A Multimodal Measurement Approach Using Narratives and Eye tracking to Investigate Visual Behaviour in Perceiving Naturalistic and Urban Environments

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I, KhizarZaman Choudhry, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in this research.

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Abstract:

The notion that exposure to the natural environment positively affects human well-being has been validated by studies showing measured cognitive, psychological, and physiological benefit. This research is unique in exploring gaze behaviour on environmental images possessing different levels of saliency by using eye tracking along with traditional data collection techniques for example narratives, connectivity to nature scores and interviews. The majority of existing landscape research has been derived by conducting heuristic evaluations without having empirical insight of real participant visual response. In this research, a modern multimodal measurement approach (using Narratives and Eye tracking) was applied to investigate visual behaviour in perceiving naturalistic and urban environments. Eye behaviour is predominantly attracted by salient locations. The concept of methodology of this research on naturalistic and urban environments is drawn from the approaches in market research. Borrowing methodologies from market research that examine visual responses and qualities provided a critical and hitherto unexplored approach. This research has been conducted by using mixed methodological quantitative and qualitative approaches.

This thesis focuses on two aspects of Human Environment Interaction (HEI).

a) The evaluation of existing environmental research and

b) The use of eye tracking as a supplementary objective environmental evaluation technique.

A combined qualitative and quantitative approach has been used, including a state-of-the-art technique, eye tracking. The eye movement data were complemented by participant-profile data elicited through background questionnaires and participant-perception data as captured through semi-structured interviews. This provides an insight into the participant experience that spans behavioural aspects such as visual search behaviour and visual search performance data, and subjective aspects such as participant expectations and preferences.

As a result of this study, when Eye tracking data was collected and analysed two types of responses were observed:

i. Immediate Involuntary Response
ii. Delayed Learned Response

In terms of key finding of this research, it is noticed that each participant has an individual unique navigation style, while surfing through different elements of landscape images. This individual navigation style is termed the ‘Visual Signature’, which is an immediate involuntary response.

On the whole, the results of this research corroborated existing landscape research findings, but they also identified potential refinements. The research contributes both methodologically and empirically to Human-Environment Interaction (HEI). This research focused on initial impressions of environmental images with the help of eye tracking. Taking under consideration the importance of the image, this research explored the factors that influence initial fixations in relation to expectations and preferences. This research adds the necessary clarity that would complete the picture and bring an insight for future landscape researchers.

Preface

"It is just that we should be grateful, not only to those with whose views we may agree, but also to those who have expressed more superficial views, for those also contributed something, by developing before us the powers of thought".

Aristotle (384-322 BC)

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Chapter 1. Introduction

1.1 The Thesis

It is evident from the literature review that there is not a substantial amount of research carried out in the field of environment using eye tracking. This research has taken an empirical, human centred approach to develop further existing research relating to the environment with the use of new research techniques like eye tracking. According to Ryan (2004) visual behaviour in relation to environment and people's perception of environment are relatively under researched areas. Therefore, this study will focus on the 'impact attributes' of surrogate landscapes on the individual through exposure to images derived from naturalistic and urban environments. This study will try to fill the gap in existing environment research related to human physical, social, and emotional needs in relation to characteristics of green infrastructure and its land use components effecting human cognitive well-being. This will be achieved by looking into the relationship between human visual behaviour and people's preferences and perceptions of environment. Findings from this research would generate evidence on the qualities of green infrastructure in towns and help to improve the planning and design of green infrastructure in towns of the United Kingdom. This research will explore:

- Why people like/dislike certain types of environments and landscapes?
- Is their visual behaviour, when exposed to the environments, natural/innate or learnt?
- And how future town planning can be improved by bringing the findings about previously unexplored areas like 'use of eye tracking in the field of human visual behaviour' in relation to different landscapes?

Due to the complex nature of both human visual behaviour and different landscapes, it is difficult to tailor one solution that could answer all the questions, which arise during urban designing and town planning. It is very reasonable to think that due to huge differences in human cultures, ecology, climates and different biogeochemical structures, urban designs that work in certain areas or parts of world will not work in others. Urban planners and designers rely on existing good practices which are developed by the research methods which are not very practical and empirical. However due to the development of new technologies like eye tracking, it is now possible to bring in people centred research methods to collect data, these advanced tools can go much deeper in finding out about people's real perspectives and perceptions of nature than conventional data collection techniques. Such a study is done by De Ridder (2004) evaluates urban naturalistic space benefits (De Ridder et al., 2004). It contributes to clarify some of the complex, multi-faceted relationships between urban people's mental being and their relationships with urban nature.

According to Dupont (2014) better landscape management and planning can be achieved by bringing in people's perspective, up to recently the knowledge and insight, about how people perceive landscapes has been gained through questionnaires and in-depth interviews (Scott and Benson, 2002). It has also been noticed during past research that in situ observations[1] and photographs are one of the most frequently used stimuli in landscape research (e.g. Hagerhall, 2000; Ode et al., 2008; Palmer, 2004; Sevenant, 2010; Tveit, 2006). DuPont (2014) suggests that use of eye tracking can bring in an objective technique to study people's visual behaviour whilst observing landscapes. By using eye tracking the researcher can observe saccades (speed and direction of participants eye movements) and can also study duration and position of fixations while observing landscape photographs (Dupont 2014). Use of eye tracking is common in the field of human behaviour studies including environmental psychology (Berto et al., 2008). During the past few years, the use of eye tracking has been utilised in the field of geography (Antonson et al., 2009), cartography (Ooms et al., 2010a and 2010b) and landscape science at a very basic level (Dupont 2014, De Lucio et al., 1996; Tveit et al., 2006). Eye tracking is considered as a very effective and powerful tool to study human visual behaviour therefore its use is commonly seen in the field of market research and hence is introduced in the field of landscape studies (Sevenant and Antrop, 2011).

The majority of existing environmental research has been derived from subjective evaluations through interviews and questionnaires using simple visual research techniques. By conducting studies of participant behaviour, performance and perception regarding environment, through eye tracking provides alternative objective assessment with direct reference to the participants themselves. According to Lui (2012), "the integrated usage of eye tracking with interviewing method produces strong corroborative results." (Lui 2012:154).

There has been a growing interest in tracking participants 'eye movements' as a means of evaluating participant-environment interactions (Dix et al. 2004). This research proposes the combined use of eye tracking and other techniques such as, narratives, background questionnaires and pre- and post-session interviews as an effective means of evaluation of different types of environments using environmental photographs.

1.2 Background and motivation

This thesis investigates the gaze behaviour associated with formulating and refining queries under varying environmental images. Every individual can possess a different subjective perception of the world and this can be measured using an eye tracker. The research reported in this thesis is concerned with exploring information from eye tracking data obtained during the course of visual interaction. Eye tracking offers an adaptive approach for visual tasks that has the potential to capture the

[1] Term means here going to a place or landscape and observing it for a period of time.

participant's current needs from eye movements. Humans are capable of making rapid decisions from limited information. The eye movement data arising during these decisions can be examined for indications of visual query formulation.

As far as can be determined, eye tracking has not been used extensively in landscape preference studies but the approach offers excellent potential for advancing our understanding of how individuals perceive the landscape providing a much needed alternative objective assessment which can be compared to subjective feedback from participants. In postulating that there is a common innate response to the landscape, it should be possible to equate key landscape components with eye fixation and saccade[2]. Using a range of participants of known profiles, common fixations and saccades should be evident (or not) across a range of images. Observing reaction to urban and natural environments in a range of situations explores association between visual response and cognition.

Images play an increasingly important part in the lives of many people by linking present and past experiences through memory. This has prompted significant growth in research into new unexplored techniques. Nowadays most eye-tracking systems work on video-based pupil detection and a reflection of an infrared LED[3]. Video cameras are now much cheaper and the price for an LED is negligible. Many computer devices and mobile devices have built-in cameras, such as mobile phones, laptops, and displays. Processor power still increases steadily and standard processors are powerful enough to process the video stream necessary to do eye tracking, at least on desktop and laptop computers. The head-tracking system used in this study, which was necessary to give the participants the freedom to move in front of their display, is also video-based. Such systems can be implemented unobtrusively with a second camera.

1.3 Research questions

The main research question is:

What factors influence the participants' visual search behaviour and performance when they look at different surrogate landscape images? That is, where do participants look, and what do they see and interpret – and what aspects of an image influence that activity?

The research objectives are to:

- Provide empirical re-evaluation of existing environmental research.

[2] Here Saccade is a gap between two fixations, when eye gaze moves from one fixation to the other. Liu (2012) A Case study of using eye tracking techniques, international journal of learning technology, issue2 vol. 7:154-171.

[3] An infrared LED light emitting diode is a device that creates light with a wavelength just slightly longer than what a human eye can see.

- Demonstrate the usefulness of eye tracking when combined with other Conventional techniques to explore detailed participant behaviour.

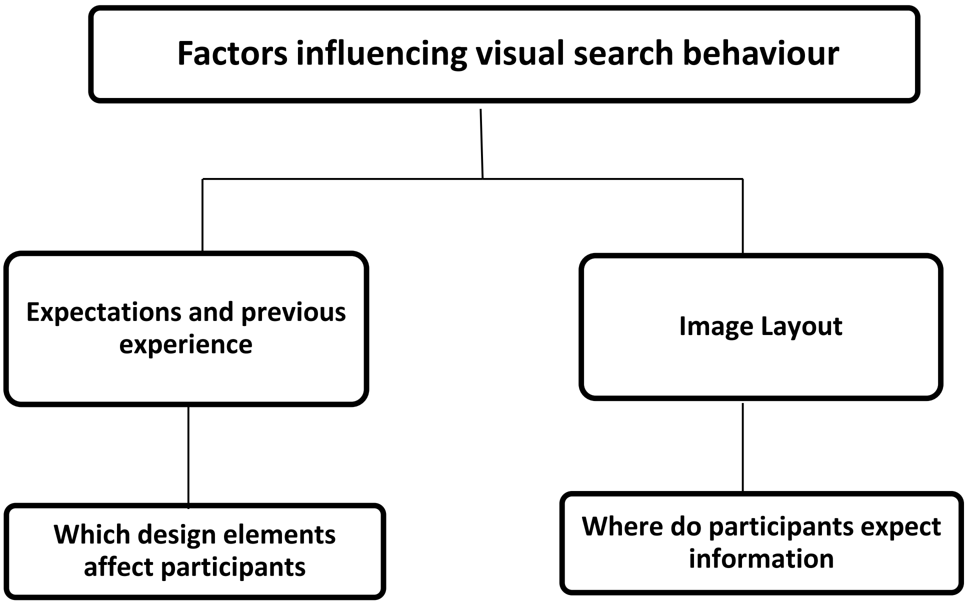

Figure 1.1. The research questions.

The way individuals use components of green infrastructure present a variety of landscape experience to them and such experience goes deeper than simply visual aesthetics. Studies suggest that different landscapes influence emotional states of people (Parry-Jones, 1990). Urban parks and trees hold a special meaning for urban residents (Dwyer et al., 2009).

The primary focus is on two main factors that influence the participant’s visual search:

- Expectations and previous experience
- Image layout and attractors (figure 1.1)

Table 1-1 illustrates the summary of eye-tracking study and associated objectives underpinning this study

1. Surrogate environment Image study	2. Participants adaptability (compliance) study (Differential environmental image base study)	3. Participants rigidity (non-compliance) study (Similar environmental image based study)
• To explore the participants' scanning behaviour and their ability to identify different elements of nature in surrogate images. • To capture the relationship between Participants' previous experiences and expectations, and their scanning behaviour.	• To examine how quickly users adapt to an unfamiliar new surrogate environment layout and, in particular, how quickly Participants adjust their expectations of where to look during each time exposures to a new (different from previous) surrogate environmental image each time. For example, beach, mountain, building, forest, factories	• To compare visual search behaviour across repeated presentation of different environmental image of similar category for example 2 pictures of beaches, 2 pictures of mountains, 2 pictures of buildings.

Table 1.1. Summary of eye-tracking study and associated objectives underpinning this study.

1.4 Context of the study

The overall idea of the project is to look at a range of participants responses to landscapes. These landscapes are composed in the form of pictures which essentially mimic views from a window. The responses are obtained via narratives and parallel measurement of indicators such as eye tracking.

A range of participants from those who express love for nature (biophilic) to those that express dislike (biophobic) will be identified through their profile biographies obtained from semi structured interviews. This will be via key questions that elicit information about themselves, their environmental values and memories of landscape, ideal landscapes and so forth. These profiles will be gathered after the participants take part in the experiment.

Exposure to nature is known to have positive effects on physical and mental health. The evidence indicates that nature can make positive contributions to our health, help us recover from pre-existing stresses or problems, have an 'immunising' effect by protecting us from future stresses, and help us to concentrate and think more clearly. Three levels of engagement with nature can be identified (Pretty et al., 2009: 319-337):

- The first is viewing nature, as through a window or in a painting (Moore 1982; Ulrich 1984; Tennessen & Cimprich 1995; Leather et al., 1998; Kaplan 1995; Kuo & Sullivan 2001; Diette et al., 2003).
- The second is being in the presence of nearby nature which may be incidental to some other activity such as walking or cycling to work, reading on a garden seat or talking to friends in a park (Cooper-Marcus & Barnes 1999; Ulrich 1990; Coles 2000).
- The third is active participation and involvement with nature, such as gardening, farming, trekking, camping, cross-country running or horse-riding (Hartig et al., 1991, 2003; Fredrickson & Anderson 1999; Frumkin 2001; Williams & Harvey 2002; Herzog et al., 2002).

This study concerns the first level of engagement, 'viewing nature through a window' or as represented in an image. Such representations can be termed 'surrogate landscapes' being a composition of real or imagined nature or natural elements in a form such as a photograph, a picture, or an electronically generated image. The proposal draws on existing landscape research looking at preference studies using images (Kaplan & Kaplan 1972, 2007, 2008, 2009; Hartig 2001, 2003), but expands the focus of investigation to consider in more detail psychological and cognitive functioning obtained through eye-tracking and verbal recordings.

1.5 Research Design

The aim of the research is to determine the properties and attributes of green infrastructure and its land use components through preference by eye tracking experiences of exposure to images of naturalistic and urban environment. Therefore, it will investigate the impacts of green infrastructure (independent variable) towards people‘s physical, cognitive and social health and well-being (dependent variable). The responses of a range of participants are obtained through individual profiles, narratives, interviews and eye tracking methods. The planning for this research had several stages; namely,

1) Definition, background and theories and concepts of green infrastructure, community preference study and their existing green infrastructure network.

2) Delphi technique, for synthesis on criteria for quality surrogate landscapes naturalistic and urban environmental images to be used in this research.

3) Profile interviews of participants and data collection.

4) Descriptive and inferential statistical analyses on participant‘s responses.

5) Mapping of findings.

6) Documentation of findings of the green infrastructure attributes and design values for enhancing community's health and well-being and conclusion and implication of study.

Chapter 2. Literature review

2.1. Strategy for literature review

A search was conducted to review the current literature on Naturalistic and Urban Environments (NAUE) and psycho-physiological variables (Table 2). A Boolean search was conducted in the various databases including Cochrane; IIED (International Institute for Environmental Development), CINHAL, Green File, PubMed and Medline. Psychological studies within NAUE have been accepted in more recent years subsequently rendering an electronic search as an appropriate approach. MESH/Thesaurus terms were employed according to the search engine. In addition, the following key words were used and combined for a more accurate search, participant recruitment; selection criteria; outcome; natural; urban; naturalistic; city; eye tracking; images; photos; market research; psychological and environment. No publication time limit was given to restrict the search because the objective was to look for methodologies thoroughly. All abstracts were screened and selection criteria (see below) were applied. Full papers were obtained for further review. Additionally grey literature[4] and reference lists from all relevant articles were thoroughly searched.

2.2. Literature selection criteria

The resulting abstracts were screened and colour coded into suitable (to retrieve full copy), unsuitable, or undecided and retrieve full copy to check for suitability. Full copies of the identified articles were obtained for consideration and confirmation of inclusion. Disagreement between the papers' authors (as readers of the papers) was resolved by looking at discussion sections of papers and discussing the paper with supervisors– further assisted by the use of the inclusion and exclusion criteria mentioned below.

Papers were included in the review if the following conditions were met:

i. A method is used to ascertain the influence of psycho- physiological variables upon exposure to naturalistic and urban environment including one or more of the following; administration of psycho physiological measures, interviews, algorithms and questionnaires.
ii. A method is used to ascertain the influence of psychological variables upon exposure to naturalistic and urban environment including one or more of the following; administration of psychological measures, interviews, algorithms and questionnaires.
iii. Participants are included in the studies to gain insight into the psychological characteristics involved and to evaluate exposure to naturalistic and urban environments.

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[4]Grey literature is defined as "That which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers."
Alberani V, Pietrangeli PDC, Mazza AMR (1990). The use of grey literature in health sciences: a preliminary survey. Bulletin of the Medical Library Association 78(4): 358-363

Papers were excluded if:

i. They were reviews or guidance papers that did not present original work.
ii. They did not consist of physically normal participants exposed to urban or naturalistic environments.
iii. They were single case studies.

2.3. Quality check and analyses

Selected articles were checked for quality based on the criteria used by the Public Health Critical Appraisal Skills Programme (CASP) for Cohort Studies[5]. This quality check covers four main issues: validity of results; results themselves; whether results can be applied to a local population; and whether the results fit with other similar research. Recruitment, bias, and confounding factors related to environment are also subject to critique. Included papers were reviewed to enable reporting upon several factors; study design, population studied, participants (age, sex), length of study, psychological variables studied, methods of assessment, and outcome (questionnaire score and findings).

2.4. Theoretical Framework

There is little published research on the landscape and greenery experiences (Dwyer 2009; Balram and Dragicevic, 2005). However, there is clear evidence from the literature that greenery is very important for wellbeing (social and mental well-being). It has been noticed that most of the studies in this field of research are related to an individual's attachment and feelings to landscapes (Cooper-Marcus, 1995), and neighbourhoods (Ahlbrandt, 1984; Rivlin, 1987; Lalli, 1992; Brown et al., 2003). Research within the domains of psychology and biology, such as wilderness therapy, wilderness experiences and other forms of therapies using animals has shown clearly that nature has a positive effect on a human's well-being (St Leger, 2003).

According to De Vries et al., 2003; Takano et al., 2002; and Tanaka et al., 1996, nature is positively related to human cognitive and social well-being. There are other (Wilson, 1984; Katcher and Beck, 1987; Friedman and Thomas, 1995; Roszak et al., 1995; Frumkin, 2001; and Wilson, 2001) who suggested further that nature is a human need.

[5] The 10 questions have been developed by the national CASP collaboration for qualitative methodologies.

St Leger, (2003); and Maller et al., (2005) suggest nature is vital for human well-being and good mental health. They also suggested that nature plays a vital role in developing a community and bringing people together. There are others who suggest nature has a positive relation to human psychological and social well-being; Wong (1997) researched people migrating from their country of origin; Moore (1981) studied the environment in relation to prisons. Suggestions were made relating to levels of contacts to nature in terms of viewing being the least and active participation being the most useful.

Rohde and Kendle (1994) states that exposure to nature can be prescribed for depressed patients as nature has many effects in terms of uplifting mood. Furnas (1979), linked nature to biology and physiology and suggested that the effects of nature are more prevalent on the right hemisphere[6] of the brain as well as affecting other areas of the brain in terms of restoring its harmony. It is clear from the various studies that exposure to the natural environment reduces symptoms of depression, anxiety and suppresses negative emotions. Ulrich (1979) suggests exposure to nature brings feelings of happiness, increases attention levels and helps recovery from mental illnesses. Kaplan (1989), like others also suggests exposure to nature has positive effects on health and well-being.

The urban task force 1999 suggests that exposure to nature and presence of natural space improves community relationships. Residents surrounded by large green spaces and parks form more social relationships. According to Parry-Jones, (1990), there is a clear relationship between open space and human wellbeing who use that space regularly in terms of their residence and work. The relationship between the use of land is much deeper than visual aesthetics and has been further explored in this study.

Marc Fried (1963) identified that urban residents moving away from an area of open space or having to adjust to a change in the open space feel grief and loss of belongings. Therefore it is necessary to involve local communities before making any changes to local parks and other social spaces. Urban trees and parks have a very special meaning for local residents (Dwyer et al. 2009). When people like an environment setting, that becomes their favourite and they use it regularly. People describe their experiences as feeling relaxed and forgetting common worries (Schroeder, 1988; Dwyer et al., 2009). People think their favourite natural setting brings peace and tranquillity. They have different relationship with the environment, have an ownership and attachment, a sense of belonging to such areas (Ryan, 2005, Levitt, 1991; Weiss, 1991).

[6] Depression is associated with hyper activity right hemisphere (RH) and relatively hypo activity of left hemisphere Hecht (2010) Neuro science Res (2010) 68 (2): 77-78. Doi: 10.1016/j.neures.2010.06.030. Epub 2010 Jul 21.

There are several factors which are involved in terms of people's attachment to nature, for example, their needs, past experiences, and certain aspects of landscape components of environments (Thwaites, 2001). Most individual have a picture of part of a natural environment that is very individual and based on the imagination (Tveit and Fry, 2006). Generally, people choose environments which satisfy their psychological and emotional needs (Bonnes and Secchiaroli, 1995). According to Tveit and Fry (2006), an individual's landscape imagination is described as the quality of landscape elements and power of landscapes to create a strong visual impact.

All of the studies with the exception of Tan (2006) examine green infrastructure and its potential benefits to human well-being within Western cities. No studies other than Dupont (2014) have been identified which explore peoples' behavioural preferences when exposed to a series of surrogate landscapes including innate and personality dependant factors, as well as determining properties and attributes of naturalistic infrastructure that enhances psychological and cognitive functioning in relation to well-being of people. There are a few studies (Table 2.1) which have explored some physiological parameters with regards to exposure to surrogate landscape images.

Table 2.1 Studies on naturalistic and urban environments (NAUE) and peoples' preferences.

A. Naturalistic Infrastructure and Open Spaces in Urban

Authors	**Problems, concerns and outcome of research**	**Parameter measured**
Thompson (2002), Dovey et al., (2000), Thwaites (2001), Thwaites et al., (2005), Tan (2006), Tveit and Fry, (2006), Alexander et al., (1977).	Significance of network of open space to ecosystem and human health and well-being. Network of linked open spaces that are woven into the fabric of urban areas. Link between ecological and social systems. Link between spatial arrangement of open space and social benefits. Values of small and loose-fit spaces in urban planning.	Accessibility and connectivity. Openness Heterogeneity Naturalness Coherence Way finding
Laumann et al., (2003)	Nature scenes: forest with lakes and creeks; park with various plant species and artificial creek; sea area with coastline, grass, cows and birds; mountain with snow and ice. Restorative effect: environments with nature elements generally scored higher rating scale measures of	Interview and Questionnaires

	restoration than city environments.	
Staats et al., (2004)	Urban scene: major pedestrian street, bus/train station, rush hour. Restorative effect: city environment scored lower rating scale measures than natural environments.	Interview and Questionnaires
Kaplan (2001)	Natural environment; dense and open forest, path, no people. Attention fatigue gave higher preference for the natural environment over the urban environment. Urban environment; inner city, shopping streets, traffic, residential areas, urban park, people. Attention fatigue gave lower preference for urban environment	Self-reports of emotional state
Schroeder (1988)	View including natural elements. Availability of nature in the view strongly affected satisfaction and restorative ratings; less frustration and more patience, higher enthusiasm and life satisfaction as well as overall health. View without natural elements. No view or no access gave lower values of satisfaction and restorative ratings. Forest landscapes of different density (dense versus half open) and accessibility (path versus interrupted path). Higher pleasure for higher accessibility, no significant difference related to density, indication that low density gave rise to more pleasure.	Self-reports of emotional state
Kuo et al., (1998)	Amount of green vegetation in neighbourhood common spaces (greenness rating 0–4). Stronger social ties, higher sense of safety and adjustment. Weaker social ties, lower sense of safety and adjustment than residents with higher degree of greenery.	Neighbourhood social ties test

Kuo and Sullivan (2001a)	Amount of green vegetation in neighbourhood common spaces (greenness rating 0–4) Less aggressive behaviour, fewer crimes reported to the police (both property crimes and violent crimes) than in areas without greenery. More aggressive behaviour, more crimes reported to the police (both property crimes and violent crimes) than in areas with greenery.	Crime rate reported to police
Kuo (2001)	Amount of green vegetation in Neighbourhood common spaces (greenness rating 0–4). Lower mental fatigue: residents with nearby nature were more likely to be able to deal with the major issues of their lives. Such residents felt more hopeful and less helpless about the issues facing them. Higher mental fatigue: residents without nearby nature were less likely to be able to deal with the major issues of their lives. Such residents felt less hopeful and more helpless about the issues facing them.	Mental fatigue via interview and questionnaire
Taylor et al. (2001)	Amount of window view of nature (0–4scale) improved self-discipline in inner city girls: For girls, view accounted for 20% of the variance in scores on the combined self-discipline index. For boys, view from home showed no relationship to performance on any measure. Lower self-discipline ratings for girls with less greenery in the window view.	Attention tests
Larsen (1998)	Workplace greenery; four levels from no view of and no access to garden to view of and access to garden at workplace	Interview and Questionnaire
Leather et al., (1998)	View or access to garden gave improved comfort, pleasure and well-being (‘‘trivsel’’ in	Self-report of emotional state

	Swedish) and lower stress levels. No view or no access gave lower values of comfort, pleasure and well-being (trivsel) and higher stress levels than employees with access to or view of garden.	
Kaplan et al., (1989, reported in Kaplan, 1993)	Percentage of the view from window with rural elements (trees, vegetation, plants, and foliage) A view of natural elements was found to buffer the negative impact of job stress, intention to quit and a marginal positive effect on general well-being. Higher stress values; lower job satisfaction, higher intention to quit when no or low percentage of rural view.	Job satisfaction survey
B. **Personal meaning and social value of naturalistic spaces**		
Authors	Problems or concerns of research	Parameter measured
Ryan (2005), Brown et al., (2003), Cooper-Marcus (1995), Lalli (1992), Rivlin (1987), Ahlbrandt (1984), Tyrväinen et al., (2005), Tyrväinen et al., (2007), Takano et al., (2002), Tanaka et al., (1996).	Social values of naturalistic spaces to urban dwellers. Personal meaning and cultural values linking to restoration and psychological well-being. Residents‘ preferences and emotional feelings to greenery enhance sense of community	Sense of place Place attachment Aesthetic Social Image ability Comfort and being relaxed
Ulrich (1979)	Nature scenes; dominated by green vegetation including cultivated fields improved well-being and reduced anxiety: increased positive affect factors and reduced fear arousal factor. Urban scenes; commercial landscapes and industrial areas increase in sadness, decline in attentiveness.	Anxiety levels, fear levels
Moore (1981)	Rolling farmland and trees: Stress reduction compared to prisoners viewing prison courtyard. Prisoners viewing prison courtyard had a 24% higher frequency of sick-call visits, compared to those viewing	Sickness records, stress levels

	Farmland.	
Hartig et al., (2003)	Natural environment: tree views/nature reserve reduced stress and improved mood: reduced stress levels/lower blood pressure. Increase in positive affect and decrease in anger/aggression. No view/urban environment with medium density professional office and retail development increase in blood pressure, reduced positive affect and increased anger/aggression.	Emotional tests
Schroeder (1988)	Natural environment; dense and open forest, path, no people. Attention fatigue gave higher preference for the natural environment over the urban environment. Urban environment; inner city, shopping streets, traffic, residential areas, urban park, gave people Attention fatigue and lower preference for urban environment.	Interview and Questionnaire
Tennessen and Cimprich (1995)	Natural or mostly natural view (trees, grass, bushes and/or lakes, no evidence of human influence). Natural views gave higher scores on directed attention than built views. Natural views had no effect on mood state. Built or mostly built view (city street, other buildings, brick wall) gave lower scores on directed attention than natural views.	Attention tests
Grahn et al., (1994)	School playground with high degree of naturalness resulted in fewer sick-days, fewer attention problems, fewer concentration problems, improved motor function. School playground with low degree of naturalness-higher number of sick days, attention problems, higher degree of concentration problems and lower motor	Behavioural Observation

	function than children playing in ‘‘natural’’ playground.	
Ulrich (1991)	Nature scenes; dominated by vegetation including cultivated fields-positive influence on psycho-physiological state; significantly higher alpha; positive influence on emotional state. Nature scenes with water-positive influence on psycho-physiological state; significantly higher alpha; particularly positive influence on emotional state. Urban scenes; commercial landscapes and industrial areas-less positive influence on psychophysical state; lower alpha, less positive influence on emotional state.	Interview and Questionnaire
Herzog and Chen (2002)	Natural scene: field/forest with high and low degree of openness- higher tranquillity, lower feeling of danger. Urban scenes with high and low degrees of openness-lower tranquillity, higher feeling of danger.	Interviews and Questionnaire
Veladre (2007)	Park-like forest area with and without creek. Restoration; higher happiness, lower stress, anger, depression and tension. Improved mood and concentration. No difference was detected between environments with and without water. Urban environment: street along a canal with shops on the other side of the street and street with shops on both sides- no affective restoration with respect to overall happiness and stress. Less restoration with respect to depression, anger and tension.	Emotional test
Heerwagen (1993)	Painting of natural scene; distant mountains, sunset, clustered trees and open grassy areas, path (mystery) - stress reduction: patients felt calmer and less tense in the mural condition than in the plain waiting room. The restorative benefits of the nature scene	Interview and Questionnaire

	were evident both in heart rate data and self-reports of emotional states. Patients watching white wall had higher heart rate increase during waiting period, were feeling less calm and more tense than patients watching landscape painting	
Wells (2003)	Amount of nature in window view (different rooms in the house) on a naturalness scale 1–5. Yard material; 4 naturalness categories Higher naturalness score post-move gave better cognitive functioning. Lower naturalness score on the view from the window related to lower cognitive functioning.	Behavioural Observation
C. **Physiological effects of encountering greenery**		
Authors	Problems or concerns of research	Parameter measured
De Vries et al., (2003), Kaplan (2007), Hartig et al. (1991, 2003), Kaplan et al.,(2009.1995,), Ulrich et al. (1999, 1984), Kuo (1998), Kuo and Sullivan (2001), Korpela et al., (2001), Newell (1997), Frumkin(2003), Kendle (1994), Beck and Katcher (1996), Russell et al., (1976), Lewis (1996), Herzog et al., (2000), Tennessen and Cimprich (1995), Weiss (1991)	Public attachment to urban parks and natural areas Natural views restore attention fatigue and recovery from stress and increase cognitive performances, and relaxation Favourite place often relate to natural settings	Cognitive performances Preference Place attachment Self-regulation Comfort
Ulrich (1984)	Natural scene; trees Shorter post-operative hospital stays, lower scores for minor post-surgical complications, received fewer negative comments in evaluative nurses’ notes and took fewer strong analgesics than the patients looking at brick wall. - Longer post-operative hospital stays, higher scores for minor post-surgical	Doses of pain killers during recovery

	complications, higher frequency of negative evaluative comments from nurses' notes, higher number of doses of strong analgesics than patients looking At natural scene.	
Hartig et al., (2003)	Natural environment: tree views/nature reserve- reduced stress and improved mood: reduced stress levels/lower blood pressure. Increase in positive affect and decrease in anger/aggression. No view/urban environment with medium density professional office and retail development Increase in blood pressure, reduced positive affect and increased anger/aggression.	Blood pressure
Laumann et al., (2003)	Natural environment: waterside/coast environment with grazing cows Restorative effect: lower heart rate than subjects who watched the urban environment. Urban environment: pedestrian street, bus station, streets with traffic - higher heart rate than the group watching the natural environment.	Blood pressure
Parsons et al., (1998)	Natural scenes; forest (1) and golf (2) Inter-beat interval: golf more complete recovery than urban (passive stressor). Blood pressure: forest and mixed more complete than urban (passive stressor). Golf quicker recovery than urban (passive stressor), urban quicker recovery than golf (active stressor). Skin conductance level: golf more complete recovery than others. Immunization: forest/golf less responsive than mixed/urban. Facial electromyography (EMG) activity; forest greater than others. Urban scenes; mixed residential and light development (1) and urban (2)	Blood pressure, skin conductance and EMG

	Skin conductance level: urban greater than others. Urban slower recovery than mixed.	
Ulrich et al., (1991)	Natural scene: vegetation and vegetation with water Lower fear and anger, higher levels of positive affects and intake/attention, faster and more complete recovery, greater stress reduction heart period deceleration (no significant differences between scenes with and without water). Urban scenes; with light or heavy traffic, few or many pedestrians (mall) Slower and less complete recovery, lack in recovery in pulse transit time (PTT) for traffic environments, heart period acceleration. The traffic settings produced more recuperation than did the pedestrian mall exposures	Heart rate
Lohr and Pearson-Mims(2006)	Urban background with trees with varying canopy form (spreading, rounded and conical)- positive emotional responses to urban with trees versus urban with inanimate object. Lower blood pressure and positive emotional response to trees with spreading shape compared to trees with rounded or conical forms. Positive response and lower blood pressure when viewing dense canopies. No significant differences in skin temperature or blood pressure when seeing trees than when viewing scenes with inanimate objects. Urban background with inanimate object Urban with inanimate object less positive response versus urban with trees.	Skin conductance
Nakamura and Fujii (1992)	Hedge Relaxing effect: the EEG data supported the conclusion that the greenery elicited relaxation. Concrete block fence Watching the concrete block fence brings sensory stress.	Brain activity EEG

Ottosson and Grahn (2005)	Garden, with old fruit trees and a variety of flower species increased powers of concentration after resting in a garden outside the geriatric home compared to that after resting indoors in their favourite room. The results did not show any effects on blood pressure or heart rate. Indoor environment (favourite room) - lower power of concentration after resting inside	Blood pressure
Diette et al., (2003)	Nature scene; mountain stream in spring meadow, plus nature sound - significantly reduced pain for the participants exposed to nature scene and sound. No difference in mean level of anxiety. Without any scene or sound - control group reported higher levels of pain. No difference in mean level of anxiety.	Pain levels
Maas et al., (2006)	Amount of green space within a radius of 1 km and 3 km from residence - better perceived general health – higher amount of green space - worse perceived general health – lower amount of green space.	Self-rating of health perception

Table 2.2: Naturalistic and Urban studies selected for review.

