 2018).

Analysis based on the Asian vs Western (Geographical Regions) Macro Level Group Distinctions

The analyses carried out in this section is focused on macro level group comparisons based on geographical regions (Asian and Western cultural backgrounds). Categorising participants based on geographical distinctions can be oversimplistic as it neglects key cultural features of nations beyond their locations (Goodwin et al., 2020; Van De Vijver & Leung, 2000; Vignoles et al., 2016). Furthermore, as discussed in Chapters 1 and 2, some participants could not be categorised due to factors like multiple nationalities.

Figure N1

Cultural Orientations of Asian and Western Respondents on the COS

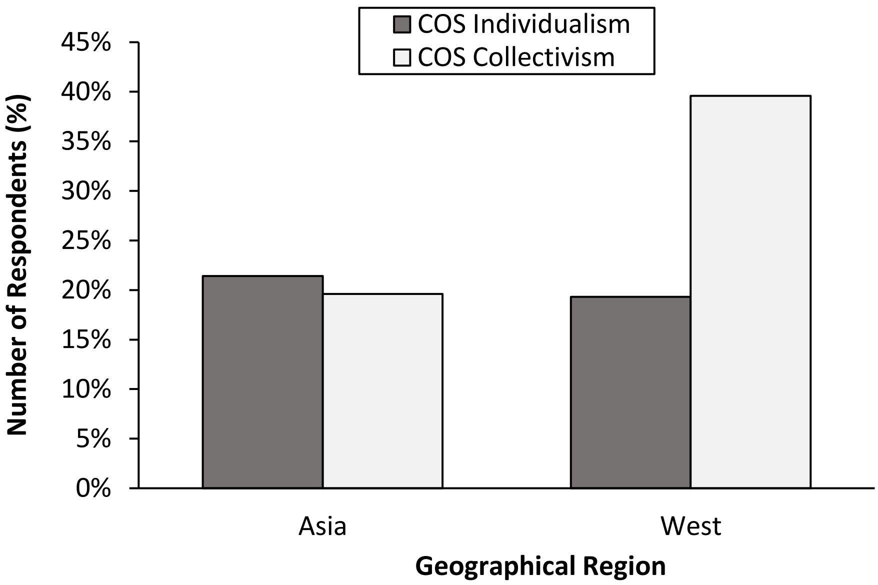


Note. Both Asians (n = 129) and Westerners (n = 176) were equally likely to adhere to the four different cultural orientations

Cultural Orientation Scale. Based on the sample of Asian and Western respondents who completed the COS, there was no statistically significant association between the COS and background variables, X^2 (3, N = 305) = 5.38, p = .146, thus indicating that both Asians and Westerners were equally likely to adhere to the four different cultural orientations (see Figure N1). Amongst the Asian and Western respondents, 40 could not be categorised on the four cultural dimensions of the COS. Therefore, the four dimensions were condensed into individualism and collectivism dimensions which increased the sample size from 305 to 336 respondents (nine respondents could not be categorised). There was a statistically significant association between the alternative COS categories and background variables, χ^2 (1, N = 336) = 12.60, p < .001. Interestingly, as seen in Figure N2 below, although both Asians and Westerners were equally likely to be individualistic, Westerners were more likely to be collectivistic as indicated by the COS.

Figure N2

Alternative Cultural Orientations of Asian and Western Respondents on the COS



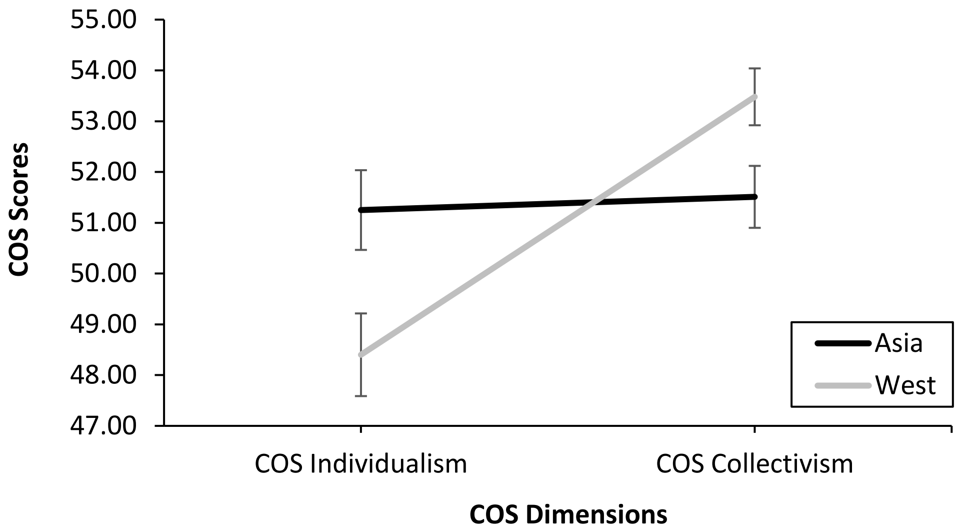
Note. Although both Asians (n = 138) and Westerners (n = 198) were equally likely to be individualistic, Westerners were more likely to be collectivistic as indicated by the COS.

To further expand on this finding, a t-test comparing the COS individualism and COS collectivism scores of Asian and Western respondents revealed a significant effect of background on COS individualism scores, t(343) = 2.91, p = .004, d = .316, as well as the COS collectivism scores, t(264.65) = -1.99, p = .047, d = .222 (*equal variances not assumed*). As seen in Figure N3, Asian respondents (M = 51.25; SD = 9.36) scored higher than Western respondents (M = 48.40; SD = 8.69) on the individualism subscale, while Western respondents (*M* = 53.48; *SD* = 7.97) had greater collectivism scores than the Asian respondents (*M* = 51.51; *SD* = 9.70). The effect sizes were small. Levene's test for equality of variances was violated for the collectivism scores.

Taken together, the findings on the COS indicate a cultural shift whereby previous assumptions that nations in the West are typically more individualistic may no longer be an accurate representation of Western cultures. For example, Hakim et al. (2017) identified similar patterns of findings where Easterners in their sample scored higher on the individualism dimensions and lower on the collectivism dimensions. It thus appears that the impact of globalisation and shifts in shared values structures within different contexts (e.g., home, workplaces, etc.) could change the values and beliefs that individuals may hold (Chen et al., 2018, 2020).

Figure N3

Cultural Orientations Differences between Asian and Western Respondents on the COS

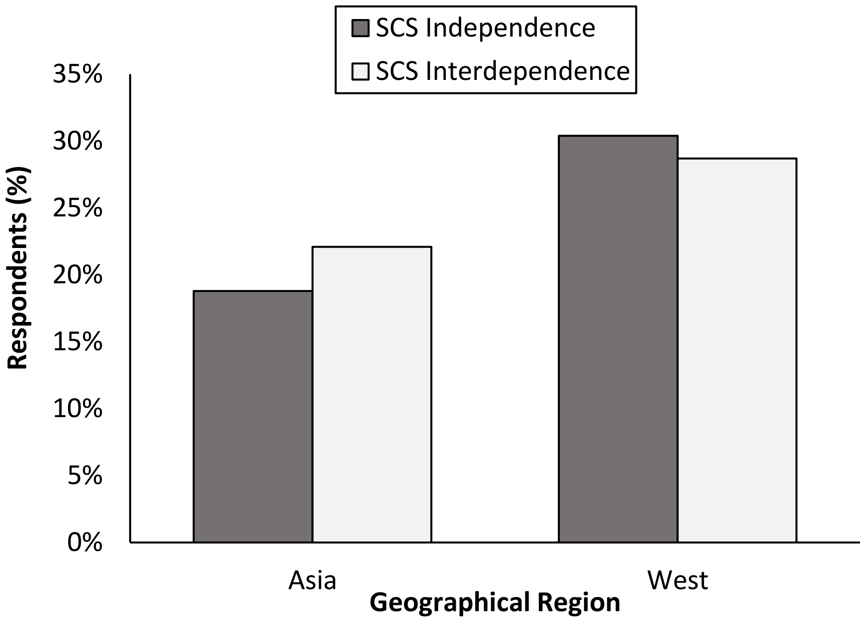


Note. Asian respondents (*n* = 142) had significantly higher COS individualism scores than Western respondents (*n* = 203). In contrast, Western respondents had significantly higher COS collectivism scores than Asian respondents. Error bars represent standard errors.

Self-Construal Scale. Figure N4 shows that both the Asian and Western respondents were equally likely to hold independent or interdependent self-construal as measured using the SCS. There was no statistically significant association between the SCS and background variables, χ^2 (1, N = 335) = .991, p = .320, thus indicating that Asians and Westerners were equally likely to possess independent and interdependent self-construal. Nine participants with equal scores on both subscales were excluded from this analysis.

Figure N4

Self-Construal Categories of Asian and Western Respondents on the SCS

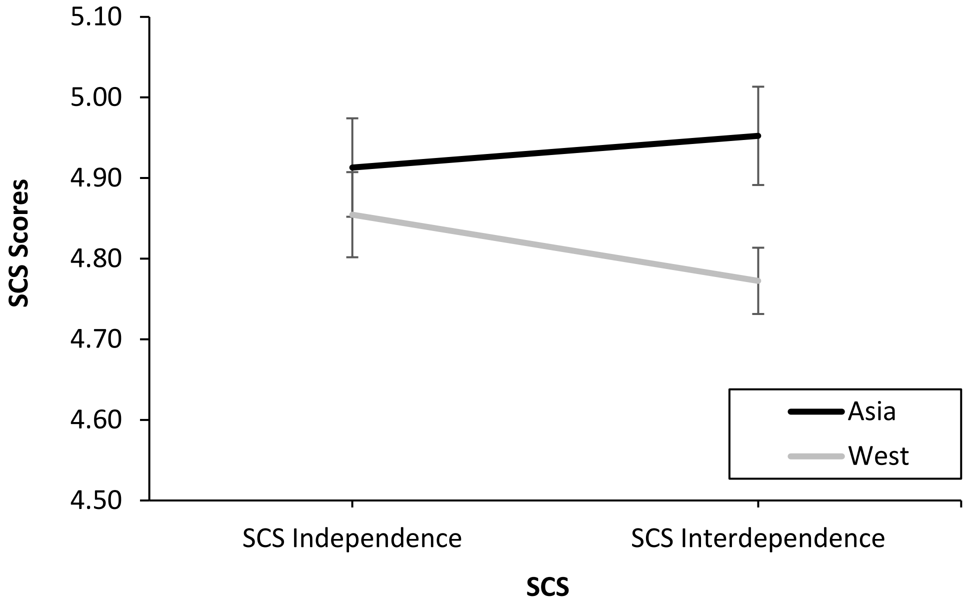


Note. Both Asians (n = 137) and Westerners (n = 198) were equally likely to hold independent or interdependent self-construal as measured using the SCS.

A t-test on all respondents who completed the SCS (including those who could not be categorised) revealed a significant effect of background on interdependence scores as measured by the SCS, $t(257.56) = 2.45$, $p = .015$, $d = .273$ (equal variances not assumed). The effect size was small. As seen in Figure N5, Asian respondents (M = 4.95; SD = .722; n = 140) scored higher on the interdependence subscale than Western respondents (M = 4.77; SD = .587; n = 204). Assumptions of normality were met, although Levene's test for equality of variances was violated for the interdependence scores.

Figure N5

Visualisation of the Self-Construal Differences between Asian (n = 140) and Western (n = 204) Respondents on the SCS

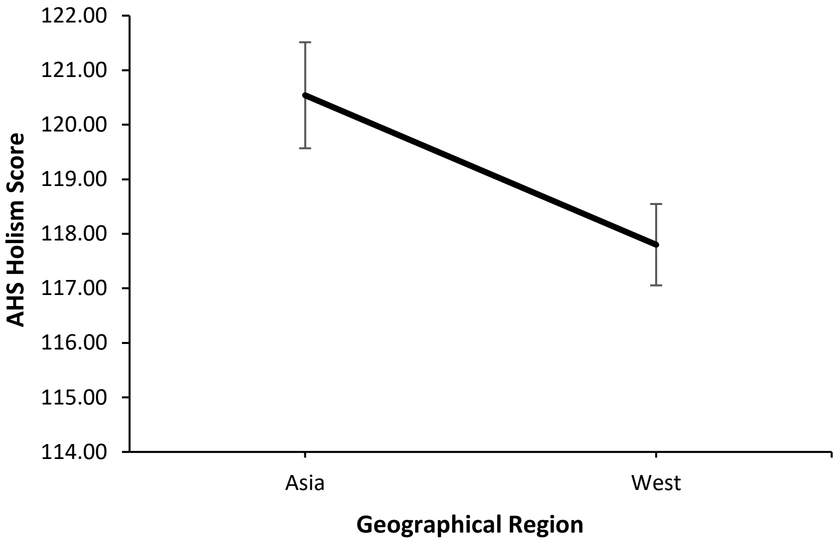


Note. Asian respondents (*n* = 140) had significantly higher SCS interdependence scores than Western respondents (*n* = 204). There were no group differences in SCS independence scores. Error bars represent standard errors.

Analysis-Holism Scale. A t-test revealed a significant effect of background on the overall holism scores, $t(331) = 2.26$, $p = .025$, $d = .280$. The effect size was small. As predicted, Asians (M = 120.54; SD = 11.25; n = 134) were more holistic than Westerners (M = 117.82; SD = 10.41; n = 199) as measured on the AHS (see Figure N6). Holism scores for the Asian group was skewed (Skewness = -.819; SE = .209) and kurtotic (Kurtosis = 3.50; SE = .416). The violation of normality assumptions for the Asian group could be attributed to the use of geographical distinctions that resulted in unequal sample sizes in each group. Therefore, while the analysis on Asian-Western categories revealed that Asians exhibited more holistic thinking styles, group level differentiations using the individualism-collectivism dimensions (Hofstede, 2017) in lieu of geographical distinctions presents an advantage as it could minimise the loss of data. Furthermore, measurement equivalence was not established for the groups distinguished by geographical regions on the three measures. As such, the findings reported on these measures should be interpreted cautiously.

Figure N6

Comparison of the Holism Scores between Eastern and Western Respondents on the AHS



Note. Asian respondents (*n* = 135) had significantly higher holism scores on the AHS than Western respondents (*n* = 199). Error bars represent standard errors.

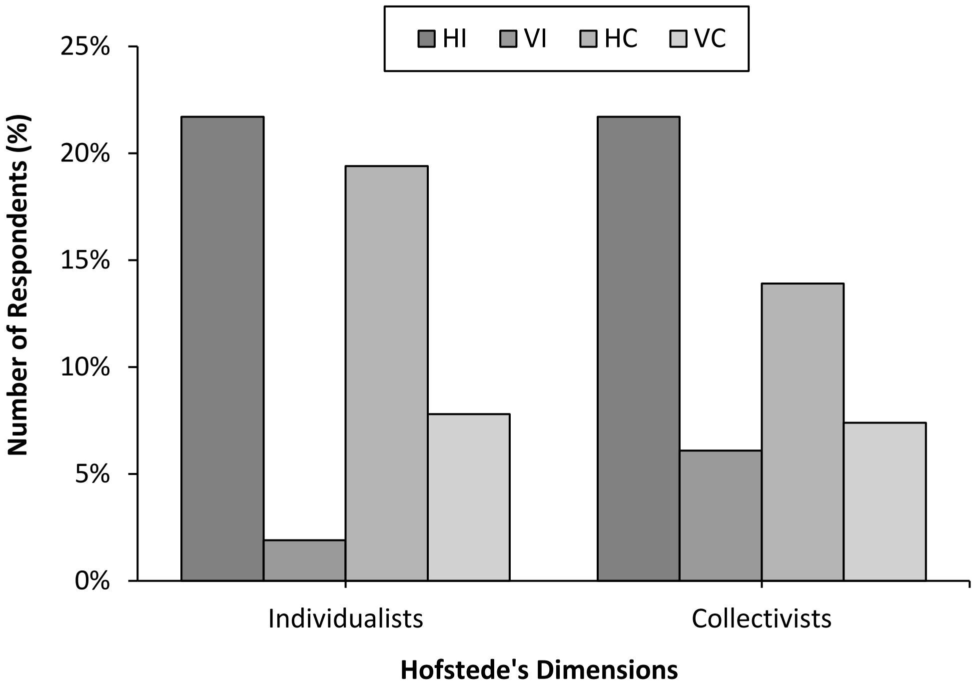
Analysis based on the Individualism-Collectivism Constructs as Macro Level Group Distinctions

In this section, Hofstede's (2017) individualism-collectivism constructs were used as the group level differentiation rather than geographical distinctions. Respondents were classed as individualistic or collectivistic based on their nationalities. As mentioned previously, this method of classification reduced the number of excluded responses from 5.9% in the geographical distinction analyses to 3.5%. Additionally, the sample sizes were more comparable when the individualistic and collectivistic distinctions were used (see Chapter 2: Table 3). Notably, differentiating macro level groups based on national cultural constructs (e.g., Hofstede, 2017) may be more representative of the countries' sociocultural determinants and institutional norms. Indeed, this is an important consideration given the appeal for cross-cultural comparative research to move beyond two-country comparisons (Sivadas et al., 2008; Boer et al., 2018).

Cultural Orientation Scale. Based on the individualistic (*n* = 157) and collectivistic (*n* = 152) distinctions, both groups were equally likely to be in the HI, HC, and VC categories (see Figure N7). Interestingly, the collectivistic group was significantly more likely to be vertical individualists (VI) than the individualistic group, χ^2 (3, *N* = 309) = 9.51, *p* = .023.