Type of scientific evidence.	Authors	Concerns of Research/population studied	Parameters measured	Methods
Outcomes of Divergent Trials (Subjects exposed to some situation or environment to measure physiology.	Ulrich, (1984)	Recovery from gall surgery	Improving recovery time	Observation
	Ulrich (1979)	Reduction in anxiety	Anxiety levels	Questionnaires
	Moore,(1982,1981) West (1985)	Prisoners view of nature	Reducing sickness incidence	Records of sickness seen
	Rohde and Kendle, (1994).	Young Adults Proof reading subjects mood enhancement	Mood scales	Questionnaires

	Evans et al.(2000) Wells (2000)	Replacing asphalts space to natural environment effects	Comparing child hood and adult experiences to nature.	Physiological Parameters plus self-reporting of mood improvement.
	Hartig et al. (1991)Hartig et al., (2003)	Changes in DBP	Blood pressure changes	Questionnaires
Findings of studies using metaphors (photos) and videos.	J.V. De Lucio (2012)	Visual behaviour	Eye tracking	Eye tracking data analysis
	Mooney and Nicell, (1992); Rice and Remy, (1994, 1998)	Trees and level of violence, Alzheimer's patients and prisoners	Number of incidence reported, pre and post exposure to photos.	Records of violence
	Kweon et al., (1998)	Older adults social ties and amount of exposure to natural photos	Self-reporting and incidences of unpleasant events	Records of incidence of unpleasant events
	Bixler and Floyd (1997)	School children exposures to naturalistic slides	Views of urban and rural background children	Observation and questionnaires
	Heerwagen (1990)	Painting of natural scene in waiting room	Stress level self-reporting	Questionnaires
	Lien Dupont (2012,2014)	Environmental photos	Visual behaviour	eye tracking
The results of behavioural surveys. (Psychology)	Pate et al., (1995); U.S. Department of Health and Human services, (1996),	The value of physical activity as part of healthy living survey among general American population.	Peoples views filling in surveys forms	Telephonic and postal survey
	Ball et al., (2001)	Physical and mental gains of environment used for walking	Filling in survey form	Post walk filling in survey forms
	Sallis and Hovell, (1990); Sallis and Owen (1997).	Interactions between individual psychological, social and biophysical environmental variables	Theoretical communal studies	Review of available literature with respect to variables.
	Bell et al.,(2004).	Stress levels measurements	In questionnaire surveys filled	Questionnaire

			by participants after exposure to green flora.	
	Ball et al.,(2001).	Australian adults associations of environmental aesthetics	Phone interviews	Likert scale replies
	Bixler et al., (1994)	Patterns of negative reaction of urban students on a field trip	Observation done by teachers	Field Observations
	Bell et al., (2004). Burgess, (1995b), Ward Thompson et al., (2004)	Differences among men and women in levels of vulnerability in green space	Filling in questionnaire post exposure	Questionnaire
	Burgess, (1995a, b); Burgess et al., (1988).	Ethnic minorities in the East Midlands perception of naturalistic spaces	Fill in a questionnaire and focus group discussion	Questionnaire& focus group
	Bell et al., (2004).	Diverse attitudes to urban naturalistic spaces in various communities across London	Interview and questionnaire	Structured interview and questionnaire
	Kweon et al., (1998)	The benefits of contact with natural landscapes seem particularly significant among the elderly.	Focus group discussion, questionnaire	Questionnaire and focus group
	Milligan et al., (2003)	Natural areas intimately linked to older people's social interactions	Focus group exercises and interviews with people over 65 in Carlisle,	Focus Group and Interviews
	Sullivan and Kuo (1996) Hartig et al., (2003), Kuo and Sullivan, (2001).	Levels of violence in urban public housing where there were trees	Records of incidents of violence in the area	Quantitative methods
	Galea et al., (2005).	Examined the association between both the internal living environment and the external built	Interviews in New York	Interviews

		environment and depression		
	Schroeder and Lewis (1991)	Synthesising ideas and findings on the physiological and psychological benefits of urban forests and nature	Positive memories associated with nature and negative impacts derived from feelings of fear	Interviews
Findings of countrywide and local statistics	Lewis and Booth, (1994).	Psychiatric morbidity was assessed using the General Health Questionnaire in UK	Found an association was found between urban residence and the prevalence of psychiatric morbidity	Questionnaires

2.5. Theoretical Underpinnings

Theories that underpinned this study can be divided into two categories;

(1) Theories on spatial arrangements that may be valuable to human wellbeing (bodily and emotionally) (Forman 1996).

(2) Perceptual theories that relate to human perceptions and preferences.

In urban areas, practical use of available landscape and green patches is only possible if these areas are distributed rationally and equally in different parts of the city. Due to this equal distribution, quality of life in the city can be enhanced (Forman 1996). People can use these available green spaces to develop more social coherence and form new relationships. According to Thwaites et al., (2005), the arrangement of landscape components in the cities have three essential components: metrics, corridors and patches.

- Here metrics stands for circumstantial echo system[7].
- A patch is a piece of land which is surrounded on both sides by a different type of neighbouring land. Patches are generally consistent and diverged from surroundings.
- Corridors are generally related to their shape, which is a long strip.

[7] Circumstantial echo system means, individuals' need related echo system, for example ethnic minorities prefer to be based in inner sites, to find work, being close to other members of group and then they use land according to their individual needs, hence sometimes more green space is required in inner cities.

When a space is arranged in a way which fits human needs, it will also enhance biodiversity (Thwaites et al., 2005; Tan, 2006). According to Forman (1996, p96), “land mosaics are actually patterns of patches corridors and metrics”. When arranging an environment it is important to have a mixture of elements and dimensions (Thwaites et al, 2005). A three-dimensional arrangement of space can improve practical efficacy, juxta positioning, endurance and effective use for the community. (Thwaite’s et al, 2005). Gordon Cullen (1971) describes ideas of serial vision as psychosomatic linkage to the environment is only attainable through provisional experience of the environment. Christopher Alexander theory of centres states (Alexander et al., 1977) restorative qualities of landscape are very important within an urban setting, which can only be achieved through proportionate distribution of patches, metrics and corridors (Thwaites et al, 2005).

The key perceptual theories are:

1. Landscape Preference Theory by Kaplan (1986);
2. Prospect and Refuge Theory by Appleton (1975) and;
3. Topophilia by Tuan (1974).

Kaplan (1986) and Zeller (2006) views, natural landscapes ability to reduce psychological stress makes it more favourable for people which is why research related to preferences and aesthetic responses show people choose natural environments more so than urban environments. Heerwagen and Orians (1993) suggests, a landscapes usability, practicality, safety, simplicity and user-friendly qualities makes it more desirable. This is linked back to our evolutionary needs of feeling safe, fore-seeing danger, and navigating easily through the environment. Forests are more desirable when it is easier to venture and navigate. According to Kaplan (1989), human instinct of survival is very important and plays a substantial role when selecting and choosing a landscape. Whilst investigating work done by different researches on landscape preferences, it is noticeable that humans prefer grasslands to woodlands as it is easier to navigate through a grassland with substantially less risks attached to this in comparison to woodland.

The refuge theory suggests, human beings are natural hunters and rely on other species for food hence preferring only landscapes as they are more favourable for hunting. In addition, a landscape provides an opportunity for camouflage, further increasing chances of good hunting as well as enhancing chances of survival. According to Appleton (1975), these are the qualities of a landscape which makes it visually desirable.

According to Topophilia’s hypothesis by Tuan (1974), a landscape preference depends on personal or individual attributes such as age, gender, profession and hobbies. People choose landscapes which fit their physical and social needs. According to this theory, cultural values and norms of society play an important role whilst giving preference to a certain landscape. In some cultures where people prefer to go out into a natural environment for a picnic, these people prefer a landscape where they can socialise (Tuan, 1974). Specific previews (Ogunseitan, 2005, Ryan 2004) for Topophilia include:

- familiarity (e.g., perceptible, privacy and solitude)
- ecodiversity (e.g., Rocks, .water bodies and trees)
- synesthetic tendency (e.g., colours and sounds)
- cognitive challenge (e.g., intricacy and lucidity) (Ogunseitan, 2005).

Achieving full usage of green space in an urban setting can only be done if the space fits the needs of residents such as making the space appropriate for people with mobility problems and ageing populations. Research has shown the following attributes to be important in terms of landscape preferences; physical and cognitive functioning; social imaginibility (Thwaites, 2001); community empowering factors; sense of community; community integrity; community place attachment and social territory. These are important factors which require investigation in relation to green environments (Kuo, 2003). Other researchers suggest the need to determine the relationship between greenery and social mobility; active living; sense of belonging; favourite places and favourite green environment components (Fried, 1963; Tuan, 1974; Ryan, 2005 Schroeder, 1988; Dwyer et al., 2004). Investigating landscape components are the main focus of this present study.

2.6 Reasons for disengagement from nature and exposure to urban green space

It is crucial to look at the reasons for disengagement of humans from nature and exposure to urban environments. It is important to view different domains that have emerged from previous research and establish the reasons as to why humans have a natural inclination towards the environment. Among these domains are innate, behavioural or learnt responses (Sevenant 2009). Human Evolution is also considered to be playing an important role. (Ulrich, 1977, 1983; Kaplan, 1987, 1995; Kaplan and Kaplan, 1989). Modern research suggests that humans make choices which are important for survival of the species.

In recent years, factors such as globalisation and modernisation have changed people’s perception of success. To achieve more, people are moving towards big cities from more rural areas and so moving away from the natural environment (Antonson 2009). Urbanisation alone is not at fault, modernisation has played a part in this process particularly advancement of IT; frequent use and reliance on computers; computer games and work environments, all contributing to human disengagement with nature (Berto 2005). This disengagement has resulted in a large impact on our social, mental, and physical well-being (Cooper and Marcus 1999). In the past, children played physical games whereas children of modern times play on computers and engage in games which are mentally more stimulating than physically challenging or active. Here it is important not to forget the impact of industrialisation over human health. All these four factors of urbanisation, modernisation, globalisation, and industrialisation have played significant roles in human disengagement from nature (Dwyer 2009). Many modern psychological conditions are named after these phenomena such as urbanisation and industrialisation syndromes (Dwyer 2009).

The only natural spaces available in dense overcrowded cities are public parks and reserves (Antonson 2009). Many natural environment activists protest to protect green reserves and natural areas and make town planning rules more environmentally friendly. Health is the key justification factor in promoting the preservation of green environments (Parsons, 1991; Ulrich, 1993). It is evident from modern research that natural places and parks within cities not only give health benefits but also have an impact on social issues such as reducing rates of crime and antisocial behaviour (Hamilton-Smith and Mercer, 1991; Rohde and Kendle, 1997). There is now greater emphasis on primary care in health, health promotion and prevention measures. Improving greenery in big cities can have direct and beneficial impacts on many stress-related conditions (Rohde and Kendle, 1997). There is much work still required in linking institutes like the NHS, Environmental Health and Town Planning as it is clear that the urban landscape has its own specific role with regards health promotion (Urban Task Force, 1999).

According to Ward Thompson (2002), urban spaces and parks are used for many different activities which include eating outdoors, social activities, physical activities and venues for civic or political gatherings. Local authorities within the UK are required to ensure that green spaces are available within cities so as to allow such activities to take place (Ward Thompson, 2002). Due to vital importance of the environment, this matter requires great attention. Interestingly, there is an increasing trend where local authorities now check quality of air and level of plantation in such areas as the quantity and quality of these elements have a direct effect on land valuation (Tyrvainen et al. 2005; Tyrvainen et al., 2007). Data related to air quality in any part of city, is an important factor for many property buyers, therefore it directly influences property valuation, because it is thought to be directly linked to plantation, greenery and pollution levels (Tyrvainen et al., 2007).

Much of the published research relates to parks (Dovey et al., 2000, Ward Thompson, 2002) with very little research addressing non-parks e.g. green patches and loose fit green areas which are not classified as parks. According to Ward Thompson (2002), a green area presented for planning is composed of three types of components; natural, semi-natural and artificial (Tzoulas et al., 2007). All these different types of green areas are equally necessary for well-being (Weber et al., 2006). Green areas such as woods, forests, wastelands and grasslands play a vital role in the balance of the ecosystem. They play an important role in sustaining clean water, clean air and natural resources which enrich our quality of life (Benedict and McMahon, 2002). These functions occur naturally by patches of land which are often called loose fit places. Loose fit places and unregulated places are important for the ecosystem as well as providing opportunities for being used in future construction of urban areas, wastelands, cemeteries, road development, and railway developments (Dovey et al., 2000). Some researchers refer to such places as urban wild side, waste lots, and gap sites (Davidson, 1999, Ward Thompson, 2002).

To understand urban development research, it is important to include roads, bridges, streets, forests and loose fit places as all of these play an important role in connecting people to each other (Ward Thompson, 2002). Roads and streets are just as important as parks and green spaces in terms of their usability, how comfortable residents can feel whilst using them (Ward Thompson, 2002). Roads and streets play vital role in social development of an urban area therefore studying people's experiences of using these components of an urban landscape provides valid information which can be used for future developments. It can also inform relevant bodies of how comfortable and content residents are in a particular area (Ward Thompson, 2002). In addition, regardless of how much green areas are available in a city, residents can only approach and use such spaces and facilities with the help of well-developed street and road system (Tan, 2006). Hence, in addition to looking at green infrastructure, urban network system or mosaic study is also important (Thwaites, 2005).

Other than connections and social development, the attractiveness of a place is also important. The attractiveness of an area is measured using different parameters such as cultural diversity, age, sex, crime data and professional background of the people living in that area (Purcell 2001). Some researchers suggest that humans like environments which are safe and resourceful (Purcell 2001). Other suggest that different combinations such as forest surrounded by open meadows, presence of lakes, forests and abundance of grass, make an urban landscape attractive (Schroeder, 1988). Some strongly suggest that humans prefer environments which are natural and devoid of man-made changes as these interventions decrease landscapes attractiveness (Kaplan, 1978; Sandstrom 2002). Kaplan also suggests bringing in natural scenes within urban development to make cities more interesting and increase the aesthetic value of landscapes (Kaplan, 1978; Schroeder, 1988). In the present study, these phenomena and exposure to surrogate nature images and the impact of nature on human visual psychology will be explored.

Although it is not possible to measure the true impact of exposure to nature in human psychology, many researchers have studied landscape features such as, spatial content of scene, attractiveness, refuge and prospects like legibility and coherence (Fernandez and Wilkins 2008, Kaplan, 1975; Kaplan, 1977; Kaplan and Kaplan, 1982, 1989). Research has also looked at natural landscape components such as mountains, forests and lakes, with some studies looking in detail at the amount of water, its colour, clarity and freshness (Kaplan, 1984; Herzog, 1985). Participants in some studies preferred waterfalls in place of swamps and algae covered water. Overall it was noticed that water plays a vital role in improving the aesthetic value of a landscape. There are many other studies which identify positive and negative effects of these landscape components on human psychology (Bonnes 1995, Kaplan, 1984; Herzog, 1985). There is a question as to whether specific environmental elements which include the colour and shape of natural environment components such as mountains, forests and lakes are more important than aspects like attachment and belonging. These are the areas which have value for future studies.

Such studies will reveal aspects of nature which are necessary to enhance human psychological, social and physical well-being. There is little attention given to research of surrogate landscape images and their effect and potential to improve psychological well-being in an indoor setting. The impact of surrogate landscape images on the psychological well-being is a well-known phenomenon which is why many dental practices use natural environment images in the waiting rooms to relax patient's (Wilson, 2001). The effects of the natural environment on mental health is a well-studied phenomena hence it is important to give natural environment fundamental importance when planning urban development and public health priorities. (Frumkin et al. 2001).

This research focuses on proposing a series of environmental improvements based on research findings. These enhancements would result in more users visiting the sites for "keep fit", "well-being", "décor" and "flora and fauna" (Frumkin et al., 2001 Bonnes 1995).

Nature is studied by using surrogate landscape images to evaluate qualities of components and elements of nature to enhance factors like mental health and psychological well-being during different stages of urban development. This research brings mental health issues at grass roots level during urban development process. At the present time, diabetes mellitus, coronary disease and psychological well-being are the biggest challenges for the modern world (Parsons et al., 1998)). Some of these challenges can be tackled by bringing nature close to city life (Wilson 2001). Positive effects of exposure to nature for all these conditions are well researched. The concept of green exercise suggests that exercise in the presence of natural environment has more positive effects than exercise in a room setting or gym (DoH, 2004).

2.7 Scenery, Healthiness and Way of life Overview

According to Maller et al., (2005), green environment exposure has very positive effects on human health as certain hormones such as endorphins, which help the body to relax are released. In addition, the presence of green environment motivates people to go out and actively participate in activities such as walking, running and cycling. Green environments enhance biodiversity and outdoor recreational activity levels.

In previous sections, reasons for disengagement with the environment have been explored with the main reason for conservation of environment not being due to its health benefits (Parsons et al., 1998). There is a great requirement that the organisations which are key players for conservation of environment should use health and well-being benefits to drive the conservation agenda instead of commercial, ethical and economic reasons (Dwyer 2009). According to Dwyer 2009 and Frumkin et

al., (2003), people are mentally more healthy and happy when which is possibly why rural communities have less mental health issues in comparison to people living in urban settings. Contact with animals, plants and other living organisms make people generally happier which is why people have pets and other domestic animals (Wilson, 2001; Maller et al., 2005).
Many suggest that living away from nature could intensify unhealthy behaviours like smoking drinking and overeating. These behaviours seem to have a direct relationship to morbidities like depression, stroke, cardiovascular problems, arthritis and diabetes mellitus (Wilson, 2001; Maller et al., 2005). A sharp increase in these morbidities has been seen in recent years interestingly with a parallel trend in urbanisation. The link between these morbidities and urbanisation is direct (Maller 2005). Due to disengagement with nature, childhood obesity is increasing and is a major challenge for public health professionals in the developed countries (WHO, 2001). At this moment in the 21st-century, the number of people living in cities is much greater than people living in rural areas, hence, emphasising why it is important to preserve natural environments which are essential for good public health. Mental health conditions like depression, psychosis, schizophrenia are the biggest concerns for public professionals in the developed world. (WHO, 2001). Overeating and overconsumption of alcohol are emerging as key strategies to cope with depression. There is a great need for change in sedentary and indoor lifestyle to tackle obesity, heart disease, depression and diabetes mellitus (CDC, 1996; DCMS, 2002; DoH, 2004). Physical activity stimulates the human mind and enhances chances of survival in a battle against chronic conditions such as cancer, Type II diabetes and hypertension (Paffenbarger et al., 1994; Scully et al., 1998; Pretty et al., 2009). It is estimated that in 2030, Britain will have twice the number of elderly people therefore conserving green environment is very important to enhance physical activities, mental health and independence of this growing population (DoH, 2013).

The fall in physical activity levels together with transitions towards calorie-rich diets, obesity and hypertension have presented serious challenges to the health of industrialised countries occupants (DoH, 2004). When coronary rehabilitation programs were looked at, “Lycra phobia” [8] was prevalent thus conservation of environment is necessary to tackle coronary heart disease to some extent. Due to development of green infrastructure, activities like cycling, walking and jogging can be increased and people can adopt new healthier lifestyles such as going to school on foot and possibly cycling to work. According to the Department of Health (2004), in the last 50 years the overall fitness of residents in the UK has reduced. All above-mentioned facts show even greater need of bringing nature close to people so that they can get full benefits in terms of improving physical, mental, social and psychological well-being.

[8] A fear of participating in physical activities in a commercial fitness industry setting. People prefer natural settings to take exercise.

2.8 The Wellbeing Benefits of Environment.

There is a mountain of evidence which shows a direct relationship between human well-being and the environment. A cross-sectional study of many disciplines of health, for example environmental health, medicine, psychiatry, town planning, mental health science, health care policy, and public health give evidence of this positive relationship between well-being and environment (Wilson, 2001; Maller et al., 2005, Thompson 2011, Pretty, 2009; Maller et al., 2002; Bird 2004; Morris, 2003; Jenny 2011; Pretty et al., 2009, 2005; Bell 2004; Rohde and Kendle, 1994; Herbert 2007;Coles, 2000; Frumkin, 2004).

When looking at benefits of health in relation to exposure to the environment, it is worth mentioning the biophilia hypothesis which states that human beings are designed to look in depth at all the processes which have direct effects on their lives, including nature and its effect on human well-being (Wilson, 1984; Wells 2000; Heerwagen, 1993). Hence contact with the nature is as a result of human instinct as an innate tendency. Therefore it's impossible to separate people and nature due to our relationship which has a genetic, evolutionary and hereditary basis (Taylor, 1998, 2001). Due to this threat to human existence related to the absence of natural environments, it is therefore vital for humans to make it possible to conserve environment as much as possible. According to Reynold (2002), urban parks can bring people together, improve social coherence and have a direct impact in reducing stress-related psychological conditions and depression.

Urban researchers have discovered that a dysfunctional environment can cause social problems such as an increase in petty crimes, theft, robbery and alcohol related street violence (Frumkin et al., 2004). It is important to have social networks and sport mechanisms to tackle above-mentioned social problems. Kaplan (1998) suggests, the effects of greenery on mood and psychological well-being is often underestimated. Social coherence and social engagement are factors which enhance health and well-being in busy urban environments (Taylor et al., 1998; 2001). Presence of green parks have lots of benefits according to researchers from Sweden, Japan and Norway such as people living longer in cities where there is more greenery. This again can potentially be linked to direct effects of greenery on health or social and psychological effects of greenery on human well-being (Takano et al., 2002; DeVries et al., 2003;). Lower crime rates are linked to increased greenery in big cities. A significant difference is noticed however, it is not entirely clear if this is due to reduced stress levels or merely due to less opportunities for crime and thus this aspect of research in nature requires further exploration (Grahn 1994,1996).

Koi et al 1998 states, neighbourhood social ties (NST) is another measure of impact of green environment. With robust infrastructure and access to green environments, neighbourhood social ties improve automatically. There is greater help and support for each other with stronger bonding and linkage leading to close knit communities (Kuo et al., 2003). There is another phenomena which is worth exploring, ‘the green plot relationships’ during the process of ‘urban sprawl’ (Frumkin et al., 2001). These are relationships which people make with one another on small allotments (Frumkin et al., 2004). This is active involvement in nature which is at the top of the hierarchy in terms of contacts with nature. Researchers have indicated a clear relationship between the number of visits to the green environment and the levels of self-reported stress (Grahn 1994). According to Grahn (1996), people who live less than 50 m away from a green patch visit 3 to 4 times more than those who live distances of 1000m. This research proves the importance of building more natural reserves and parks within cities and so within reach of residents so that they can use and get benefits of these facilities regularly. Research has shown that the number of people in Oxford that use cycling as mode of travel is greater than Birmingham (DoH 2013). This is due to the greater availability of cycling tracks and walking pathways for residents in Oxford. Hence it is important to build infrastructure which helps in improving physical activity and safety for people whilst engaging with the environment. (DoH 2013). This relationship between the number of facilities and activity level is known as ‘ dose-response[9]’. (Reynold 2202; Pretty 2005; Oister 2001).

It is important to discuss that the contact with the environment can be either, “therapeutic” or “pathogenic” (Balram 2005). Hence it is in the hands of individuals to either benefits from or expose themselves to the harmful aspects of pathogenic nature. Disease and nature are closely related hence the conservation of nature is obligatory not a choice for health promotion. The concept of green exercise defines health not merely as physical health but also mental health to complete the definition of “health” proposed by the World Health Organisation. Green exercise brings synergetic benefit of environment and exercise together (Pretty. 2006). There is a clear relationship between physical activity and mental health (Liu 2012) which is why doctors prescribe physical activity as a treatment for depression. The effects of nature and urbanisation are well studied, however, despite swift urbanisation and reduction of natural reserves the therapeutic effects of surrogate/alternative environments still requires in-depth reviewing.

2.9 Levels of contact with Nature

In the above section, the dose or frequency of contact with nature was discussed and so within this section the levels at which these contacts with nature take place are further elaborated (Pretty et al., 2004; Pretty, 2004). There is plenty of evidence available that exposure to nature has positive effects on our health and well-being, however, the definition of exposure is different. Pretty (2004), describes exposure at different levels (Pretty et al., 2004; Pretty, 2004).

[9] Here dose response means frequency of use of green environment by an individual.

1. The Window View (Viewing nature through a window or in a painting but not directly engaging with it). This is the very first level of viewing nature. It implies sitting inside looking at nature from a window without having direct experience of any kind with that nature. There is clear evidence that even involvement with nature at this level has health benefits (Diette et al., 2003; Pretty et al., 2005, Kaplan, 2001; Kuo and Sullivan, 2001; Lewis et al, 1995, Tennessen and Cimprich, 1995; Leather et al., 1998; Parsons et al., 1998, Moore, 1981; Ulrich, 1984, 1993; Heerwagen and Orians, 1993).

2. Secondary contact to nearby environment Being in the presence of nearby nature which is incidental to some other activity such as walking or cycling to work, reading in a garden seat or talking to friends in a park (Ulrich, 1999). This is second level of involvement with nature and there are clear benefits of involvement with nature at this level. Researchers have successfully analysed the effects of nearby nature in neighbourhoods or in the grounds of hospitals and care homes (Velarde 2007; Cooper-Marcus and Barnes, 1995, 1999; Wells, 2000; Whitehouse et al., 2001; Ulrich, 2002; Wells and Evans, 2003). In addition, other studies have researched the effects of plants in offices (Lewis, 1994; Randall et al., 1992; Ulrich and Parsons, 1998; Larsen et al., 1998).

3. Active involvement with nature and green spaces (Such as gardening, farming, trekking or camping, forest schools, cross-country running or horse riding). This is the third level of engaging with nature. It is important to remember here that this is active engagement and is a well-planned activity, not an incidental impact. It implies a positive decision to visit places where there is green nature (Hartig et al., 1991, 2003). A number of wilderness experience studies have been conducted (Rossman and Ulehla, 1977; Emma 2011) and a wide variety of adventure therapy research has been reported (Kaplan and Talbot, 1983; Kaczynski and Henderson, 2007); together with many therapeutic camping studies (Mitchell and Popham, 2008, Byrne and Sipe, 2010). Most of the evidence relates to the USA, Scandinavia and Japan and very few empirical studies analysing the health benefits of nature and green space have been conducted within the UK (Reynolds, 2002; Countryside Agency, 2003; William, 2001; Pretty et al., 2005). In addition, very few research studies have separated the effects of nature on social capital and collective well-being (Burgess et al., 1998; Coley et al., 1997; Fredrickson and Anderson, 1999; Ulrich, 1999; Ward-Thompson, 2002).
Here it is worth repeating that this study concerns the first level of engagement, ‘viewing nature through a window’ or as represented in an image. Such representations can be termed ‘surrogate landscapes’ being a composition of real or imagined nature or natural elements in a form such as a photograph, a picture, or an electronically generated image. This study draws on existing landscape research looking at preference studies using images (Kaplan and Kaplan 1972, 2007, 2008, 2009; Hartig 2001, 2003), but expands the focus of investigation to consider in more detail psychological and cognitive functioning obtained through eye tracking and verbal recordings.

2.10 Conclusion

Kaplan (2007) further concludes that involvement with nature at any level has positive effects for the participants. The relationship between humans and nature is through evolution[10]. Humans and nature complement each other, with escape to nature a kind of refuge and protection from urban life which may be full stress and anxiety (Nora 2010, Greenbie, 1981; Nicholson-Lord, 1987). These restorative effects of nature on health are only possible if nature is assessable and cities have effective transport systems in place (Burgess, 1998). Active participation in nature for the elderly population requires good networks of pathways and roads (Coles and Bussey, 2000). It is human nature, wish to feel safe, therefore people tend to use natural reserves where they feel safe. Due to involvement with nature, people can build new relationships as a result of social coherence which can increase as a direct effect over mental health and psychological well-being. Involvement with nature provides social, health and psychological benefits. Involvement with nature can halt disease activity and reduce stress (Ulrich, 1979; Greenbie, 1981; Nicholson-Lord, 1987; Kaplan and Kaplan, 1989; Bussey, 1996, Grahn, 1994, 1996).

Research also shows that alongside mental health gains from contact with nature in urban areas, physical health, biodiversity, and air pollution in urban areas warrant the inclusion of a variety of naturalistic spaces in all urban design, from formal city squares to patches of natural vegetation and wildlife habitat. All such naturalistic spaces will have multi-purpose benefits however, it is important to note the negative perceptions some people have of some areas of natural vegetation. Thus planning for natural landscapes in urban areas must involve public participation and close consultation with residents and local communities.

[10] Human are naturally designed to live and survive in natural environments.

Chapter 3. Eye tracking in Human Environment Interaction (HEI).

3.1 The Eye and its Movements.

To understand eye gaze interfaces, it is important to gain an understanding of the eye tracker and its interaction with the human eye. This chapter presents general knowledge of the eye and the eye tracker equipment. The first section gives an overview of the anatomy of the eye followed by a section on the types and principals of eye tracking. The final section in this chapter discusses the speed and accuracy of eye gaze and why it is not relevant to apply Fitts' law to eye movements.

3.2 Anatomy and movements of the eye.

A simple analogy of an eye with its requisite muscles is a photo camera with an image stabilisation system. The eye has six extra ocular muscles (Figure 3.1) that connect the eye to the head. These six muscles are arranged in three pairs; the media and later rectus, superior and inferior rectus, and the superior and inferior oblique muscles. By working in pairs, the muscles compensate for all movements of the head. This compensation is further added to by the nerves[11] which supply these muscles being connected to the equilibrium apparatus present in both ears.

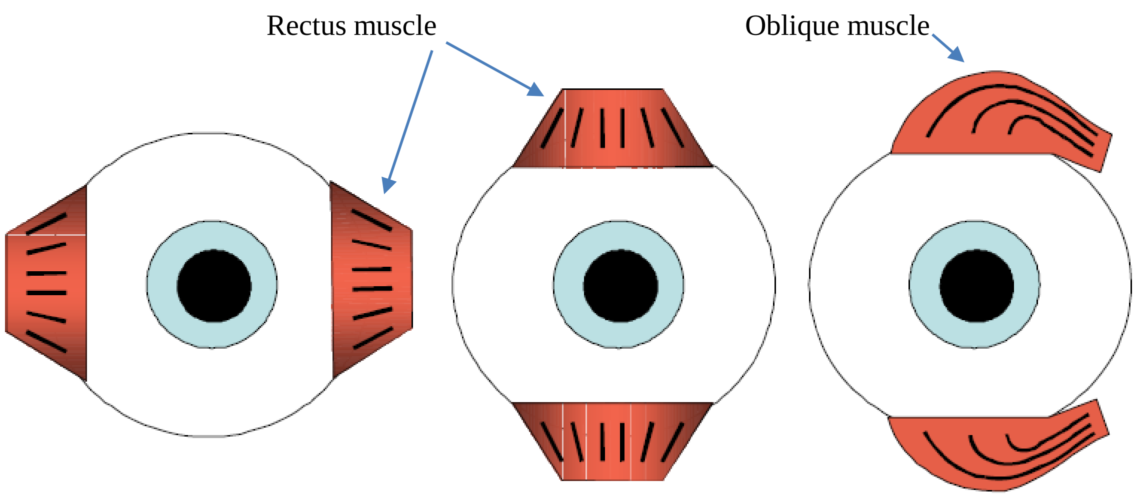

Figure 3.1. Three pairs of muscles can compensate all movements of the head

The eye is built in a very similar fashion to a photo camera. The pupil of the eye (hole in the middle of the eye) is surrounded by the iris which acts like the diaphragm of a camera allowing the pupil to change its size (diameter). The main difference between the camera and the eye is however the focusing system. The eye focuses by changing the shape of the crystalline lens whilst the camera

[11] Oculomotor nerve (superior, inferior and medial rectus muscles, and medial rectus), Abducent nerve (Lateral rectus) and Trochlear nerve (superior and inferior Oblique muscles).

focuses by changing the position of its lens. The retina is the light sensitive area at the rear interior surface of the eye behind the iris (Figure 3.2).

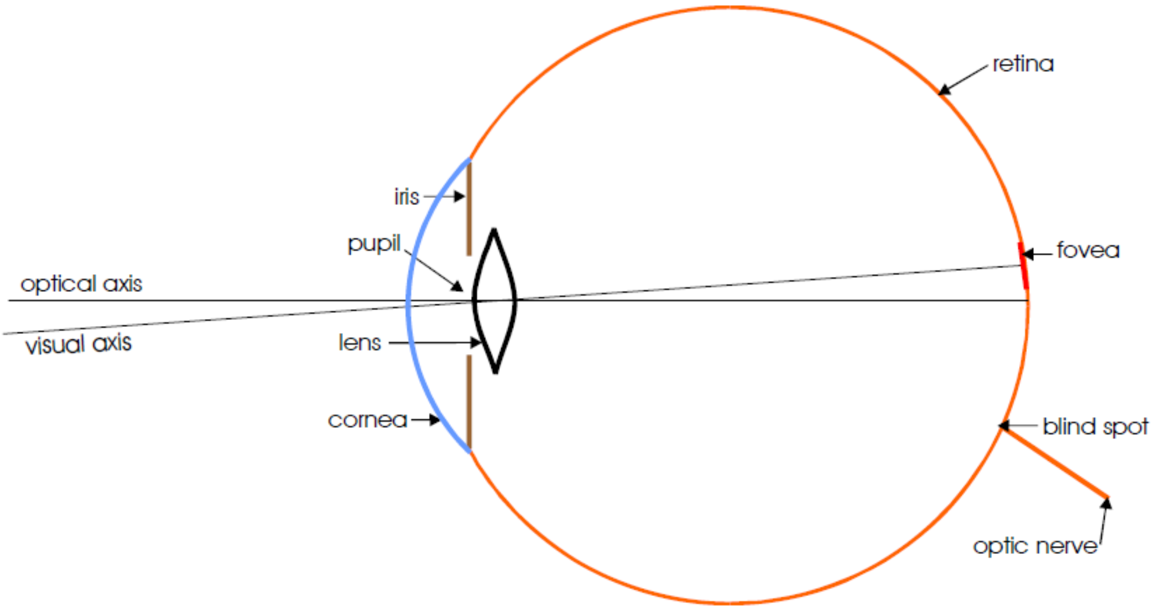

Figure 3.2. A simplified schematic of the human eye. (Sobotta 2004:366)

The retina is ellipsoid in shape and extends horizontally 180° and vertically 130° degrees. It consists of two different types of light sensors called rods and cones (photoreceptor cells). Both rods and cones have different functions. Rods are more sensitive to light and so more suited to night vision. Cones are less sensitive to light and only detect chromatic light. Rods and cones are generally unequally distributed in the retina Fig 3.3. The Fovea however, a small circular area of 1° - 2° in size has a higher density of cones, approximately 150000 cones/mm$^{2.}$. The fovea has higher resolution than the neighbouring visual field and so plays a major role in the perception of ambient motion (Duchowski 2002, p. 33).

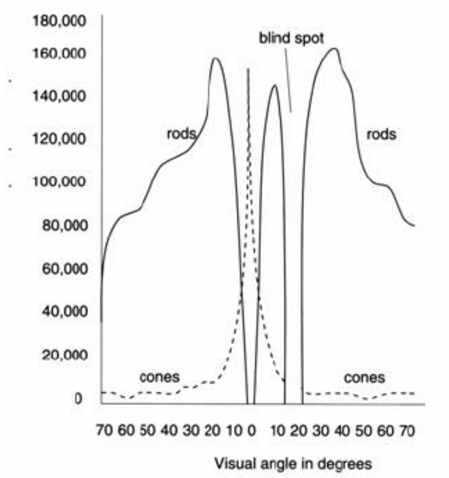

Figure 3.3

Figure 3.4

Figure 3.3. The density distribution of rod and cone receptors. (Duchowski 2002 p34)

Figure 3.4. The effect of density distribution of receptors for a retinal image.

(Land 2006 p42)

Both eyes move in a synchronised manner which ensures stable image projection onto the retina allowing image recognition. The general role of the three muscles pairs is to counter and compensate various head movements. The eyes move inversely to head movements which help with the focusing of moving objects. When the head is stable, the eyes jump from one point to other with an abrupt motion. These abrupt movements are called saccades. In between saccades, the eyes are stable, known as fixation. Saccades are related to the size of the fovea with 1° area that can produce a high-resolution image[12]. Saccades are important for clarity of image in that to obtain a clear image, the eye has to at first fix this image on the fovea after which fixation occurs. During fixation, the brain has time to process and recognise the object being viewed. The cycle continues with saccades following fixations resulting in a clear image.

Further detail can be applied to eye movements with regards smaller time scales in terms of micro saccades, drifts and tremors. To study such motions, very sensitive eye trackers are required. The eye tracker used in the present study filtered all such movements providing a smooth signal (Engbert and Mergenthaler, 2006).

3.3. History of eye tracking technology

The first eye movement study was conducted in 1901 by Dodge and Cline (1901) who developed a system to study eye movements on a photographic plate. This system required participants to move

[12] There is direct relationship between image resolution and each degree size of fovea involved.

their heads with their horizontal eye movements being recorded on a falling photographic plate. Dodge's method was accurate and non-invasive. This technique was reused again by Taylor (1971) and Duchowski, (2002). More recently, scientists have become interested in studying eye movements as it gives enriched data and insight into the intentions and thought processes of human, and we can study new relationships between eye moments and cognitive processes (Rayner and Pollatsek, 1992). Psychologists now research eye movements to explore cognition and human behaviour. Researchers also use eye tracking to control computer-based devices (Jacob and Karn, 2003).

Two-dimensional eye movements were first explored in 1920. In the beginning, these eye trackers were only used to study eye movements whilst looking at images (Duchowski, 2002). As time progressed, scientists used eye tracking for different types of investigations such as studying cultural differences in reading, habits and human computer interactions (Duchowski, 2002).

Hartridge and Thompson (1948) discovered the first head mounted eye tracking device. Until this time, all previous devices were not user-friendly. However in the 1960, an improved device was built by Macworth and Thomas which was more advanced than previous devices allowing some head movements (Land 2006).

The next major breakthrough came in the 1970s with the development of modern technology. New eye tracking systems were built which were able to record the data with more accuracy even during head movements (Land 2006). These new eye trackers were able to measure eye movements more accurately, particularly at a specific point at which an individual was looking at. However, whilst these were more accurate, these devices were still unable to eliminate the restrictions on head movements. However, with the addition of a chin rest, small head movements were isolated thus achieving more accurate results (Land 2006).

The literature highlights that most research up to 1970 was on developing appropriate hardware for eye trackers so as to make them more user-friendly and restrict head movements to increase accuracy (Land 2006). With the advent of computers, eye tracking devices were being built which were able to produce data which could be analysed quickly and efficiently by appropriate computer software. As technology further progressed, more advanced eye trackers were built which are non-intrusive and freely allow head movements (Land 2006).

At present, there are many cost-effective eye tracking equipment available. A Madurai tracking device was used in this research which was placed over participant's heads whilst they sat in front of a computer to record their eye movements. This eye tracking device allowed participant head movements. There are two main types of devices available on the market (Dix et al. 2004).

- A Head-Mounted Eye Tracking device (as used in this study)
- A Remote Eye Tracking device (e.g. ASL 504 pan/tilt eye tracker system).

In this modern era of science and technology, very small and portable eye tracking devices are available which can be attached to glasses/spectacles allowing individuals to venture outdoors whilst eye movements are being recorded (Land 2006). In terms of choosing an appropriate eye tracking device for this research, a head mounted device was selected which allowed free head movements. Some researchers argue that head mounted eye trackers can restrict an individual's view and hence a remote device should be used. In addition, remote devices are assumed to be better as they can be hidden whilst participants' data is being recorded in a more natural way (Land 2006). However, in the present study, participants are informed that eye tracking data is being recorded. An advantage of head mounted devices however is that they can be calibrated to ensure that only data is recorded when the participant is looking at selected images. Fixed eye trackers do not give this choice of field of vision to the participants (Iqbal 2004).

3.4. Linking eye tracking to cognition: Fitts Law

The use of eye tracking and eye movements to study cognitive psychology came from the aviation industry and dates back to the 1950 where a scientist named Fitts started to observe eye movements amongst pilots flying aircrafts. This was done to improve cockpit designs and make them more user-friendly. This research was done with the aid of a cockpit mounted video camera and mirrors to capture eye movements of pilots (Jacob and Karn 1990). This pioneering study revolutionised cockpit designs. The major findings of the study were that pilots fixated more on controls they assumed were of greater importance with the duration of fixation more linked to how easy or difficult was the use of that control (Fitts et al., 1954). The study looked at frequency, time durations and eye movement patterns and showed a clear relationship between eye movements and the cognition process.

The literature review discussed previously shows a major use of eye tracking in market research, where eye tracking is used to identify people's perception (Iqbal 2004). In addition, eye tracking has been used to aid the design and manufacture in aviation and car industries. Within the present study, this concept is applied to human environment interaction (HEI). Here, the frequency of fixation can be related to the importance of a particular point of fixation, i.e. an environmental element and duration can be linked to how user friendly or how complex a certain element of the environment is within surrogate images. As Fitts et al., (1954) mentioned, the duration can be related to the ease of understanding information; here in this case ease of understanding can be linked to previous similar kinds of interactions.

It is important to briefly look at Fitts law which was derived by Fitts in 1954. This law explains a model of human psychomotor behaviour which could explain the relationship between saccades and fixations in a more elaborate way. According to Fitts law, the time required from the original position to the target depends on the distance between the target and the original position and the importance of target and size of the target (Iqbal 2004). Fitts's Law states "movement time is a logarithmic function of distance when target size was held constant, and that movement time is also a logarithmic function of target size when distance was held constant". According to Fitts law, the movement time from original position to the target is affected by the distance moved and the precision demanded by the size of the target (Dix,1998). Fitts suggested a mathematical equation for his law as follows:

$MT = a + b \log_2 (2A/W)$ where:
MT = Movement time
a,b= Regression Coefficients
A = Distance of movement from start to target centre
W = Width of the target (Dix, 1998).

There are lots of practical applications of Fitts law which include studying fine movements of eyes, hands and fingers, as well as computer keyboards, and clicks on mouse in a computer. It is also used to predict fine controlled movements for writing and drawing (Iqbal 2004). Another way of applying Fitts law is in designing computers and other controls in terms of relation between the size of controls and the distance from the user; however, this is only one aspect of the design process with other elements which can make a design more practical and robust. In terms of application of this law in the present research, it will give a baseline for the study of eye movements and will allow the exploration of trade-offs when applying Fitts law to interface different environmental images on the computer screen. It will explain the relationship between fine eye movements, saccades and fixations in relation to HEI.

3.5. Visual search behaviour

According to Horowitz and Wolfe (1998), the basic purpose of a visual search is to get information over time related to design elements of an environment (Henderson 2003). This makes it very important to study visual search behaviour before designing any environment and incorporating eye tracking as a method of gathering information. Research suggests that visual search behaviour is guided by visual features of an environment whereas post cognitive modelling of research suggests that people use anticipatory information and knowledge as guiding principles behind their visual search behaviour (Henderson 2003). The use of eye tracking in this research and studying a human environment interaction is based on these findings from the research. It is important to mention that there is a gap in the research of studying human environment interaction in relation to visual behaviour and use of eye tracking (Henderson 1990).

There are different theories as to how we process data in our brain gathered through our vision. The following are two main ways of visual data processing:

1. Pre-attentive (processing which is done rapidly through parallel processing).
2. Post-attentive (processing during which items, scenes, words, objects are looked at in a serial manner) (Henderson 2003)

According to Henderson (1990) visual search behaviour can have either a bottom-up or top-down process. Here top-down processing includes participant's perceptions and previous exposure to certain types of environments; and bottom-up stands for individual landscape components. In this study, examples of bottom–up processing refers to the design elements of an environmental image and the influence of the visual scene itself such as presentation, attractiveness, daylight, colour, position, presence or absence of four basic natural elements of a natural scene, water, greenery, soil, sky and position of manmade interventions within a scene (De Vries et al. (2003). Top-down processing however refers to the expectations, preferences, predictions, built in participant's mind due to past experiences of visiting such environments, mental associations and attachment developed, including the purpose of previous visits can also effect participant's future choice of environment. Hence bottom-up influences may correspond largely to post-attentive processing, and top-down influences may correspond largely to pre-attentive processing. Interactions between top-down and bottom-up influences are identified as 'Information Scent' or 'Information Foraging' by Henderson 2003. Unless the design elements such as presentation, colour, daylight, water, vegetation, mountains (bottom–up) are looked at, there is no 'scent', and therefore, there is no basis for selection (De Vries et al., 2003).

3.6. Eye tracking and cognitive processes

In recent times, the study of eye movements, gaze patterns and visual behaviour has attracted much attention and importance from various domains of science and arts research. The relationship between eye movements and cognitive patterns were in the first instance looked at by Just and Carpenter (1976), who mentioned that the way we look at different things and gaze patterns carry information about our attention and preferences (Henderson 2003). In terms of scope for the present study, this could make a good modality for a proactive relationship and interaction between the environment and the human mind. Just and Carpenter studied human visual behaviour whilst reading and discovered interesting insights. They found that readers only focus on 67.7% of the words, with content word being fixated 83% of the time and function words fixated 38% of the time (Henderson 2003). This information showed that participants interpret each word as it comes rather than holding it in memory and assigning meaning to it later. This also gave information that both bottom-up and top-down processing was happening at the same time to allow for an understanding of the true meaning of what the participants were reading. Many other researchers tried to establish the link between eye tracking and cognition (Hayhoe, 1999). As research progresses, we are gaining an increased understanding of the relationship between eye tracking and cognition hence the importance of applying eye tracking to environment research (Hayhoe, 1999).

The recent growing interest in eye tracking is due to many reasons particularly the reduction in price of eye tracking equipment, more portable and robust equipment availability, and interesting results/findings of using eye tracking in market research. Scientists have been able to locate an area in the temporal lobe for the processing of eye tracking data (Henderson 2003). The temporal lobe is important in processing information hence it is suggested that eye movements carry important information related to decision-making processes, problem-solving and encoding information (Hayhoe, 1999). This presents a strong case for using eye tracking in environment research. Put simply, eye movement data provides information about, what, where and how long the participant is focusing (Henderson 2003). This could help environmental researchers to answer questions arising in relation to psychophysiological responses and restorative value of wilderness environments.

The current study of eye tracking research is but one narrow investigation into a potentially rich field of recreation-restorative environments. It offers several future research questions such as to what extent do different wild land recreation environments evoke different psychophysiological responses. Do favourite places and wilderness areas of extreme naturalness rank higher in value / benefits from a physiological perspective? And what environmental features and / or recreation settings yield the "higher" responses?

Eye movements allow inferences to be made about cognitive processes. It can be argued that eye movements do not entirely reveal a person's cognitive processes, but their flexibility means they can be used as a supplement to other sources of data.

It is important to note that according to Attention Restoration theory (Kaplan, 1995), viewing the natural environment can help restoring mental fatigue, improve human cognitive capacity and help psychological recovery (Hartig 1997; Kaplan 1995). All these domains can be studied by using eye tracking in the presence of green environment. All these domains have been studied by researchers before with the help of research methods which can only express individual wishes and feelings, whereas eye tracking will provide more reliable data when used in collaboration with existing/conventional research techniques. Another field with regards to the environment that is worth exploring is 'direct attention capacity' which can be made with the help of eye tracking in an environmental setting (Ulrich 1988; Ulrich et al., 1991). When direct attention capacity is fatigued an individual cannot concentrate and feels it difficult to deal with uncertainty, confusion and psychologically demanding tasks. All these different uses of eye tracking research warrant the use of this technology in the field of environmental research.

3.7. Eye tracking for the evaluation of an environment

The main advantage of using eye tracking in environment research over conventional research techniques like participant based observations which focus on participants' activities and performance while looking at images, is that with eye tracking it is possible to understand a participants' cognitive processes (Henderson 2003). By using conventional techniques it is possible to misinterpret the possible cognitive differences underlying participants' performance differences as conventional techniques are more performance-based. If conventional methods were used in this study it is possible to capture aspects of task performance such as screen navigation and selection of surrogate landscape components from the images but it would be difficult to understand cognitive processes (Henderson 2003). With the use of eye tracking data in environmental research, it is possible to understand the underlying cognitive processes and explanation and recommendations can be given for how human environment interaction can be changed rather than just an evaluation of the environment. With the use of eye tracking devices, it is also possible to understand in greater depth, how people use the environment which could help develop new theories and new knowledge about human environmental interaction (Henderson 2003). In terms of outcomes of this research, this is an exploratory study of human navigational and visual behavioural interaction with environmental images, hence, the results of this study may influence town planning research, architectural design research and future layouts of man-made interventions in environmental designs. This research would be a unique and pioneering example in bringing individual opinions and perceptions into the heart of environment design processes.

These are a few examples of previous studies to illustrate the nature and the scope of the influences the current study will bring in the environment research.

It was recommended by Pirolli (2001) to use eye tracking as navigational tool for research on images. Pirolli used eye tracking for participants who navigated through screens showing images of network browsers. He used time spent on each image and durations and patterns of fixations as indicators to justify how important certain design elements and parts of images were. Where participants fixed more were thought to be important for that participant and parts of images avoided by participants during eye tracking were thought to be complex and difficult for information extraction. The main advantage of such studies is the addition to knowledge base regards efficacy and effectiveness of eye movement-based metrics being used as indicator of liking or disliking certain elements and components of images shown to participants. According to Jacob and Karn (2003), number and duration of fixation are the most used metrics in eye tracking research. Consequently, such metrics are used in the current study to provide the theoretical backing from the literature for the potential use of eye tracking as an indicator of searching strategies on natural environmental scenes.

Specific design recommendations for prototype environment-based developments are developed by investigating search efficiency on multiple environmental scenes. It can also be seen later on that results of this study suggest that design recommendations should emphasise that important 'environmental elements i.e. sun light, water, greenery' should initially be key elements of any future landscape development. The discovery of a 'visual signature' during the present study can be linked to perspectives such as biophilia and an evolutionary basis for nature. This natural response draws on the intuitive notion that humans' long term evolution in natural environments must have resulted in some physiological and perhaps psychological 'adaptation' to natural, as opposed to urban, physical settings. (Kaplan 2004 Ulrich 1983; Orians, 1986). The main point to be noted here is our innate predisposition to the natural environment and natural preference for environments which favour survival and support evolution (Stainbrook, 1968; Appleton, 1975; Driver and Greene, 1977; Kaplan and Kaplan, 1989; Ulrich 1983; Orians, 1986).

In order to learn the effects across the environmental scenes presented to the participants, a within subjects research design[13] is used in this research. To evaluate existing research in the field of human environment interaction and develop an advanced level, eye tracking is used as it is a participant centred technique and hence has helped to devise new environmental design guidelines in town planning with participant perspective being central. The following are a few studies mentioned here as methods and findings of these studies were used as a precedent for this study. Although the studies mentioned below are not environmental studies, the researchers studied images on computer screens therefore these studies provide a good baseline and starting point for bringing eye tracking to environmental image research.

Multimedia information presentations shown on a computer screen were studied by Faraday and Sutcliffe (1996) using eye tracking. In their study, six participants were shown multimedia presentation for 18 seconds on the computer screen and an arrow was used to divert participant's attention towards certain points of interest in the multimedia presentation.
This study was very useful in studying human behaviour and helped in developing new guidelines for multimedia presentations.

[13] Here this refers to exposing same people to different types of surrogate environment images.

In another study by Crowe and Narayanan (2000), participants' actions and eye movements were compared to evaluate images shown on the computer screen. These researchers used combined methods to study human behaviour. They demonstrated the advantages of combining action logs and eye movement data to analyse participants' interactions with interfaces. As a consequence of such work, the current study used combined methods within the research on environmental images. Running narration, interview, environmental preference scores and eye tracking data are used in combination to study human behaviour in this research. Crowe and Narayanan (2000) suggested that a combination of eye movement data and data from other sources enhances understanding of a participant's behaviour and perception.

The study conducted by Narayanan and Schrimpsher (2000), assisted in developing analysis software and gave a framework to analyse eye tracking data along with data obtained from other sources for this natural environment image study.

Narayanan and Schrimpsher (2000) conducted a study to:

i. evaluate the usefulness and usability of Hypermedia Information Presentations Systems (HIPS),
ii. develop software for the analysis of eye movement data, and
iii. apply an interactive algorithm visualisation designed for computer science undergraduates in a pilot experiment.

According to Narayanan and Schrimpsher (2000), eye tracking is effective in analysing human interaction with visual image presentations. It revealed information that could not have been obtained by traditional evaluation techniques such as participant observation.

Similar to the above-mentioned studies, research conducted by Renshaw et al., (2003) also assisted in the process of research design and data analysis for the present study. In Renshaw study the researcher focused on participants' visual attention by comparing the relationship between eye movements and visual designs. The research compared two graphic designs, one of them was designed based on previous design research and other was designed by the research by completely ignoring previous design research. The results obtained were very interesting and assisted the researcher to understand participants' visual attention and visual behaviour.

It was concluded in their research that the graph constructed using previous research guidelines has a significant advantage over the design which did not follow previous guidelines in terms of time spent to complete the task and also participant satisfaction. Their study showed how effective the use of eye tracking is for evaluating previous guidelines to design a graph. Again, findings of their study gives a strong evidence base for increased use of eye tracking in environment design research.

Many studies using eye tracking data are usability studies. The current study is different in two ways; firstly, this is not a usability study and secondly, this study is unique in that it allows participants freedom to observe any part of an image without restriction such as time. Previously mentioned studies are not environmental studies but do provide a baseline to use eye tracking metrics for an environmental study. Eye tracking data from previous research provides a wealth of information to develop design guidelines therefore justifying its use for improvement of existing design guidelines and development of new guidelines in other fields such as environmental research.

Some researchers suggested that it is of vital importance to use new technologies to study environmental research as this could help to provide a new insight into the previously unseen characteristics of nature that could enhance overall human functioning and contribute to domains of human psychology and sociology (Ulrich et al., 1990, 1991; Parsons et al., 1998, Driver, 1976; Knopf, 1987; Schroeder, 1989).

Historically, landscape research was thought to be a complex phenomenon. However, due to the emergence and development of new technologies the interest in studying landscape research is growing (Council of Europe, 2000). The literature review highlighted that there are different definitions to describe the landscape. The most important and acceptable definition of a landscape is given by the Council of Europe (2000), "Landscape is an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors". This definition makes clear the importance of people perspective. Eye tracking provides an in-depth insight into people's perception of landscapes which has not previously been achieved through other research methods. According to the European Council (2000), desires and aspirations of the public are important to consider by planning and development authorities when devising any changes and developments in the landscape. It was also emphasised that landscape plays an important role in human social, physical and psychological well-being.

The literature clearly suggests that the existing landscape research is based on conventional research methods including observation, recording interviews and questionnaires (Scott and Benson, 2002). Most of the development authorities also rely on these conventional methods before asking people's opinions to make any changes in the landscape. According to Scott and Benson (2002), questionnaires and in-depth interviews are the most widely used methods of landscape research. The most frequently used stimuli in these empirical researches are photographs or in situ observations (e.g. Hägerhäll, 2000; Ode et al., 2008; Palmer, 2004; Sevenant, 2010; Tveit, 2006).

Eye tracking allows an 'objective manner' to measure peoples' perception of landscape whereas most of the conventional techniques are very 'subjective'. This is achieved by recording the speed and direction of eye movements (saccades) and the position and duration of fixations while observing landscape images. Eye tracking measurements are now well known in the field of environmental psychology (e.g. Berto et al., 2008). It has, however, also been introduced in geography (e.g. Antonson et al., 2009), cartography (e.g. Ooms et al., 2010a and 2010b) and landscape science (e.g. De Lucio et al., 1996; Tveit et al., 2006). Because landscape photographs are often used in landscape perception research (Sevenant and Antrop, 2011), eye tracking is a powerful tool for analysing people's observation of landscapes. Subsequently, these objective measurements can be compared to data collected from questionnaires, and related to the aesthetic and cognitive variables of landscapes. These approaches fit into the current international research to define objective landscape indicators for landscape perception.

There are very few studies conducted on eye movements to study behaviour using environmental images **(**De Lucio 2012, Lien Dupont 2012). This study may potentially set a precedent to assess the value of eye tracking as a tool for visual behaviour study in the field of environmental research.

Scan path theory[14] by Noton and Stark (1971) suggested that some participants tend to develop a habitually preferred visual path/scan path and proposed the use of serial encoding for the integration of sensory and motor elements which guide the saccades of the eye for each visual image. Noton and Stark claimed that when a particular visual pattern is viewed, a particular sequence of eye movements is executed, and furthermore that this sequence is very important in assessing the visual memory for this pattern. In the present study, it is noticed that all participants tend to develop a very individual, habitually-preferred visual path, scan path, across different displays of environmental images. This phenomenon is described under the heading of 'visual signature' in Chapter 4. This is a descriptive study in nature which explored navigational styles of participants by investigating the factors that influence navigation styles. However, recent studies (Outing and Ruel, 2004, Pan et al., 2004) attempted to understand the factors that influence participant's visual-search behaviour. Pan et al., (2004) investigated factors such as individual differences, design characteristics of the image displayed, the order in which images were viewed and different tasks that were given to the

[14] The term "scan path" was first used by Noton and Stark in their papers published in 1971 in Vision Research and Science, entitled "Scan paths in saccadic eye movements while viewing and recognising patterns" and "Scan paths in eye movements during pattern perception", respectively.

participants to complete. According to Lucio (2012), gender and viewing order were found to be key determinants of visual search behaviour. Men applied different scan paths from women and the order in which the stimuli were presented influenced the scan paths also (De Lucio, 2012**)**.

In the present study, visual search behaviour is the main focus as it is as a good indicator for usability and visual behaviour science. Moreover, by combining eye tracking with other techniques, richer data can be captured which enables a better understanding of participant's behaviour. The following section describes the proposed research which aims to explore such influential factors in order to enrich existing environmental research.

3.8. Proposed research

According to Jacob and Karn (2003), development of eye tracking hardware and software has been very 'encouraging and promising' over the last 50 years and has allowed the use of eye trackers in a variety of fields of research. The human environment interaction (HEI) community however must still learn more about use of eye tracking to study participants' perception, visual behaviour and must learn more about designing environments that fit human needs more closely (De Lucio 2012).

Goldberg and Wichansky (2003) emphasise that there is still much to be learned with regards eye tracking suggesting "little is known about how the density of a display or visibility of image elements influencing eye tracking results and perceived effectiveness". It is evident from the literature review that every evaluation technique has its strengths and weaknesses. A powerful interpretation of results can be obtained with the help of eye tracking data in visual search behaviour because it can be analysed both qualitatively and quantitatively (Goldberg and Wichansky 2003). Use of eye tracking can bring about an enriched set of data when combined with conventional data collection techniques by addressing the limitations of these techniques and improving direction and precision of results. Interestingly, studies that do not use eye tracking to collect data related to participant's perceptions rely on individual self-reports which are subjective and could affect variability of results obtained from such studies. Eye tracking can improve variability of results by bringing in objectivity in perceiving participants perceptions as it records the activity directly without relying on self-reports or the memory of participants. Eye tracking data are also important as they reflect cognitive processes and their relation to eye movements. Establishing a clear link between eye movements and participants perceptions is significant because it reflects the difficulties faced by individuals during human environment interaction (HEI) (Goldberg and Wichansky 2003).

Jacob and Karn (2003) indicate that there are three ways to interpret eye tracking data.

- *top-down,* when aspects of cognitive theories are tested,
- *top-down,* when a design hypothesis is tested, or

- *bottom-up,* when inferences are based on patterns across eye movement data.

In the current study, both top-down and bottom-up approaches are used to analyse data, (Chapter 5 to Chapter 9). The literature review conducted and findings from past studies have been used to understand visual perception in relation to landscapes. However, an open approach was applied to learn more about previously unexplored aspects of landscape with the help of combining objective techniques like eye tracking to the conventional subjective data collection techniques. This approach was applied as it is well-known that no single technique is perfect enough to access a participant's behaviour in fine granularity. By applying these principles, quantitative data were obtained via eye tracking with qualitative data obtained via interviews and narratives. Such approaches and methodologies of capturing behavioural data is unique and pioneering.