Figure N7

Cultural Orientations of Individualistic and Collectivistic Groups on the COS (Triandis & Gelfand, 1998)

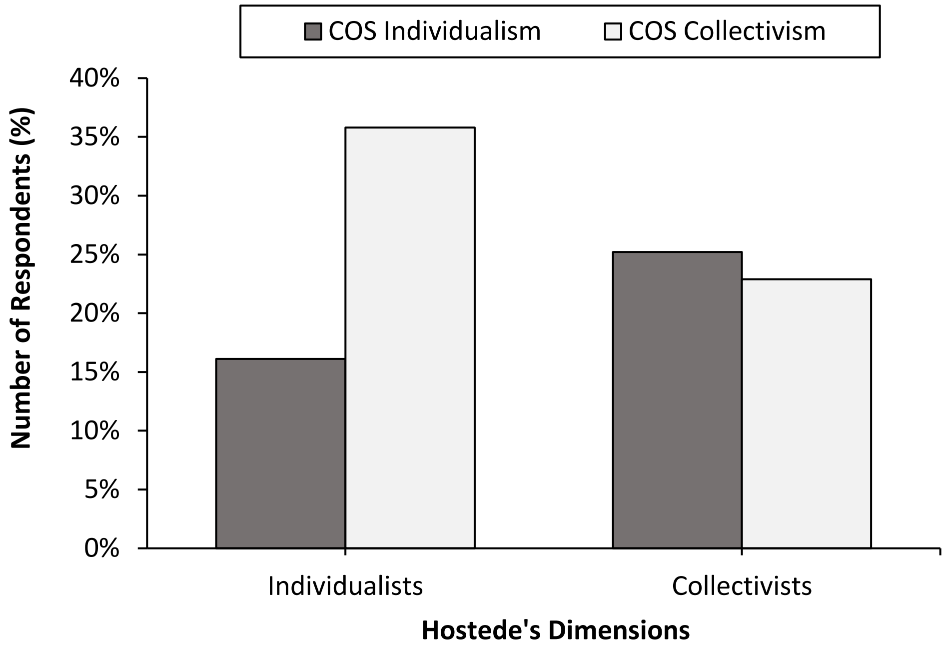


Note. Both individualistic (n = 157) and collectivistic (n = 152) groups were equally likely to adhere to the HI, HC, and VC categories. However, the collectivistic group was significantly more likely to be vertical individualists (VI).

Forty-one respondents could not be categorised into one of the four COS dimensions. Therefore, a consolidation of the four dimensions into two (COS individualism and COS collectivism) decreased this number to nine uncategorised respondents. There was a significant association between the alternative COS variables and Hofstede's categories, χ^2 (1, N = 341) = 16.02, $p < .001$. The post-hoc Bonferroni test revealed that the individualistic group were more likely to adhere to collectivism values as measured using the COS (see Figure N8).

Figure N8

Alternative Cultural Orientations of Individualistic and Collectivistic Groups on the COS (Triandis & Gelfand, 1998)

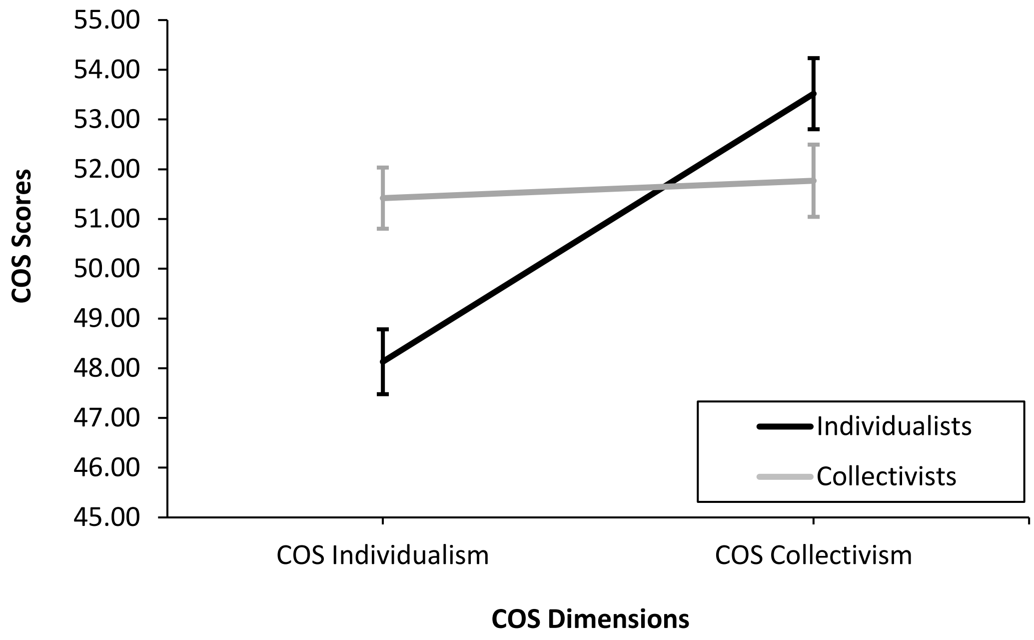


Note. The individualistic group (*n* = 177) were more likely to adhere to COS collectivism values compared to the collectivistic group (*n* = 162).

A t-test was also conducted to compare the COS individualism and COS collectivism scores of individualistic and collectivistic respondents (see Figure N9). To control for Type 1 errors, the statistical significance for this analysis is set at $p < .025$. Assumptions of normality were met. Interestingly, the collectivistic group had significantly higher scores on the COS individualism dimension than the individualistic group, $t(348) = 3.402$, $p = .001$, $d = .364$. The effect size was small. The collectivistic group ($M = 51.42$; $SD = 9.27$) had significantly higher scores on the individualism dimension of the COS compared to the individualistic group ($M = 48.13$; $SD = 8.79$). In contrast, group differences in collectivism scores were not significant ($p = .066$).

Figure N9

Cultural Orientations Differences between Individualists and Collectivists on the COS (Triandis & Gelfand, 1998)

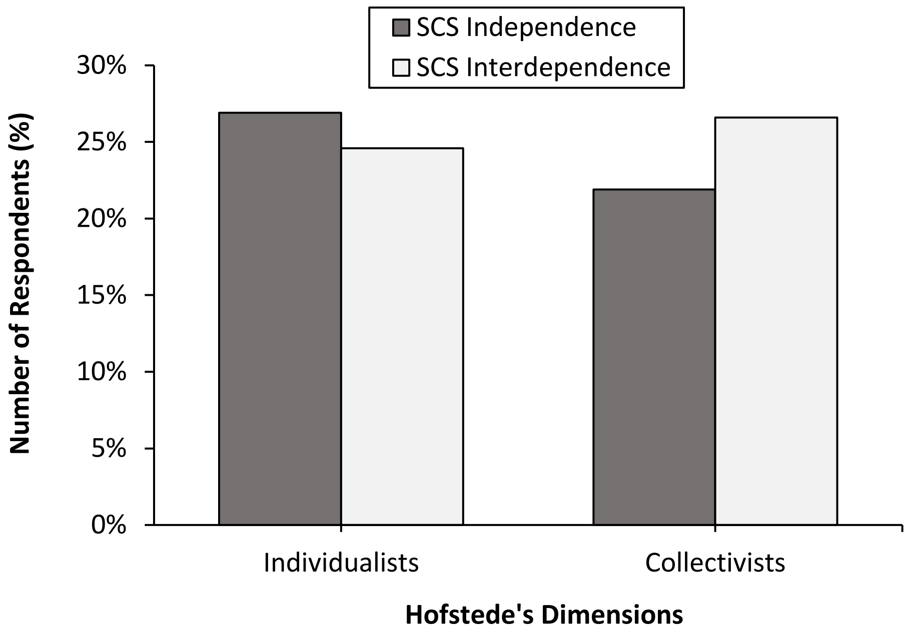


Note. Collectivists (n = 168) had significantly higher COS individualism scores than individualist respondents (n = 182). There were no group differences in COS collectivism scores. Error bars represent standard errors.

Self-Construal Scale. Figure N10 shows that both the individualistic and collectivistic groups were equally likely to hold independent or interdependent self-construal as measured using the SCS. Indeed, there was no statistically significant association between the SCS and Hofstede's categories, χ^2 (1, N = 342) = 1.72, p = .190, thus indicating that both individualists and collectivists were equally likely to possess independent and interdependent self-construal. Nine participants with equal scores on both subscales were excluded from this analysis.

Figure N10

Self-Construal of Individualistic and Collectivistic Groups on the SCS (Singelis, 1994)

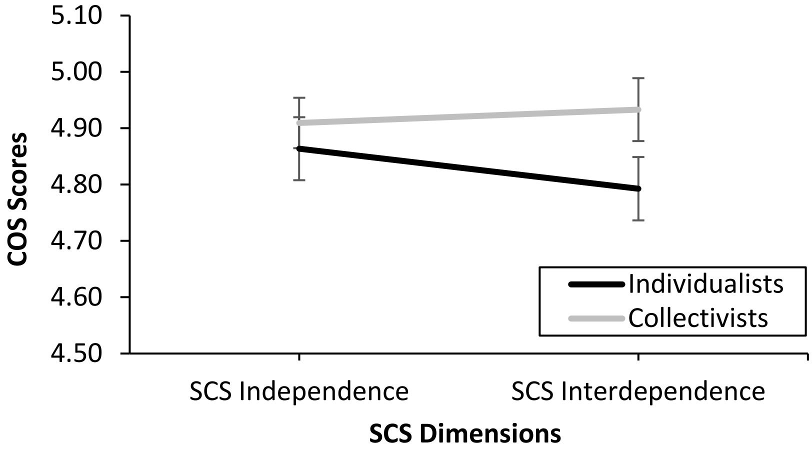


Note. Both individualistic (*n* = 176) and collectivistic (*n* = 166) groups were equally likely to hold independent or interdependent self-construal as measured using the SCS.

A t-test on all respondents (including those who could not be categorised) revealed no significant differences in SCS scores on the independence and interdependence dimensions between the individualistic and collectivistic groups. As seen in Figure N11 below, although collectivists (*M* = 4.93; *SD* = .726) appeared more likely than individualists to possess interdependent self-construal (*M* = 4.79; *SD* = .604), these differences only approached significance (*p* = .051). There were no differences in independent self-construal between both groups (*p* = .565).

Figure N11

Self-Construal Differences Between Individualists and Collectivists on the SCS (Singelis, 1994)

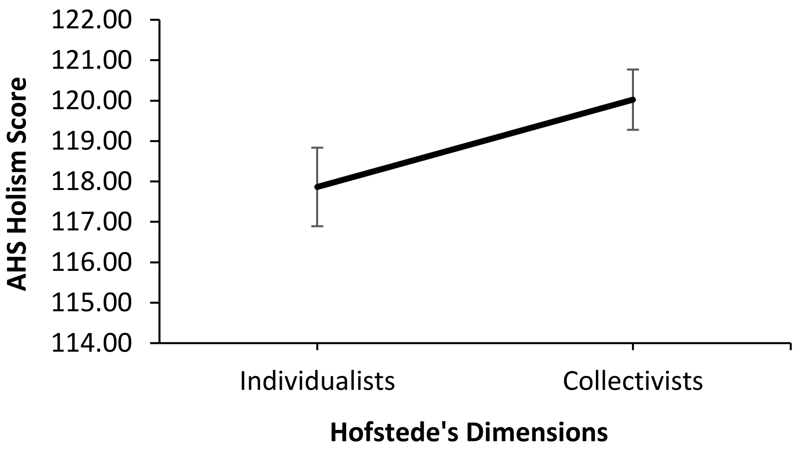


Note. Collectivists (*n* = 182) had higher SCS interdependence scores than individualist respondents (*n* = 203), although these differences were not significant. Both groups reported similar scores on the SCS independence dimensions. Error bars represent standard errors.

Analysis-Holism Scale. As seen in Figure N12, collectivists (*M* = 120.02; *SD* = 10.69; *n* = 162) were more holistic than individualists (*M* = 117.86; *SD* = 10.87; *n* = 177) as measured on the AHS. However, a t-test revealed no significant group difference in overall holism scores (*p* = .066).

Figure N12

Comparison of Composite Holism Scores Between Individualistic and Collectivistic Groups on the AHS (Choi et al., 2007)



Note. The analytic-holistic cognitive styles of the individualistic (n = 177) and collectivistic (n = 162) groups on the AHS were identified based on a median split.

Taken together, the inconsistency of the three measures in reflecting macro group differences (geographical regions and individualism-collectivism dimensions) suggest that the questionnaires assessed in the present study could be inadequate in determining social or cultural orientations as well as cognitive styles. Responses on the COS, SCS, and AHS should be able to identify if an individual's attitudes and beliefs are consistent with the cultural systems associated with their country. For example, individuals from Asian countries or collectivistic backgrounds tend to hold more collectivistic, interdependent, and holistic values, whereas individuals from Western countries or Individualistic backgrounds are more likely to be individualistic, interdependent, and analytic (Choi et al., 2007; Dong et al., 2019; Masuda et al., 2008; Masuda & Nisbett, 2006; Nisbett et al., 2001; Senzaki et al., 2014; Talhelm et al., 2014; Uskul et al., 2008). However, the findings reported here found that the individualistic and Western groups were more collectivistic regardless of the macro level distinctions used, as reflected on the COS. The collectivistic group (defined by Hofstede's dimension) was also more likely to be vertical individualists. These findings could be related to cultural shifts or convergence of collectivistic values across societies (Chen et al., 2020). Ma et al. (2016) have also previously attributed the increase of VI amongst Chinese employees to changes in economic and family structures. Therefore, the contradictory findings that Westerners were more collectivistic, and the observations that the collectivistic group (based on Hofstede's individualism-collectivism dimensions) expressed more individualistic values further support the notion of a possible sociocultural shift (Chen et al., 2020; Vignoles et al., 2016). Accordingly, it is important to consider additional features and demographics of different societies and nations to inform a multilevel cultural framework.

Appendix O

Correlation Matrices of the COS, SCS, and AHS

Table O1

Correlation Matrix for COS items (N = 363)

		HI_1	HI_2	HI_3	HI_4	VI_1	VI_2	VI_3	VI_4	HC_1	HC_2	HC_3	HC_4	VC_1	VC_2	VC_3	VC_4
HI_1	I'd rather depend on myself than others.	–															
HI_2	rely on myself most of the time; I rarely rely on others.	.518**	–														
HI_3	I often do "my own thing."	.280**	.389**	–													
HI_4	My personal identity, independent of others, is very important to me.	.209**	.393**	.307**	–												
VI_1	It is important that I do my job better than others.	.294**	.285**	.292**	.292**	–											
VI_2	Winning is everything.	.175**	.212**	.155*	.154*	.411**	–										
VI_3	Competition is the law of nature.	.211**	.178**	.192**	.154*	.343**	.470**	–									
VI_4	When another person does better than I do, I get tense and aroused.	.067	.047	.088*	.067	.389**	.336**	.326**	–								
HC_1	If a coworker gets a prize, I would feel proud.	-.016	.079	.023	.068	-.069	-.093*	-.046	-.193**	–							
HC_2	The well-being of my coworkers is important to me.	.022	.073	.071	.124*	-.032	-.064	-.048	-.097*	.417**	–						
HC_3	To me, pleasure is spending time with others.	-.040	-.089*	-.064	.037	-.033	-.039	.037	-.120*	.211**	.271**	–					
HC_4	I feel good when I cooperate with others.	.010	.028	.001	.109*	-.074	-.030	-.025	-.116*	.341**	.314**	.352**	–				
VC_1	Parents and children must stay together as much as possible.	.048	.093*	-.004	.033	.097*	.071	.074	-.044	.139*	.174**	.269**	.207**	–			
VC_2	It is my duty to take care of my family, even when I have to sacrifice what I want.	.068	.104*	.034	.085	.084	.020	.091*	.033	.259**	.259**	.158*	.258**	.427**	–		
VC_3	Family members should stick together, no matter what sacrifices are required.	.081	.106*	.061	.009	.129*	.116*	.160*	.046	.097*	.047	.171*	.196**	.461**	.557**	–	
VC_4	It is important to me that I respect the decisions made by my groups.	.003	.064	.019	.065	-.004	-.006	.017	.000	.317**	.300**	.248**	.386**	.112*	.201**	.181**	–

*significance at <.05, **significance at <.001

Table O2

Correlation Matrix for the Self-Construal Scale (Independent) Items (N = 363)