The key eye tracking terminology defined for this study is:

Fixation: According to Cowen et al., (2002) a fixation is defined as minimum duration from 150 to 300 m seconds for a stable eye position. There is not fixed definition of fixation, the definition changes depending on the type of study and the type of eye tracking apparatus used and fixation is an indication of information gathering (Hansen, 2003).

Saccade: These are abrupt eye motions which occur in between the fixations and they are generally shorter than the fixations and last between 15-50msec (Cowen et al., 2002). No information is gathered during the saccade, the size of the saccade depends upon the amplitude of the saccade which is related to the distance travelled by eye between the scenes (Hansen, 2003).

Scan paths: These represent the patterns emerged during the fixations and saccades, over the period of time, figure 3.5 represents an example of a user's scan path on a environment image during this study (Cowen et al., 2002). In the figure 3.5 the red dots are fixations, representing the order of fixations and the lines between the fixations are saccades. According to Cowen et al., (2002) scan paths spatial arrangement gives information about the sequence of the visual search behaviour.

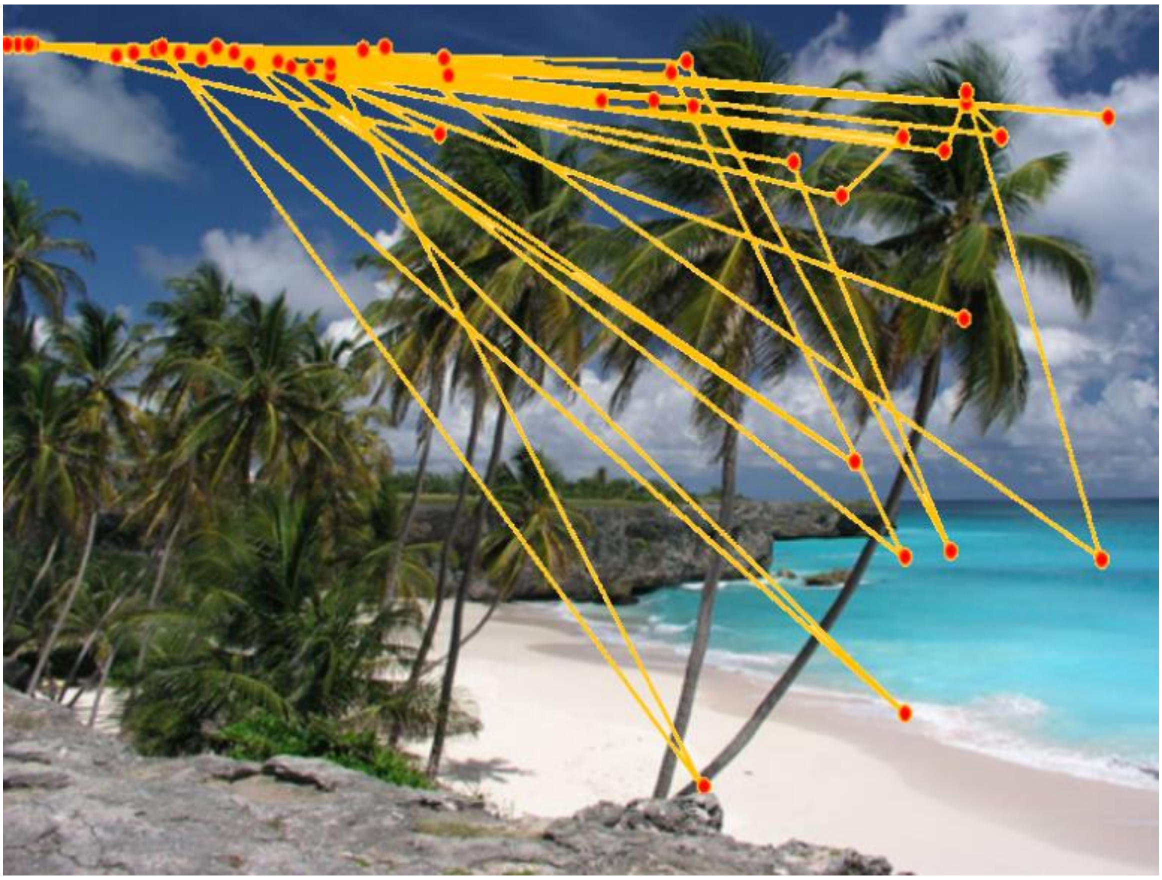

Figure 3.5. Example of Participant's 'Scan Path'.

Look Zones or Areas of Interest: These are defined as an area which is displayed within the visual field of a participant, with particular design elements which surround this area. Look zones or area of interest generally represent semantics of the scene, for example, an environmental image, on the screen might be defined as a look zone in order to determine whether, how often and for how long a user looks at that specific design element. According to Cowen et al., 2002 all the coordinates including along the x-axis and y-axis which represent fixations and lie within the specified bounded region are used as an indication of attention to that design element.

Scan path efficiency: According to Rayner and Pollatsek, (1994) localised scan paths are more efficient scan paths. Hence Whether or not scan paths reach the bottom of the environmental image displayed, the distribution of scan paths is important well-organised grouping of components in an image display results in, scan paths that covered smaller areas (more efficient scan paths). Efficient (localised) scan paths indicate that the environmental image elements/ components are well organised and easy to find. In contrast, scan paths that reach the bottom of the environmental images display screen indicate that a comprehensive search was required and hence the organisation is less efficient. And such environmental scenes are considered as complex scenes and participants generally showed lack of interest in complex scenes and spent less time on such images.

Initial gaze: this is defined as an area of fixation where the participant looked less than a second (100 msec) prior to the environmental images appearing on the screen. It was suggested by Loftus and Mackworth (1978), who conducted eye tracking studies in reading that the eyes fixate initially on areas that are surprising, salient or important through experience. Hence, location of initial fixation is significant. In this research, location of initial fixation has been separated into two metrics,

1. initial gaze
2. entry point

this follows from Loftus and Mackworth (1978) that where participant's look before any stimulus appears but when stimulus is expected imminently, they are likely to reveal areas that are anticipated as important through experience for example in this research previous environmental encounters drive initial gaze. Initial gaze was used to indicate where users expected to find target links.

Entry point: The main difference between the entry point and initial gaze is, initial gaze depends on previous environmental encounters and whereas entry point is more driven by the type, quality and salient features of the environmental elements present in the images. Entry point is defined in literature as where the participant looked within 250 msec of the environmental image appearing on the screen. Again following Loftus and Mackworth (1978, p28) conclusion about the significance of the location of initial fixation, entry point was used to identify initial design elements that attracted attention.

Gaze duration on look zones or AOIs: This is defined as the amount of time the participant fixates on points within a given look zone. Fitts, Jones and Milton (1950, p21) distinguish between gaze duration, reflecting depth/intensity of interest in information extraction (Top Down processing), and frequency of gazes, reflecting the importance of that area of display (more Bottom up Processing). Gaze duration on look zones was used to indicate importance of information extraction.

Transition of fixations between design elements: The number of transitions between two specified areas of interest. Jacob and Karn (2003,p33) suggest that number of transitions between related design elements indicates the efficiency of the arrangement of elements on the images, with fewer transitions reflecting more efficient arrangement, and high numbers of transitions indicating a referencing or interpretation difficulty. Transition of fixations was used to indicate efficiency of layout.

Metrics	As used in previous research	As used in this research
• ***Scan path efficiency***	Rayner and Pollastek (1994)	Used in this study
• ***Location of first fixations:(adapted as initial gaze and entry point)***	Loftus and Mackworth (1978) Byrne et al., (1999) Ellis et al., (1998)	Used in this study
• ***Time to target fixation***		Used in this study
• ***Gaze duration on look zones***	Fitts et al., (1950), Harris and Christhilf (1980), Hendrickson (1989), Benel et al., (1991), Flemisch and Onken (2000)	Used in this study
• ***Transition of fixations between elements***	Hendrickson (1989), Kotval and Goldberg (1998)	Used in this study

Table 3.1. Additional eye movement-based metrics as used in previous studies and as applied across this research.

Chapter 4. Research back ground and paradigm

4.1 Introduction

This chapter will discuss why a mixed methods approach was chosen for this research study. In the first instance, phenomenology or interpretivism stances will be discussed to justify the use of a mixed method approach. The chapter will also justify the use of quasi experimental approach alongside a case study approach for the study. According to Martyn (2008, p 33), "Quasi experimental design is often integrated with individual case studies and the figures and the results generated by using this method reinforce findings of case study methodology." The use of this mixed methodology has many advantages such as obtaining a general overview and then following with case studies to find out the reasons behind the results (Martyn 2008, p 33). By mixing these two approaches is the best way to tackle shortcomings of quasi experimental designs, especially when true experiments are not possible.

The use of mixed methodology is not a new practice in the field of environment research. Leger (2003) studied wildness therapy using both quantitative and qualitative methods. Many studies in the field of recreation, leisure, horticulture therapy, eco psychology and animal assisted therapy have shown benefits of nature in terms of its effects on psychology and physiology using a mixed methods approach. Sevenant (2010) looked at landscape perception and preferences using a mixed methods approach. Use of qualitative methodology in environmental research has been conducted in Scotland by Bringer (2004). Palmer (2004) used spatial metrics to predict scenic perception in a changing landscape. Antonson (2009) researched effects of surrounding landscape on driving behaviour in a driving simulator study and used a qualitative approach.

The next section discusses the rationale for the study design and details the elements of analysis. It also provides an overview of the data collection methods used for the thesis as well as the means used to analyse the data. The chapter concludes with sections on the limitations of the research and ethical considerations.

4.2 Research philosophy

Many researchers use the terms 'methodology' and 'methods' in a different way. Methodology is the overall approach considered whilst collecting the data, whilst the term method refers to the means used to collect and analyse the data (Hussey & Hussey, 1997). Researchers suggest that methodology provides a theoretical basis for a study, like an umbrella term which includes any particular methods used in that research (Mason 2002, p30). In the present study, these terms are used in accordance with Hussey & Hussey (1997) and Mason (2002) concepts of research methodology. Hence, data collection methods, means of analysis, and other elements of research design are considered as part of the methodology for this research. This research adopted a code that involves a clear understanding of the distinction that is frequently made regarding research philosophies of 'positivism' and 'interpretivism'[15] (Bryman and Bell, 2007; Hughes and Sharrock, 1997; Travers, 2001).

The differences between positivist philosophy and scientific approach were well integrated by considering the central code of positivism that researchers can take a scientific approach by using an objective data collection and analysing methods to study human behaviour. Considering this, eye tracking was used as an objective technique to study human visual behaviour. Although it is assumed that positivism and science are synonymous concepts, in reality, there are considerable differences between positivity philosophy and scientific approach (Bryman and Bell 2007). According to Bryman and Bell, (2007, p 16), "knowledge arrived thorough gathering of facts that provide the basis of laws" which shows that inductive strategies are part of positivism. A bigger sample size is generally required when positivist study favours use of quantitative methods to investigate large-scale phenomena (Travers, 2001). According to Hughes and Sharrock (1997), social phenomena can be viewed objectively whilst measuring social behaviour. Within a positivist philosophy, the number of propositions are generated which are then tested at a later stage using deductive theories (Babbie, 2005), whereas inductive theories are used during interpretivist studies and deductive theories are only used at a later stage to generate new concepts (Babbie, 2005). Within interpretivist philosophy, researchers observe aspects of the social world and try to generate new patterns to describe and explain underlying wider processes and principles (Babbie, 2005). Robinson (2002) argues that there is no reality, it is only human perceptions and experience. According to Hughes and Sharrock (1997, p 102), facts of reality and humanity are lost when they are analysed and reduced to barely the interactions of variables. Keeping these aspects in mind, the role of the researcher in the research process is very important and researchers should aim to analyse the various interpretations as participants relate to particular phenomena, with an open and neutral approach (Easterby-Smith et al., 2002).

An interpretivist position was adopted predominantly in this research. That is, it is considered that there are multiple realities that make measurement difficult, and we can only seek to understand real-world phenomena by studying them in detail within the context in which they occur. For example, the purpose of the eye tracking study is to investigate participants' real experiences with surrogate naturalistic images from their individual perspective and eye tracking provides an objective approach to study human behaviour.

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[15] "Positivism" means scientific approach, highly organised, measureable and numerical, whereas "interpretivism" is an approach adopted by social sciences mainly, collects qualitative data using unstructured interviews and observations (Babbie, 2005).

4.3. Qualitative research

The interpretivist position is believed to be the best qualitative approach to research in investigating the factors that influence the participants' visual search behaviour and performance when they look at different surrogate landscape images (Hayhoe 1999). A qualitative approach to research provides both in-depth and variety of data to understand phenomena under any study (Miles and Huberaman, 1994). A qualitative approach plays a crucial role in explaining any phenomena when generating theory. The major strengths of this approach are realism, providing a longitudinal perspective, explaining meanings of experiences in a social world and placing a phenomena in its context (Miles and Huberaman, 1994).

According to Gummesson, (2005), qualitative research plays an important role in the regeneration of new theories. In contrast to this, other disciplines like quantitative and positivists aim to test theories (Bryman and Bell, 2007). Quantitative research has its strength in generalising the results to statistical sampling (Bryman and Bell, 2007). Qualitative research has its strengths whilst studying human behaviour and can also be used in combination with quantitative methods to test theories.

As Silverman (2005:14) notes:

"Qualitative research can mean many different things involving a wide range of methods and informed by contrasting models".

Quantitative research can also be used in theory regeneration like qualitative research (Robson, 2002). It is not possible to assume that only one type of methodology is the best choice, however it is noticed that combining different approaches complements in explaining research aims and questions, gives clear purpose to a study and justifies the operational conceptual framework for research (Silverman, 2005). Qualitative approaches are generally criticised based on being descriptive in nature, not rigorous, and that data collection flawed due to subjective role of researcher (Goulding, 2002). Researchers combine qualitative approaches with quantitative approaches to reduce subjectivity and improve academic rigour (Goulding, 2002). Quantitative and qualitative approaches are brought together because quantitative approaches are more objective, researchers use mathematical data to view and measure phenomena 'from the inside' (Miles and Huberman, 1994). With this in mind, a mixed method approach is used in the present study.

4.4. Rationale for the research design

Within a qualitative framework and an interpretivist stance, this thesis is concerned with identifying the factors that impact on how the environmental layout in environmental photographs can have an effect on participant's decisions in terms of where to focus or look. A review of the literature, existing environmental research related to HEI, and the impact of environment on our well-being means that the task of identifying such factors is a complex one. With this in mind, the nature of the research presented in this thesis is exploratory, building on existing knowledge and theories, but also being receptive to any new or as yet unconsidered thought, relationship or phenomena. It seeks to generate theory to suggest possible relationships between the use of eye tracking in environmental research and studying human visual behaviour more objectively than any previous environment psychology study.

4.5. The case study as a research approach

This research favours the importance of 'direct research' as argued by Mintzberg's (1979). A case study approach has its strengths in the generation of a theory and understanding of phenomena during such direct research (Eisenhardt, 1989). There are many advantages of using case studies with a quasi-experiment approach in terms of a rigorous research to study human behaviour in a social setting (Hartley, 2004, p 323). There is much evidence of using this mixed approach in market research (Bonoma, 1985; Johnston, Leach and Liu, 1999, Perry, 2000; Riege, 2003). The main advantage of using a case study approach to study phenomena is its nature as a single unit of analysis which has exhaustive depth and gives meaningful, realistic and holistic characteristics of a phenomena or any real-life event (Ball, 1996). According to Yin (2003), a case study defines contemporary phenomena of real-life and serves as an adequate method of investigation particularly when the boundaries between phenomena and context are not clear. In Yin's definition, there is an emphasis on the clearance of the 'boundaries' because it is crucial for the difference between context and phenomena to be clear (Miles and Huberman, 1994). Miles and Huberman defined a case as a phenomenon that is growing in a bounded context. Case study is also defined as an analysis of the context and studying a process underlying a phenomenon (Johnston et al., 1999). The strength of a case study is not only in describing phenomena and context, it also provides in-depth information of the relationship between context and phenomena and also describes how a particular incident/phenomena happened in addition to the processes that lead to that phenomena (Hartley, 2004). It also describes how behaviour influences context, and a context can influence behaviour (Hartley, 2004). This point is reinforced by many who argue in favour of case studies to be used in market research which has influenced the researcher case study as method of research in this present study (Bonoma, 1985: 202).

A case study approach has been justified in the present study in that it attempts to understand the factors that influence participants' visual behaviour strategy in terms of where to focus or look at when exposed to an environmental image. The use of eye tracking in market research to create more effective layouts and improve customers purchasing behaviour is a well-researched phenomena. Based on this market research idea, the research in this study is conducted by using an eye tracker. Environmental researchers adopting/not adopting certain aspects of use of eye tracking in market research would have difficulty without the contextual picture provided by the case study approach (Patton, 1990). It is always matter of a choice depending on the type of research and availability of cases to conclude how many participants will take part in a particular research (Hartley, 2004). The next section considers the use of multiple cases in this research. It also describes how behaviour influences context, and a how context can influence behaviour (Hartley, 2004).

4.6 Multiple Cases

There are generally three types of case studies; intrinsic, instrumental and collective (Yin, 2003). The intrinsic case study looks at a particular case and explores enhanced understanding of that case but does not explain the phenomena or build theory. The instrumental case study looks deep into a case and tries to explain and shed more light on phenomena to build theory. Here, the case plays a secondary role in explaining the understanding into phenomena (Yin 2003). The third type, collective cases, are multiple instrumental cases which may be the same or different but have redundancy and variety. It is not in line with the interpretvist stance to choose multiple cases because more in number or a bigger sample size means more generalisation to a wider range of populations (Robson, 2002). The large number of cases are chosen here only because this would lead to a better understanding and perhaps better theorising (Yin, 2003: 446)

The case study participants for this thesis are quite different in many respects. As will be demonstrated in the next chapter, the participants have a variety of differences in terms of age, sex, birth place, country of origin and history of exposure to nature. This fact does not lessen their usefulness as a collection of cases. Indeed, within multiple case studies, such variety can be particularly useful when conducting cross-case analysis (Yin, 2003). Nonetheless, in order for the differences to be sufficiently illustrated, this thesis has a separate section in Chapter 6 for each class of images and each participant. Details regarding each case will be set out commencing with an overview of brief history and relation to a natural environment of each (CNS form scores). While these sections might be assumed to be somewhat descriptive, such detail is, as Eisenhardt (1989, p 540) points out, “central to the generation of insight”. Each case section will conclude with an analytical summary. The final section in Chapter 6 will provide a synthesis of all the cases (classes of images), following Yin (2003, p 50), who noted that “both the individual cases and the multiple-case results can and should be the focus of a summary report”.

4.7 Data collection with a case study approach

The process of combining two or three different methods of data collection is called triangulation, a useful research option (Denzin, 2006; Flick, 2002). The main aim of regulation is to combine different sources and methods of data collection to improve the quality of data and improve the validity of research (Flick, 2002). According to Easterby-Smith et al., (2004), there are four different types of triangulations;

- data triangulation (data collected from different sources or at different times)
- methodological triangulation (combining different methods)
- theoretical triangulation (the application of a theory from a different discipline)
- triangulation by investigators (the use of multiple independent investigators).

In terms of incorporating triangulation in this thesis, multiple perspectives of same phenomena such as visual behaviour, are considered through analysis of different sources. According to Denzin, (2006), triangulation gives richness and depth to the research process by analysis of the multiple sources of data that are available to the research.

Landscape research has a significant role in social, economic and political life. However, it is influenced by visual communication just like market research (Loizos, 2006). Therefore, it is important to recognise terms such as 'visual' (Loizos, 2006). This phenomenon is very apparent in market research as it is based on its ability to seek communication through a visual route (Fill, 2005). Dissecting and analysing the data collection and data analysis processes during this research shows the power of visual communication tools to analyse human and environment interaction and its significance to the modern environment/landscape research. That said, the principal method that was adopted for this study was eye tracking alongside running narratives and in-depth interview which will be addressed in a separate section. This is followed by a section outlining the narratives, and a section on the secondary data (environmental initial assessment) sources used.

4.8. Interviews

Kvale (1996, p 1) describes the importance of interviews as, "to understand the world from the subjects' points of view, to unfold the meaning of peoples' experiences, to uncover their lived world". Qualitative research interviews open windows for researchers to view a research topic from the perspective of the interviewee (King, 2004, p 11). King further describes the importance of interviews in analysing participant's views, motivations, opinions and suggestions as a means of collecting data. In accord with the research questions, in-depth interviews were conducted at the end of eye tracking and narrative data collection exercises from each participant (university students and staff). The position titles for each interviewee is provided in Table 5.1. However, it has been deemed unnecessary to attribute the quotes used in subsequent chapters to identify individuals. The interviews took place at Birmingham City University data collection laboratory between 2011–2014.

It is evident from the literature that there are no set rules for the number of interviews and participants in a study. According to Kvale (1996: 103), "some qualitative research takes a positivist stance, tending to adopt the approach, the more interviews, and the more scientific". However, according to an interpretivist framework, "researchers will simply need enough data to explore and document a range of themes" Travers (2001:31). It was considered from the literature review (Rayner 1992, Henderson 2003) that a minimum of twenty interviews from students and staff from the university was an appropriate sample size[16] for this study, depending on the saturation of data. A significant aspect of this decision was the resource and logistical implications of a huge amount of data being obtained from eye tracking and other methods. A semi-structured approach to the interviews was chosen as the inherent flexibility of this approach is major advantage (Babbie, 2005).

The literature makes clear that when research follows a regulated and standard set of open-ended questions for a survey, interviewees are able to express themselves more freely (Flick, 2002). This reduces the chance of missing important information and themes during the interview sessions (Babbie 2005). However, this is not to indicate that interviews should not follow any formal structure. As Babbie (2005: 314) cautions: "it is vital for the qualitative interviewer…to be fully familiar with the questions to be asked". The themes for the interview schedule **(**Appendix B) were structured around the issues raised in the review of the literature relating to factors influencing visual behaviour whilst looking at environmental images that formed the basis of the research questions noted in Chapter 1. The pilot study revealed that it was not essential to follow a fixed schedule and that better results could be obtained when participants were not following a set criteria (King, 2004). However the researcher made sure not to neglect any important themes for this research.(Easterby-Smith et al. 2002). The researcher was also aware of the importance of keeping the wording and meaning of the questions the same for each participant so as to achieve cross case compatibility which in return ensure greater research validity (Bryman and Bell, 2007). Hence the use of semi structured interviews allowed a comparative review of the results. All interviews lasted a minimum of 1 hour. Once the interview had concluded, reflective interview notes were made. Each interview was audio recorded and subsequently transcribed into Microsoft Word by the researcher. The researcher subsequently replayed the tapes and amended the transcripts in relation to any inaccuracies with transcription and to clarify inaudible responses (MacLean, Meyer and Estable, 2004). This process also allowed an additional opportunity to reflect on the content of each interview (see Chapter 5 for more details).

4.9. Narrative research methods

Improvement in recording and transcribing technologies has seen an increase in the number of studies making use of narrative research methods within the humanities and environmental sciences (Millman, 2011). Narrative research includes many different methodologies such as oral history, life history, personal history, autobiography, auto ethnography and narration of the phenomena or an

[16] Sample size was mainly depending on the data saturation and similar previous research studies were also considered.

event, as used in this study (Merrill and West, 2009). Despite a degree of differences among all these subtypes, all share a common theme of narration of lived experience (Merrill and West 2009).

According to Connelly and Clandinin (1990), narratives emphasise ‘individual’ instead of the social context in which they live. Despite this criticism of narratives, this method of data collection is commonly used in fields of environmental research, history, society and mostly used to illuminate and examine intersection of biography (Riessman, 2003). The reason behind the explicit use of narratives is that it offers an insight into the way in which the environment and society configures life of an individual. Narratives are ideal in providing insight into personal experience and complexity of environmental, cultural, social and historical processes (Riessman, 2001; Andersen, Dausien and Larsen 2005; Antoft and Thomsen 2002; Mensinga, 2009).

One of the strengths of narratives is in conceiving the individual ‘identity’ and allowing expression of changes that can influence ‘identity’ throughout the course of life. According to Connelly and Clandinin (1990: 10), “narrative and life go together and so the principal attraction of narrative as a method is its capacity to render life experiences, both personal and social, in relevant and meaningful ways”. Individual biographies of conditions of lives express the reality of one’s life (Merrill and West 2009; Skeggs, 2004). Narratives play an important role in organising and configuring overall lives, and lives of people around us by clarifying our ‘identities’ (Mensinga, 2009). Narratives make the environment and lives coherent and meaningful by linking past to present. Ricoeur (1999), states “we read ‘the end [of a life] into the beginning and the beginning into the end” (cited in Lawler, 1999: 10).

Mensinga (2009) argues that narratives are employed to discover meaning, not to reveal or discover only truth. Narratives play an important role in constructing identities of subjects and themselves. Byrne (2003: 30) expresses this as “The interest in narrative and the narration of identity signifies a move away from the search for essential, universal or even rational identities and a stress on the more uncertain and creative processes of construction and fabrication”.

Experiences and silenced/hidden stories can be brought out by using narratives (Merrill and West, 2009) which is why narratives are commonly used in feminist research to explore experiences of women, and voices of women, which is not possible to explore otherwise (Byrne 2003). As there are many women participants in this research, the use of narratives was valid. Narratives are aligned with feminist studies due to the concept of ‘voice’ (Byrne, 2003).

Reasons for using narrative research methods is thus twofold; in researching individual experiences of exposure to different environmental images, and share a commitment to giving voice to how individuals feel and experiences in environmental research as well as an interest in examining how visual exposure to different environmental images map onto individual lives. The whole point of this exercise was that when people look at images or natural scenes they have feelings about what they see, which normally they don't express openly. Narration, whilst looking at images provided a chance to know how individuals feel about exposure to certain landscapes.

4.10. Implications of using narrative research methods in environmental/landscape research

According to King (2004: 27) we live in an 'interview society' where "interviewing of all kinds mediates temporary life", for example the celebrity interview, the job interview, the police interrogation, the therapeutic interview and so forth. In this way, individual interviewing can be viewed as a part of the modern environment, governing mentality and as a technology of the self **(**King 2004 p 26**).** Thus, investigations into the self, can make an effective expression of the self[17], hence use of narrative is effective way to collect data about personal perceptions.

Use of narrative research and interviews can be justified in environment psychology research as a technology of the 'self' which requires the ability of the research participant to produce a coherent account of the personal experiences. Byrne (2003, p23) argues that this makes a narrative approach appropriate and relevant not only in specific circumstances, but also that one can learn from those instances where research participants 'fail' to narrate the self in a coherent manner. In relation to the empirical study in my thesis, considering how narrative research methods focus upon expression of participants' experiences is complemented or even substituted by other forms of previously unexplored expressions; for example visual research methods in environment psychology such as eye tracking. The intentions of this study have been to allow for a discussion of how narrative research methods enable a 'voice' and bring to the fore the hidden expressions of individual experiences whilst exposed to environmental images and eye tracking at the same time.

4.11 Secondary sources

As noted previously, within a broad qualitative approach to research, triangulation of data sources can provide a richness of data that can give each case additional depth (Easterby-Smith et al., 2004; Flick, 2002; Mason, 2002). In addition, Fillis (2000) has noted that new theory generation can benefit from embracing non-traditional modes of enquiry. The aim here was to use a Connectedness to Nature Scale (CNS) and other background information to provide a broader perspective of each participant's visual behaviour (Mayer 2004:512).

The background CNS questionnaire elicited:

- the participant profile (that is: name, age, gender,), and

[17] The phrase means here, if we need some information about what an individual is thinking about something, the best possible way to find out is, if that individual describes it himself. So use of narratives is effective mechanism of data collection.

- Previous environmental experience (such as frequency and purpose of environmental use).

The Connectedness to Nature Scale (CNS)[18] provides a measure of an individual's trait levels of feeling emotionally connected to the natural world. It was designed to measure the extent to which participants generally feel a part of the natural world and emotionally connected to it. This measure consists of 14 items rated on a 5-point Likert scale with a rating ranging from 1 (strongly disagree) to 5 (strongly agree). Respondents were asked to "Please answer each of these questions in terms of the way you generally felt". There are no right or wrong answers and participants are asked, "Using the following scale in the space provided next to each question simply state as honestly and candidly as you can what you are presently experiencing". Items 4, 12, and 13 are reversed scored. Scores are summed and the total scale score ranges from 14 to 70. Higher scores reflect a higher degree of affective connectedness to nature.[19]

4.12 Data analysis methods

Data analysis has been defined as "stuff of analysis" by Miles 1994, this includes combining the data obtained from different data sets and methodologies, differentiating and reflecting on them (Miles and Huberman 1994: 56). According to Bryman and Bell (2007) this is a process of putting codes and assigning inferential tags to a set of data for the purpose of relating it to the research question (Flick, 2002). Based on perceptual framework, aims and objectives, and the key factors from literature and research question of this study, a preliminary set of codes were derived to start the data analysis process. According to some researchers the analysis process involves revisiting, re-examining and re-evaluation of the data (Robson and Hedges 1993). During this study the data were revisited several times and multiple codes were derived from the data, later on some of the redundant codes[20] were dropped which were thought not giving any substantial information, various important codes and themes were revisited and studied in detail in the light of already available literature. Some important codes have been discussed in chapter 7 and chapter 8 of this thesis.

4.13 Perceptual Framework used for Data Analysis

The beginnings of a sense of image (SOI) that may create a process for continued understanding and dialogue hopefully come from allowing a person to explore their own SOI by explaining their connection and perspectives of an image (Buswell, 2003; Sevenant, 2009). This SOI will be varied and will depend on 3 factors. 1) Connections, 2) Visions and 3) Perspectives. The figure below gives a visual representation of this concept.

[18] See chapter 5 for details
[19] For more details of CNS scale see chapter 5 for methodology.
[20] Redundant codes, are when NVivo makes some categories due to repeated use of certain terms, which in reality do not give any substantial information regarding research question.

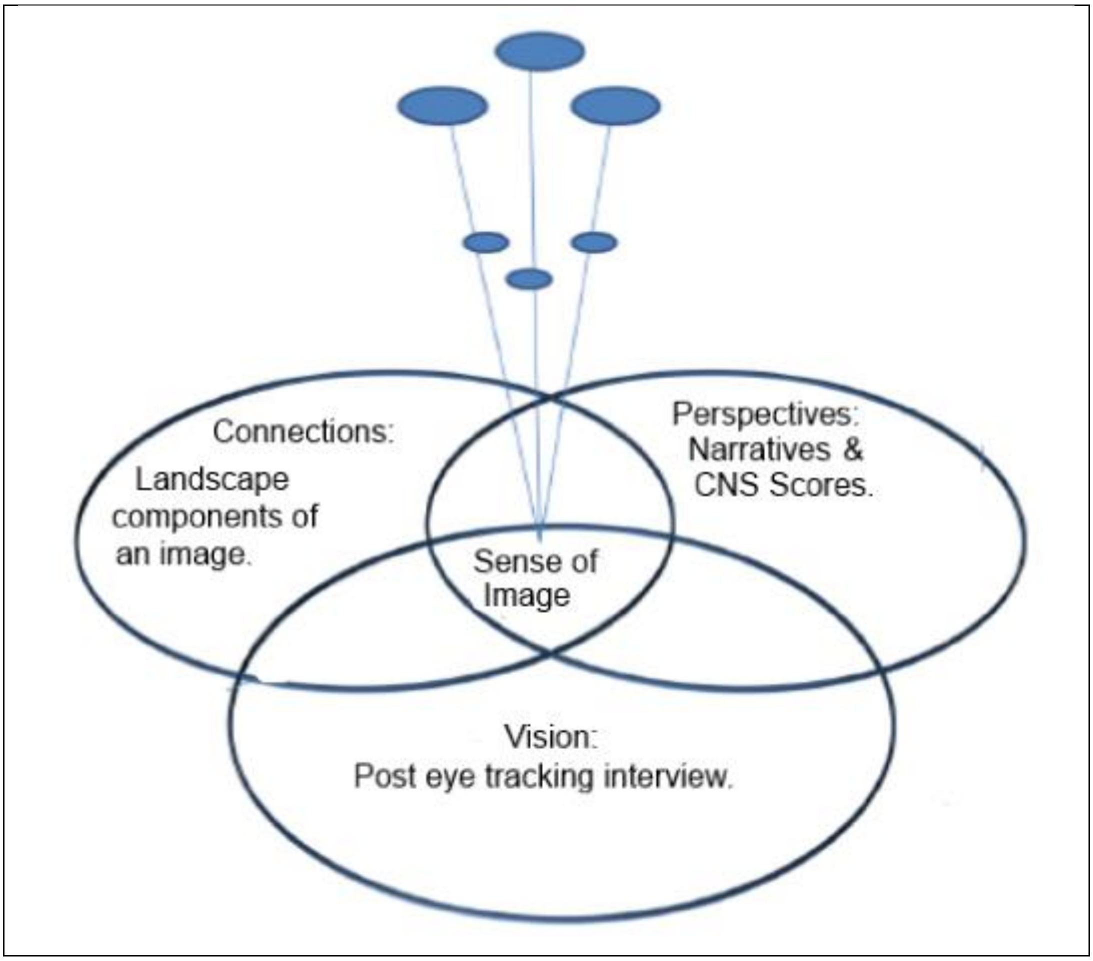


Figure 4.1. Sense of Image Framework (SOI) for data analysis

It is useful to keep in mind that this is a representation of something that is dynamic, as one cannot determine the SOI of a person. Connections are influenced by the presence or absence of certain landscape components in an image, past positive or negative experiences of similar type of landscapes and any memories. Vision can be found by asking questions about landscapes. Perspectives are the running commentary of the landscape viewed by an individual. Drawing on this framework, the researchers' worldview is incorporated through narrative inquiry using data collection procedures that uncover the beginnings of each part. The researcher revisits this framework in the conclusions of Chapter 6 which begin to explore the diversity of relationships revealed through the research.

4.14. Computer assisted data analysis

There is lots of criticism about use of computer software for qualitative data analysis, in spite that NVivo[21] is one of the most common software used in qualitative data analysis (Easterby-Smith et al., 2002). The main criticism presented here is the inappropriate quantification of qualitative data

[21] Qualitative data analysis software

neglecting contextual productivity and richness of qualitative data and bringing in frequency counts and other measures (Bringer, Johnston and Brackenridge 2004). Researchers criticise that despite the advantages like, an easy retrieving of computer based analysis, the aggressive defragmentation of data endangers the continuity of narratives and natural flow of qualitative data (Bryman and Bell, 2007). Continuity and narrative flow is one of the important factors for using qualitative data (Bryman and Bell, 2007). Bryman and Bell, (2007) suggest that despite their disadvantages of using computer-based data analysis softwares, there are many advantages of using these time-saving programmes for example highlighting important aspects, easy cutting and pasting, categorisation of themes, and linking different themes with the help of diagrams. NVivo provides transparent and more congruent data analysis and is significantly less laborious in comparison to conventional qualitative data techniques (Bringer et al., 2004; Bryman and Bell, 2007). According to Wickham and Woods (2005) the ability of computers to code multiple categories, linking these categories together via visual representation assists clear analysis of searchable memos and production of new themes. Due to the above reasons, the researcher used NVivo 10.0 a product of QSR[22]. Bringing in the researchers past experience and the literature review on the software used for qualitative data analysis, it has been noticed that there is no one particular software that is the best for qualitative data, hence Nvivo 10.0 was selected due to its features for example hierarchical categories, and searchable annotations (Richards, 1999; 2005)

Interview transcripts, individual narratives, eye tracking images data, background information and connectedness to nature (CNS) data text versions were imported into the software. In the current study, NVivo 10.0 is used to analyse the data obtained from participant narratives, and interviews. However a preliminary set of codes was well-established before starting the analysis based on literature review, pilot study, aims and objectives of this research and perceptual framework. This information provided a baseline for interview questions and an initial structure to start the analysis process using an NVivo 10.0. As the data obtained from narratives and interviews were analysed, a hierarchy of themes begin to emerge, and named as ‘connections’ in this study. Some of these themes with respect to the importance, are discussed in chapter 7 and chapter 8 of this study. In table 8.1 a subsequent hierarchy of the themes and some common threads which emerged during this study are presented and later discussed in the result section. NVivo 10.0 played a vital role in creating and analysing different themes emergent from the data. The visual representation of the themes by using aNVivo10.0 gave the researcher a clear view of how different themes relate to each other for example figure 7.3 A and 7.3 B gives a hierarchical view of theme structure and different perspectives emerged. It is important to notice that Nvivo only provides a tool to create different categories and themes and cannot replace or duplicate a human brain when it comes to analyse data (Easterby-Smith

[22] Company that produces NVivo

et al., 2002; Weitzman, 2000). NVivo allows easy comparisons and comparatives, which allows themes and ideas to be teased out from the data with least effort however the responsibility of actual analysis is still performed by the researcher.

4.15. Analysis of secondary sources

In this study content analysis techniques were used to study data obtained from secondary sources for example CNS scores, background information of participants, and eye tracking data. For the last few years the use of content analysis in social sciences and environmental research has been continuously observed (Neuendorf, 2002). According to Krippendorff (2004: 18), content analysis is defined as a research technique which make more valid and replicable inferences from the data obtained from different text sources with regards to context. This technique can be applied to a wide variety of research other than the written words (Krippendorff 2004: 18). Content analysis can investigate all sort of communication including non-verbal and visual communication, therefore is applied in this study (Riffe, Lacy and Fico 1998: 24). This can be used on photographs, TV advertisements, and eye tracking data (Riffe, Lacy and Fico 1998: 24).

In this context, this kind of hierarchical theme structure emerged as each participant perceived the content of the images. According to Barnard (2005) there is a clear link between communication and graphic design and hence there is a link between design elements of landscape and human communication. As noted above, an extensive eye tracking photographic record of individual participants was collected to provide a similar insight. From the research it is evident that images are regarded as “a subjective, inferior or even an eccentric form of data compared to words and numbers” by academics (Stiles, 2004:127). It is evident from the history of the photographs that have been used in the fields of anthropology and ethnography that in comparison to numbers and words, photographs are less respected as data (Flick, 2002). Despite of all these stereotypes there is clear evidence that use of photographs is becoming more frequent among academics (Flick, 2002). In this study the photographs and eye tracking are used to create, “visual record [which seeks to] systematically record visual detail with emphasis on reproducing objects, places, signs and symbols” (Prosser and Schwartz 2006: 144). The use of photographs along with other sources of data collection in this study is best justified by Flick (2002: 53), that “the analysis of visual material is mostly triangulated with other methods and data”. Therefore the analysis of different landscape photographs with eye tracking can be related to a phenomena called ‘look and feel’ explained by different landscape researchers (Flick 2002: 53).

4.16 Limitations of methodology

As previously discussed, there are perceived limitations with a qualitative research approach. The criticisms noted are that qualitative research is purely descriptive and therefore not rigorous, and that it is too subjective and impressionistic (Goulding, 2002). A further criticism is that there is a lack of transparency in qualitative research, that is, it is difficult to see why and how a researcher might reach their conclusions (Bryman and Bell, 2007). This chapter has sought to address this issue by noting the reasons for choosing certain methods such as interviews and narratives, and how these methods were analysed. With the latter, in particular, the use of CAQDAS has meant that the research process is well documented.

While the study reported here was constructed carefully to overcome several limitations of earlier studies, there were still some limitations that had to be accepted. Some of these result from a limitation of resources; others are consequences of unavoidable trade-off decisions. Examples of the first type include the choice of equipment (especially the use of head-mounted equipment) and sample size which was constrained by laboratory access and operational overheads. Examples of the latter type are discussed below.

A laboratory was used for the study as this allowed a high level of experimental control while keeping resource requirements relatively low. This decision carries a cost in terms of reduced ecological validity. For example, were the participants' performances during the studies similar to that in real outdoor environmental interaction? The main limitation of the reported empirical work is that none of the participants was asked to interact within a natural environment setting, nor were they observed during longer tasks. They were asked only to look at a set number of environmental images for a very short duration, whereas in naturally-occurring interactions, such as using real exposure to the natural environment, the user would have been able to record more accurate and real life exposure to nature for much longer intervals.

These limitations on the observed interactions might have led to limited or atypical behaviour, and this is a matter for further study. However, the experimental tasks were representative sub-tasks of authentic interaction (e.g. identifying what sort of elements one has found), the images were selected from an authentic site by applying Delphi consensus and a modified Hartig Restorative Scale (See appendix). The subjects were readily able to relate experiment tasks to their prior experience, and so there is reason to believe that the design preserved reasonable ecological validity while allowing necessary control.

Another question to ask is to what extent the results of the reported research can be generalised. The participants were a relatively small, volunteer sample, may be not appropriate for qualitative study but many will argue may be not a representative selection. Limitations of the eye tracking devices (which rely on reflected light) mean that spectacle-wearers were excluded from participation.

However, they certainly do not represent the whole range of people, and the results cannot be generalised more widely. Although the conclusions are thus limited, this study certainly yielded well-founded preliminary insights that provide a good basis for further investigation of factors that are likely to influence visual search behaviour when interacting with a natural environment.

4.17 Ethical considerations

It is of the utmost importance that research involving human participants is carried out to the highest possible ethical standards. The key principles taken for all four studies in this research were:

- not to harm,
- to ask for consent (an example of the consent form used for this research can be found in Appendix A),
- to allow freedom to withdraw at any time
- to ensure confidentiality

These are the main principles identified by the British Psychological Society (BPS) in its ethical code of conduct (BPS, 2002). All participants were over 18 years and volunteered to take part in the research. Information about the eye tracking device and how it operates was given during the recruitment process. Briefing of what the participants, were to expect and a clear account of the purposes of the research was given upon arrival to the laboratory. All necessary steps were taken to ensure that the participant felt comfortable and entitled to withdraw at any stage of data collection. The results of the studies have been accessed only by research team members as stated on the consent form. Examples of the participants' data such as quotations or scan paths have been anonymised. Upon completion of the study, the participants were asked to report any negative experience and provide feedback for further improvement of the data collection session.

Like any other study, when studying environment and landscape the researcher has to keep number of issues in mind to make the study unbiased and ethical. It has been noticed from the literature review that the importance of informed consent is not well debated in the literature (Bryman and Bell 2007). There are other issues to be considered for example confidentiality. According to Robson (2002), it is important to protect participant safety, physical and emotional well-being during the course of research. Due to all these factors, during the course of this research participants well-being was considered at every point, every measure was adopted to address any concerns and it was made sure to conduct this research in an ethical manner. The Birmingham city University ethical guidelines for research were followed throughout the process of this research. The study was conducted after granting ethical approval from the research ethics committee. All the paperwork was prepared in simple plain English avoiding any technical terminology and presented, before an ethical committee which included, interview consent form (appendix A), information sheet for the participants (appendix B), questionnaire for interviews (appendix C), images to be presented to participants (appendix D) and connectivity to nature CNS score forms (appendix E). All the interviews were given a copy of information sheet and consent form at the beginning of data collection process. All the participants were informed about the potential risks and benefits of the research in the information sheet. It was also explained to participants that all the information they provided will be stored securely against the access of any other person other than for the researcher for five years, and will be only used for this study. It was also explained that electronic records and paper records will be securely destroyed at the end of five years period.

Due to the fact that everyone who participated in this research was linked to Birmingham City University either as a staff or student, and some of the people involved in this research knew each other well, therefore keeping anonymity and informing participants about the anonymity process was important so that, they can express their views confidently knowingly that all processes is completely anonymous. It was made clear in the participant information sheet that participants' real names will not be mentioned in the thesis. Participants were given full opportunity to review and amend their interview data and delete any information they did not wish to be included. However, there were no amendments.

4.18. Conclusion

The main focus of this chapter was to examine the methodology for this study. The differences, advantages and disadvantages of using quantitative and qualitative methodologies was discussed in the first section of this chapter. The presence of Positivists/interpretivist dichotomy between different research approaches was discussed in the first part of this section (Bryman and Bell, 2007; Hughes and Sharrock, 1997; Travers, 2001). The reason for choosing qualitative approach for this study is partially based on the researcher's interpretivist stance. Due to the subjective nature of this study, a perceived fault of qualitative research for being subjective was the main reason for the researcher to adopt this approach for the current study (Golding 2000). The subjective nature of qualitative approach allows to explore phenomena deeply from inside (Miles and Huberman, 1994). The research design was shaped by the interpretivist stance and qualitative framework. It was made sure during the research process and considering the 'analysis unit' for this study that every participant is individual in providing a census of factors influencing his/her visual behaviour during eye tracking process using landscape images. Therefore the participants past experiences of exposure to nature, and their background was considered to play an important role in liking or disliking a landscape image (Hartig

2007). This also justifies the use of case study approach because according to Yin (2003), this approach allows to investigate individual behaviours within everyday life milieu.

Case study approach with regards to issues related to data collection were discussed in the subsequent sections of this chapter. Different data sources and techniques were used in this study ensure triangulation to reduce the bias related to individual data collection techniques (Denzin 2006). Different types of data were collected using secondary sources for example CNS score data, eye tracking data, background data, interviews and narratives and related it to the topic to minimise the bias. The pros and cons of using different data collection techniques were carefully considered for example for a qualitative approach, interviews provide vital information and allow the researcher to understand the point of view provided by the interviewee as well as allowing the researcher to explore the research question from different angles (King, 2004; Kvale, 1996). After discussing different methods of data collection, data analysis techniques were discussed in this chapter. According to Easterby-Smith et al., 2002 computer assisted data analysis techniques are commonly used due to their advantages to the conventional or manual qualitative data analysis techniques. Criticism related to computer assisted techniques was also discussed for example Beryman and Bell (2007) expressed their concerns regarding discontinuity and defragmentation of data, whereas Bringer 2004 called it as 'inappropriate quantification'. However based on all the advantages of using computer assisted data analysis techniques NVivo 10.0 is used in this research. Thematic analysis using preliminary set of codes based on aims, objectives, research questions, key factors evident from literature, and perceptual framework was conducted using a NVivo 10.0. A content-based analysis was used on CNS (connectivity to nature score) data and eye tracking data was conducted which provides a complete picture of each case and provided 'triangulation'. The limitation of research section describes the perceived limitations of qualitative approach. The section on research philosophy justifies use of mixed methods including qualitative methods for this research. The final section described the issues related to lack of informed consent (Robson 2002) and confidentiality (Beryman and Bell 2007). And this section also described the procedure followed in line with Birmingham city University ethical research guidelines before conducting this study.

Chapter 5. Research Design

5.1. Introduction

The previous chapters have introduced the background of this research outlining available environmental research techniques the primary evaluation techniques applied. This chapter presents the methodology of the study. The set of techniques chosen for data collection are based on a set of existing environmental landscape research guidelines and then tested by conducting an eye tracking study. The first section of this chapter briefly addresses the rationale of the study.

5.2. Rationale for the environmental experiment

It has been noticed from the literature, that there is not much evidence of using eye tracking to study human visual behaviour using surrogate landscape images. The uniqueness of this study is evident due to the fact that in the past the relationship between the participants' previous experiences and expectations to the scanning behaviour is not studied by any researcher. According to Maller 2005 studying of nature by using new technologies is important, because in the past many researchers who studied traditional disciplines for example biology and human psychology, wilderness therapy, recreational and leisure therapy and environmental psychology have discovered that nature provides huge emotional and psychological benefits (St Leger, 2003). There are many other studies and scientists who discovered positive relationships between green space and human health and well-being. (De Vries et al., 2003; Takano et al., 2002; Tanaka et al., 1996).
It is evidence based that the contact with natural environment can bring positive effects to human mental health, it is important to study human well-being inclusively by bringing various disciplines of science together for example public health being an umbrella discipline, may constitute horticulture, landscape research, psychology, environmental and ecology (Burgess et al., 1998; Rohde and Kendle, 1994; Helena et al., 2009;Cathrine, 2012; Frumkin,2003; Herbet 2007; Mooney et al., 2012; Seymour, 2003; Manuela, 2009; Jenny, 2011; Pretty et al., 2003, 2005; St Leger, 2003; Thompson 2011; Emma, 2011; Pretty, 2004).

Some scientists have gone to further and deeper lengths and proposed a theory which is called biophilia hypothesis (Wilson, 1984, 2001; Kellert and Wilson, 1993; Heerwagen, 1993, Weber 2006). According to this advanced viewpoint, the connection between the human and the natural environment is inherited and therefore has an innate nature, they linked environment to genetic make-up DNA (Weber 2006). They also proposed that this contact enhances our mental health and well-being in general. Thus, it is important to further identify in detail this contact with the environment via eye tracking which could provide such detailed and in-depth information.

5.3. Method

This study focused primarily on participants' visual search such as the points of fixation on an environmental image that appears on a screen. First fixation on an environmental image is indicative of very early scanning behaviour whilst a participant looks for the image's environmental typing identity and component POI (point of interest). The study also considered factors that might influence the participants' expectations when searching for this information, such as previous experience of visiting similar kinds of environment as shown in the image. In this study, the information and data is collected in three phases which are interlinked. Table 5.1 provides an overview of the conceptual framework of this research and how different sets of data are linked together.

	Surrogate environment Image study	
Phase 1: **Literature Review** • Existing Environmental Research • Existing Eye tracking studies and use of eye tracking in environmental research. • Looking at use of eye tracking in Market Research	**Phase 2:** **Selection of Images.** • Delphi technique[23] **Eye tracking session** • Position of first fixation within given time • Reading and analysing of scan paths • Accuracy of task responses • Recording running narratives.	**Phase 3:** **A. (CNS)[24] Background Questionnaire** • Participant's profile • Previous environment experience **B. Post–session Interview** • Perceptions and expectations of information on Environmental Images • Interaction with 'Stills' of eye tracking session

Table 5.1. Data collected during Environmental Image Study

[23] Consensus for selection of images

[24] The Connectedness to Nature Scale (CNS) provides a measure of an individual's trait levels of feeling emotionally connected to the natural world

5.4. Participants

Twenty anonymous participants (male and female) were recruited. Their ages ranged from 23-54 with a median age of 32. Ten participants (Bold) had viewed the images before during the selection process of images prior to their participation in the session.

Name	Age	Sex	Country of origin	CNS Score/70
Alan	28	M	Qwait	56
Casey	40	F	UK	46
Edvina	54	F	UK	46
Jamela	54	F	UK	42
Mona	31	F	China	58
Moo	x	M	Iran	57
Nicklus	30	M	Uk	42
Nini	40	F	Thiland	49
Romia	33	F	Uk	29
Rosy	46	F	Uk	55
Robert	32	M	Uk	49
Rina	28	F	Poland	56
Shahzadi	35	F	Kashmir	53
Tariq	32	M	UK	46
Tom	27	M	UK	47
Ursila	23	F	UK	48
Ussama	24	M	Uk	48
Venessa	29	F	UK	49
Zafira	31	F	Uk	49
Zara	32	M	UK	48

Table 5.2. Participants profile and CNS scores

5.5. Devices

This research used a video-based eye-tracking system that projects harmless infrared light onto the eyeball to track reflections from landmarks of the eye. These are recorded by video cameras fitted with relevant filters. Image processing software is used to identify and map eye positions to the display. The lens, cornea, and other parts of the eye absorb a small amount of energy from the infrared light, but it is less than one per cent of the Maximum Permissible Exposure Level as certified by the American Standards Institute (ANSI Z 136.1-1973). This is the equivalent amount of light one experiences during a sunny day.

There are numerous video-based systems. This study used a Sensori Motoric Instruments (SMI) (SensoriMotric, 1999), a head-mounted system (HED-II) with a sampling rate of 10 Hz that corrects for head movement and allows general movement (Figure 5.1 and 5.2).

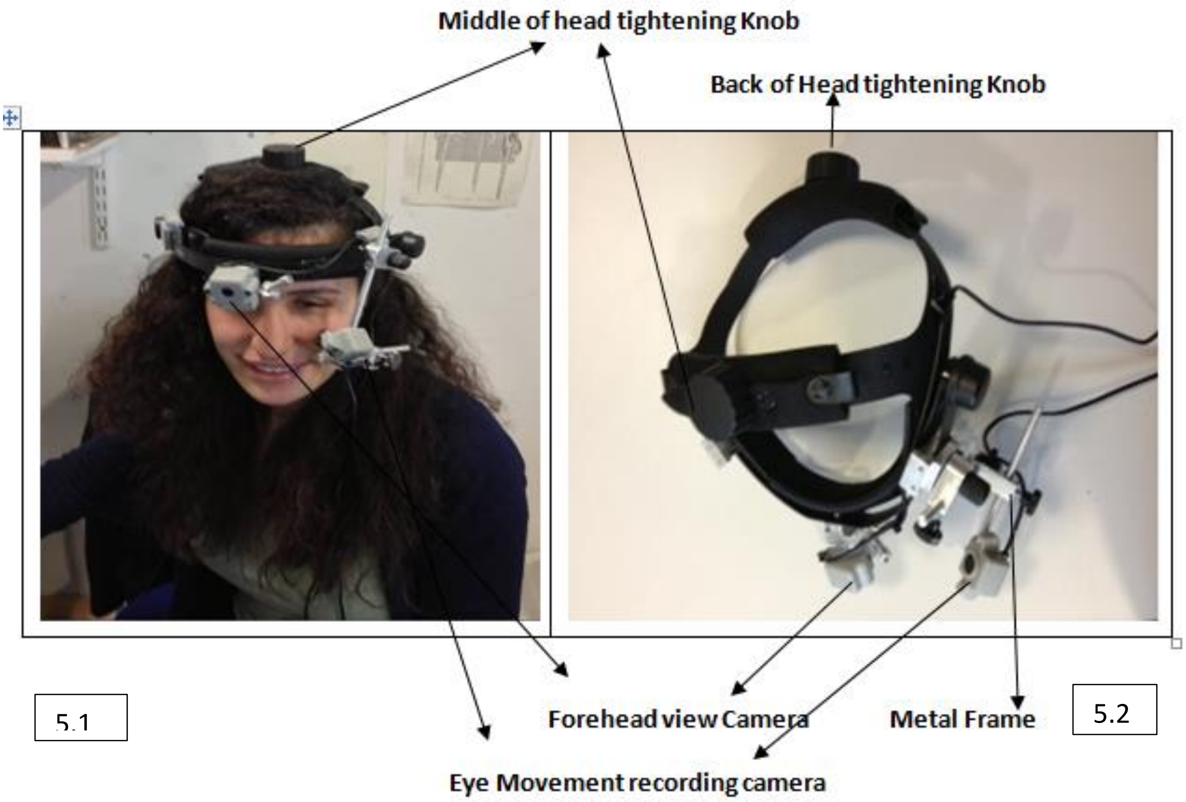


Figure: Eye Tracking Device Used in this research.

Figure 5.1 and 5.2. Equipment used in this study

Systems differ in the amount of time required to set-up and adjust the hardware. In some cases, additional items are used such as chairs that can be adjusted to change the height of the display relative to the participant. A study by Nevalainen and Sajaniemi (2004) compared three eye tracking devices to explore their ease of use and accuracy. They also observed the trade-offs of using each device in terms of inconvenience the participants faced. The three devices they examined were: Tobii 1750™ from Tobii Technology, ASL504 from ASL, and the ASL 501 from ASL. They found that the ASL 501 required approximately twice as much time for the preparation as the other two devices. Tobii 1750™ seemed to be the most unobtrusive for the participants, and the ASL504 needed to be checked manually for possible loss of data.

With this in mind and considering all these facts, the eye tracking device used in this research was purpose built in the Faculty of Engineering, Aston University (UK). The present study used this device as it required less time to set-up in addition to the device being less intrusive for the participants as it used a comfortable head band used in a standard ophthalmoscopes. This allowed a full range of head movements during exposure and also allowed for the measuring of pupil size during the exposure. The organisation of the data was eased by the use of accompanying analysis software (GazeTracker™).

5.6. Eye tracking data collection

The SMI's Head Mounted Eye Tracking Device (HED-II) uses two small cameras (the eye camera and the scene camera) and an infrared light mounted on an ophthalmoscope band thus weighing in total 450 g (Figure 5.2). A beam splitter glass is positioned to reflect the downward pointing light into the eye. The front of the eye is illuminated with the infrared light. This produces a dark pupil and a corneal reflection (Sensori Motoric Instruments, 1999). The scene camera (fore head view camera) records what the participant is viewing on the screen. This recording and the eye movement data are transferred via video encoding hardware to the researcher's machine. This enables the creation of mpeg video files of the scene video with an over-laid moving dot representing the participant's eye movements. The iView™ software on the researcher's computer is connected to the eye tracker to analyse the transmitted data from environmental images; the Point of Regard is then computed (Sensorimotor Instruments, 1999). The eye movement data can be exported to Excel spreadsheets for further analysis.

Eye movements were recorded using an eye tracking camera capturing eye movement data at a sample rate of 10 Hz. The camera is placed in front of the participant's eye without obscuring the participants' view and is adjustable. The presentation of the stimuli is controlled by means of the Gaze Tracker™ software and presented on the screen viewed by participants from a distance of 6 feet from the 60'x 60' inches flat screen. The GazeTracker™ software also records the eye-movements and enables the researcher to view the data. ASL Eye pose software also records the data and is used as a back-up. The study conducted as part of this research was technology-intensive. As the laboratory was shared with other members of the university, this required a separate set-up each time a participant was undertaking an eye tracking session as part of the conducted study. A detailed presentation of the set-up is presented in Figure 5.3.

It is important to mention that this is an exploratory study and the need to control viewing conditions was considered important.

Hence, the room selected had no windows, was temperature controlled, and contained a large viewing screen. The distance of participants seating from the screen was kept constant. Such preparations and controls ensured that there was no interference with participants gaze.

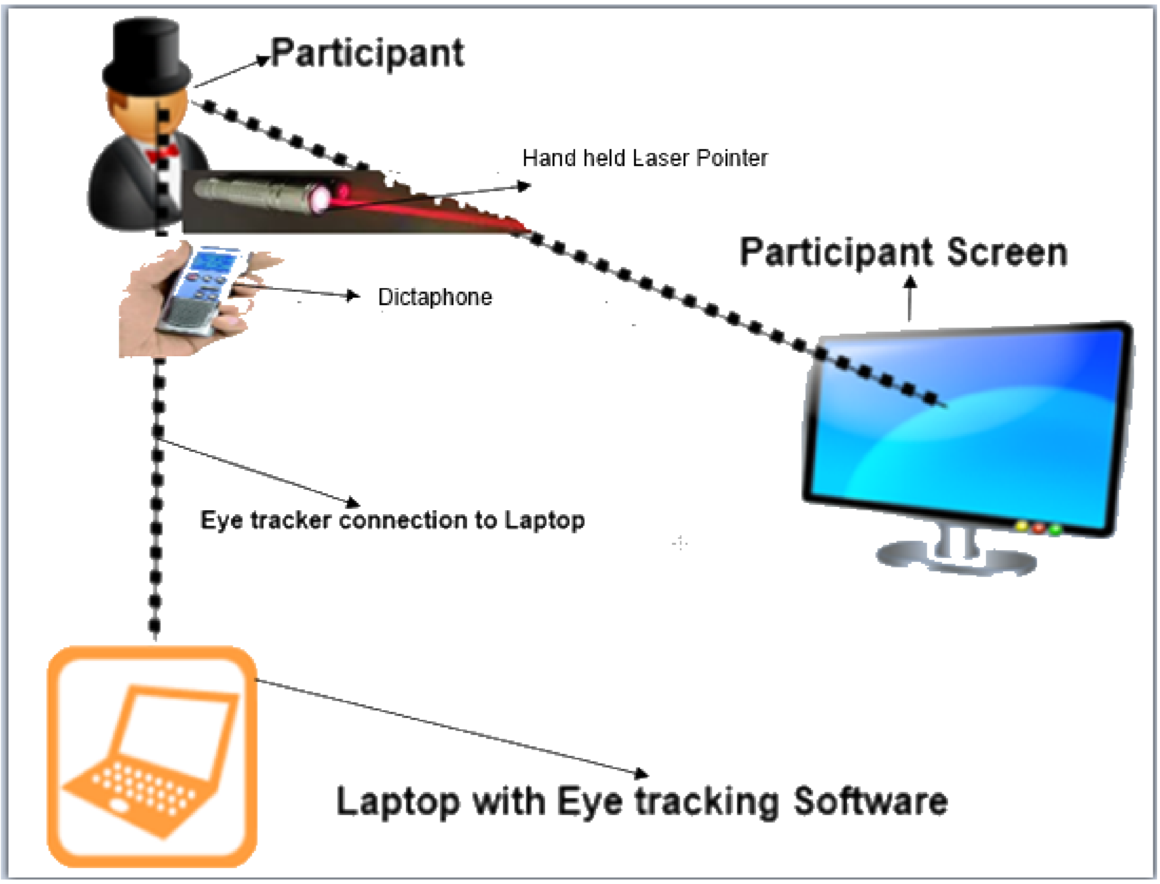


Figure 5.3. Overview of lab setup for data collection

5.7 The techniques

The complementary nature and dichotomy between the quantitative and qualitative approaches have been kept in mind while designing conceptual framework for data collection in this study (Hamersley, 1999). According to Savenye and Robinson (1996) findings from one technique can shed light on the findings from other techniques therefore the phenomena can be studied in depth by a pragmatic combination of quantitative and qualitative methods. Many scientists suggest use of this kind of triangulation deliberately in all human studies (Mackay, and Fayard, 1997). Crowe and Narayanan (2000) suggest that the combination of eye tracking and other evaluation techniques gives a richer set of data. The primary evaluation technique used in this research as an indicator of visual behaviour is eye tracking. Eye tracking data is complemented by data from narratives, background questionnaires and post-session interviews.