		IND1	IND2	IND3	IND4	IND5	IND6	IND7	IND8	IND9	IND10	IND11	IND12
IND1	I enjoy being unique and different from others in many respects.	–											
IND2	I feel comfortable using someone's first name soon after I meet them, even when they are much older than I am.	.036	–										
IND3	I'd rather say 'No' directly, than risk being misunderstood.	.152*	.188**	–									
IND4	Having a lively imagination is important to me.	.329**	-.006	.207**	–								
IND5	I prefer to be direct and forthright when dealing with people I've just met.	.222**	.153*	.391**	.167*	–							
IND6	I am comfortable with being singled out for praise or rewards.	.170*	.084	.129*	.119*	.192**	–						
IND7	Speaking up during a class is not a problem for me.	.247**	.181**	.209**	.150*	.324**	.307**	–					
IND8	I act the same way no matter who I am with.	.097*	.187**	.261**	.027	.345**	.121*	.301**	–				
IND9	I value being in good health above everything.	.077	.087*	.092*	.123*	.105*	.116*	.124*	.235**	–			
IND10	Being able to take care of myself is a primary concern for me.	.228**	.068	.139*	.193**	.132*	.096*	.138*	.109*	.202**	–		
IND11	My personal identity independent of others, is very important to me.	.344**	.044	.129*	.258**	.087*	.141*	.137*	.125*	.128*	.298**	–	
IND12	I act the same way at home that I do at school.	.048	.191**	.215**	-.002	.248**	.171*	.355**	.617**	.185**	.113*	.127*	–
COL1	Even when I strongly disagree with group members, I avoid an argument.	-.144*	-.003	-.064	-.047	-.135*	-.093*	-.197**	-.067	-.013	-.101*	-.106*	-.055
COL2	I have respect for the authority figures with whom I interact.	.158*	.114*	.042	.093*	.101*	.113**	.072	.127	.212**	.121*	.134*	.079
COL3	I respect people who are modest about themselves.	.105*	-.015	.008	.198**	-0.029	.021	-.067	-.005	.060	.244**	.179**	.047
COL4	I will sacrifice my self-interest for the benefit of the group I am in.	-.088*	-.011	-.108*	-.032	-.093*	-.061	-.092*	.012	-.032	-.149*	-.102*	-.009
COL5	I should take into consideration my parents' advice when making education/career plans.	.022	.135*	-.050	-.011	.062	.068	.000	.032	.130*	.010	-.014	.096*
COL6	If my brother or sister fails, I feel responsible.	-.005	-.056	-.010	.094*	.059	-.004	.038	.046	.145*	-.008	-.018	.101*
COL7	I often have the feeling that my relationships with others are more important than my own accomplishments.	-.085	.035	-.056	.007	-.079	.017	-.007	.038	.080	-.108*	-.134*	.064
COL8	I would offer my seat in a bus to my professor.	.022	-.118*	.011	.084	-.062	-.062	.105*	-.003	.068	.005	-.039	.033
COL9	My happiness depends on the happiness of those around me.	-.001	.083	-.001	.059	.078	-.072	.019	.128*	.069	.007	-.015	.100*
COL10	I will stay in a group if they need me, even when I'm not happy with the group.	-.064	.010	-.090*	-.129*	-.124*	-.066	-.049	.003	-.035	-.036	-.062	.005
COL11	It is important to me to respect decisions made by the group.	.013	.039	.013	.081	-.007	-.071	-.007	.084	.132*	.005	.021	.079
COL12	It is important for me to maintain harmony within my group.	-.024	.003	-.107*	.104*	-.103*	.024	.001	.044	.084	.044	.004	.016

*significance at <.05, **significance at <.001

Table O3

Correlation Matrix for the Self-Construal Scale (Interdependent) Items (N = 363)

		COL1	COL2	COL3	COL4	COL5	COL6	COL7	COL8	COL9	COL10	COL11	COL12
IND1	I enjoy being unique and different from others in many respects.	-.144*	.158*	.105*	-.088*	.022	-.005	-.085	.022	-.001	-.064	.013	-.024
IND2	I feel comfortable using someone's first name soon after I meet them, even when they are much older than I am.	-.003	.114*	-.015	-.011	.135*	-.056	.035	-.118*	.083	.010	.039	.003
IND3	I'd rather say 'No' directly, than risk being misunderstood.	-.064	.042	.008	-.108*	-.050	-.010	-.056	.011	-.001	-.090*	.013	-.107*
IND4	Having a lively imagination is important to me.	-.047	.093*	.198**	-.032	-.011	.094*	.007	.084	.059	-.129*	.081	.104*
IND5	I prefer to be direct and forthright when dealing with people I've just met.	-.135*	.101*	-.029	-.093*	.062	.059	-.079	-.062	.078	-.124*	-.007	-.103*
IND6	I am comfortable with being singled out for praise or rewards.	-.093*	.113*	.021	-.061	.068	-.004	.017	-.062	-.072	-.066	-.071	.024
IND7	Speaking up during a class is not a problem for me.	-.197**	.072	-.067	-.092*	.000	.038	-.007	.105*	.019	-.049	-.007	.001
IND8	I act the same way no matter who I am with.	-0.067	.127*	-.005	.012	.032	.046	.038	-.003	.128*	.003	.084	.044
IND9	I value being in good health above everything.	-0.013	.212**	.060	-.032	.130*	.145*	.080	.068	.069	-.035	.132*	.084
IND10	Being able to take care of myself is a primary concern for me.	-.101*	.121*	.244**	-.149*	.010	-.008	-.108*	.005	.007	-.036	.005	.044
IND11	My personal identity independent of others, is very important to me.	-.106*	.134*	.179**	-.102*	-.014	-.018	-.134*	-.039	-.015	-.062	.021	.004
IND12	I act the same way at home that I do at school.	-.055	.079	.047	-.009	.096*	.101*	.064	.033	.100*	.005	.079	.016
COL1	Even when I strongly disagree with group members, I avoid an argument.	–											
COL2	I have respect for the authority figures with whom I interact.	.087*	–										
COL3	I respect people who are modest about themselves.	.167*	.129*	–									
COL4	I will sacrifice my self-interest for the benefit of the group I am in.	.271**	.182**	.198**	–								
COL5	I should take into consideration my parents' advice when making education/career plans.	.130*	.237**	.067	.179**	–							
COL6	If my brother or sister fails, I feel responsible.	.035	.049	.055	.195**	.155*	–						
COL7	I often have the feeling that my relationships with others are more important than my own accomplishments.	.199**	-.015	.107*	.305**	.139*	.137*	–					
COL8	I would offer my seat in a bus to my professor.	.068	.123*	.041	.087*	.174**	.268**	.174**	–				
COL9	My happiness depends on the happiness of those around me.	.111*	.180**	.166*	.296**	.165*	.165*	.333**	.150*	–			
COL10	I will stay in a group if they need me, even when I'm not happy with the group.	.260**	.095*	.070	.295**	.142*	.144*	.314**	.111*	.306**	–		
COL11	It is important to me to respect decisions made by the group.	.161*	.309**	.188**	.369**	.204**	.101*	.195**	.146*	.226**	.250**	–	
COL12	It is important for me to maintain harmony within my group.	.252**	.282**	.234**	.247**	.200**	.131*	.242**	.113*	.315**	.280**	.473**	–

*significance at <.05, **significance at <.001

Table O4

Correlation Matrix for the Analysis-Holism Scale (Causality and Contradiction) Items (N = 351)

		CAUSALITY 1	CAUSALITY 2	CAUSALITY 3	CAUSALITY 4	CAUSALITY 5	CAUSALITY 6	CONTRA 1	CONTRA 2	CONTRA 3	CONTRA 4	CONTRA 5	CONTRA 6
CAUSALITY1	Everything in the universe is somehow related to each other.	–											
CAUSALITY2	Nothing is unrelated.	.300**	–										
CAUSALITY3	Everything in the world is intertwined in a causal relationship.	.535**	.359**	–									
CAUSALITY4	Even a small change in any element of the universe can lead to significant alterations in other elements.	.331**	.206**	.367**	–								
CAUSALITY5	Any phenomenon has numerous numbers of causes, although some of the causes are not known.	.275**	.214**	.310**	.363**	–							
CAUSALITY6	Any phenomenon entails a numerous number of consequences, although some of them may not be known.	.357**	.177**	.290**	.351**	.582**	–						
CONTRA1	It is more desirable to take the middle ground than go to extremes.	.025	.052	.091*	.018	.026	.024	–					
CONTRA2	When disagreement exists among people, they should search for ways to compromise and embrace everyone's opinions.	.049	.078	.130*	.198**	.120*	.099*	.219**	–				
CONTRA3	It is more important to find a point of compromise than to debate who is right/wrong, when one's opinions conflict with other's opinions.	.154*	-.001	.196**	.263**	.133*	.161*	.336**	.469**	–			
CONTRA4	It is desirable to be in harmony, rather than in discord, with others of different opinions than one's own.	.155*	.102*	.177**	.107*	.071	.131*	.227**	.345**	.377**	–		
CONTRA5	Choosing a middle ground in an argument should be avoided. (Reversed)	-.034	-.088*	-.044	-.039	.006	.008	.056	.071	.096*	.069	–	
CONTRA6	We should avoid going to extremes.	.058	.130*	.118*	.075	.101*	.082	.554**	.190**	.197**	.186**	.001	–
CHANGE1	Every phenomenon in the world moves in predictable directions. (Reversed)	-.118*	-.048	-.215**	-.019	-.021	-.057	-.116*	-.020	-.074	-.067	.246**	-.101*
CHANGE2	A person who is currently living a successful life will continue to stay successful. (Reversed)	-.003	-.154*	-.138*	.147*	.041	.042	-.139*	-.044	-.092*	-.020	.193**	-.107*
CHANGE3	An individual who is currently honest will stay honest in the future. (Reversed)	-.050	-.072	-.096*	.113*	.019	-.041	-.118*	-.080	-.139*	-.119*	.149*	-.094*
CHANGE4	If an event is moving toward a certain direction, it will continue to move toward that direction. (Reversed)	.135*	-.013	-.071	-.004	.076	.124*	-.153*	-.091*	-.076	-.104*	.178*	-.170*
CHANGE5	Current situations can change at any time.	.133*	.039	.203**	.327**	.303**	.277**	.017	.200**	.155*	.095*	.107*	.045
CHANGE6	Future events are predictable based on present situations. (Reversed)	-.103*	-.077	-.139*	-.063	-.106*	-.097*	-.104*	.028	-.051	.030	.085	-.071
ATTENTION1	The whole, rather than its parts, should be considered in order to understand a phenomenon.	-.011	.048	.039	.106*	.209**	.093*	.046	.085	.122*	.018	-.173*	.093*
ATTENTION2	It is more important to pay attention to the whole than its parts.	-.003	.008	.086	.031	.120*	-.013	.162*	.164*	.152*	.057	-.163*	.214**
ATTENTION3	The whole is greater than the sum of its parts.	.046	.067	.080	.114*	.201**	.059	.090*	.117*	.163*	.001	-.180**	.204**
ATTENTION4	It is more important to pay attention to the whole context rather than the details.	-.022	.104*	.083	.017	.199**	.076	.114*	.098*	.148*	.071	-.171*	.078
ATTENTION5	It is not possible to understand the parts without considering the whole picture.	.061	.279**	.189**	.238**	.265**	.182**	.095*	.071	.127*	.124*	-.073	.154*
ATTENTION6	We should consider the situation a person is faced with, as well as his/her personality, in order to understand one's behaviour.	.171*	.103*	.199**	.290**	.326**	.298**	.026	.178**	.174*	.146*	.106*	-.025

*significance at <.05, **significance at <.001

Table O5

Correlation Matrix for the Analysis-Holism Scale (Change Perception and Locus of Attention) Items (N = 351)

		CHANGE 1	CHANGE 2	CHANGE 3	CHANGE 4	CHANGE 5	CHANGE 6	ATTENTION 1	ATTENTION 2	ATTENTION 3	ATTENTION 4	ATTENTION 5	ATTENTION 6
CAUSALITY1	Everything in the universe is somehow related to each other.	-.118*	-.003	-.050	.135*	.133*	-.103*	-.011	-.003	.046	-.022	.061	.171*
CAUSALITY2	Nothing is unrelated.	-.048	-.154*	-.072	-.013	.039	-.077	.048	.008	.067	.104*	.279**	.103*
CAUSALITY3	Everything in the world is intertwined in a causal relationship.	-.215**	-.138*	-.096*	-.071	.203**	-.139*	.039	.086	.080	.083	.189**	.199**
CAUSALITY4	Even a small change in any element of the universe can lead to significant alterations in other elements.	-.019	.147*	.113*	-.004	.327**	-.063	.106*	.031	.114*	.017	.238**	.290**
CAUSALITY5	Any phenomenon has numerous numbers of causes, although some of the causes are not known.	-.021	.041	.019	.076	.303**	-.106*	.209*	.120*	.201**	.199**	.265**	.326**
CAUSALITY6	Any phenomenon entails a numerous number of consequences, although some of them may not be known.	-.057	.042	-.041	.124*	.277**	-.097*	.093*	-.013	.059	.076	.182**	.298**
CONTRA1	It is more desirable to take the middle ground than go to extremes.	-.116*	-.139*	-.118*	-.153*	.017	-.104*	.046	.162*	.090*	.114*	.095*	.026
CONTRA2	When disagreement exists among people, they should search for ways to compromise and embrace everyone's opinions.	-.020	-.044	-.080	-.091*	.200**	.028	.085	.164*	.117*	.098*	.071	.178**
CONTRA3	It is more important to find a point of compromise than to debate who is right/wrong, when one's opinions conflict with other's opinions.	-.074	-.092*	-.139*	-.076	.155*	-.051	.122*	.152*	.163*	.148*	.127*	.174*
CONTRA4	It is desirable to be in harmony, rather than in discord, with others of different opinions than one's own.	-.067	-.020	-.119*	-.104*	.095*	.030	.018	.057	.001	.071	.124*	.146*
CONTRA5	Choosing a middle ground in an argument should be avoided. (Reversed)	.246**	.193**	.149*	.178**	.107*	.085	-.173*	-.163*	-.180**	-.171*	-.073	.106*
CONTRA6	We should avoid going to extremes.	-.101*	-.107*	-.094*	-.170*	.045	-.071	.093*	.214**	.204**	.078	.154*	-.025
CHANGE1	Every phenomenon in the world moves in predictable directions. (Reversed)	–											
CHANGE2	A person who is currently living a successful life will continue to stay successful. (Reversed)	.229**	–										
CHANGE3	An individual who is currently honest will stay honest in the future. (Reversed)	.317**	.478**	–									
CHANGE4	If an event is moving toward a certain direction, it will continue to move toward that direction. (Reversed)	.408**	.354**	.375**	–								
CHANGE5	Current situations can change at any time.	.085	.193**	.163*	.131*	–							
CHANGE6	Future events are predictable based on present situations. (Reversed)	.360**	.166*	.249*	.232**	-.117*	–						
ATTENTION1	The whole, rather than its parts, should be considered in order to understand a phenomenon.	-.115*	-.129*	-.029	-.124*	.051	-.112*	–					
ATTENTION2	It is more important to pay attention to the whole than its parts.	-.210**	-.142*	-.168*	-.218**	.062	-.101*	.454**	–				
ATTENTION3	The whole is greater than the sum of its parts.	-.270**	-.129*	-.208**	-.235**	.008	-.176**	.440**	.543**	–			
ATTENTION4	It is more important to pay attention to the whole context rather than the details.	-.126*	-.127*	-.120*	-.163*	-.021	-.169*	.444**	.553**	.400**	–		
ATTENTION5	It is not possible to understand the parts without considering the whole picture.	-.052	-.084	-.028	-.032	.171*	-.173*	.313**	.224**	.278**	.285**	–	
ATTENTION6	We should consider the situation a person is faced with, as well as his/her personality, in order to understand one's behaviour.	.147*	.178**	.118*	.105*	.304**	-.018	.040	-.066	.011	-.047	.170*	–

*significance at <.05, **significance at <.001

Appendix P

Factor Analysis Tables for the COS

Table P1

Factor Loadings for the COS for all Participants (N = 363)

		Descriptive Statistics		Loadings				
		M	SD	Factor 1: HC	Factor 2: HI	Factor 3: VI	Factor 4: VC	Communality
HC_4	I feel good when I cooperate with others.	7.19	1.62	**.601**	.012	-.052	.167	.263
HC_2	The well-being of my co-workers is important to me.	6.68	1.94	**.592**	.104	-.087	.052	.707
HC_1	If a co-worker gets a prize, I would feel proud.	7.34	1.74	**.572**	.083	-.156	.085	.337
VC_4	It is important to me that I respect the decisions made by my groups.	7.18	1.49	**.528**	.023	.032	.103	.392
HC_3	To me, pleasure is spending time with others.	6.82	1.71	**.456**	-.106	.000	.173	.270
HI_2	rely on myself most of the time; I rarely rely on others.	4.39	2.22	.005	**.835**	.048	.091	.432
HI_1	I'd rather depend on myself than others.	6.36	1.85	-.044	**.560**	.129	.074	.451
HI_3	I often do "my own thing."	6.00	2.15	.021	**.492**	.165	-.010	.388
HI_4	My personal identity, independent of others, is very important to me.	4.82	2.26	.154	**.461**	.161	-.031	.342
VI_2	Winning is everything.	6.55	2.02	-.043	.175	**.630**	.049	.487
VI_3	Competition is the law of nature.	6.13	2.24	-.001	.170	**.591**	.099	.680
VI_4	When another person does better than I do, I get tense and aroused.	6.87	1.49	-.131	.019	**.569**	-.005	.291
VI_1	It is important that I do my job better than others.	5.93	2.16	-.051	.350 [a]	**.566**	.077	.362
VC_3	Family members should stick together, no matter what sacrifices are required.	6.39	1.93	.090	.031	.121	**.810**	.249
VC_2	It is my duty to take care of my family, even when I have to sacrifice what I want.	6.91	1.61	.288	.072	.036	**.631**	.372
VC_1	Parents and children must stay together as much as possible.	6.71	1.77	.209	.029	.039	**.562**	.365
	Eigenvalue			3.06	2.76	1.60	1.24	
	% of Total Variance			19.10	17.23	9.98	7.74	
	Total Variance						**54.04%**	

Note. Factors were extracted using principal axis factoring and an orthogonal (Varimax with Kaiser Normalization) rotation.

[a] Complex variable.

Table P2

Factor Loadings for Individualistic and Collectivistic Groups on the COS

Subscale and Item	Individualistic (n = 182)		Collectivistic (n = 168)	
	Factor Loading	h^2	Factor Loading	h^2
Factor 1: Horizontal Individualism				
HI_1	.494	.287	.632	.408
HI_2	.780	.610	.810	.686
HI_3	.537	.335	.470	.234
HI_4	.362	.206	.579	.397
Factor 2: Vertical Individualism				
VI_1	.538	.427	.519	.478
VI_2	.643	.448	.655	.461
VI_3	.680	.491	.475	.276
VI_4	.495	.257	.555	.321
Factor 3: Horizontal Collectivism and one Vertical Collectivism Item				
HC_1	.573	.380	.527	.359
HC_2	.571	.338	.512	.366
HC_3	.405	.202	.512	.311
HC_4	.595	.374	.657	.452
VC_4	.553	.312	.684	.475
Factor 4: Vertical Collectivism				
VC_1	.532	.329	.714	.533
VC_2	.614	.431	.695	.604
VC_3	.876	.779	.605	.475

Note. Factors were extracted using principal axis factoring and an orthogonal (Varimax with Kaiser Normalization) rotation.

Table P3

Factor Loadings the COS for Western Participants (n = 203)

		Loadings				Communality
		Factor 1: HC	Factor 2: VI	Factor 3: VC	Factor 4: HI	
VC_4	It is important to me that I respect the decisions made by my groups.	**.581**	-.034	.041	.006	.708
HC_4	I feel good when I cooperate with others.	**.572**	-.033	.132	.013	.560
HC_2	The well-being of my co-workers is important to me.	**.561**	-.067	.019	.056	.617
HC_1	If a co-worker gets a prize, I would feel proud.	**.533**	-.146	.071	.150	.443
HC_3	To me, pleasure is spending time with others.	**.462**	.004	.119	-.119	.750
VI_3	Competition is the law of nature.	-.015	**.661**	.161	.132	.794
VI_2	Winning is everything.	.021	**.641**	.058	.147	.687
VI_1	It is important that I do my job better than others.	-.104	**.562**	.028	.299	.601
VI_4	When another person does better than I do, I get tense and aroused.	-.135	**.531**	-.021	.011	.563
VC_3	Family members should stick together, no matter what sacrifices are required.	.002	.127	**.799**	.071	.434
VC_2	It is my duty to take care of my family, even when I have to sacrifice what I want.	.168	.018	**.634**	.056	.638
VC_1	Parents and children must stay together as much as possible.	.174	.043	**.571**	.043	.675
HI_2	rely on myself most of the time; I rarely rely on others.	.014	.002	.062	**.815**	.671
HI_1	I'd rather depend on myself than others.	-.073	.182	.070	**.507**	.417
HI_3	I often do "my own thing."	.072	.201	-.007	**.490**	.824
HI_4	My personal identity, independent of others, is very important to me.	.257	.111	.091	**.310**	.667
	Eigenvalue	2.87	2.59	1.61	1.35	
	% of Total Variance	17.91	16.18	10.06	8.43	
	Total Variance				**52.58%**	

Note. Factors were extracted using principal axis factoring and an orthogonal (Varimax with Kaiser Normalization) rotation.

[a] Complex variable.

Table P4

Factor Loadings the COS for Asian Participants (n = 142)

		Loadings					
		Factor 1: HI	Factor 2: VC	Factor 3: VI	Factor 4: HC(A)	Factor 5: HC(B)	Communality
HI_2	rely on myself most of the time; I rarely rely on others.	**.829**	.116	.114	.094	.011	.722
HI_4	My personal identity, independent of others, is very important to me.	**.605**	-.150	.061	.276	.054	.471
HI_1	I'd rather depend on myself than others.	**.597**	.089	.037	.075	.047	.373
HI_3	I often do "my own thing."	**.473**	.021	-.051	.146	.027	.249
VC_3	Family members should stick together, no matter what sacrifices are required.	.106	**.746**	.323 [a]	.113	-.186	.719
VC_1	Parents and children must stay together as much as possible.	-.002	**.705**	.052	.054	.206	.544
VC_2	It is my duty to take care of my family, even when I have to sacrifice what I want.	.126	**.630**	.342 [a]	.134	.178	.580
VC_4	It is important to me that I respect the decisions made by my groups.	.083	.120	**.729**	.079	.088	.566
HC_4	I feel good when I cooperate with others.	.044	.158	**.658**	-.002	.126	.476
HC_3	To me, pleasure is spending time with others.	-.073	.291	**.381**	-.043	.163	.264
VI_4	When another person does better than I do, I get tense and aroused.	.007	-.026	-.020	**.617**	-.035	.383
VI_1	It is important that I do my job better than others.	.391 [a]	.160	-.002	**.591**	.131	.545
VI_2	Winning is everything.	.188	.076	-.053	**.562**	-.108	.371
VI_3	Competition is the law of nature.	.168	.072	.096	**.422**	.032	.222
HC_2	The well-being of my co-workers is important to me.	.142	.113	.235	.020	**.872**	.849
HC_1	If a co-worker gets a prize, I would feel proud.	.031	.169	.406 [a]	-.117	**.459**	.419
	Eigenvalue	3.74	2.61	1.51	1.19	1.01	
	% of Total Variance	23.38	16.29	9.43	7.42	6.30	
	Total Variance					**62.81%**	

Note. Factors were extracted using principal axis factoring and an orthogonal (Varimax with Kaiser Normalization) rotation.

[a] Complex variable.

Appendix Q

Factor Analysis Tables for the SCS

Table Q1
Factor Loadings for the SCS for all Participants (N = 363)

		Loadings							Communality
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	
INT 7	I often have the feeling that my relationships with others are more important than my own accomplishments.	**.564**	.042	-.094	-.031	-.124	.088	.171	.382
INT 4	I will sacrifice my self-interest for the benefit of the group I am in.	**.562**	-.030	-.081	-.009	.134	-.107	.072	.358
INT 12	It is important for me to maintain harmony within my group.	**.528**	.004	.147	-.129	.305 [a]	.004	.045	.412
INT 10	I will stay in a group if they need me, even when I'm not happy with the group.	**.518**	.013	-.092	-.112	.045	.008	.056	.295
INT 9	My happiness depends on the happiness of those around me.	**.511**	.084	.036	.105	.073	.008	.139	.306
INT 11	It is important to me to respect decisions made by the group.	**.466**	.050	.101	.015	.371 [a]	-.075	.069	.378
INT 1	Even when I strongly disagree with group members, I avoid an argument.	**.394**	-.050	-.060	-.074	.077	-.199	-.029	.213
IND 12	I act the same way at home that I do at school.	.049	**.779**	.052	.110	.013	.180	.054	.660
IND 8	I act the same way no matter who I am with.	.044	**.702**	.054	.267	.074	.111	-.003	.587
IND 9	I value being in good health above everything.	.010	**.238**	.186	.049	.223	.062	.146	.169
IND 2	I feel comfortable using someone's first name soon after I meet them, even when they are much older than I am.	.063	**.194**	-.022	.191	.126	.162	-.182	.153
IND 11	My personal identity independent of others, is very important to me.	-.108	.099	**.541**	.008	.067	.121	-.058	.337
IND 4	Having a lively imagination is important to me.	.020	-.113	**.504**	.240	-.007	.103	.163	.362
IND 10	Being able to take care of myself is a primary concern for me.	-.095	.134	**.487**	.029	.081	.050	-.013	.274
IND 1	I enjoy being unique and different from others in many respects.	-.094	-.052	**.453**	.177	.074	.283	.035	.335
INT 3	I respect people who are modest about themselves.	.304 [a]	.020	**.453**	-.041	.028	-.154	-.022	.325
IND 5	I prefer to be direct and forthright when dealing with people I've just met.	-.093	.194	.081	**.639**	.074	.208	.005	.509
IND 3	I'd rather say 'No' directly, than risk being misunderstood.	-.082	.179	.159	**.502**	-.018	.079	-.009	.322
INT 2	I have respect for the authority figures with whom I interact.	.161	.047	.170	.057	**.637**	.071	.022	.472
INT 5	I should take into consideration my parents' advice when making education/career plans.	.233	.051	-.035	.011	**.323**	.060	.152	.190
IND 7	Speaking up during a class is not a problem for me.	-.067	.263	.106	.193	.017	**.597**	.110	.491
IND 6	I am comfortable with being singled out for praise or rewards.	-.051	.094	.138	.084	.069	**.404**	-.056	.208
INT 8	If my brother or sister fails, I feel responsible.	.128	-.008	.012	-.048	.101	.026	**.578**	.364
INT 6	I would offer my seat in a bus to my professor.	.181	.066	.013	.042	.047	-.014	**.445**	.240
	Eigenvalue	3.238	3.17	1.76	1.30	1.15	1.09	1.03	
	% of Total Variance	13.493	13.19	7.33	5.41	4.80	4.55	4.29	
	Total Variance							**53.07%**	

Note. Factors were extracted using principal axis factoring and an orthogonal (Varimax with Kaiser Normalization) rotation.

[a] Complex variable.

Table Q2

Descriptive Statistics and Factor Analysis with a Two-Factor Preset for the SCS (N = 363)

	Loadings			Descriptive Statistics	
	Factor 1	Factor 2	Communality	*M*	*SD*
INT 1	**.375**	-.227	.192	4.43	1.57
INT 2	**.362**	.248	.192	5.60	1.00
INT 3	**.297**	.099	.098	5.95	.930
INT 4	**.564**	-.161	.344	4.55	1.36
INT 5	**.361**	.081	.137	4.94	1.37
INT 6	**.286**	.063	.086	3.86	1.70
INT 7	**.465**	-.087	.223	4.18	1.48
INT 8	**.272**	.022	.075	5.00	1.62
INT 9	**.518**	.069	.273	4.61	1.44
INT 10	**.488**	-.151	.261	4.26	1.63
INT 11	**.584**	.060	.344	5.31	1.00
INT 12	**.606**	.000	.367	5.64	.980
IND1	-.043	**.418**	.176	5.39	1.19
IND2	.055	**.262**	.072	4.46	1.67
IND3	-.080	**.451**	.210	4.89	1.44
IND4	.057	**.329**	.111	5.51	1.33
IND5	-.068	**.542**	.299	4.54	1.50
IND6	-.040	**.353**	.126	4.70	1.55
IND7	-.030	**.544**	.297	4.28	1.94
IND8	.118	**.545**	.311	3.99	1.76
IND9	.164	**.325**	.133	5.41	1.39
IND10	-.009	**.366**	.134	5.73	1.13
IND11	-.038	**.381**	.147	5.63	1.11
IND12	.122	**.513**	.278	4.02	1.79
Eigenvalue	3.24	3.17			
% of Total Variance	13.49	13.19			
Total Variance		**26.68%**			

Note. Factors were extracted using principal axis factoring with a two-factor preset and an orthogonal (Varimax with Kaiser Normalization) rotation.

Table Q3

Factor Analysis Table for the Self-Construal Scale for the Individualistic Group (n = 182)

	Loadings									Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	
IND 12	**.895**	.027	.163	.007	-.052	.026	-.019	.068	.013	.837
IND 8	**.638**	.059	.301	.003	-.042	.035	.033	.127	-.064	.525
IND 1	.026	**.657**	.141	-.107	-.023	-.050	-.079	-.019	-.079	.480
IND 4	-.174	**.540**	.083	.079	-.252	.117	.115	-.011	.051	.428
IND 11	.164	**.518**	.035	-.022	-.004	.183	-.052	.126	-.055	.352
IND 7	.303 [a]	**.419**	.361 [a]	.068	-.118	-.189	-.020	-.110	.239	.521
IND 5	.132	.202	**.664**	-.132	-.132	-.031	.126	-.016	-.088	.559
IND 3	.083	.215	**.526**	-.115	.004	.043	.057	.064	-.153	.376
IND 2	.151	-.080	**.452**	.112	.064	.025	-.164	.090	.055	.288
IND 6	.166	.105	**.363**	.012	-.191	-.053	-.094	.016	.194	.256
INT 12	-.116	-.089	-.040	**.740**	.033	.291	-.135	-.057	.253	.742
INT 2	.037	.013	-.023	**.561**	.046	-.006	.054	.140	-.131	.359
INT 11	.080	.044	-.065	**.467**	.330 [a]	.045	.164	-.022	-.021	.370
INT 5	.017	-.123	.099	**.290**	.123	-.089	.265	.137	.112	.234
INT 10	-.043	-.057	-.013	.069	**.729**	.020	-.027	-.067	.139	.566
INT 4	-.040	-.113	-.151	.199	**.421**	.127	.348 [a]	-.171	-.036	.422
INT 1	-.095	-.187	-.127	.201	**.319**	.073	.017	.120	.089	.230
INT 3	.044	.130	-.065	.090	.080	**.604**	.073	.033	-.027	.410
IND 10	.004	.288	.172	.023	-.039	**.293**	-.084	.256	-.032	.274
INT 9	-.053	-.117	.144	.182	.254	**.272**	.262	-.085	.129	.301
INT 6	.006	-.024	.006	-.021	.007	.064	**.383**	-.017	.034	.153
INT 8	-.001	.106	-.137	.212	-.001	-.147	**.359**	.102	.201	.276
IND 9	.139	.044	.070	.122	-.067	.037	.017	**.680**	.037	.510
INT 7	-.036	-.084	-.046	-.011	.209	-.004	.213	.038	**.572**	.428
Eigenvalue	3.532	2.458	1.751	1.431	1.349	1.206	1.13	1.077	1.002	
% of Total Variance	14.72	10.24	7.30	5.96	5.62	5.03	4.71	4.49	4.18	
Total Variance									**62.24%**	

Note. Factors were extracted using principal axis factoring and an orthogonal (Varimax with Kaiser Normalization) rotation.

[a] Complex variable.

Table Q4

Factor Analysis Table for the Self-Construal Scale for the Collectivistic Group (n = 169)

	Loadings								Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	
INT 7	**.691**	.109	-.067	.090	.079	.017	-.149	.030	.532
INT 9	**.675**	.181	.125	.141	.137	-.002	.284	-.111	.636
INT 10	**.521**	.020	-.066	.155	.221	-.130	-.053	.038	.371
INT 4	**.455**	.099	-.092	.384 [a]	.036	-.086	-.146	.225	.453
IND 12	.153	**.787**	.096	-.016	.093	.041	-.052	-.051	.667
IND 8	.115	**.683**	.036	.127	-.041	.195	.093	-.072	.550
IND 7	-.042	**.476**	.030	-.046	.140	.101	.211	.150	.328
IND 2	.047	**.323**	.060	.063	-.009	.015	-.088	.179	.154
IND 9	.064	**.287**	.144	.217	.108	.036	.229	.108	.231
IND 10	-.158	.197	**.597**	-.011	.049	-.058	.052	-.124	.444
INT 3	.203	-.051	**.576**	.156	.005	.015	-.230	.126	.470
IND 11	-.093	.045	**.541**	.044	-.126	.021	.136	.164	.367
IND 4	.051	.081	**.443**	.149	.055	.213	.034	.094	.286
IND 1	-.020	.008	**.442**	.063	.132	.046	.390 [a]	.208	.415
INT 11	.219	.068	.138	**.722**	.044	.081	-.056	-.025	.606
INT 12	.444 [a]	.007	.152	**.549**	.123	-.060	-.012	-.070	.546
INT 2	.069	.143	.247	**.428**	.181	.072	.256	.264	.442
INT 5	.117	.135	.117	**.267**	.242	-.155	-.012	.221	.249
INT 8	.139	-.015	.037	.017	**.629**	.119	-.008	-.072	.437
INT 6	.181	.171	-.051	.170	**.492**	-.069	.073	.044	.348
IND 3	-.101	.265	.118	-.020	.041	**.751**	-.045	.001	.662
IND 5	-.064	.354 [a]	.030	.092	.036	**.365**	.260	.073	.347
INT 1	.258	-.089	-.015	.204	.059	.024	**-.307**	-.031	.216
IND 6	-.009	.079	.156	.011	-.039	.027	.081	**.528**	.319
Eigenvalue	4.15	2.77	1.97	1.32	1.23	1.10	1.05	1.02	
% of Total Variance	17.30	11.52	8.21	5.49	5.11	4.59	4.37	4.25	
Total Variance								**60.83%**	

Note. Factors were extracted using principal axis factoring and an orthogonal (Varimax with Kaiser Normalization) rotation.

[a] Complex variable.

Table Q5

Factor Analysis Table for the Self-Construal Scale for the Western Group (n = 204)

	Loadings								Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	
IND 12	**.858**	-.037	.028	.003	.106	.176	.084	.001	.787
IND 8	**.640**	-.062	.025	.083	.257	.077	.090	-.020	.502
INT 10	-.002	**.557**	.049	-.125	-.024	-.035	.009	-.080	.337
INT 4	-.019	**.536**	.152	-.042	-.072	-.168	-.042	.102	.358
INT 7	-.059	**.440**	-.014	-.054	-.069	.157	-.030	.191	.267
INT 9	-.054	**.436**	.155	-.059	.168	-.038	.107	.159	.286
INT 2	.072	.022	**.652**	.013	.022	.005	.049	-.004	.433
INT 12	-.156	.197	**.609**	-.028	-.108	.056	.166	-.023	.478
INT 11	.118	.378 [a]	**.498**	.131	.008	-.146	-.066	.031	.448
INT 5	.087	.130	**.304**	-.156	.062	.197	-.046	.279	.264
IND 9	.194	-.170	**.264**	-.026	.061	.096	.238	.141	.226
IND 1	.051	-.119	-.047	**.583**	.165	.091	.104	-.090	.413
IND 4	-.172	-.176	.042	**.552**	.127	-.029	.249	.189	.482
IND 11	.168	-.014	.073	**.370**	.019	.035	.349 [a]	-.111	.306
INT 1	-.080	.228	.225	**-.229**	-.061	-.133	.065	-.008	.187
IND 3	.128	-.042	-.045	.199	**.641**	-.030	.061	-.037	.477
IND 5	.181	-.098	-.122	.196	**.581**	.252	.028	.058	.500
IND 2	.129	.111	.171	-.050	**.380**	.242	-.006	-.107	.275
IND 7	.262	.021	.020	.489 [a]	.126	**.550**	-.113	.015	.640
IND 6	.113	-.127	.001	.063	.131	**.532**	.070	-.076	.343
INT 3	.035	.177	.046	.061	-.052	-.121	**.525**	.006	.332
IND 10	.052	-.116	.065	.133	.125	.145	**.483**	-.038	.310
INT 8	.008	.072	.098	.085	-.143	-.003	-.067	**.505**	.303
INT 6	-.019	.063	-.056	-.047	.046	-.067	.025	**.375**	.158
Eigenvalue	3.37	2.59	1.72	1.45	1.35	1.23	1.12	1.08	
% of Total Variance	14.06	10.79	7.16	6.02	5.62	5.13	4.67	4.50	
Total Variance								**57.94%**	

Note. Factors were extracted using principal axis factoring and an orthogonal (Varimax with Kaiser Normalization) rotation.