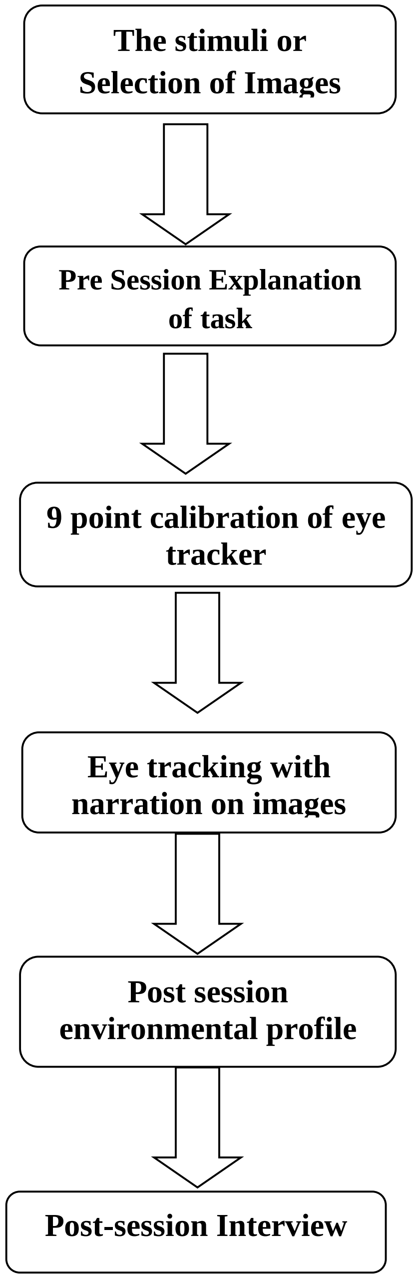


Figure 5.4. Collection of evaluation techniques as applied across this research

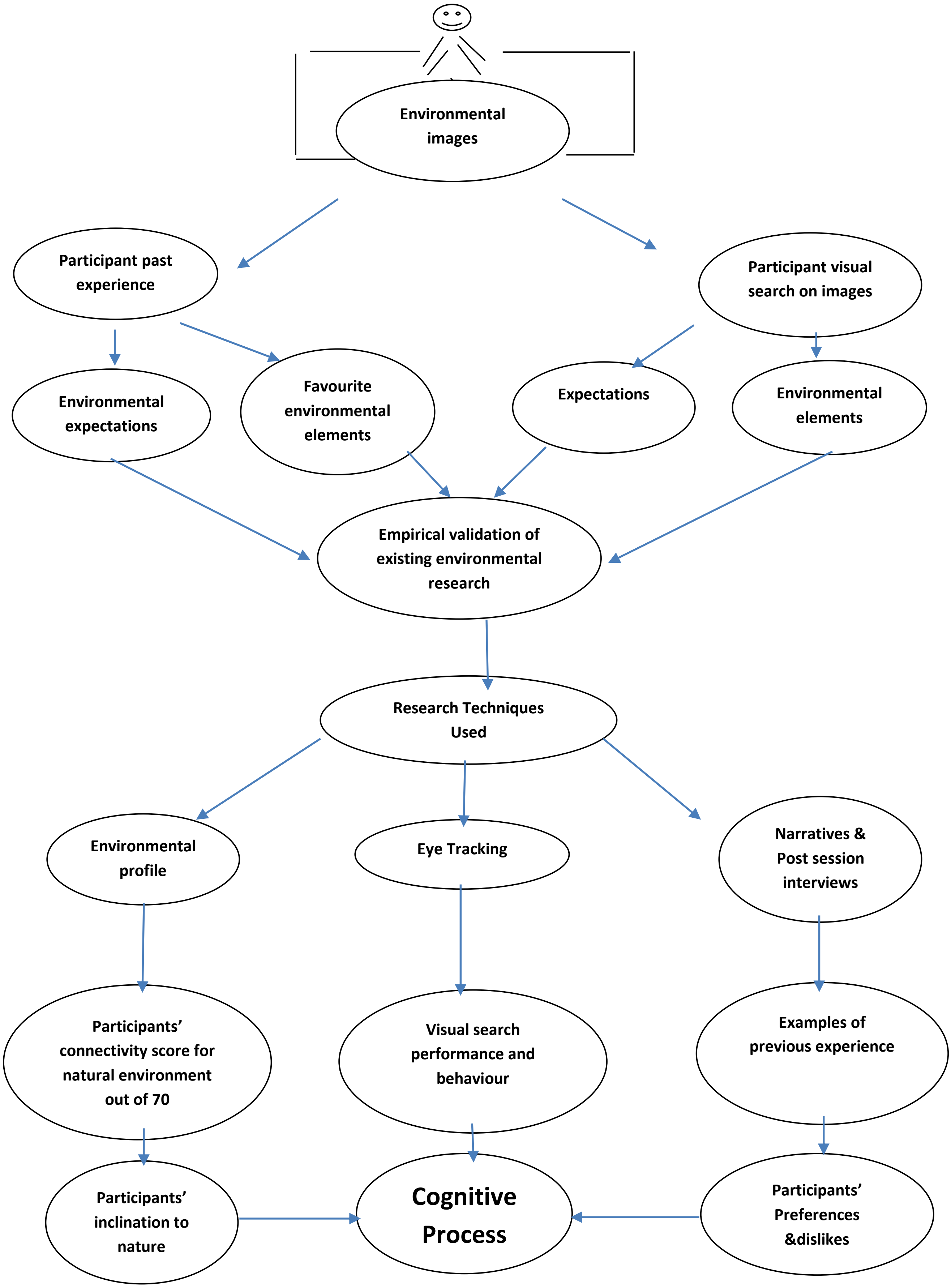


Figure 5.5. Overview of conceptual framework of research.

5.8. The stimuli

Environmental images are visually complex, involving many different environmental elements. Hence, although it might be desirable, it can be difficult to attribute performance or behaviour variations to a particular environmental element. The use of eye tracking as an indicator of the points of interest in an image has received criticism (Jacob and Karn, 2003) because of the difficulty in interpreting results given the large number of variables on an image. All the stimuli were taken from environmental images active at the time of testing. In order to control the number of variables, it was decided to use static environmental images, and certain effects were manipulated using design tools such as image shop, and Paint.net. Variables such as the number of environmental images appearing on the screen, the colour of environmental elements such as water, the position of design elements were standardized[25].

5.9. Selection of images

Images were selected from, the data base of scene classification project run by Stanford Vision Laboratory, UIUC Beckman Institute, after granting their full permission to use these images in the research. Categorization of good and bad examples of natural scenes have been undertaken via the Delphi technique* (Mullen, 2000) after images were selected from a pool of images of natural and urban landscapes. The Delphi technique uses a consensus approach to identify which images were highly positive and which have negative associations inviting descriptions of the images which explain the rationale for their selection. A maximum of 12 images were taken forward for use with participants in the eye tracking experiment in three broad categories; pure natural environments, heavily urbanised environments, and environments containing both urban nature/natural elements. Their selection from the wider Stanford Vision pool of images was facilitated by asking volunteers (as naive subjects i.e. non landscape professionals) to rate the images as positive, negative or neutral categories using Hartigs's (1991) perceived restorativeness scale. Here images were rated on a 5-point scale by asking participants to complete the phrase; 'it makes me feel…'.1=Very pleasant 3=Neutral and 5=Very unpleasant.

*(The Delphi technique (Mullen 2000) is a collaborative estimating or forecasting technique that combines independent analysis with maximum use of feedback, for building consensus. Within this approach, the topic under discussion was circulated (in a series of rounds) among participants who comment on it and modify the opinion(s) reached up to that point, and so on, until some degree of mutual agreement was reached (Mullen 2000). The approach used in the Stanford Vision Pool was

[25] Standardization means Images were selected from, the data base of scene classification project run by, Stanford Vision Laboratory, UIUC Beckman Institute, after granting their full permission to use these images in my research. Images were of same size, in terms of length and breadth and also same pixels.

thus a process which allows consensus, from everyday users regarding the images, in particular which induce positive and negative responses and to eliminate personal bias for the selection of environmental images for the eye tracking phase of this study. The inclusion of Hartig's approach allows a further element of refinement and alignment with current approaches important for this study.

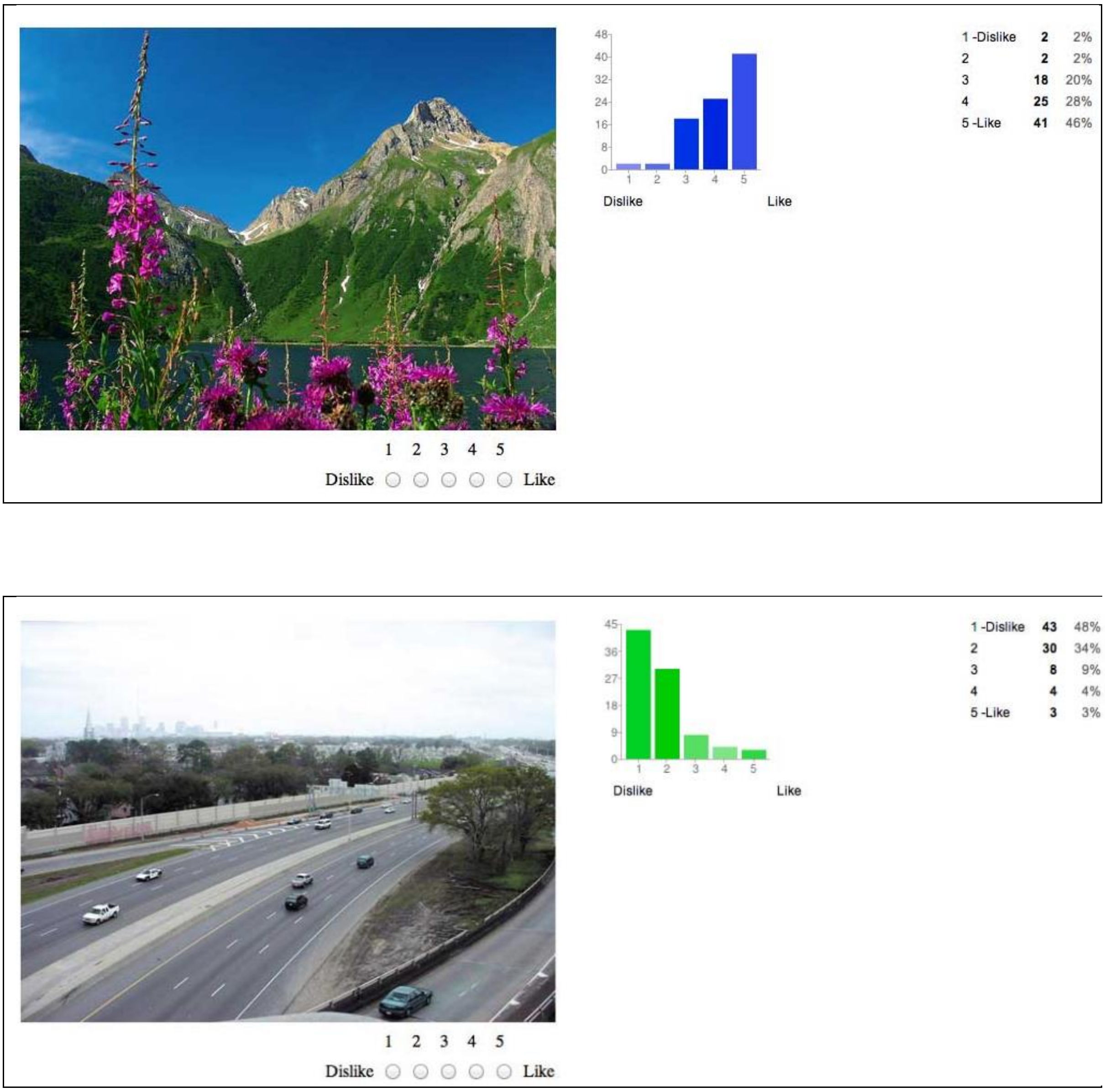


Figure 5.6. Examples of data obtained via Hartig approach for selection of Images

Six types of environmental images were selected as stimuli for this study based on the results of the above mentioned data. Within Figure 5.5 numbers from 1 to 12 represent the sequence in which these images were presented to participants. Amongst six categories of images, one image with highest score was selected and one image with lowest score also selected from each of the six categories. The following twelve images were selected for the main study.

Category	*Image 1 Highest Score*	*Image 2 Lowest Score*
Beach	 **2**	 **1**
Buildings	 **4**	 **3**
Forest	 **6**	 **5**
Highway	 **7**	 **8**
Industry	 **10**	 **9**

Mountain	 **11**	 **12**

Figure 5.7. Sequence as presented during the research.

Six sets of images were selected from the data base of scene classification project run by Stanford Vision Laboratory, UIUC Beckman Institute, after granting their full permission to use these images in the research. Eye movements were recorded using a Sensory Motor Instruments (SMI)'s Head-Mounted Eye Tracking Device II (HED-II) at a sample rate of 50 Hz (Sensori Motoric, 1999) (as introduced in Chapter 4). The head-mounted camera captures the images of the participant's eye and scene of view. It tracks the eye by the detection of two reflections of a low intensity beam of infra-red light from the eye tracker: one from the participant's retina and the other from the cornea. The computed gaze position is overlaid on the scene image and visualized in real time. An integrated MPEG video file was produced representing the participant's eye movements.

5.10. Pre-session explanation

The researcher described a summary of the process and explained the use of the eye tracking equipment practically. Questions were answered fully and after the participant had read the information sheet, the consent form was signed. This helped the participant to clarify any doubts about the process.

Participants were guided through the technique of eye tracking including how to correctly wear the eye tracker. They were also briefed on how to give a running commentary (verbal narratives) on each environmental image displayed on the projector screen. Participants were also shown how to operate the Dictaphone for voice recording. The researcher explained all the process of data collection step by step and answered all the questions asked by participants about the process. The slide show was controlled by a laser pointer as the participant had control of the amount of time that could be spent on each image. Participants were also briefed on the apparatus calibration process.

5.11. Nine Point Calibration of eye tracking device

After an initial explanation, a 9 point calibration[26]was done whilst the participant's eye movements were recorded. Participant was asked to look at 9 dots at different areas of screen and respond positively with a yes to confirm if they were looking at the correct dot; e.g. top left, 2nd left, bottom left, top middle and so forth. The device was calibrated in the same way for each participant. Once calibration had been completed, the participants were exposed to the environmental images and asked to give a running commentary about the various aspects of the environmental images they were looking. These narratives were recorded on a digital Dictaphone.

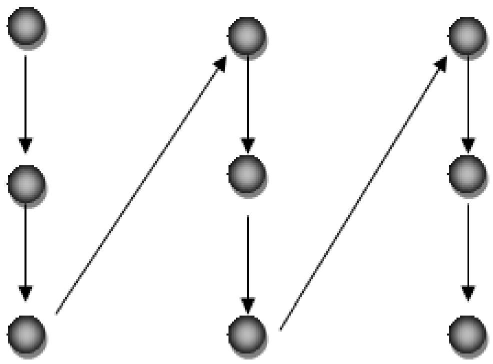


Figure 5.8. Gaze movements during nine point calibration on screen.

5.12. Eye tracking session

During eye tracking each participant looked at all twelve images at their own speed whilst providing running narratives which were recorded and later transcribed in exactly the same words. Some participants revisited some images during the session.

Here, there is a need to ensure a common understanding of the use of terms and definitions related to eye tracking in the context in which they are used. For example, there is no standard operational definition for a single fixation, (where the eye stops briefly over a point), and there are different psychological theories about the relationship between eye movements and cognitive processes (Hansen, 2003). This section discusses eye movement based metrics that were applied across this research.

[26] Nine point calibrations means here, the eye tracking apparatus is calibrated by showing 9 different points on the screen and then participant was asked to look at them one by one. Then eye tracking apparatus was calibrated by using each of points individually for every participant before data collection process.

Eye trackers provide a continuous stream of *x* and *y* coordinates which identify the users' position of gaze at any specific moment. This data stream is then processed for interpretation. The eye movement model most commonly used is the fixation saccade model. It divides eye movements into rapid movements (saccades) between points of relatively stable gaze (fixations) (Jacob and Karn, 2003; McCarthy, 2003).

Three forms of eye movement data were recorded:

- I*nitial gaze* location to indicate where on the environmental image users *expected* to find the point of interest (POI)
- *Entry point*, to indicate which POI attracted their visual attention
- *Scan path*, to assess how easy or difficult it was for the users to find the POI

5.13. Post-session interview

After each eye tracking session, the participants' recall and recognition of the exposure to the images was tested in three parts:

- Spontaneous recall,
- Prompted recall
- Recognition with the aid of a short, post exposure semi structured interview.

The spontaneous recall was recorded by asking which part of the participant's exposure to the images he/she recalled the most. Exactly what the participant was recalling was noted in his/her words. He/she was asked why he/she remembered that particular part and again his/her comments were noted.

Prompted recall based on immediate mapping results of participants obtained from the tracking logs was recorded by asking the individual participants about certain features of the images from urban and naturalistic environments, based on the data findings. He/she was asked what he/she liked and why he/she liked that particular feature.

Finally, participants' recognition was tested by showing different images taken from the naturalistic and urban environment and repeating the same questions.

The post-session semi-structured interview used open questions about users preferences and dislikes regarding the environment. Moreover, participants were presented with print-outs of the previously seen environmental images (during the eye tracking session) in order to assist them in commenting on the overall image element layout.

Participants were asked the following questions:

Q1. How did you feel about the task?

Q2. What do you think you memorised the most about the task?

Q3. Which image did you like the most and why?

Q4. Which image is your least favourite and why?

Q5. Would you like to say anything else?

How, what and which questions were asked to each individual at the end of task and responses were recorded. The aim of the interview was to elicit the users' perceptions and expectations about POI on environmental images and to compare the users' perceptions of where they first looked to their actual eye movements. The interviews were recorded verbatim. Examples of the post-session protocols are found in Appendix B, and C.

5.14 Post Session Connectedness to nature Scale

The background CNS questionnaire elicited:

- the user profile (name, age, gender,)
- previous environmental experience (such as frequency and purpose of environmental use).

The Connectedness to Nature Scale (CNS) provides a measure of an individual's trait levels of feeling emotionally connected to the natural world. It was designed to measure the extent to which participants generally feel a part of the natural world and emotionally connected to it. This measure consists of 14 items rated on a 5-point likert scale, with a rating ranging from 1 (strongly disagree) to 5 (strongly agree) as discussed previously.

The Environmental profile (EP) and background questionnaire elicited a user profile (age and gender), previous natural environmental exposure experience (frequency and purpose of exposures), and a few examples each of familiar and frequently used environments. The EP and background questionnaire provided data to address how previous experience of visiting environmental sites influences users' expectations about where to find the point of interest (POI) on the image and over all views about green environment. An example of the environmental profile is found in Appendix E.

Chapter 6. Environmental image study and 'Visual Signature'.

This chapter reports on the conduct and findings of the eye tracking study intended to re-explore HEI from a finely-grained behavioural perspective as explained in Chapters 1 and 2.

The two main focuses for this study are;

- To capture the relationship between users' previous experiences and expectations, and their scanning behaviour.
- To explore the participants' scanning behaviour and their ability to identify different elements of nature in surrogate images.

As mentioned, this chapter will look at conduct and findings of this study to capture a correlation between scanning behaviour, narratives and previous experienced and expectations of participants.

The data will be looked at in three different ways:

1. In the first part of this chapter, data of the twenty participants will be assessed particularly the three participants with consecutive highest CNS scores and one participant with the lowest values CNS score. In addition, an important finding of this study, the "**Visual Signature**[27]**"** will be discussed in detail.
2. The second part of the chapter will look at data for each of the six categories of images and important findings will be discussed.
3. Chapter 7 will look at data in context to the second main focus of study which is to explore the participants scanning behaviour and their ability to identify different elements of nature in these surrogate images.

6.1. Pilot study

An initial pilot study with three users was conducted using a similar structure to the main research conducted. Previous research (Loftus and Mackworth, 1978:567, Mackworth 1988, Rayner 1992) showed that 15 seconds is sufficient to capture a complete scan path for the first inspection of a display. The initial pilot study corroborated this for a complete scan of an environmental image, however, it suggested some improvements to the protocol. As a result, the study design was altered with the incorporation of larger screen images of the environment, a blank screen between environmental image presentations, and the post-session interview.

[27] This is a phenomena discovered in this study, which shows that every participant of this study has his unique style of navigation through the images presented to him.

The background questionnaire and post-session interview questions were piloted separately with three users to establish whether questions were comprehensible and if they elicited relevant responses. One of the major changes made after the pilot was to lift the 15 second bar of time spent on each image, with a view that time spent on each image provides data regarding the level of interest each individual showed for each image. Other changes which took place was a decision to eliminate order bias and the completion of the 'Environmental Profile'(EP) to be completed after the eye tracking exercise as opposed to before it.

6.2. Study design

This study focused on participants' visual micro strategies – such as where they fixate before the environmental images appears on the screen; first fixation on the environmental image; and very early scanning behaviour while participants look for the POI. It also considered factors that might influence the participants' expectations when searching for this information such as previous experience of visiting environmental sites.

The study questions were:

- Does the overall design layout of environmental images influence initial inspection?
- Do previous experience and preferences influence expectations of initial inspection of environmental Images?

The Participants' task was to identify a POI (point of interest). After a briefing about the study, in particular the use of the eye tracking equipment, each participant completed a consent form. The eye tracking equipment was then calibrated for each participant. The 12 selected environmental images appeared in sequence as a Power Point™ slide show. This slide show was controlled by the participant with the help of laser pointer. Participants spent as much time as they wanted on each image before moving to the next image in sequence with a click on a laser pointer.

In the first instance, a blank screen was presented to the participant. Once the participant was ready, they were able to click on the pointer to display the first of the environmental images. The narrative associated with this image was recorded followed by another blank screen. Once the participant was ready to proceed, a click of the pointer displayed the next environmental image with the running narrative being recorded and so forth.

The participant's eye movements (fixations and saccades) were recorded before and during inspection of each environmental image. The participant's spoken responses were audio recorded.

A post-session, semi-structured interview followed. During the interview, participants were shown print-outs of the environmental images, so that they could indicate on each point where they thought they had looked first. They were also asked to comment on the POI layout. At the end participants filled in their EP (environmental profile).

6.3. Procedure summary

After a brief introduction about the study, each participant completed a consent form. The eye tracking equipment was then calibrated for the participant. The six sets of environmental images appeared as a slide show. The participants were asked to record their narrative about the images. The participant's eye movements were recorded, and the participant's verbal responses and interactions with the environmental were audio and video recorded. A post-session, semi-structured interview followed which, was also audio recorded. At the end of session each participant filled in his EP.

6.4. Data analysis

The analysis of the data for this study focused on initial impressions of environmental images. The questions looked at the initial scanning of the environmental images. The eye movement-based metrics used to answer the study questions were: *initial gaze*, *entry point* and *scan path efficiency*. Data from the other techniques used enabled the investigation of possible relationships between the users' visual behaviour and type of environment. When interpreting previous experience, the examples of previous exposure to a natural environment by the participants were obtained from the narratives and background questionnaires. These were taken as representative examples of the types of environments with which participants were familiar. The gaze point layout was examined and compared with the stimuli image as the main focus of this study was a first impression of an environmental image. Moreover, eye movement data was supported with data from the questionnaire and interview so as to explore how previous experience and preferences might affect initial scanning of images. Data was obtained via four streams. The four types of data were analysed and compared. The qualitative data added value to performance whilst eye movement data revealed participants expectations and perceptions (Figure 6.1 and 6.2).

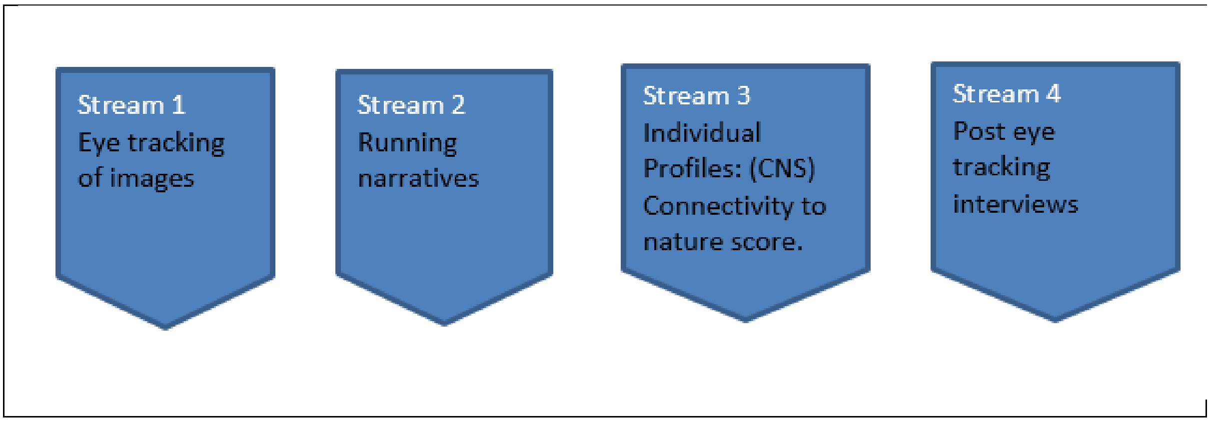


Figure 6.1. The four streams of data.

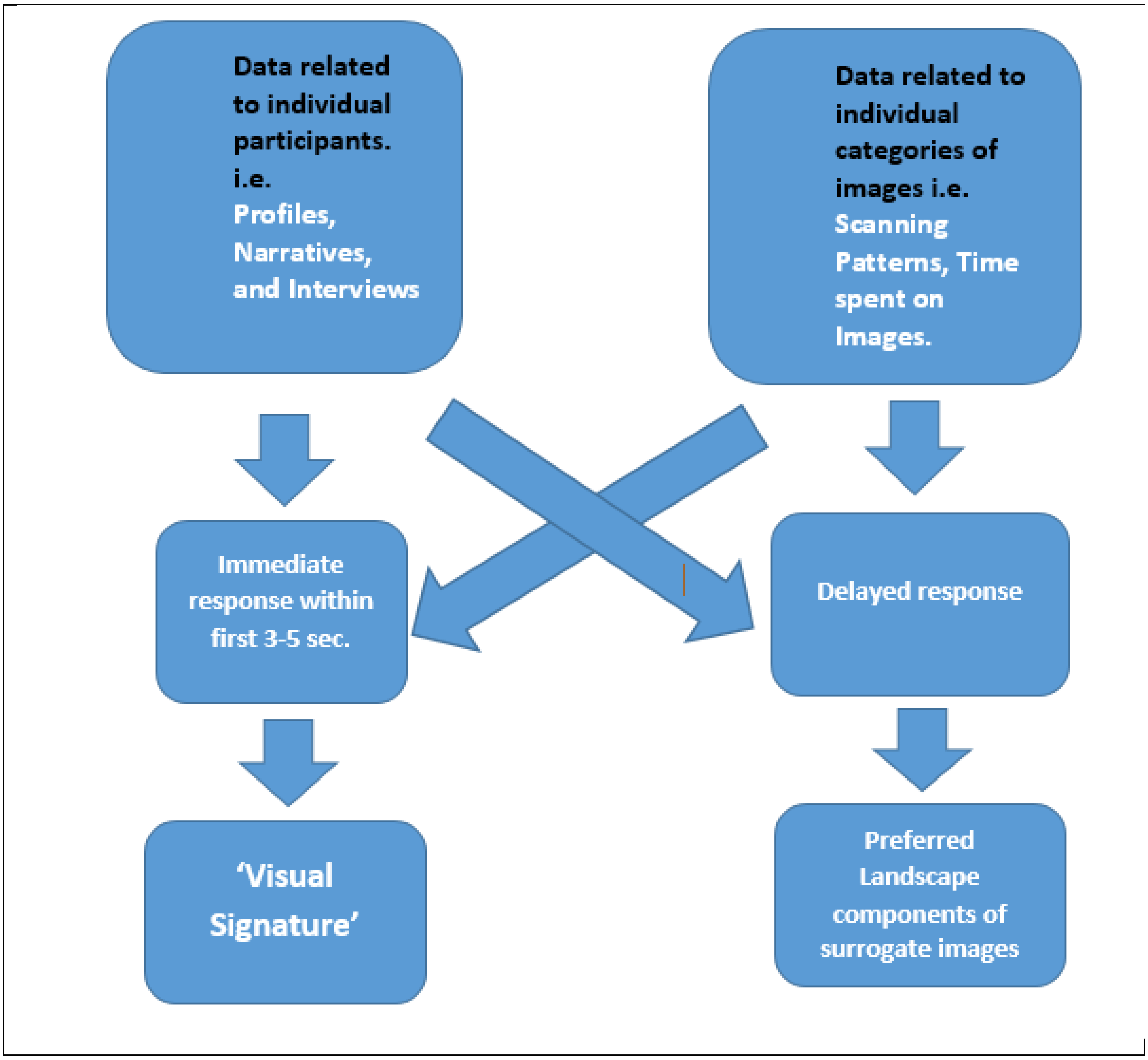


Figure 6.2. Data processing.

6.5. Eye Tracking Session

During the eye tracking session each participant's scan path was recorded (Figure 6.3). Two measures were used:

- 'initial gaze': where the participant looked 100 msec prior to the environmental image appearing on the screen
- 'entry point': the first fixation within 300 msec of the display of the image. 300 msec is the duration of a typical fixation and the typical time in which information extraction occurs (Cowen et al., 2002).

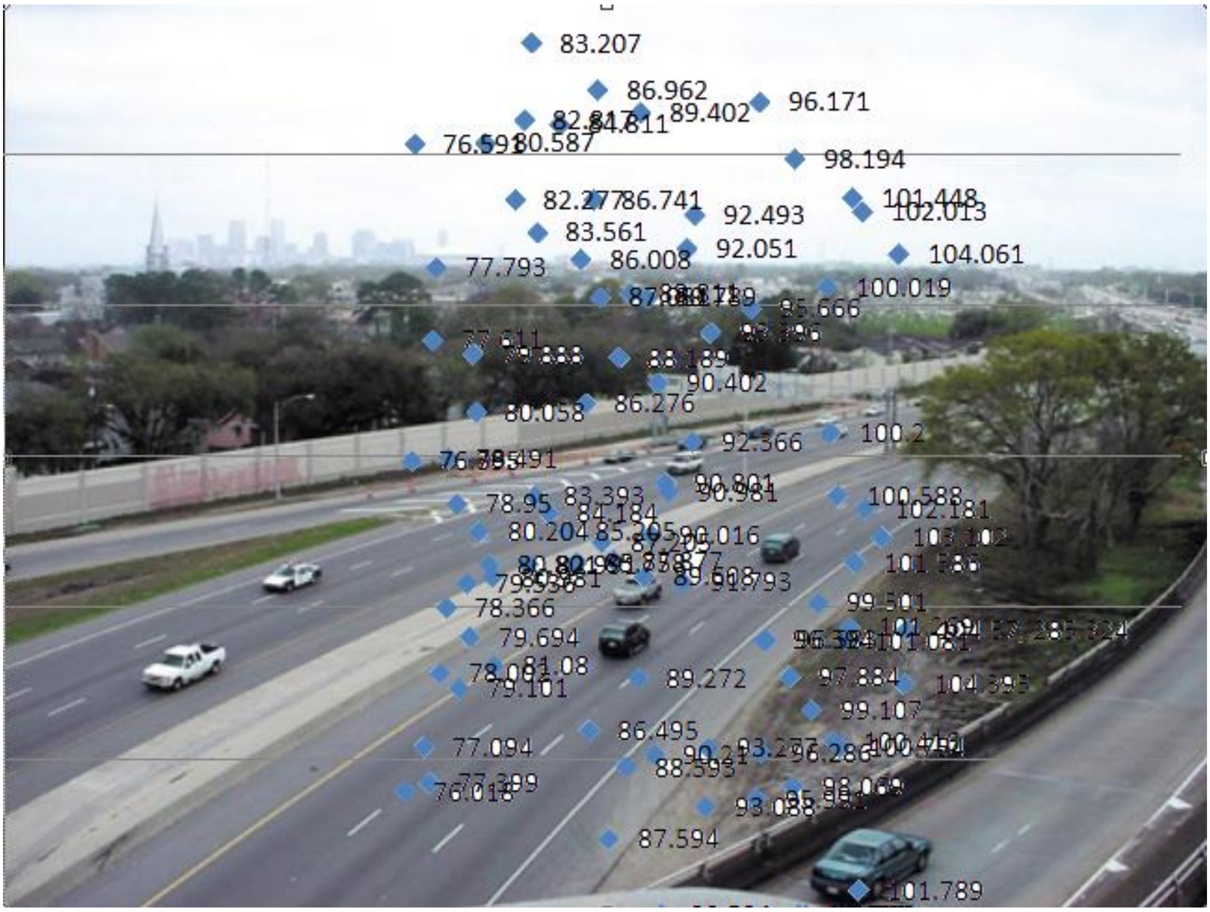


Figure 6-3. Coordinates: Note each coordinate relates to msec from initial viewing i.e. low values indicate earlier stages of scanning. In this example the entry point is 76.05 where scanning starts at the sky, located in the upper middle section of the image.