[a] Complex variable.

Table Q6

Factor Analysis Table for the Self-Construal Scale for the Asian Group (n = 140)

	Loadings								Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	
INT 7	**.647**	.036	-.099	.033	-.059	.035	.070	-.051	.443
INT 9	**.614**	.164	.099	.096	.191	-.051	.009	.038	.464
INT 12	**.595**	.014	.165	.379 [a]	.077	-.034	-.071	-.108	.549
INT 10	**.564**	-.073	-.086	.055	.182	-.026	-.013	-.027	.368
INT 4	**.493**	.000	-.141	.248	.031	.207	.170	-.113	.409
INT 6	**.435**	.183	.022	-.022	.368 [a]	.063	.029	.207	.406
IND 8	.156	**.717**	.027	.123	-.028	-.063	.195	.137	.616
IND 12	.270	**.693**	.115	-.071	-.052	-.124	.175	.079	.627
IND 5	-.148	**.578**	-.042	.189	.280	.117	-.074	-.085	.499
IND 7	.065	**.501**	.064	-.143	.162	.063	.023	.178	.342
IND 3	-.129	**.490**	.051	.065	-.003	.224	-.017	-.064	.318
IND 10	-.083	.089	**.650**	.052	.066	-.137	.049	.076	.471
IND 11	-.142	.048	**.587**	.007	.015	.247	.052	.068	.436
INT 3	.210	-.076	**.488**	.213	.018	.184	.026	-.344 [a]	.487
IND 1	-.041	.022	**.455**	.033	.361 [a]	.192	-.075	.098	.392
IND 4	.154	.150	**.395**	.170	-.015	.352 [a]	.125	-.014	.371
INT 11	.308 [a]	.049	.137	**.714**	.017	.032	.042	.006	.629
INT 2	.089	.145	.220	.382 [a]	**.433**	.278	.031	.102	.499
INT 5	.157	-.079	.103	.259	**.408**	-.058	.380 [a]	-.115	.436
INT 8	.210	.095	.038	-.035	**.397**	-.022	-.041	-.005	.215
IND 6	.009	.055	.121	.011	.041	**.562**	.021	.029	.336
IND 2	.019	.183	.059	-.004	-.040	.065	**.626**	.015	.436
INT 1	.321	-.050	-.073	.068	-.003	-.003	.045	**-.439**	.310
IND 9	.232	.189	.095	.259	.074	.122	.058	**.397**	.347
Eigenvalue	4.22	2.67	2.16	1.38	1.21	1.11	1.10	1.07	
% of Total Variance	17.57	11.11	9.00	5.74	5.03	4.63	4.59	4.47	
Total Variance								**62.14%**	

Note. Factors were extracted using principal axis factoring and an orthogonal (Varimax with Kaiser Normalization) rotation.

[a] Complex variable.

Appendix R

Factor Analysis Tables for the AHS

Table R1

Pattern Matrix for the AHS for all Participants (N = 351)

		Loadings						
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Communality
ATTENTION2	It is more important to pay attention to the whole than its parts.	**.728**	-.072	-.089	.083	.067	-.014	.564
ATTENTION4	It is more important to pay attention to the whole context rather than the details.	**.701**	-.064	-.059	-.017	-.026	.036	.477
ATTENTION1	The whole, rather than its parts, should be considered in order to understand a phenomenon.	**.683**	.068	-.003	.048	-.034	.040	.446
ATTENTION3	The whole is greater than the sum of its parts.	**.608**	.066	-.008	.060	.045	-.161	.468
ATTENTION5	It is not possible to understand the parts without considering the whole picture.	**.372**	.181	.021	-.166	.093	.043	.258
CONTRADICTION5	Choosing a middle ground in an argument should be avoided. (R)	**-.210**	.120	-.130	.122	.083	.194	.166
CAUSALITY5	Any phenomenon has numerous numbers of causes, although some of the causes are not known.	.196	**.565**	.055	-.206	.022	-.027	.487
CHANGE5	Current situations can change at any time.	.009	**.555**	-.096	.065	.015	.017	.324
CAUSALITY6	Any phenomenon entails a numerous number of consequences, although some of them may not be known.	-.008	**.533**	.000	-.244	.005	-.094	.418
CAUSALITY4	Even a small change in any element of the universe can lead to significant alterations in other elements.	.045	**.467**	-.133	-.219	-.030	-.009	.373
ATTENTION6	We should consider the situation a person is faced with, as well as his/her personality, in order to understand one's behaviour.	-.026	**.461**	-.165	-.052	-.050	.078	.294
CONTRADICTION3	It is more important to find a point of compromise than to debate who is right/wrong, when one's opinions conflict with other's opinions.	.080	.111	**-.677**	.032	.054	-.063	.544
CONTRADICTION2	When disagreement exists among people, they should search for ways to compromise and embrace everyone's opinions.	.095	.074	**-.615**	.046	.029	.022	.422
CONTRADICTION4	It is desirable to be in harmony, rather than in discord, with others of different opinions than one's own.	-.030	-.009	**-.488**	-.113	.082	.004	.295
CAUSALITY3	Everything in the world is intertwined in a causal relationship.	-.046	.158	-.124	**-.605**	-.001	-.127	.517
CAUSALITY1	Everything in the universe is somehow related to each other.	-.115	.176	-.058	**-.587**	-.032	-.026	.436
CAUSALITY2	Nothing is unrelated.	.060	-.050	.047	**-.576**	.081	.080	.324
CONTRADICTION6	We should avoid going to extremes.	.032	-.016	.064	-.058	**.809**	.006	.644
CONTRADICTION1	It is more desirable to take the middle ground than go to extremes.	-.036	-.053	-.148	.027	**.658**	-.054	.521
CHANGE1	Every phenomenon in the world moves in predictable directions. (R)	-.021	-.020	-.020	.025	-.022	**.640**	.426
CHANGE4	If an event is moving toward a certain direction, it will continue to move toward that direction. (R)	-.074	.144	.114	-.108	-.065	**.551**	.404
CHANGE3	An individual who is currently honest will stay honest in the future. (R)	.008	.222	.179	.097	.030	**.536**	.418
CHANGE6	Future events are predictable based on present situations. (R)	-.017	-.228	-.113	-.037	-.057	**.514**	.280
CHANGE2	A person who is currently living a successful life will continue to stay successful. (R)	-.065	.360	.095	.215	-.020	**.361**	.371
	Initial Eigenvalue	4.12	3.05	1.95	1.85	1.19	1.12	
	% of Total Variance	17.15	12.71	8.11	7.70	4.96	4.66	
	Total Variance						**55.29%**	

Note. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation.

[a] Complex variable.

Table R2

Structure Matrix for the AHS for all Participants (N = 351)

		Loadings						Communality
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	
ATTENTION2	It is more important to pay attention to the whole than its parts.	**.733**	-.026	-.141	-.037	.230	-.259	.564
ATTENTION4	It is more important to pay attention to the whole context rather than the details.	**.686**	.006	-.088	-.110	.124	-.206	.477
ATTENTION3	The whole is greater than the sum of its parts.	**.665**	.070	-.077	-.098	.188	-.343	.468
ATTENTION1	The whole, rather than its parts, should be considered in order to understand a phenomenon.	**.660**	.110	-.043	-.071	.093	-.156	.446
ATTENTION5	It is not possible to understand the parts without considering the whole picture.	**.415**	.262	-.087	-.275	.179	-.098	.258
CAUSALITY5	Any phenomenon has numerous numbers of causes, although some of the causes are not known.	.280	**.624**	-.091	-.397	.096	-.042	.487
CAUSALITY6	Any phenomenon entails a numerous number of consequences, although some of them may not be known.	.102	**.585**	-.128	-.413	.071	-.056	.418
CHANGE5	Current situations can change at any time.	.043	**.558**	-.187	-.102	.069	.115	.324
CAUSALITY4	Even a small change in any element of the universe can lead to significant alterations in other elements.	.121	**.551**	-.234	-.373	.073	.005	.373
ATTENTION6	We should consider the situation a person is faced with, as well as his/her personality, in order to understand one's behaviour.	-.008	**.512**	-.228	-.176	.019	.152	.294
CONTRADICTION3	It is more important to find a point of compromise than to debate who is right/wrong, when one's opinions conflict with other's opinions.	.161	.216	**-.719**	-.118	.315	-.102	.544
CONTRADICTION2	When disagreement exists among people, they should search for ways to compromise and embrace everyone's opinions.	.134	.179	**-.637**	-.067	.255	-.019	.422
CONTRADICTION4	It is desirable to be in harmony, rather than in discord, with others of different opinions than one's own.	.037	.109	**-.527**	-.176	.254	-.047	.295
CAUSALITY3	Everything in the world is intertwined in a causal relationship.	.114	.324	-.230	**-.685**	.123	-.223	.517
CAUSALITY1	Everything in the universe is somehow related to each other.	-.001	.336	-.146	**-.627**	.039	-.085	.436
CAUSALITY2	Nothing is unrelated.	.137	.126	-.047	**-.557**	.121	-.083	.324
CONTRADICTION6	We should avoid going to extremes.	.192	.035	-.221	-.134	**.798**	-.139	.644
CONTRADICTION1	It is more desirable to take the middle ground than go to extremes.	.113	-.012	-.363	-.051	**.705**	-.152	.521
CHANGE1	Every phenomenon in the world moves in predictable directions. (R)	-.238	.081	.025	.172	-.119	**.651**	.426
CHANGE3	An individual who is currently honest will stay honest in the future. (R)	-.173	.256	.168	.170	-.110	**.595**	.418
CHANGE4	If an event is moving toward a certain direction, it will continue to move toward that direction. (R)	-.246	.238	.128	.005	-.184	**.591**	.404
CHANGE2	A person who is currently living a successful life will continue to stay successful. (R)	-.203	.337	.089	.217	-.124	**.496**	.371
CHANGE6	Future events are predictable based on present situations. (R)	-.198	-.117	-.034	.133	-.107	**.477**	.280
CONTRADICTION5	Choosing a middle ground in an argument should be avoided. (R)	-.259	.130	-.140	.140	.052	**.291**	.166
	Initial Eigenvalue	4.12	3.05	1.95	1.85	1.19	1.12	
	% of Total Variance	17.15	12.71	8.11	7.70	4.96	4.66	
	Total Variance						**55.29%**	

Note. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation.

Table R3

Pattern Matrix for the AHS for the Individualistic Group (N = 177)

	Loadings						Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	
CAUSALITY6	**.698**	-.168	-.118	-.081	.226	.073	.622
CAUSALITY5	**.626**	-.019	.200	.011	.152	-.058	.507
ATTENTION6	**.294**	.177	-.009	-.290	.050	-.030	.283
CHANGE2	-.038	**.822**	-.046	-.012	-.008	.040	.685
CHANGE3	-.104	**.722**	.081	.068	.074	-.002	.450
CHANGE4	.365 [a]	**.382**	-.164	.069	-.122	-.038	.414
CHANGE5	.218	**.351**	.131	-.311	.147	-.047	.400
ATTENTION1	-.014	.087	**.765**	.001	-.020	-.074	.549
ATTENTION4	.137	.058	**.675**	.065	.000	.077	.478
ATTENTION3	-.045	-.043	**.649**	-.082	-.029	.044	.451
ATTENTION2	-.161	-.005	**.636**	-.054	-.096	.121	.462
ATTENTION5	.313	-.084	**.408**	-.028	.002	.052	.293
CONTRADICTION5	.068	.131	**-.202**	-.121	-.184	.184	.182
CONTRADICTION2	-.042	-.016	.044	**-.758**	-.080	-.087	.520
CONTRADICTION3	-.013	-.152	.051	**-.578**	.022	.144	.421
CONTRADICTION4	-.009	-.001	-.068	**-.455**	.054	.181	.301
CAUSALITY3	-.074	.039	-.110	-.075	**.823**	.010	.644
CAUSALITY1	.130	.078	-.133	.016	**.770**	-.014	.634
CAUSALITY2	.137	.004	.018	.089	**.496**	.051	.295
CHANGE1	.361	.252	-.130	.043	**-.396**	.003	.405
CAUSALITY4	.124	.188	.037	-.237	**.393**	.009	.328
CHANGE6	-.031	.220	-.138	-.067	**-.265**	-.016	.187
CONTRADICTION1	-.001	-.016	.040	.000	.030	**.793**	.642
CONTRADICTION6	-.023	.029	.078	-.001	.026	**.648**	.438
Eigenvalue	3.67	3.24	2.39	1.92	1.28	1.18	
% of Total Variance	15.30	13.50	9.96	8.01	5.32	4.92	
Total Variance						**57.01%**	

Note. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation.

[a] Complex variable.

Table R4

Structure Matrix for the AHS for the Individualistic Group (N = 177)

	Loadings						Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	
CAUSALITY6	**.723**	.020	-.016	-.226	.405	.118	.622
CAUSALITY5	**.656**	.077	.234	-.106	.337	-.015	.507
ATTENTION6	**.405**	.300	-.026	-.370	.124	.074	.283
CHANGE2	.178	**.825**	-.230	-.158	-.144	.005	.685
CHANGE3	.091	**.654**	-.076	-.048	-.050	-.047	.450
CHANGE4	.419	**.523**	-.274	-.031	-.127	-.086	.414
CHANGE1	.323	**.427**	-.252	-.020	-.374	-.028	.405
CONTRADICTION5	.084	**.236**	-.235	-.192	-.208	.198	.182
ATTENTION1	.015	-.085	**.732**	-.018	.097	.017	.549
ATTENTION4	.155	-.074	**.671**	-.028	.136	.140	.478
ATTENTION3	-.035	-.185	**.662**	-.108	.089	.153	.451
ATTENTION2	-.160	-.173	**.635**	-.085	-.016	.214	.462
ATTENTION5	.306	-.092	**.440**	-.108	.163	.126	.293
CONTRADICTION2	.073	.109	.056	**-.710**	.000	.183	.520
CONTRADICTION3	.065	-.076	.133	**-.605**	.112	.358	.421
CONTRADICTION4	.093	.075	-.015	**-.519**	.090	.331	.301
CHANGE5	.403	.413	.088	**-.417**	.204	.072	.400
CAUSALITY3	.144	-.063	.029	-.155	**.789**	.023	.644
CAUSALITY1	.328	.029	-.017	-.093	**.764**	-.031	.634
CAUSALITY2	.242	-.053	.108	-.009	**.522**	.029	.295
CAUSALITY4	.312	.196	.077	-.340	**.427**	.095	.328
CHANGE6	-.027	.294	-.234	-.059	**-.322**	-.020	.187
CONTRADICTION1	.029	-.061	.148	-.280	.043	**.799**	.642
CONTRADICTION6	.014	-.023	.156	-.236	.033	**.657**	.438
Eigenvalue	3.67	3.24	2.39	1.92	1.28	1.18	
% of Total Variance	15.30	13.50	9.96	8.01	5.32	4.92	
Total Variance						**57.01%**	

Note. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation.

Table R5

Pattern Matrix for the AHS for the Collectivistic Group (N = 162)

	Loadings								Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	
ATTENTION2	**.935**	-.163	.066	.045	-.090	.016	.108	.152	.873
ATTENTION4	**.668**	-.074	-.028	-.079	-.109	-.084	-.060	-.023	.533
ATTENTION3	**.599**	.128	.036	-.237	.131	-.009	.137	-.042	.545
ATTENTION1	**.539**	.304 [a]	-.002	.080	-.075	.010	-.167	-.119	.458
CAUSALITY5	.081	**.728**	.085	-.027	-.026	-.085	.042	.045	.653
CAUSALITY6	.001	**.688**	-.008	-.113	-.046	.033	.067	-.009	.489
ATTENTION6	-.137	**.449**	-.076	.048	-.119	-.148	.020	.168	.371
CAUSALITY4	.043	**.435**	-.070	.076	-.106	-.168	.032	.233	.435
CONTRADICTION6	.050	.020	**.802**	.067	.095	-.125	.026	-.061	.659
CONTRADICTION1	-.097	-.054	**.728**	-.048	-.169	.083	-.021	.063	.596
CHANGE1	-.028	-.155	-.082	**.743**	-.135	-.104	-.083	.031	.583
CHANGE3	-.052	.133	.072	**.670**	.266	.046	-.036	.008	.582
CHANGE4	-.036	.006	-.101	**.484**	.151	.144	.225	.019	.419
CHANGE6	-.073	-.012	-.056	**.469**	-.214	-.019	-.015	-.410 [a]	.440
CONTRADICTION5	-.211	.017	-.006	**.281**	-.066	.021	.109	.160	.219
CHANGE2	-.036	.251	-.043	**.252**	.224	.199	.046	.028	.273
CONTRADICTION3	.141	.098	.100	.101	**-.713**	.133	.107	.153	.661
CONTRADICTION2	.100	.131	.164	.006	**-.503**	.012	-.019	.015	.377
CONTRADICTION4	-.040	.039	.020	-.093	**-.457**	-.134	.125	-.148	.327
CAUSALITY2	-.088	.026	.061	-.006	.029	**-.716**	.033	-.087	.509
ATTENTION5	.261	.101	.029	.095	.086	**-.519**	-.020	.127	.427
CAUSALITY3	.028	.114	.014	-.083	-.249	**-.302**	.203	.262	.450
CAUSALITY1	.057	.038	.011	.004	-.077	-.034	**.927**	-.082	.889
CHANGE5	-.015	.137	-.006	.041	-.042	.011	-.030	**.662**	.516
Eigenvalue	4.58	3.07	1.97	1.56	1.32	1.27	1.05	1.02	
% of Total Variance	19.07	12.78	8.23	6.50	5.48	5.29	4.37	4.25	
Total Variance								**65.98%**	

Note. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation.

[a] Complex variable.

Table R6

Structure Matrix for the AHS for the Collectivistic Group (N = 162)

	Loadings								Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	
ATTENTION2	**.903**	.100	.266	-.256	-.207	-.172	.038	.126	.873
ATTENTION4	**.704**	.050	.157	-.299	-.184	-.223	-.116	-.048	.533
ATTENTION3	**.675**	.216	.179	-.398	.005	-.149	.077	.017	.545
ATTENTION1	**.592**	.346	.103	-.056	-.130	-.133	-.154	-.041	.458
CAUSALITY5	.257	**.784**	.140	.004	-.175	-.264	.210	.303	.653
CAUSALITY6	.155	**.686**	.034	-.030	-.134	-.125	.215	.226	.489
CAUSALITY4	.128	**.578**	-.011	.106	-.202	-.284	.193	.401	.435
ATTENTION6	-.043	**.529**	-.049	.134	-.187	-.235	.188	.335	.371
CONTRADICTION6	.203	.048	**.796**	-.121	-.134	-.226	.029	-.021	.659
CONTRADICTION1	.058	-.044	**.745**	-.169	-.300	-.062	.027	.057	.596
CHANGE1	-.251	-.051	-.194	**.727**	-.072	.011	-.057	-.001	.583
CHANGE3	-.244	.155	-.142	**.704**	.292	.188	-.026	.055	.582
CHANGE4	-.259	.062	-.258	**.551**	.204	.259	.211	.057	.419
CHANGE6	-.198	-.084	-.124	**.474**	-.156	.045	-.032	-.395	.440
CONTRADICTION5	-.297	.089	-.086	**.354**	-.047	.058	.178	.193	.219
CHANGE2	-.137	.228	-.179	**.341**	.268	.258	.064	.102	.273
CONTRADICTION3	.195	.271	.261	.041	**-.745**	-.129	.262	.225	.661
CONTRADICTION2	.210	.212	.300	-.066	**-.561**	-.194	.093	.076	.377
CONTRADICTION4	.063	.079	.159	-.123	**-.520**	-.273	.194	-.088	.327
CAUSALITY2	.054	.117	.150	-.090	-.180	**-.702**	.072	-.015	.509
ATTENTION5	.345	.285	.128	-.041	-.101	**-.562**	.023	.200	.427
CAUSALITY3	.143	.325	.155	-.122	-.400	**-.445**	.330	.366	.450
CAUSALITY1	.000	.236	.066	.008	-.254	-.125	**.932**	.100	.889
CHANGE5	.006	.354	.008	.082	-.068	-.067	.126	**.704**	.516
Eigenvalue	4.58	3.07	1.97	1.56	1.32	1.27	1.05	1.02	
% of Total Variance	19.07	12.78	8.23	6.50	5.48	5.29	4.37	4.25	
Total Variance								**65.98%**	

Notes. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation.

Table R7

Pattern Matrix for the AHS for the Western Group (N = 199)

	Loadings							Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	
ATTENTION 1	**.983**	.118	.009	-.043	-.112	.044	-.057	.909
ATTENTION 4	**.565**	-.217	-.086	.088	.002	-.018	.095	.450
ATTENTION 3	-.043	**-.761**	-.058	.032	.080	-.033	.062	.572
ATTENTION 2	.074	**-.701**	.057	-.057	.047	.074	-.015	.484
ATTENTION 5	-.077	**-.652**	.166	-.099	.018	-.033	-.182	.498
CAUSALITY 1	-.028	**-.626**	.040	-.016	-.055	-.093	-.103	.442
CAUSALITY 3	.161	**-.411**	-.094	-.032	-.061	-.008	.177	.265
CAUSALITY 2	.072	.149	**-.672**	-.032	.040	-.061	-.289	.614
CAUSALITY 4	.167	.130	**-.648**	.012	.081	.047	-.173	.569
CAUSALITY 6	-.041	-.063	**-.623**	-.058	-.109	.034	.164	.393
CAUSALITY 5	.120	-.007	**-.387**	-.026	.159	-.248	-.040	.336
CHANGE 4	-.048	-.068	-.115	**-.963**	-.041	.093	.069	.876
ATTENTION 6	-.020	-.074	-.028	**-.506**	-.017	-.081	-.023	.303
CHANGE 3	.084	.186	.145	**-.216**	.118	-.054	.066	.163
CHANGE 2	.031	.016	.107	.049	**.857**	.030	-.057	.730
CHANGE 5	-.125	-.058	-.056	-.018	**.685**	.078	.057	.446
CONTRADICTION 2	.223	-.097	-.125	.009	**.293**	-.268	.060	.349
CONTRADICTION 3	.208	-.030	-.110	.006	**.226**	-.222	.113	.265
CONTRADICTION 4	-.095	-.037	-.023	.068	-.076	**-.794**	.123	.569
CONTRADICTION 1	.083	-.043	.034	-.189	-.115	**-.506**	-.110	.402
CONTRADICTION 6	.051	.044	.032	-.159	.051	**-.386**	-.152	.260
CONTRADICTION 5	.035	.082	.157	-.043	.061	-.029	**.617**	.480
CHANGE 6	.170	.130	-.039	.017	.307 [a]	.079	**.417**	.443
CHANGE 1	-.091	.158	.177	-.013	.155	-.129	**.194**	.196
Eigenvalue	3.53	3.16	2.35	1.94	1.23	1.16	1.00	
% of Total Variance	14.70	13.17	9.80	8.07	5.13	4.85	4.18	
Total Variance							**59.89%**	

Notes. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation. Subscript a represents complex variables.

Table R8

Structure Matrix for the AHS for the Western Group (N = 199)

	Loadings							Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	
CAUSALITY6	**.938**	.037	-.367	-.114	.082	-.186	.031	.909
CAUSALITY5	**.618**	-.248	-.333	.021	.095	-.146	.140	.450
CHANGE5	**.407**	-.079	-.223	-.113	.379	-.386	.152	.572
ATTENTION6	**.365**	-.016	-.186	-.090	.332	-.321	.190	.484
ATTENTION1	.050	**-.746**	-.144	-.025	-.063	-.077	.019	.498
ATTENTION4	.085	**-.687**	-.067	-.092	-.096	-.014	-.041	.442
ATTENTION3	-.008	**-.644**	-.057	-.096	-.201	-.119	-.166	.265
ATTENTION2	-.107	**-.643**	.084	-.167	-.170	-.084	-.220	.614
ATTENTION5	.234	**-.435**	-.196	-.063	-.062	-.079	.134	.569
CAUSALITY3	.320	.028	**-.714**	-.039	-.015	-.125	-.340	.393
CAUSALITY1	.397	.035	**-.711**	.038	.056	-.032	-.197	.336
CAUSALITY2	.202	-.163	**-.596**	-.005	-.109	.006	.044	.876
CAUSALITY4	.363	-.057	**-.446**	-.115	.201	-.337	-.027	.303
CONTRADICTION1	.071	-.147	-.051	**-.920**	-.038	-.241	-.024	.163
CONTRADICTION6	.058	-.123	-.016	**-.538**	-.015	-.259	-.069	.730
CONTRADICTION5	.082	.213	.158	**-.236**	.214	-.154	.129	.446
CHANGE2	.138	.206	.122	.026	**.846**	-.112	.220	.349
CHANGE3	.024	.089	.022	.004	**.649**	-.031	.235	.265
CONTRADICTION2	.105	-.087	-.024	-.197	.079	**-.735**	.087	.569
CONTRADICTION3	.180	-.120	-.041	-.385	-.041	**-.573**	-.146	.402
CONTRADICTION4	.139	.009	-.012	-.310	.102	**-.461**	-.134	.260
CHANGE1	.064	.157	.232	-.023	.282	-.050	**.662**	.480
CHANGE4	.265	.215	-.022	.056	.476	-.007	**.535**	.443
CHANGE6	-.083	.226	.258	-.040	.258	-.120	**.262**	.196
Eigenvalue	3.53	3.16	2.35	1.94	1.23	1.16	1.00	
% of Total Variance	14.70	13.17	9.80	8.07	5.13	4.85	4.18	
Total Variance							**59.89%**	

Notes. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation.

Table R9

Pattern Matrix for the AHS for the Asian Group (N = 134)

	Loadings							Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	
ATTENTION2	**.750**	-.074	.222	-.153	.130	-.087	-.040	.750
ATTENTION1	**.715**	.127	-.006	.095	-.044	.017	.128	.502
ATTENTION4	**.642**	-.158	.081	.035	-.011	.103	-.047	.527
ATTENTION3	**.490**	-.322 [a]	-.021	-.003	.036	-.059	.240	.489
CHANGE1	-.019	**.753**	.055	.036	-.098	.122	-.133	.598
CHANGE3	.019	**.739**	-.200	-.132	.050	-.101	-.005	.625
CHANGE6	.038	**.501**	.161	.457	-.088	.052	-.038	.475
CHANGE4	-.178	**.399**	.040	.039	-.139	-.235	.134	.389
CONTRADICTION5	-.192	**.359**	.085	-.038	.013	.017	.087	.219
CHANGE2	.004	**.310**	-.146	-.119	.022	-.269	.199	.280
CONTRADICTION3	.125	.081	**.803**	-.160	.032	-.092	-.016	.683
CONTRADICTION2	.145	.002	**.567**	-.069	.146	-.026	-.025	.403
CONTRADICTION4	-.021	-.053	**.528**	.145	.021	.169	.031	.383
CAUSALITY1	-.128	-.038	**.415**	.047	.007	.009	.335 [a]	.337
CHANGE5	-.052	.052	.072	**-.650**	-.020	.008	.047	.462
CAUSALITY4	.121	.139	.142	**-.434**	-.093	.153	.231	.477
CONTRADICTION6	.064	.106	-.066	.051	**.874**	.104	.076	.770
CONTRADICTION1	-.118	-.062	.190	-.005	**.685**	-.015	-.052	.550
CAUSALITY2	-.096	-.006	-.014	.082	.124	**.628**	.105	.440
ATTENTION5	.293	.083	-.058	-.223	.066	**.559**	.031	.521
CAUSALITY3	.000	-.059	.299	-.266	-.032	**.403**	.094	.482
CAUSALITY5	.117	.026	-.055	-.105	.049	.158	**.767**	.752
CAUSALITY6	.115	-.070	.043	-.013	.000	-.019	**.671**	.498
ATTENTION6	-.108	.048	.123	-.264	-.125	.214	**.339**	.391
Eigenvalue	4.80	3.11	2.07	1.58	1.37	1.29	1.08	1.02
% of Total Variance	20.01	12.96	8.63	6.58	5.71	5.37	4.48	4.25
Total Variance								**63.74%**

Note. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation. Subscript a represents complex variables.

Table R10

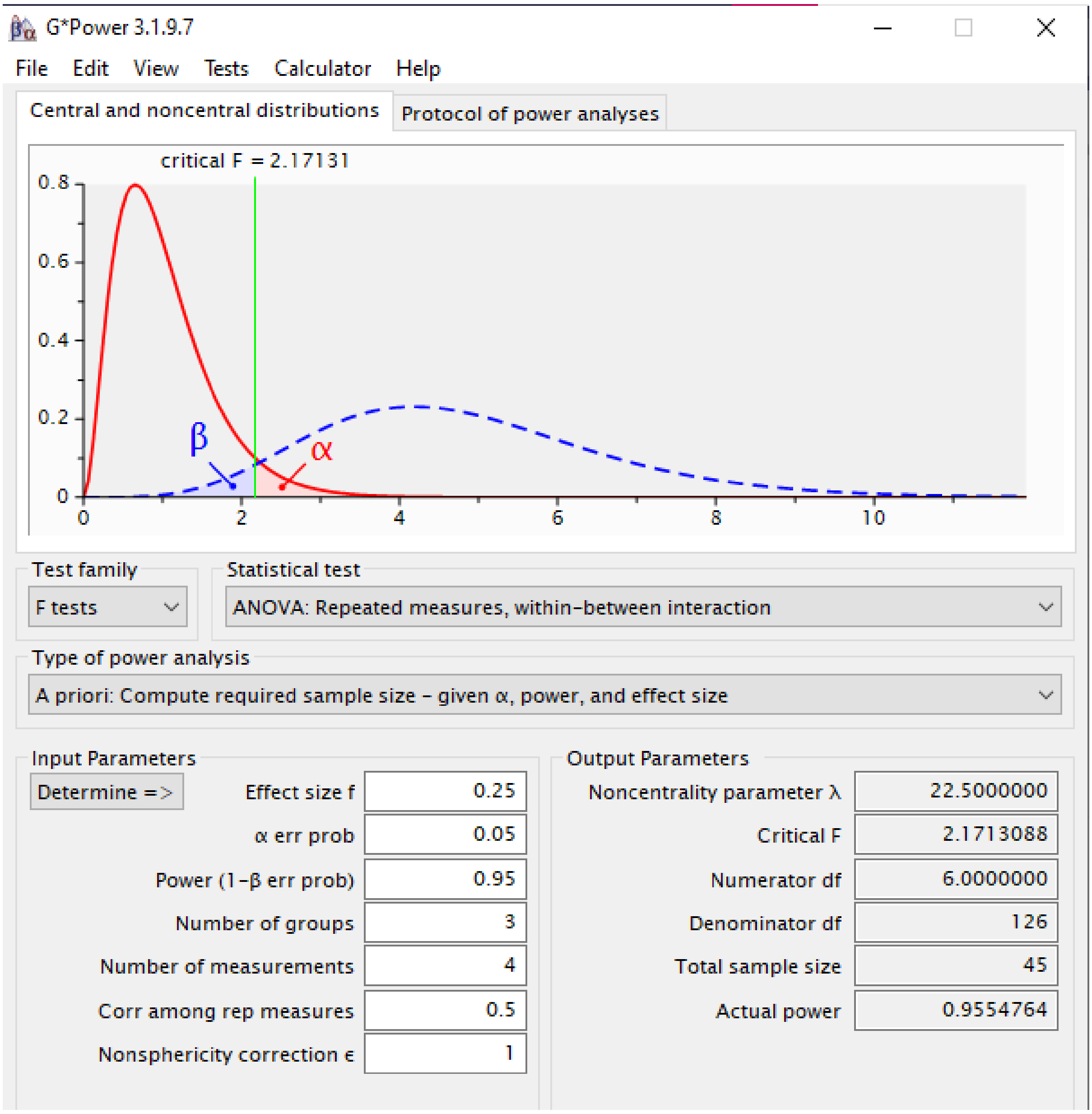
Structure Matrix for the AHS for the Asian Group (N = 134)

	Loadings							Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	
ATTENTION2	**.809**	-.298	.274	-.241	.294	.105	.130	.750
ATTENTION4	**.690**	-.346	.147	-.038	.154	.210	.032	.527
ATTENTION1	**.680**	-.039	.060	-.042	.034	.088	.193	.502
ATTENTION3	**.599**	-.422	.068	-.139	.167	.078	.246	.489
CHANGE1	-.233	**.747**	.016	.060	-.243	.001	-.027	.598
CHANGE3	-.176	**.744**	-.237	-.125	-.156	-.234	.068	.625
CHANGE4	-.318	**.520**	-.050	.027	-.292	-.298	.119	.389
CHANGE6	-.149	**.485**	.105	.442	-.179	-.022	-.098	.475
CONTRADICTION5	-.261	**.412**	.090	-.063	-.084	-.006	.142	.219
CHANGE2	-.078	**.369**	-.179	-.164	-.113	-.305	.201	.280
CONTRADICTION3	.172	.027	**.795**	-.225	.153	.173	.237	.683
CONTRADICTION2	.210	-.086	**.591**	-.124	.257	.186	.140	.403
CONTRADICTION4	.039	-.091	**.579**	.080	.132	.327	.117	.383
CAUSALITY1	-.053	.016	**.485**	-.095	.051	.175	.395	.337
CHANGE5	.022	.085	.127	**-.668**	-.004	.084	.308	.462
CAUSALITY4	.177	.140	.264	**-.560**	-.050	.257	.484	.477
CONTRADICTION6	.185	-.113	.118	-.025	**.861**	.216	.052	.770
CONTRADICTION1	.013	-.197	.275	-.009	**.710**	.131	-.050	.550
CAUSALITY2	.000	-.079	.206	-.009	.196	**.641**	.158	.440
ATTENTION5	.374	-.070	.163	-.324	.175	**.601**	.234	.521
CAUSALITY3	.122	-.097	.459	-.361	.096	**.537**	.322	.482
CAUSALITY5	.235	.057	.193	-.419	.058	.294	**.834**	.752
CAUSALITY6	.214	-.021	.204	-.278	.019	.127	**.688**	.498
ATTENTION6	-.035	.118	.258	-.403	-.101	.294	**.497**	.391
Eigenvalue	4.80	3.11	2.07	1.58	1.37	1.29	1.08	1.02
% of Total Variance	20.01	12.96	8.63	6.58	5.71	5.37	4.48	4.25
Total Variance								**63.74%**

Note. Factors were extracted using principal axis factoring and an oblique (Oblimin) rotation.