With the aid of these numbers we can locate starting and end points of a scan path. It is also apparent from these numbers that individuals have different scanning patterns/entry points. Table 6.1 shows the initial entry points by the sector of the image and frequency (by percentage). A common trend was found for the ten participants who had already seen the images during initial phase of selection of images and who had good understanding of this research process prior to participating in this research.

Top left **Area A** **10%**	**Top Middle** **Area B** **40%**	**Top Right** **Area C** **10%**
Bottom Left **Area D** **5%**	**Bottom Middle** **Area E** **30%**	**Bottom Right** **Area F** **5%**

Table 6-1. Entry point distribution across all images by percentages.
(When dividing each image in six equal areas)

Figure 6.3 shows the 'entry points', or first fixations when the environmental images appeared on the screen. Some distinction was evident between 'participants with prior exposure' and 'participants without prior exposure'. A key finding of this research which was apparent for all participants was a ***visual signature*** (Figure 6.4). The development of visual signature can be visualized when examining data for individuals as described below.

6.6. Visual Signature

Figure 6.4 shows a range of scan responses by different participants across different images. It is possible to see scanning patterns which are common to individuals, i.e. across all their images, but which differ markedly between participants. The individual scan patterns are distinctive and consistent and in essence appear to form a specific signature, termed a 'visual signature'. In this study, a visual signature is defined as:

"An individual pattern of fixations emerged as a result of involuntary initial response in the first 3 to 5 seconds after exposure to a naturalistic or urban image"

Table 6.2 briefly summarises the process of formation of the visual signature. When participants scan through urban or naturalistic images, an individual scanning behaviour emerged for each participant (Figure 6.4).

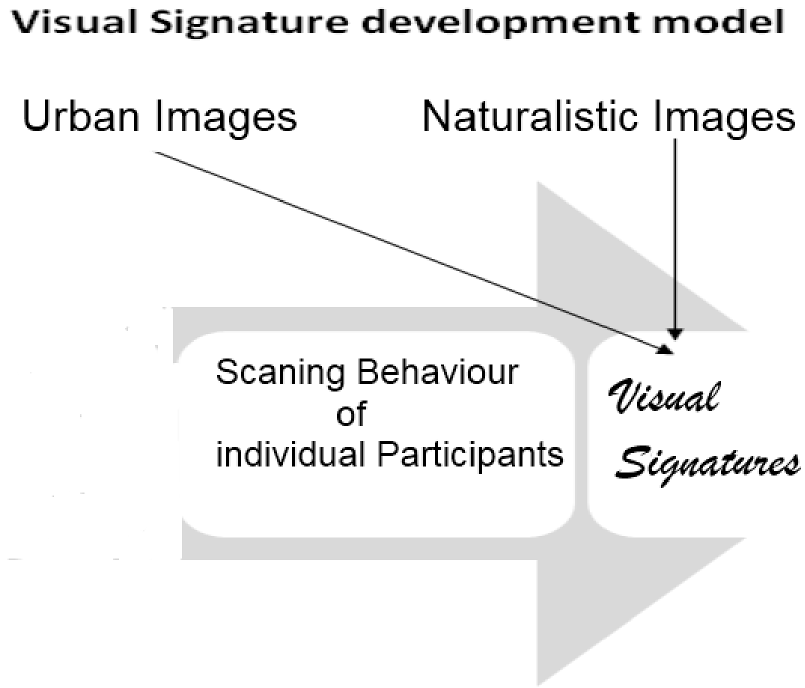


Figure 6.4. Mechanism behind Visual Signature formation.

Visual behaviour analysis is the systematic study of human eye movements and visual fixations. More specifically, it is the study of human visual behaviour. It uses instruments such as eye tracking to measure eye movements and human gaze. According to Iqbal (2004), eye gaze patterns can be used to classify the type of task the participant is performing. Visual behaviour analysis is already used to assess, plan, and treat individuals with conditions like Autism. This study encompasses quantification, i.e. introduction and analysis of measurable parameters of vision as well as interpretation, i.e. drawing various conclusions about human behaviour from individual's unique style of navigation through various images.

Hand written signatures and gait (gait analysis forensic science) are unique to each individual. Observation of the plotted eye tracking data on the viewed environmental images also shows a unique feature, which is each participant has their unique navigation style while surfing through different elements of images. Each time a participants moves to new image, they seem to keep somehow their own unique style of navigation of the new image. Due to the individual nature of the plotted data, the researcher called this unique phenomenon the "visual signature". An individual's 'visual signature' is individual like many other biometric techniques that have been used for personal identification in the past. Among the vision based ones are iris scanning and retinal scanning. Voice recognition or signature verification are the most widely known among the non-vision based ones. In this study, the visual data of 20 participants have been analysed (13 female, 7 male). All participants produced their own individual visual signature on each of the 12 environment images (Figure 6.4 A).

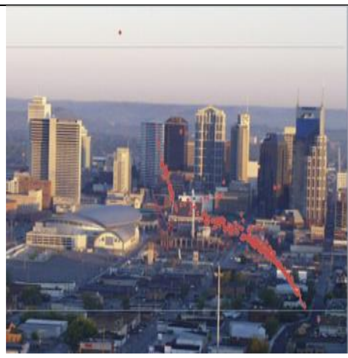
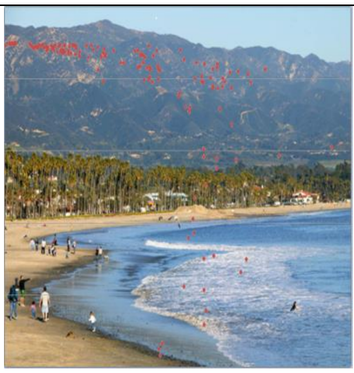
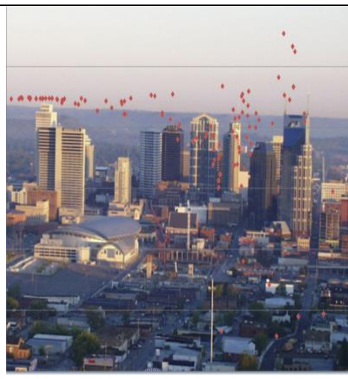
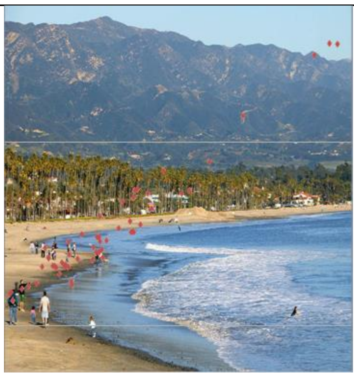
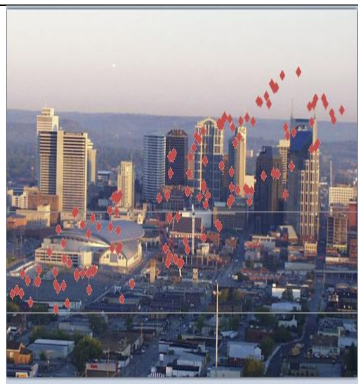
Participants	Image 1	Image 2	Image 3
Rosy			
Mona			
Robert			

Figure 6.4 A. Pattern of visual scanning and the 'visual signature'.

Hence, there is a need to examine the way participants look for specific design elements such as which sections of images are more prone to first fixations. By capturing the participants' eye movements when they visit an image for the first time, it is possible to identify which location on the image attracts immediate attention, and how the image tends to be scanned (*visual signature*). This can be related to what information is presented in those locations on the image and whether immediate attention is drawn to important information. Hence it can be assessed which elements of the environmental image are important in terms of attracting interest which are marked as points of interest on the picture. The time spent on the image was also an important element (Table 6.3). In addition to the time spent on each image, the table also displays the average time spent by each participant on all the images and the average time spent on an individual image.

6.7. Time spent scanning each image

Table 6.3 summarises the time taken by participants to scan each image. As previously explained (Chapter 5), freedom was given to participants to spend as much time as they wished in looking at each image. The longest scan time was 76.129 seconds, the shortest 7.81 seconds. There is much variation in scan times between participants and across images for the same participant. Such variation in data allows for further analysis into the behaviour of scanning and can be related interestingly to the unique visual signature of each participant.

Images	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	Avg. time
Names													
Alan	31.236	40.892	25.37	35.874	76.129	35.196	45.314	75.914	44.728	47.756	36.57	34.813	44.14933
Casey	13.86	43.738	11.497	51.429	61.675	82.813	72.59	49.74	50.31	44.368	49.714	31.014	46.89567
Edvina	24.12	39.855	34.22	36.391	18.406	9.407	10.292	9.617	42.404	15.601	11.297	10.705	21.85958
Jamela	28.552	26.508	28.095	31.902	18.863	21.543	26.387	12.503	11.714	15.616	20.187	30.838	22.72567
Mona	54.83	30.579	50.094	38.222	46.296	24.19	51.698	45.801	28.105	48.094	28.213	29.921	39.67025
Moo	64.516	23.401	67.418	72.007	40.802	21.604	47.502	31.686	43.12	34.894	34.794	20.911	41.88792
Nicklus	41.604	34.496	22.593	42.899	42.604	29.791	41.991	27.497	48.723	36.787	37.756	37.845	37.04883
Nini	21.971	31.436	9.952	19.808	19.808	23.105	29.488	22.207	25.793	35.504	38.303	31.105	25.70667
Romia	6.831	11.104	15.009	12.11	17.635	32.263	35.095	24.547	30.653	33.221	38.686	71.313	27.37225
Rosy	27.138	11.487	21.903	19.504	19.999	14.4	14.802	9.198	9.202	8.397	19.777	10.625	15.536
Robert	8.835	16.761	16.308	19.295	16.153	14.001	24.511	19.125	12.668	7.81	16	12.798	15.35542
Rina	24.392	13.683	10.705	30.403	10.89	20.795	22.137	10.004	12.863	21.741	28.985	39.609	20.51725
Shahzadi	34.813	31.014	11.297	30.838	29.921	20.911	37.845	31.105	41.313	10.625	12.798	35.609	27.34075
Tariq	36.57	29.714	15.601	20.187	28.213	34.794	37.756	38.303	38.686	19.777	16.56	28.985	28.76217
Tom	47.756	24.368	28.009	15.616	30.094	34.894	36.787	35.504	33.221	8.397	7.81	21.741	27.01642
Ursila	32.4	20.194	42.404	38.902	22.401	19.625	36.174	21.004	28.117	30.716	26.597	41.678	30.01767
Ussama	44.728	30.31	9.617	11.714	28.105	33.12	38.723	25.793	30.653	9.202	12.668	12.863	23.958
Venessa	32.914	29.74	32.106	12.503	30.801	31.686	27.497	22.207	24.547	9.198	19.125	10.004	23.52733
Zafira	30.704	11.5	39.607	35.414	31.195	34.698	22.31	24.904	32.008	34.394	27.191	25.907	29.15267
zara	45.314	22.59	10.292	26.387	41.698	27.502	21.991	29.488	35.095	14.802	24.511	22.137	26.81725
Avg.time	32.6542	26.1685	25.10485	30.07025	31.5844	28.3169	34.0445	28.30735	31.19615	24.345	25.3771	28.02105	

Table 6.2. Average time spent by each participant on all images, and average time spent on an individual image.

6.8. Discussion relating to individual categories of images (Variance between image types)

Initial results indicate that responses to images are variable, however, there is a consistent scanning pattern or distribution of fixations called the 'visual signature' for each individual. In addition to the distribution of fixations associated with scanning time we have the entry point or first fixation which shows greater consistency across participants i.e. typically in the middle of the image 30%+40% =70% (Table 6.1).

To consider scan patterns further, the following section gives examples of patterns for all 12 categories of images (Figure 5.5, Chapter 5) to ascertain common trends. As previously discussed, the resolution of the screen presented during the eye tracking study was 1280 by 1024 pixels. In these examples, interpretation of scanning behaviour is assisted by the inclusion of associated excerpts from parallel narratives. In addition, a summary of the time spent on each image by different participants is shown in graphical form. Note that for scanning times reference can be made to Table 6.3 which shows complete data for individuals and images.

6.8.1. Beach Images

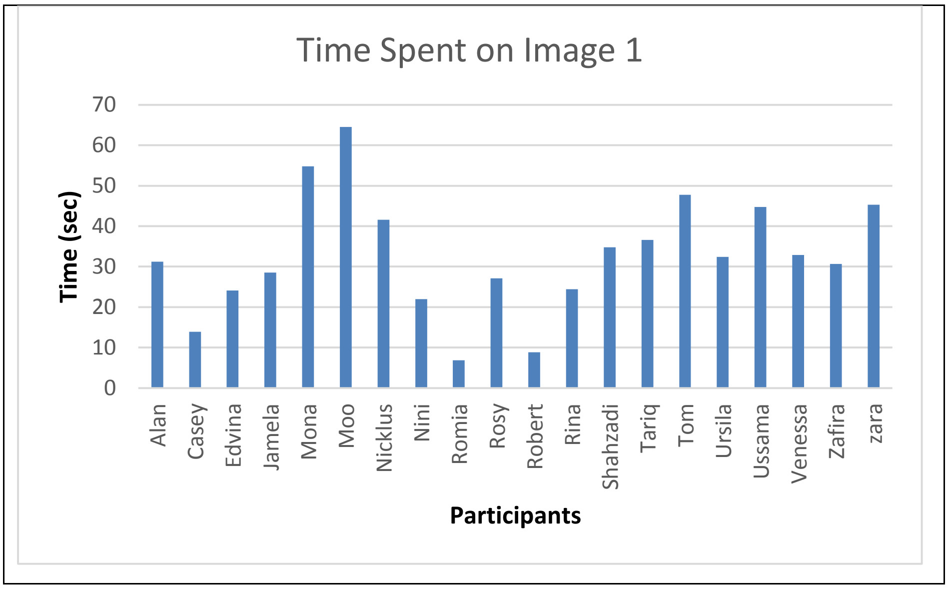
P1	P2
	

Figure 6.5. Scan path of user viewing *Beach* images

Figure 6.5 demonstrates a representative scan path of a participant viewing *beach images*. The dots on the image represent fixations. During the eye tracking session, all participants' entry points appeared on the top middle of the images where the sky was positioned. For two participants' however, their initial gazes before the beach image was presented appeared on the top middle of the page also. All other 18 participants' initial gazes appeared in the middle of the image. The two participants' with top middle page initial gazes had classified themselves as an artist and a landscape architect. This suggests a difference of initial gazes between 'regular and land scape artists', however, this can only be speculation without further investigation. The fact that the entry points of all participants were on the top middle of the image where the sky was present suggests that participants give importance to this feature. The interview responses reflect this likeness for the sky view in the image.

Participants Moo and Casey spent more time on these images, whilst Robert, Nini and Romia spent the least amount of time (Figure 6.6). All participants' scan paths reached the bottom of the image suggesting complete scan paths. Whilst most participants liked these images, one participants (p2) commented:

"Typical holiday photograph scene, trees, beech, clear blue sea… not my type of photograph image… probably nice place to go holiday." Ursila.



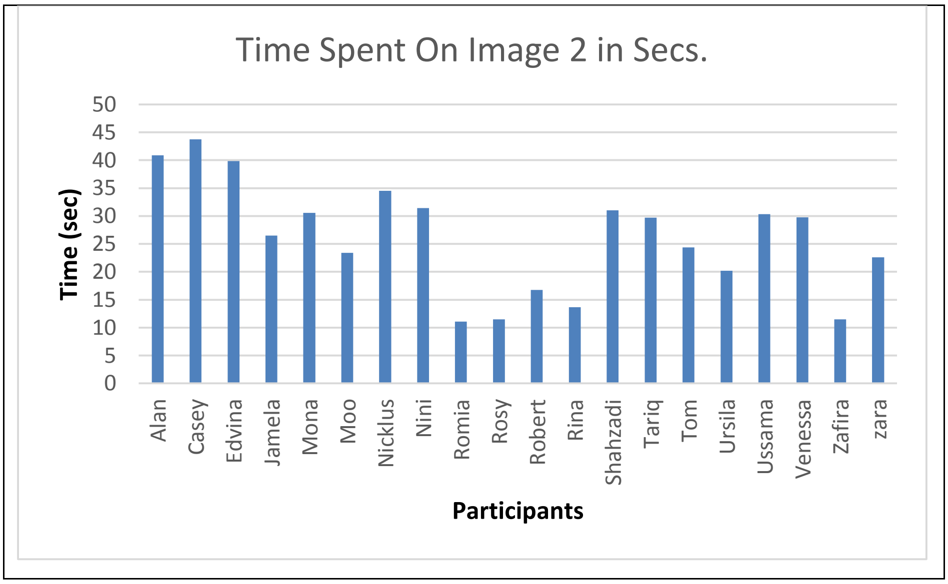


Figure 6.6. Duration of time spent by viewing the *Beach* images.

6.8.2. Building Image

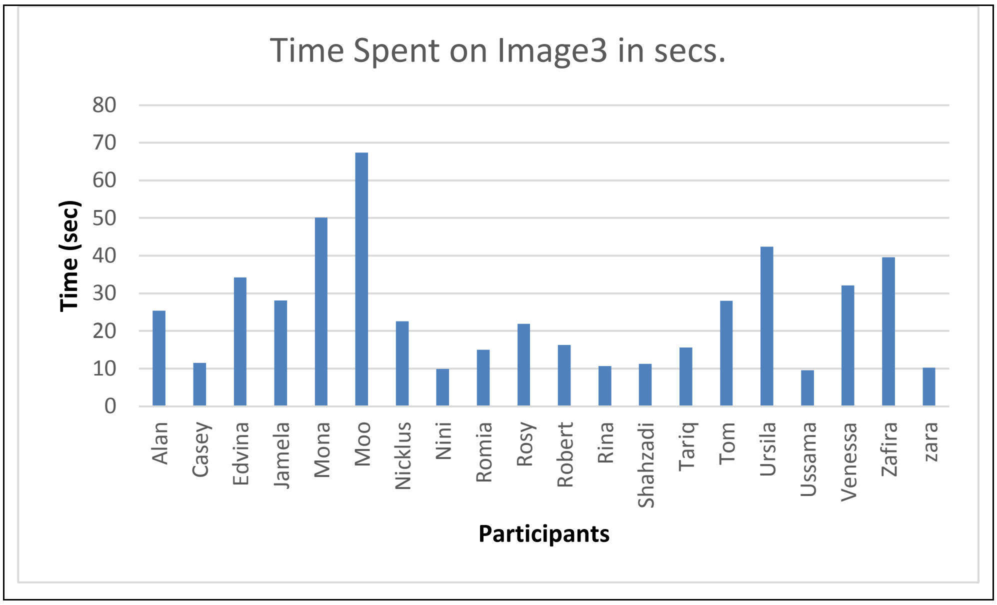
Figure 6.7. Pattern of visual scan of user viewing *Building* images

The building image's characteristic feature is that it includes many different types of buildings (Figure 6.7). During the eye tracking session, all participants' 'initial gazes' were fixated on the middle of the screen before the image was presented on the screen. Their entry points were on the top middle of the image where the sky was positioned. This was expected as the sky has already been shown to be a key feature of most images.

Participant Moo spent more time on these images, whereas Ussama and Romia spent the least time (Figure 6.8). In addition to the match of expectations, the scan path length of all participants suggest effective and complete scanning, reaching the bottom of the page. In addition to the eye movement data, the narratives were very different and are addressed in detail within the next chapter. During the post session interview when participants were asked to express any preference or dislikes about the selected images, many participants expressed their dislike about these images. For example:

"p3 I do not like this photo, it looks like a very busy city... that's have lots of building it should be that one big city that have very ...very bad pollution in that city". Nini.

Nevertheless from the eye tracking session it was revealed that despite participants not liking the images their attention was caught by them.



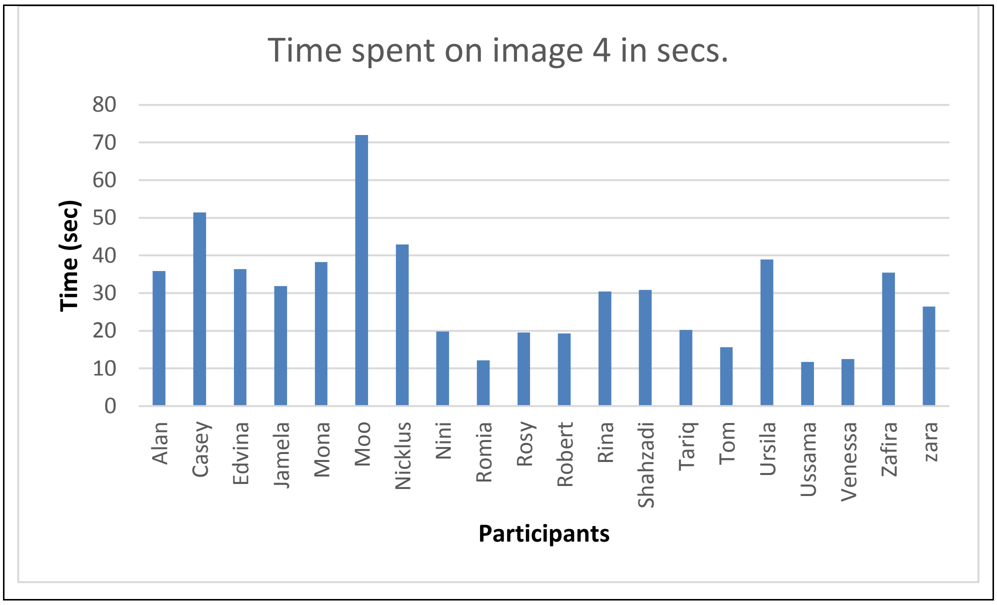


Figure 6.8. Duration of Time spent by viewing the Building images.

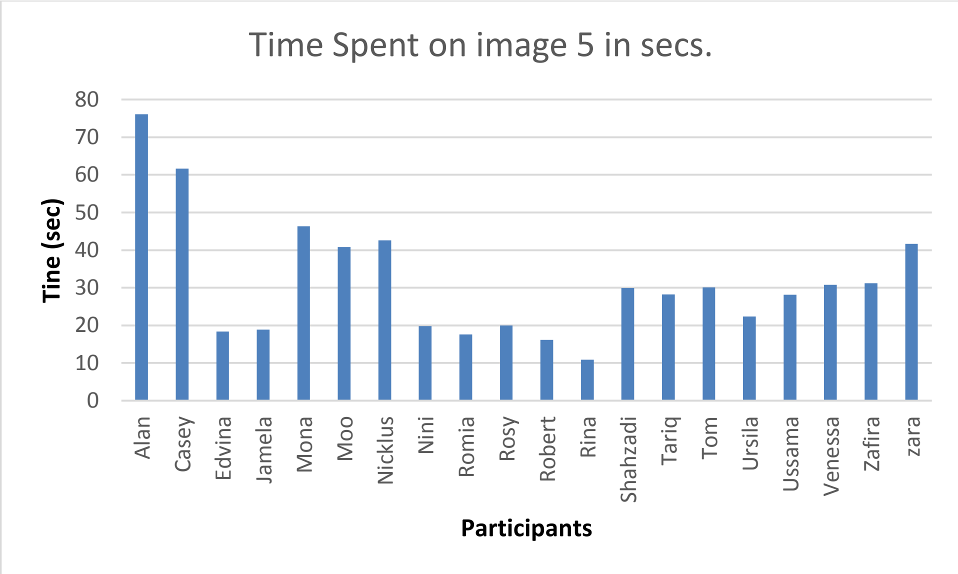
6.8.3. Forest images

Figure 6.9. Pattern of visual scan of user viewing *Forest* images

The *forest image* consists of a design layout that appears with lots of trees. One image showed some path and sky. Figure 6.9 represents an example scan path of a participant viewing the forest images. Alan and Casey were individual participants who spent more time on these images, whilst Rina and Edvina spent the least amount of time on these images (Figure 6.10).

Eight of the participants' 'initial gaze' was on the middle of the screen prior to the image being presented on the screen, whereas two of the participants' 'initial gaze' was on the top left of the screen. Seventeen participants' 'entry points' were on the top again in the image where sky can be seen. The participants' scan path length suggests a complete scanning of the image. During the post-session interview, most of the participants expressed positive comments about the images. One typical quote was:

"p6 This is very beautiful , very beautiful trees, but its particularly nice because the sun is coming thorough, so it's not dense, and it's delicious woodland so I am guessing possibly a native wood land in a English countryside which I like" Jamela.



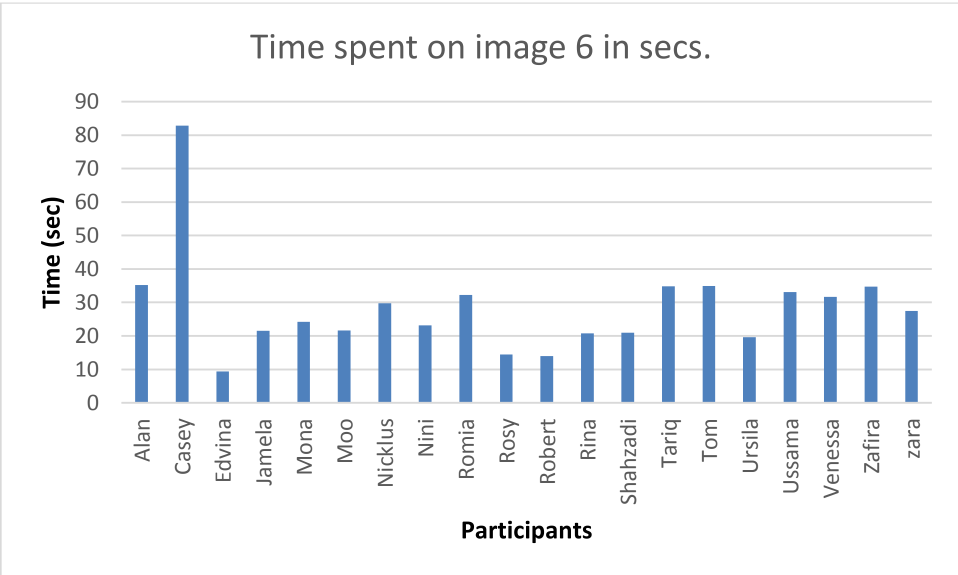


Figure 6.10. Duration of time spent by viewing forest images.

6.8.4. Road Images

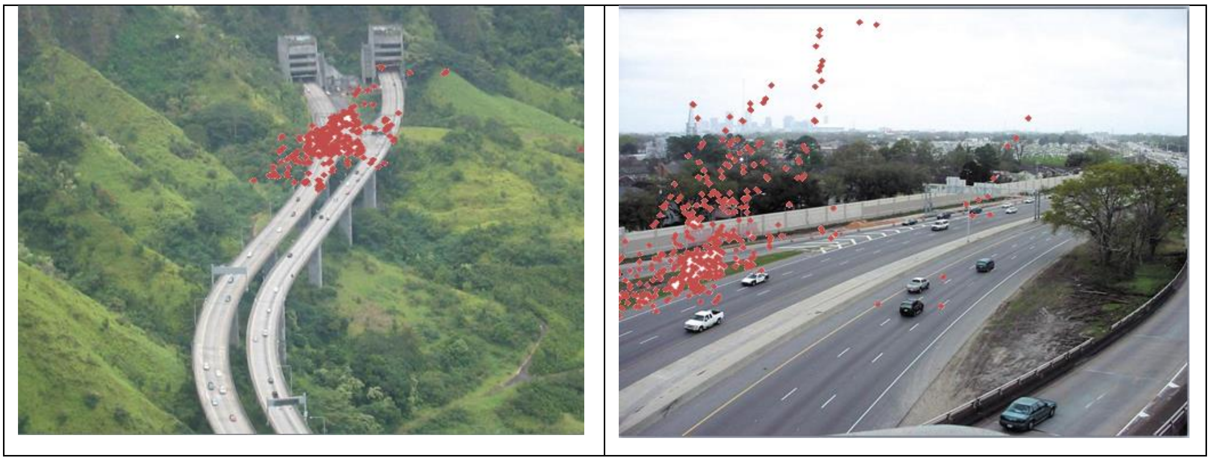
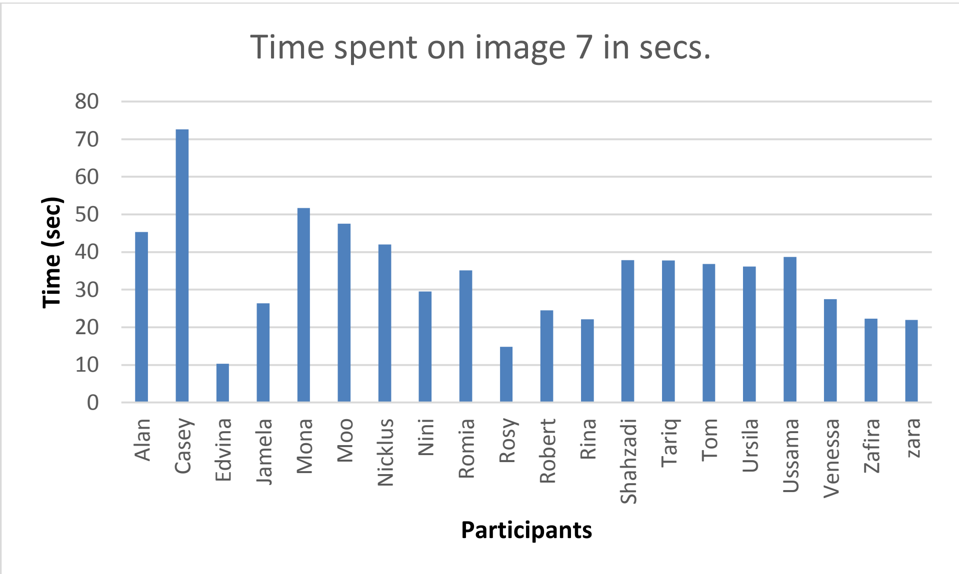


Figure 6-11. Pattern of visual scan of user viewing *Road* images.

There are two images of roads, one with lots of greenery as it's in the country side and the other through a city. The second image is disliked by the majority of participants. Figure 6-11 shows a typical scan path of a user that has not scanned to the bottom of either image. During the eye tracking session, ten participants' entry points appeared on the top left of the homepage. In the second image again participants focused on the sky. Alan and Casey were individual participant who spent more time on these images, whilst Rosy and Edvina spent the least amount of time on these images. The 'initial gazes' of all participants for image one were on the middle area of the screen.



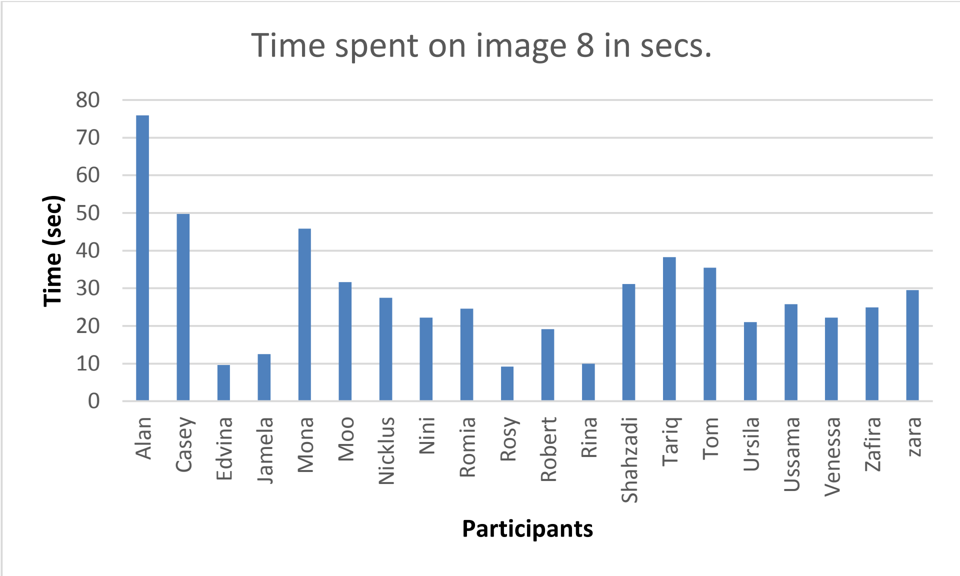


Figure 6.12. Duration of time spent by viewing the *road images*.