Appendix S

Effect Size Calculation using G*Power (Chapter 4)



Appendix T

Chapter 4 Supplementary Tables

Table T1

Self-Construals (Singelis, 1994) of Participants According to Priming Conditions

Self-Construal Categories	*n*	Percentage (%)
Independence Priming		
Independence	7	35.0
Interdependence	12	60.0
Uncategorised	1	5.0
Interdependence Priming		
Independence	12	60.0
Interdependence	8	40.0
Control Group		
Independence	9	45.0
Interdependence	11	55.0

Note. Participants were equally likely to hold independent or interdependent self-construal based on the SCS. 'Uncategorised' refers to participants with equal scores on both subscales and could not be categorised with either independent or interdependent self-construals.

Table T2

Cultural Orientation (Triandis & Gelfand, 1998) of Participants According to Priming Conditions

Cultural Orientation Categories	*n*	Percentage (%)
Independence Priming		
Individualism	3	15.0
Collectivism	17	85.0
Interdependence Priming		
Individualism	5	25.0
Collectivism	13	65.0
Uncategorised	2	10.0
Control Group		
Individualism	3	15.0
Collectivism	17	85.0

Note. Separate scores were calculated for an individualism (sum of HI and VI) and collectivism (sum of HC and VC) dimension. The aggregated scoring procedure reduced the number of uncategorised participants from 13.3% (*n* = 8) to 3.3% (*n* = 2). However, participants were equally likely to hold individualistic or collectivistic orientations regardless of the priming manipulation. 'Uncategorised' refers to participants with equal scores on both subscales and could not be categorised with either individualistic or collectivistic cultural orientations.

Table T3

Mean, Standard Deviation and 95% Confidence Interval of Response Accuracy of Experimental and Control Groups Across Four Runs

Run	*M*	*SD*	95% Confidence Interval	
			Lower	Upper
Independence Priming				
1	59.90	11.93	53.54	66.27
2	65.25	13.66	58.61	71.89
3	67.40	16.99	60.12	74.68
4	69.50	17.72	62.14	76.86
Interdependence Priming				
1	63.45	10.98	57.09	69.82
2	71.20	15.59	64.56	77.84
3	73.75	17.03	66.47	81.03
4	78.45	15.23	71.09	85.81
Control Group				
1	58.65	18.53	52.29	65.02
2	66.30	15.19	59.66	72.94
3	69.20	14.65	61.92	76.48
4	71.60	16.27	64.24	78.96

Note. No significant differences in response accuracy were observed between the experimental and control groups.

Table T4

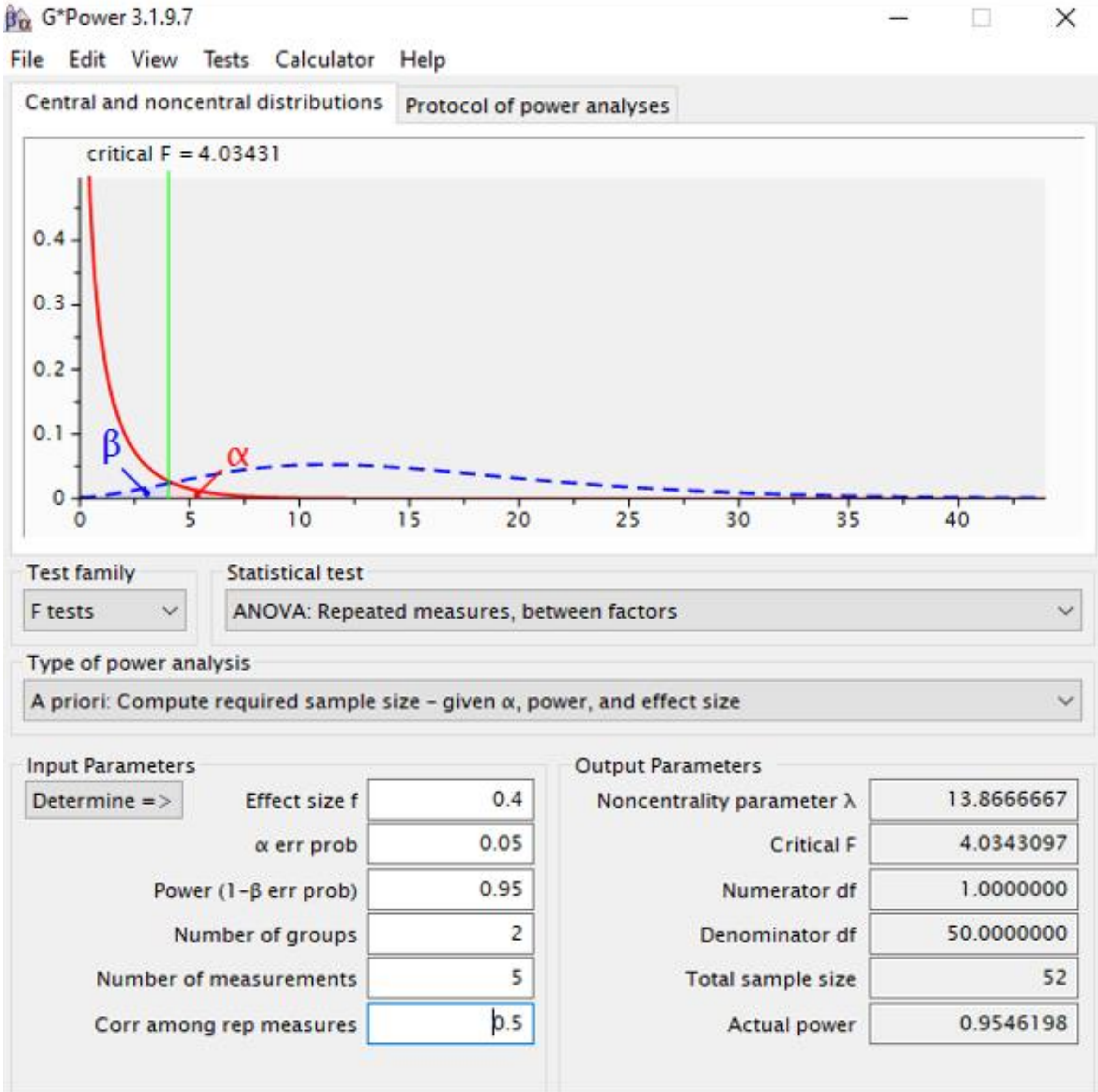
Mean, Standard Deviation and 95% Confidence Interval of RTs (Correct Responses) of Experimental and Control Groups Across Four Runs

Run	*M*	*SD*	95% Confidence Interval	
			Lower	Upper
Independence Priming				
1	.556	.178	.487	.626
2	.545	.176	.478	.611
3	.545	.180	.476	.614
4	.558	.165	.499	.618
Interdependence Priming				
1	.635	.146	.565	.704
2	.662	.127	.596	.729
3	.617	.143	.547	.686
4	.622	.115	.563	.682
Control Group				
1	.671	.141	.601	.741
2	.676	.137	.610	.742
3	.645	.137	.576	.715
4	.643	.111	.583	.702

Note. The independently-primed group had consistently faster RTs across all runs compared to the interdependently-primed and control groups.

Appendix U

Effect Size Calculation using G*Power (Chapter 5)



Appendix V

Demographics of the Collectivistic Group (Chapter 5)

ID	Nationality	Birthplace	Youth	Current Residence	Years Lived in Current Residence
2	Chinese	China	China	Sweden	2.5
46	Chinese	China	China	USA	3
64	Chinese	China	China	UK	Prefer not to say
21	Indian	India	India	USA	Prefer not to say
47	Indian	India	India	Canada	2
48	Indian	India	India	German	3.5
3	Indian	India	India	South Africa	Prefer not to say
25	Indian	India	India	USA	Prefer not to say
37	Indian	India	India	Netherlands	2.5
45	Indian	India	India	South Africa	Prefer not to say
52	Indian	India	India	Germany	1.5
56	Indian	India	India	USA	5
57	Indian	India	India	Canada	Prefer not to say
26	Indian, USA	India	India	USA	Prefer not to say
49	Korean	Korea	Korea	Canada	15
9	Korean	Korea	Korea	Korea	Not Applicable
20	Korean	Korea	Korea	Korea	Not Applicable
6	Malaysian	Malaysia	Malaysia	UK	1
8	Malaysian	Malaysia	Malaysia	Malaysia	Not Applicable
16	Malaysian	Malaysia	Malaysia	Malaysia	Not Applicable
42	Malaysian	Malaysia	Malaysia	UK	1.5
53	Malaysian	Malaysia	Malaysia	Malaysia	Not Applicable
54	Malaysian	Malaysia	Malaysia	UK	Prefer not to say
58	Malaysian	Malaysia	Malaysia	Malaysia	Not Applicable
59	Malaysian	Malaysia	Malaysia	UK	1.5
51	Taiwanese	Taiwan	Taiwan	UK	8
29	Vietnamese	Vietnam	Vietnam	UK	2
24	Vietnamese	Vietnam	Vietnam	Italy	2
27	Vietnamese	Vietnam	Vietnam	Germany	3
31	Vietnamese	Vietnam	Vietnam	Finland	6

Appendix W

Demographic Profile (Additional Questions)

In which country did you spend the majority of your youth?
____

Highest educational qualification attained:

- Less than high school degree
- High school graduate (high school diploma or equivalent including GED)
- Some college but no degree
- Foundation courses
- Bachelor's degree
- Master's degree
- Doctoral degree
- Professional degree (JD, MD)
- Prefer not to say
- Other: ___________________

What is the annual income of your household (before tax and deductions)?

- Below £10,000
- £10,001 - £20,000
- £20,001 - £30,000
- £30,001 - £40,000
- Above £40,000

Handedness

- Left
- Right
- Ambidextrous
- Prefer not to say

Do you play video games (of any sort)?

- Yes, Approximate hours per week: _____
- No
- Prefer not to say

Appendix X

Chapter 5 Supplementary Tables

Table X1

Mean, Standard Deviation, and 95% Confidence Interval of Absolute Performance Index Between Individualistic and Collectivistic Groups Across Five Runs

Run	Individualistic Group				Collectivistic Group			
	M	*SD*	95% CI		*M*	SD	95% CI	
			LL	UL			LL	UL
1	.546	.122	.504	.587	.525	.112	.483	.568
2	.591	.165	.537	.645	.567	.138	.511	.623
3	.618	.157	.563	.674	.603	.157	.545	.660
4	.660	.156	.602	.718	.618	.174	.557	.678
5	.625	.179	.562	.688	.639	.177	.574	.704

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

Table X2

Mean, Standard Deviation and 95% Confidence Interval of Relative Performance Index between Individualistic and Collectivistic Groups across Five Runs

Run	Individualistic Group				Collectivistic Group			
	M	*SD*	95% CI		*M*	SD	95% CI	
			LL	UL			LL	UL
1	.096	.123	.054	.137	.072	.108	.029	.114
2	.140	.167	.086	.195	.116	.138	.059	.172
3	.168	.156	.113	.224	.152	.156	.094	.209
4	.209	.162	.150	.269	.174	.173	.113	.235
5	.171	.174	.110	.233	.188	.175	.124	.252

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

Table X3

Mean, Standard Deviation and 95% Confidence Interval of RTs Across Five Runs for Individualistic and Collectivistic Groups

Run	Individualistic Group				Collectivistic Group			
	M	*SD*	95% CI		*M*	SD	95% CI	
			LL	UL			LL	UL
1	1.207	.192	1.144	1.271	1.193	.164	1.128	1.259
2	1.136	.177	1.071	1.202	1.107	.192	1.039	1.174
3	1.110	.215	1.038	1.182	1.077	.190	1.003	1.151
4	1.080	.217	1.008	1.152	1.053	.189	.979	1.127
5	1.054	.224	.974	1.134	1.035	.228	.952	1.117

Table X4

Mean, Standard Deviation, and 95% Confidence Interval of Absolute Performance Index Between Individuals with Independent and Interdependent Self-Construal Across Five Runs

Run	Independent Self-Construal				Interdependent Self-Construal			
	M	*SD*	95% CI		*M*	SD	95% CI	
			LL	UL			LL	UL
1	.532	.121	.490	.573	.540	.114	.497	.583
2	.552	.161	.499	.606	.608	.138	.553	.663
3	.567	.141	.514	.620	.658	.160	.603	.713
4	.603	.157	.546	.660	.679	.166	.620	.738
5	.577	.169	.517	.636	.691	.167	.629	.752

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

Table X5

Mean, Standard Deviation, and 95% Confidence Interval of Relative Performance Index Between Individuals with Independent and Interdependent Self-Construal Across Five Runs

Run	Independent Self-Construal				Interdependent Self-Construal			
	M	*SD*	95% CI		*M*	SD	95% CI	
			LL	UL			LL	UL
1	.079	.120	.038	.120	.089	.114	.047	.132
2	.101	.164	.047	.154	.158	.137	.102	.213
3	.117	.144	.064	.170	.207	.156	.152	.261
4	.155	.160	.097	.213	.232	.167	.172	.292
5	.128	.162	.070	.187	.234	.171	.173	.295

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

Table X6

Mean, Standard Deviation and 95% Confidence Interval of Reaction Times Across Five Runs for Individuals with Independent and Interdependent Self-Construal

Run	Independent Self-Construal				Interdependent Self-Construal			
	M	*SD*	95% CI		*M*	SD	95% CI	
			LL	UL			LL	UL
1	1.179	.199	1.116	1.242	1.224	.152	1.159	1.289
2	1.102	.185	1.037	1.167	1.144	.182	1.077	1.211
3	1.074	.224	1.002	1.146	1.116	.179	1.041	1.190
4	1.037	.237	.966	1.109	1.099	.156	1.025	1.172
5	1.011	.265	.932	1.090	1.081	.168	.999	1.162

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

Table X7

Mean, Standard Deviation and 95% Confidence Interval of Absolute Performance Index Across Five Runs for Individualistic and Collectivistic Cultural Orientation Across Five Runs.

Run	COS Individualism				COS Collectivism			
	M	*SD*	95% CI		*M*	SD	95% CI	
			LL	UL			LL	UL
1	.522	.103	.478	.567	.540	.124	.500	.580
2	.575	.169	.516	.633	.582	.138	.529	.635
3	.614	.153	.553	.674	.609	.160	.554	.663
4	.647	.166	.583	.711	.632	.166	.575	.690
5	.637	.182	.568	.705	.627	.176	.565	.690

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

Table X8

Mean, Standard Deviation and 95% Confidence Interval of Relative Performance Index Across Five Runs for Individualistic and Collectivistic Cultural Orientation Across Five Runs.

Run	COS Individualism				COS Collectivism			
	M	*SD*	95% CI		*M*	SD	95% CI	
			LL	UL			LL	UL
1	.069	.101	.025	.112	.090	.123	.050	.129
2	.124	.170	.065	.183	.129	.138	.076	.183
3	.157	.153	.096	.217	.163	.159	.108	.217
4	.199	.168	.134	.264	.187	.169	.129	.246
5	.185	.175	.117	.252	.175	.176	.114	.236

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

Table X9

Mean, Standard Deviation and 95% Confidence Interval of Reaction Times Across Five Runs for Individuals with Individualistic and Collectivistic Cultural Orientation

Run	COS Individualism				COS Collectivism			
	M	*SD*	95% CI		*M*	SD	95% CI	
			LL	UL			LL	UL
1	1.157	.195	1.090	1.224	1.240	.155	1.180	1.301
2	1.119	.215	1.047	1.192	1.126	.162	1.060	1.191
3	1.083	.205	1.003	1.162	1.097	.208	1.025	1.169
4	1.049	.219	.970	1.128	1.075	.195	1.003	1.147
5	1.029	.218	.940	1.117	1.052	.237	.972	1.132

Note. CI = confidence interval; LL = lower limit; UL = upper limit.

Appendix Y

Chapter 5 Supplementary Analysis on Learning Strategies

Comparison of Strategy Choice and Index for Probability Learning (Matching vs Maximisation Strategy) Between Individuals with Independent and Interdependent Self-Construal (Singelis, 1994)

The supplementary analysis presented here was conducted to identify if any differences in PI could be attributed to a specific learning strategy choice (Wang et al., 2017). Response strategies can be distinguished by a probability matching strategy, whereby the probability distributions of responses are matched to the Markov models that generated the presented sequences, or a probability maximisation strategy, whereby participants respond to only the most likely outcome for each context. The Kullback–Leibler (KL) divergence was used to compare response distributions to the matching versus maximisation strategies for the Level 1 Markov model. KL was first defined as follows, where R( ) denotes the probability distribution of participant's responses while M( ) represents the probability matching versus maximisation strategies:

$$KL = \sum_{context} \mathrm{M}(context) \sum_{target} \mathrm{M}(target|context) \times log\left(\frac{M(target|context)}{R(target)|context}\right)$$

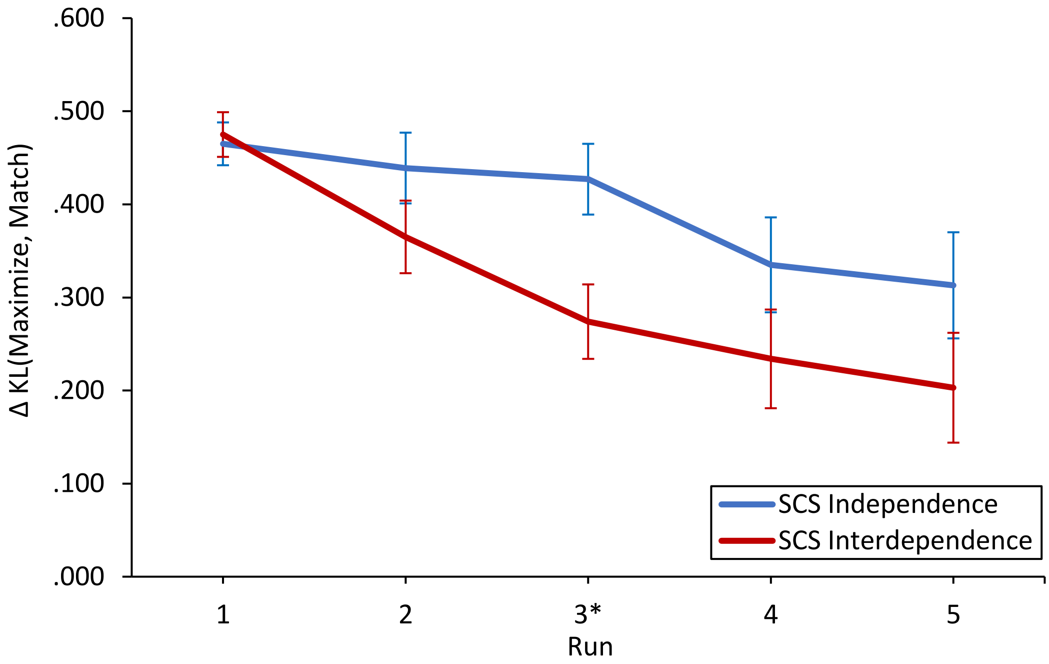
Strategy choice, ΔKL (maximisation, matching), for each run was then estimated by computing the difference between the KL divergence obtained above and the participant's response distribution. Differences in strategy choice were compared between the participant groups at each run to explain any group differences in PI. A strategy curve was plotted across all runs for each participant. An individual strategy index was subsequently estimated by calculating the integral-curve difference between the integral of the participant's strategy curve and the integral of the exact matching curve. Negative values suggest a propensity towards a probability maximisation strategy, whereas positive values indicate a propensity towards a probability matching strategy.

Taken together, to examine if the differences in PI (see Section 5.3.3) could be attributed to an underlying difference in strategy choice, a 2 (Self-Construal: Independent or Interdependent) × 5 (Run: 1, 2, 3, 4, and 5) mixed-measures ANOVA was run to compare the strategy choice between individuals with independent (n = 32) and interdependent (n = 30) self-construal across five runs. All participants exhibited changes in strategy choice as the experiment progressed from the first to the last run, $F(2.80, 167.90) = 18.24$, $p < .001$, $\eta^2_p = .233$ (Greenhouse-Geisser Corrected). However, there were no significant interactions between self-construals and strategy index across the five runs

(p = .091). Based on Figure X1, additional t-tests were conducted to identify differences in strategy choice at each run. Indeed, there was a brief divergence in strategy choice in Run 3, $t(60) = 2.76$, $p = .008$, $d = .698$. However, this effect subsequently disappeared in the final two runs.

Figure Y1

Strategy Curve for Probability Learning (Matching vs Maximisation) between Individuals with Independent and Interdependent Self-Construal

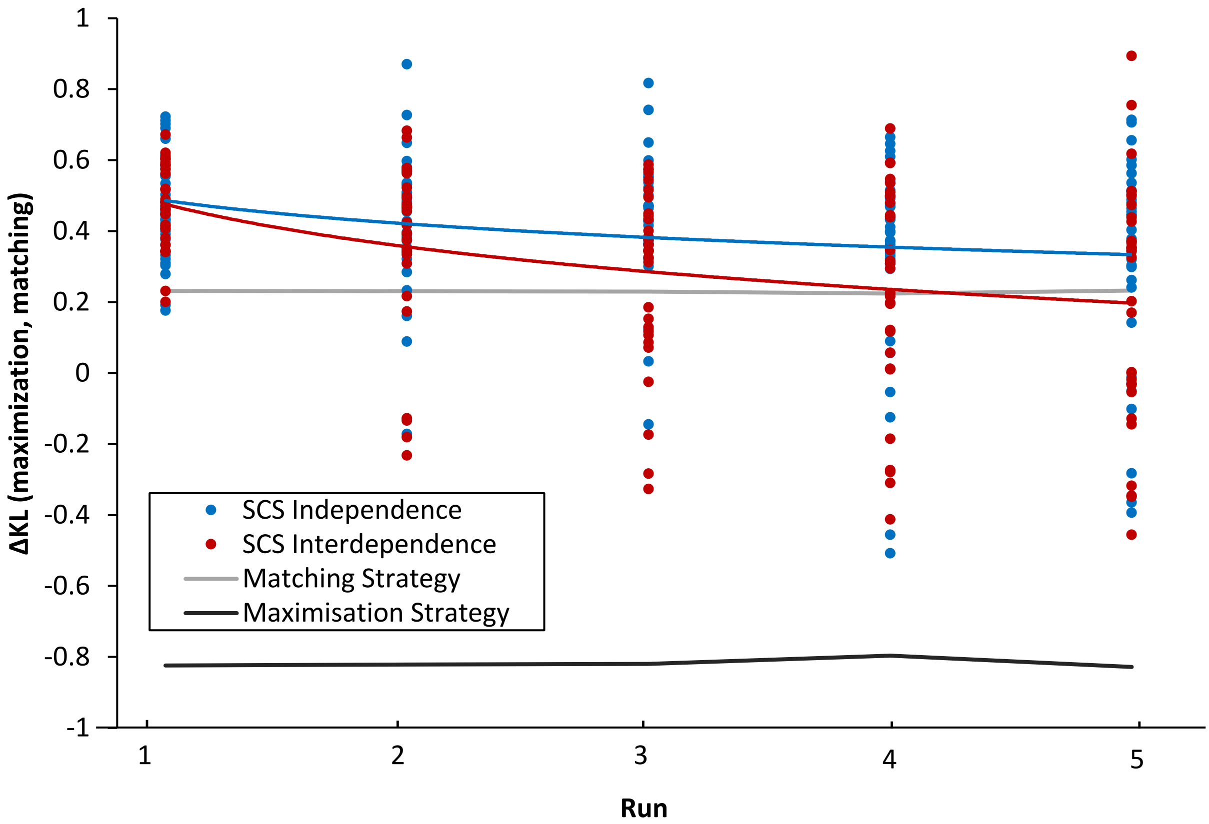


Note. There was a significant difference in strategy choice in Run 3, whereby interdependent participants deviated briefly away from the matching strategy used by the independent group. However, this effect subsequently disappeared in the final two runs. The error bars represent standard errors.

Upon closer inspection of the individual strategy index, it was found that participants in the study generally adopted a matching strategy (n = 50) as opposed to a maximisation strategy (n = 12), as seen in Figure X2. A t-test comparing the individual strategy index of participants with independent (M = -1.39; SD = .146) and interdependent (M = -.059; SD = .180) self-construal revealed no significant difference between both groups, $t(60) = 1.83$, $p = .072$. Therefore, it appears that the behavioural differences observed between participants with independent and interdependent self-construal could be attributed to the independence-interdependence cultural constructs rather than differences in individual strategies.

Figure Y2

Strategy Curve for Probability Learning (Matching vs Maximisation) for Individuals with Independent and Interdependent Self-Construal in Comparison to the Matching and Maximisation Curves



Note. Negative strategy-index values suggest a propensity towards a probability maximisation strategy, whereas positive values indicate a propensity towards a probability matching strategy. Most participants in the study (n = 50) employed a maximisation strategy.

Appendix Z

Pearson's Correlation Matrix for the SCS, COS, and AHS (Chapter 5)

	COS_HI	COS_VI	COS_HC	COS_VC	COS_IND	COS_COL	SCS_IND	SCS_INT	CAUSE	CONTRA	CHANGE	ATT
COS_HI	–											
COS_VI	.167	–										
COS_HC	-.184	-.024	–									
COS_VC	-.091	.253*	.412**	–								
COS_IND	.670**	.843**	-.118	.141	–							
COS_COL	-.158	.150	.809**	.869**	.027	–						
SCS INDEPENDENCE	.330*	.178	.008	.060	.314*	.043	–					
SCS INTERDEPENDENCE	-.231*	.079	.562**	.549**	-.067	.659**	-.106	–				
CAUSALITY	.120	-.032	-.156	.025	.041	-.069	.375*	.102	–			
CONTRADICTION	-.101	.035	.034	.366*	-.029	.254*	.109	.324*	.151	–		
CHANGE	-.011	-.100	-.168	-.028	-.082	-.109	-.301*	-.111	-.075	-.122	–	
ATTENTION	.147	.148	-.072	.158	.192	.063	.492**	.119	.251*	.327*	-.166	–
HOLISM_SCORE	.063	.026	-.159	.252*	.054	.076	.297**	.207	.567**	.653**	.296*	.655**

*significance at <.05, **significance at <.001

Appendix AA

Framed-Line Test (FLT) Instructions

Figure AA1

Absolute Task Instructions and Illustration for the FLT

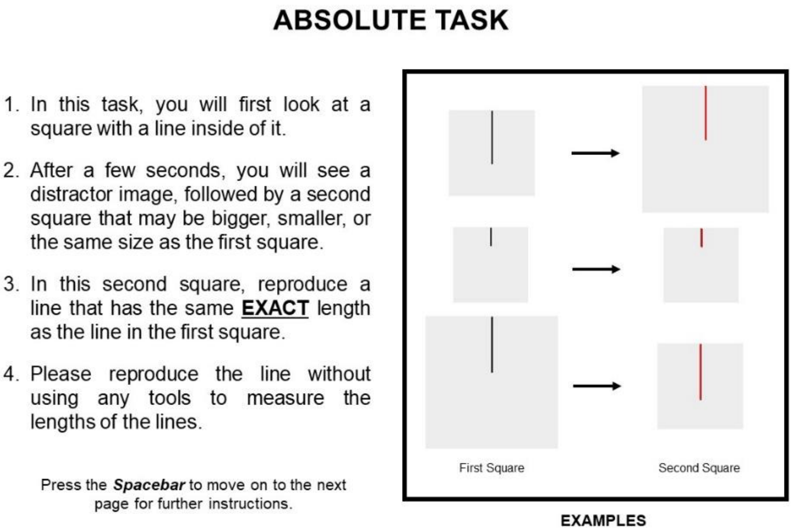


Figure AA2

Instructions for Key Presses in the Absolute Task Condition

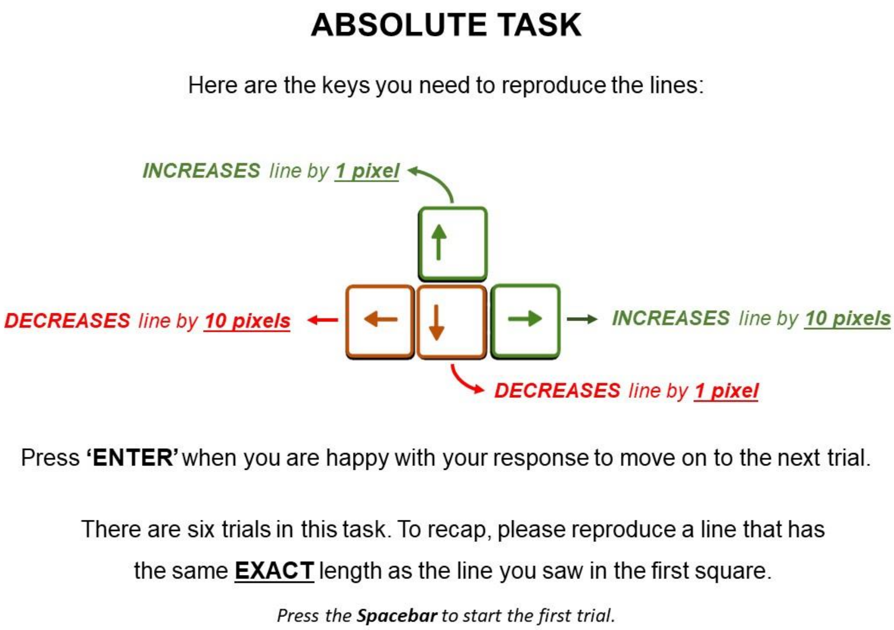


Figure AA3

Relative Task Instructions and Illustration for the FLT

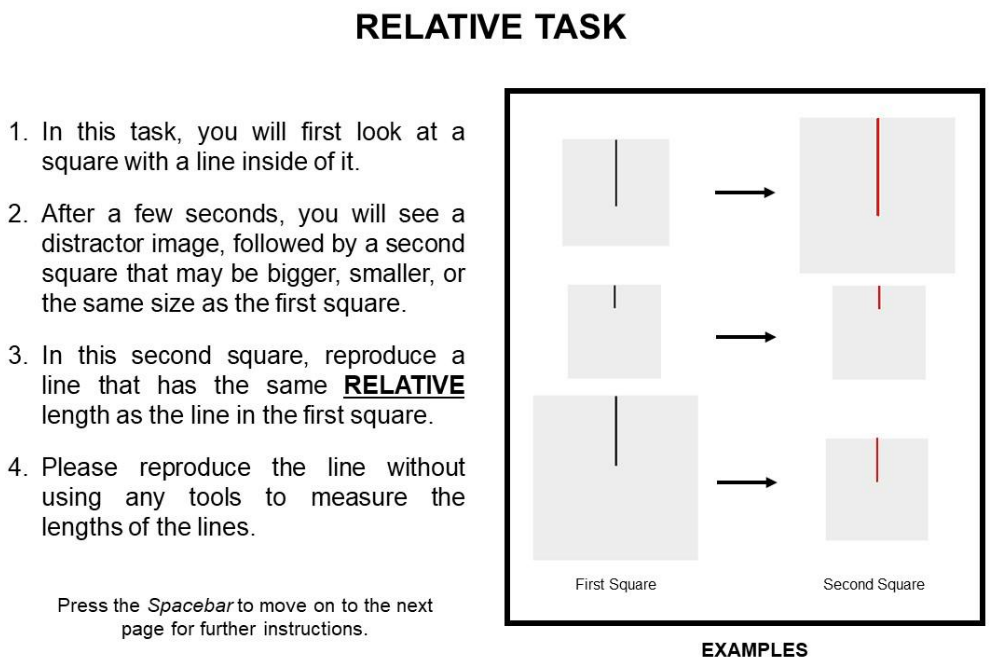
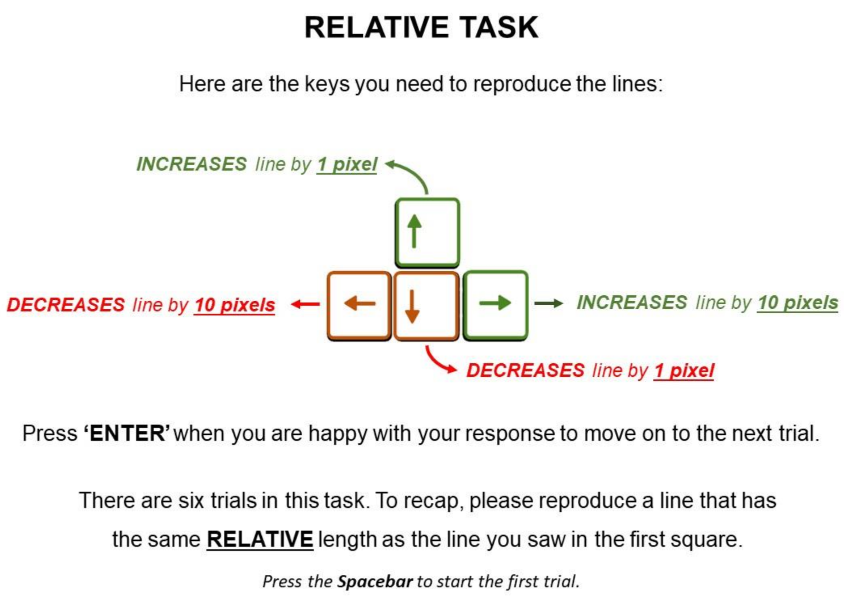


Figure AA4

Instructions for Key Presses in the Relative Task Condition



Appendix BB

Stimuli Dimensions for the Framed-Line Test

Height of First Square (pixels)	Line Length (pixels)	Height of Second Square (pixels)
585	245	1165
775	80	1165
730	100	730
1020	370	1020
775	265	585
1165	110	585

Appendix CC

Chapter 6 Supplementary Tables

Table CC1

Response Accuracy for the Easy and Difficult Stimuli Conditions across Runs

Run	Easy		Difficult	
	M	*SD*	*M*	*SD*
1	24.36	7.685	22.45	6.977
2	26.91	6.818	25.09	5.224
3	27.82	6.853	25.64	5.732
4	29.18	6.838	26.45	5.007
5	27.09	6.595	24.09	4.549
6	26.91	7.993	25.45	7.244