Based on the participants' sequence of eye movements, it was possible to see that although first fixations appeared on the top left corner of the image where the sky is present, fixations were drawn to design elements that stood out directly. For example, some participants mentioned car tyre marks in the second image. Also in image one, participants were focusing on the middle of image where the motorways seemed to merge.

In addition to this, all participants' scan paths were found to be short without reaching the bottom of the page which indicated low efficiency in scanning. The participants' comments also confirmed this lack of interest. One participant commented:

"I don't like it… just reminds me of speed on the motor way which even I don't like to drive on" Moo.

Most participants did not like these images and showed a lack of interest in them.

6.8.5. Industrial images

Figure 6.13. Scan pattern of user viewing *industrial* image.

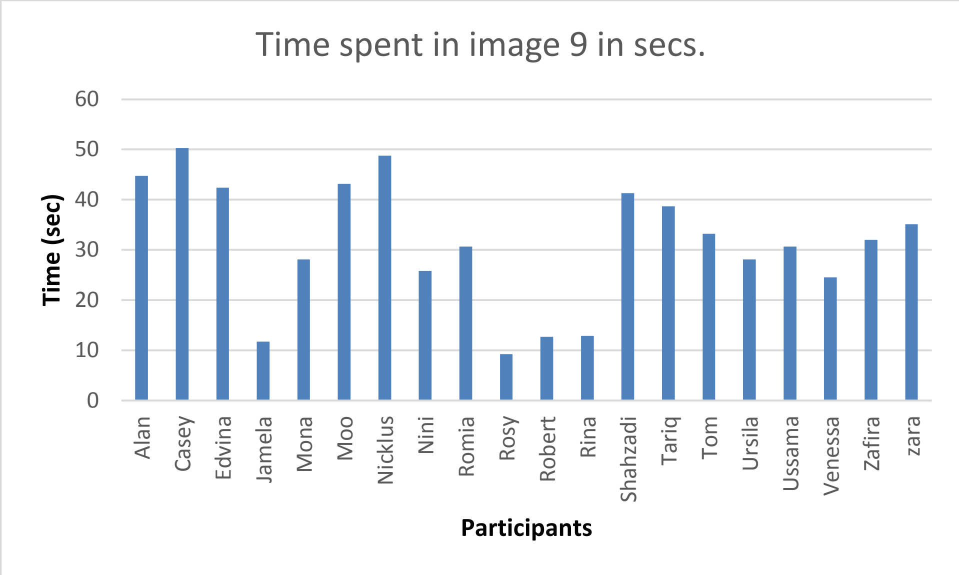
During the eye tracking session all participants' entry points appeared on the top left and right of both images with participants also focusing on the sky. Participants tended to focus on the red colour of the sky more than the industry within the image. In the second image, participants focused on the greenery. Based on the participants' sequence of eye movements it was possible to see that although first fixations appeared on the top left corner of image one where sky is present, fixations were drawn to design elements that stood out directly such as the grass in image two.

Mona and Casey were participants who spent most time on these images, whereas Rosy and Robert spent the least amount of time (Figure 6.14).

These images were very much disliked by the participants. For example two participant commented:

"p 9 This picture looks really dull because it's like a factory...but I like the blue sky" Rachal

"P8 these are not nice at all a big factory, some of grass not very nice" Robert



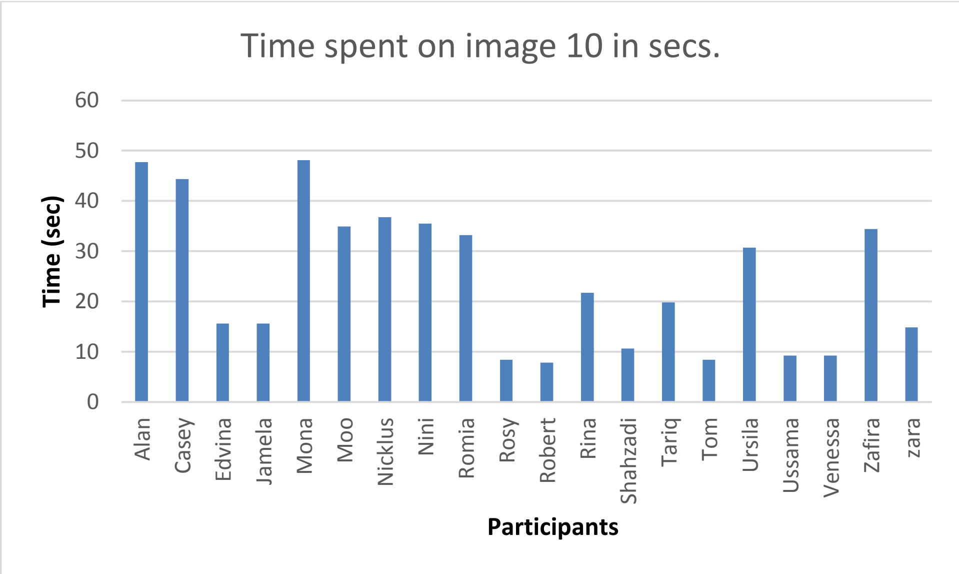


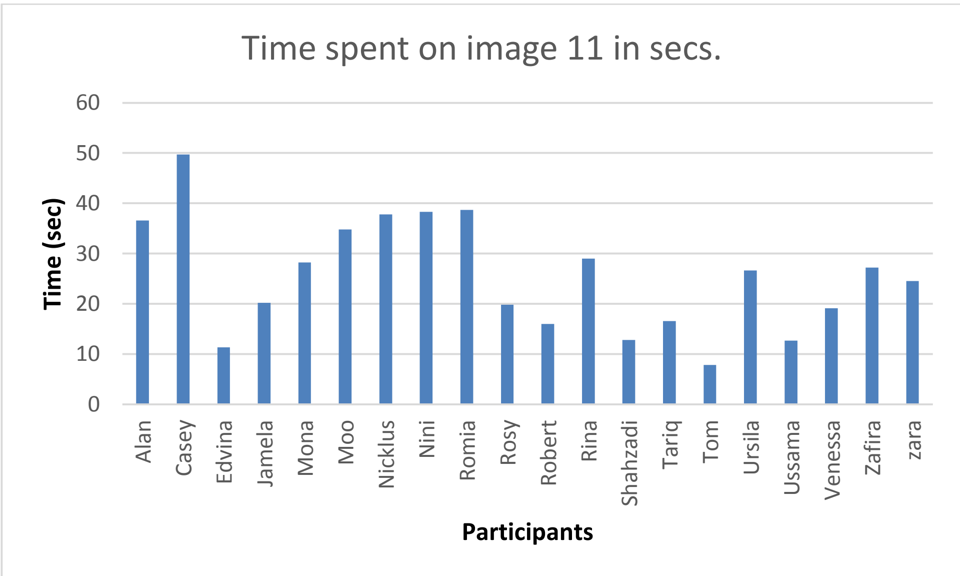
Figure 6.14. Duration of time spent by viewing *industrial images*.

6.8.6. Mountain Image

Figure 6.15. Scan pattern of viewing mountain images.

The first image is most liked and may be due to containing favoured ingredients such as a blue sky, water, colourful flowers and green mountains (Figure 6.15).

Romia and Casey were participant who spent more time on these images, whilst Rosy and Tom spent the least amount of time (Figure 6.16).



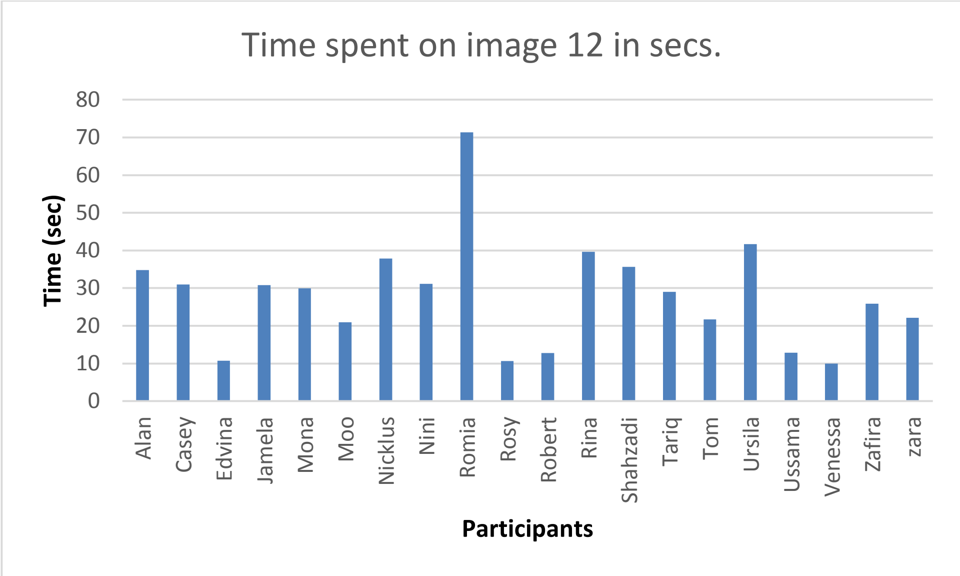


Figure 6.16. Duration of time spent by viewing *mountain images*.

'Initial gazes' of all twenty participants appeared on the top middle of both images where the sky featured. Scan path length was short for all participants. The participants scan down to the bottom of the page which demonstrates their interest in the image. The images received 95% positive comments such as:

"I love this one and I could focus in the mountain in the middle of the photo, I could feel about acoustic the sound of this mountain I think it's so nice". Alan

"p11 This is a photo of lake by surrounded by the mountains ,the mountains are rocky but covered with grass and trees and there is a bit snow on the mountains.... looks quite nice and there is vivid coloured flowers in the front makes it ... even better ...it's a nice photo" Mona.

Then data was analysed with respect to 'individual 'participants, their CNS (connectivity to nature profile score), average time spent on each image, lowest and highest times spent on images for individuals**.**

6.9. Individual profiles (Variance within subjects)

Table 6.3 shows the individual profiles (CNS scores) obtained for each participant, where a high scores indicates an affinity for the natural environment. The highest score available is 70 and the lowest being 0. For completeness, the lowest and highest scan times are included. This is followed by analysis of three selected participants who had the highest CNS scores and one with the lowest score.

Name	CNS score	Averge time spent on each image	Lowest time (Image number)	Highest time (Image number)
Alan	56	44.149	25.37 (p3)	76.129 (p5)
Casey	46	46.895	11.497 (p3)	82.813 (p6)
Edvina	46	21.859	9.406 (p6)	42.404 (p9)
Jamela	42	22.725	11.714 (p9)	31.902 (p4)
Mona	58	39.67	24.19 (p6)	54.83 (p1)
Moo	57	41.887	20.910 (p12)	72.007 (p4)
Nicklus	42	37.048	22.593 (p3)	48.723 (p9)
Nini	49	25.706	9.952 (p3)	38.303 (p11)
Romia	29	27.372	6.831 (p1)	71.313 (p12)
Rosy	55	15.536	8.397 (p10)	27.138 (p1)
Robert	49	15.355	7.81 (p10)	24.511 (p7)
Rina	56	20.517	10.004 (p8)	39.609 (p12)
Shahzadi	53	27.34	10.625 (p10)	41.313 (p9)
Tariq	46	28.762	15.601 (p3)	38.686 (p9)
Tom	47	27.0164	7.81 (p11)	47.756 (p1)
Ursila	48	30.0176	19.625 (p6)	42.404 (p3)
Ussama	48	23.958	9.202 (p10)	44.728 (p1)
Venessa	49	23.527	9.197 (p10)	32.914 (p1)
Zafira	49	29.152	11.5 (p2)	39.607 (p3)
zara	48	26.81725	10.292 (p3)	45.314 (p1)

Table 6.3. Results of CNS (connectivity to nature profile score), average time spent on each image, lowest and highest times spent on images.

6.10. Behavioural scanning patterns of individual participants

Data is presented for three participants with highest CNS scores and one participant with the lowest CNS score.

6.10.1 Mona (highest CNS score).

Mona is a 31 years old female fashion design student from china. Mona scored highest in terms of connectivity to nature score which was 58 (Table 6.4). In terms of time spent on each image, Mona spent more time on images p4 (City image) and p1 (natural image), with the least amount of on p6 (Figure 6.17).

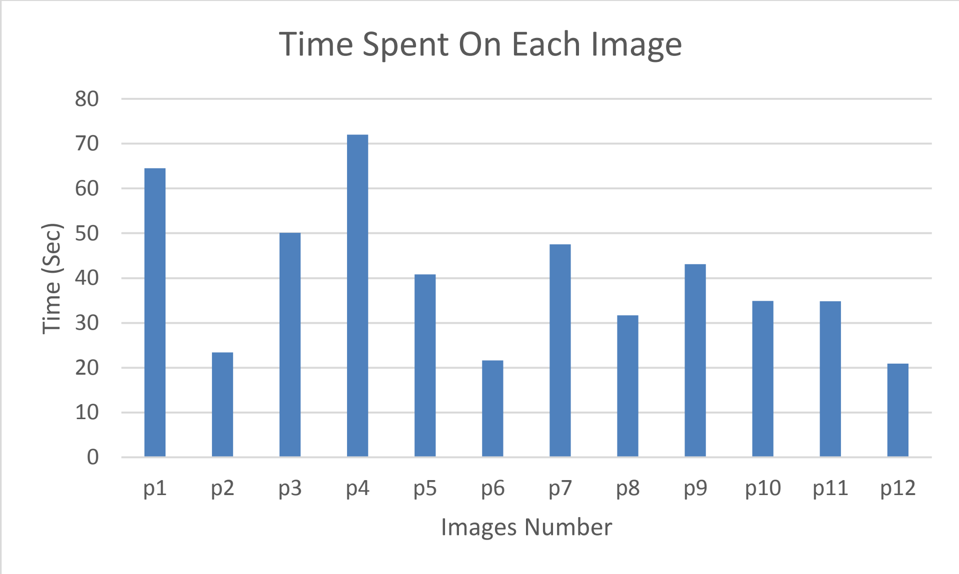


Figure 6.17. Duration of time spent by Mona viewing different images.

Analysis of Mona's data for eye tracking and narratives revealed that as Mona scans through an image, she tries to focus on natural elements within the image, i.e. fixation points are concentrated on natural components with linkage between fixation, element and positivity or negativity further confirmed by her narrative. Her main focus elements were green trees and sky views as seen in Figure 6.18. A unique visual behaviour is noticed from the eye tracking data where Mona seems to scan each image in her personal style. She starts from the left and then scans towards middle and then down the image. This pattern of scanning is noticed throughout all the twelve images scanned by Mona and represents her unique 'visual signature'.

P1

Figure 6.18. Pattern of Visual Scanning for Mona.

Entry point in the middle top of the image.

Mona liked activities on the beach and commented:

"This beach photo looks a bit messy, maybe the back ground behind the trees are houses and I don't see many people sunbathing, sunbathing on the beach, may be this is not suitable for sunbathing and this must me in a quite warm hot country and this one person serving seagulls flying over the sea, the mountains look nice surrounded by the sea". (Figure 6.18)

Figure 6-19 - Pattern of Visual Scanning for Mona.

Entry point in the middle top of the image.

With regards another beach image (Figure 6.19) Mona commented:

“This photo I can see many tress and this ocean is blue its more relaxing than the previous photo, there are rocks my the same beach and I don’t see any people in the photo still it’s a nice photo, make me feel more relaxed and sky is blue with white cloud”.

Other than green trees Mona seems to focus on the sky scenes in the images, Even though she describes the image as too grey, eye tracking data showed that she focuses on the sky and again displayed a similar scanning pattern from left to right and then downwards as she did for other images.

P3

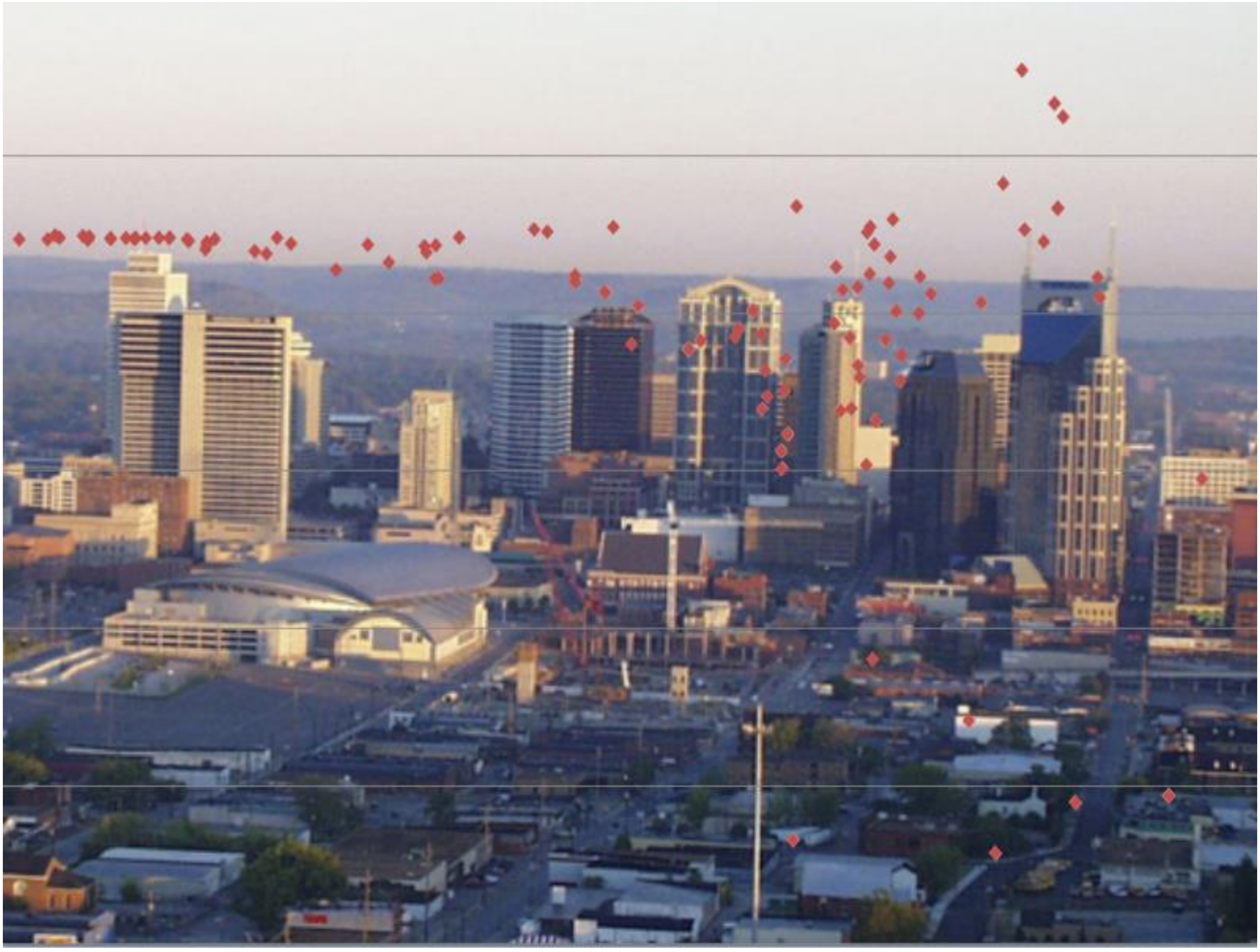


Figure 6.20. Pattern of visual scanning focusing on skyline.

Mona comments:

> *"Nice photo it's a city view its quite crowded, many high buildings, and I can see lots of traffic going on, I can imagine if I can hear noises this should be a noisy environment and air condition does not seem to be good, <u>too big grey all over the photo</u>"* (Figure 6.20).

In the next (Figure 6.21), Mona likes the sky and says because the sky is not dark the city looks nice.

P4

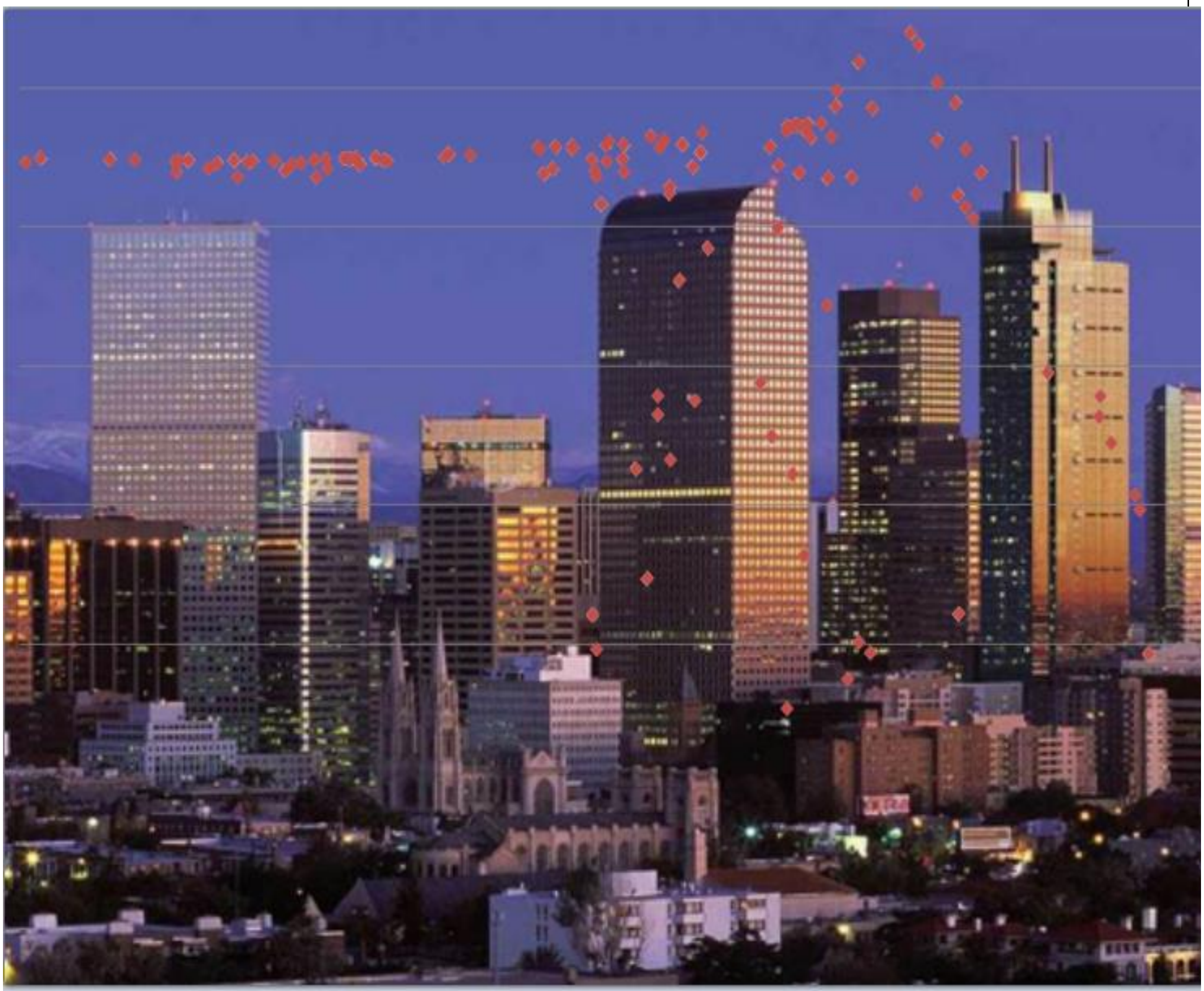


Figure 6.21. Pattern of visual scanning focusing on the skyline.

According to Mona:

"This one is a night view of a city, I can see old church and many sky scrapers, very high buildings and, it's nice even its busy and still may be because the lighting and <u>sky is not completely dark makes the city looks quite nice</u>, I cannot see any traffic at all, may be that is why this one is more peaceful than the previous one". (Figure 6.21).

Greenery and blue sky view is described by Mona as very relaxing. There was a special element about greenery which was noticed and disliked by this participant in image 6.22.

P5

Figure 6.22. Pattern of visual scanning again focusing centrally and moving away.

Mona describes unpleasantness about greenery in this image as:

"This one is in the woods........... I can see many green things attach on the tress this makes me feel a bit uncomfortable it seems to be humid and dark ......ammm....there are many tress but I do not see many leaves on the tress..... It seems a bit cold if I can feel the temperature, if I am in the woods I will think it's quite cold, many branches tangled to each other, to simply don't like this photo". (Figure 6.22).

In the next image (Figure 6.23), Mona describes the reason, why she likes this image. It is evident that order and a combination of different natural elements seems to be important factors as to whether Mona likes or dislikes a scene or environment.

P6

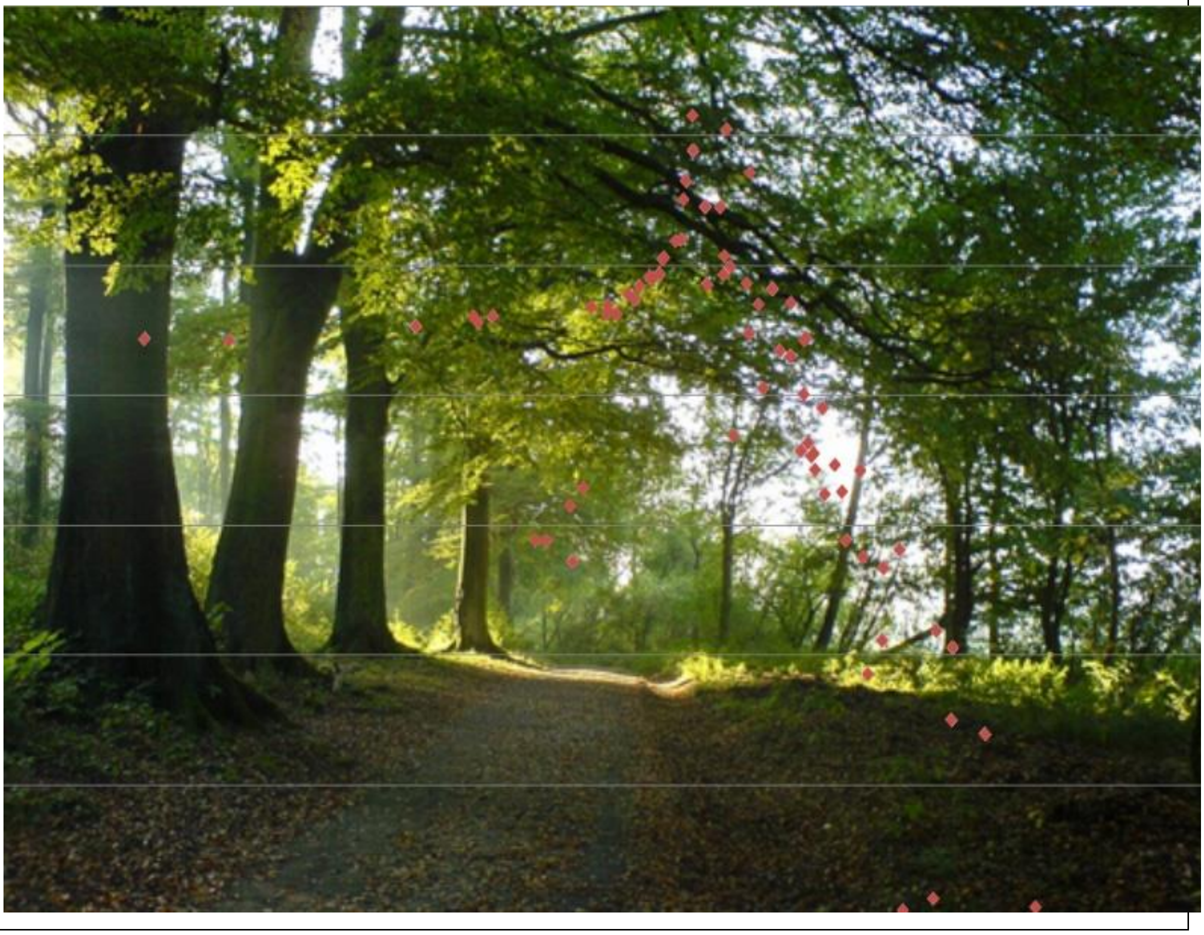


Figure 6.23. Pattern of visual scanning focusing on the middle zone.

Mona comments on the above image (Figure 6.23):

"This one is a path in the woods, this quite nice… I can see sunshine in the woods and green leaves on the tress and the path seems clean and comfortable. There is no mud on the ground, the air seems quite fresh".

In the next image (Figure 6.24) Mona describes her dislike towards non-natural elements of the image such as the concrete in the image.

P7

Figure 6.24. Pattern of visual scanning focusing on the motorway and surrounding greenery.

Mona makes the following comments on this image (Figure 6.24):

"This one is a motorway photo, two tunnels makes me feel a bit stressful......about these two roads may be because its hanging in the air not on the ground, there are quite a few cars going through the mountains and there are a few floors above the tunnels, I do not know what is the purpose for building these floors but sure they look quite ugly...the concrete colour and does not really fit into the green environment"

P8

Figure 6.25. Pattern of visual scanning, focusing on vehicles and surrounding land.

Mona once again clearly dislikes this motor way image (Figure 6.25) and says:

"This is a motorway photo ....a busy junction and two way roads... and more cars are coming up to join the motor way, and there is an island on the photo… it's a bit bare.. I don't see many trees… it's a bit sandy.. <u>and it's not a nice motorway</u>... <u>there is a bit construction waste on the side way of the motor way and the grass does not seem to grow so well".</u>

P9

Figure 6.26. Pattern of visual scanning focusing mainly a factory.

Surprisingly Mona appreciates the above image of the factory view (Figure 6.26) and thinks the air is very pleasant. She makes the following comment:

> *"This one looks cycle factory… I don't see smoke coming out, and the air quality seems quite nice... and there is green land to the factory and car park is quite well organised ...I don't feel bad about this place. It's quite well organised and neat".*

In the next image (Figure 6.27), the sky view and sunset is appreciated by Mona who states that this makes the image warm.

P10

Figure 6.27. Pattern of visual scanning focusing on the colourful sky.

With regards the factory image (Figure 6.27), Mona says:

"I suppose this is factory as well and there is sun set in the background…. <u>makes it look a bit warm… you can see a bit of smoke in the back ground</u> and it seems it's a heavy industrial factory… even this photo is quite peaceful….I still assume...... this photo produce lots of pollution with its big mass... mass of....machines".

Mona was one of the participants who had already viewed the images during the selection process and remembered the images. During the interview Mona was asked how she felt about the task to which she replied: "It's quite interesting with this eye tracking thing .....and I quite look forward to seeing what sort of results you can tell form my experiment ....I think I have done something similar for Richard before...is this same group of photos"?

When asked "what will you memorise the most about this task?", Mona replied, "the contrast between the natural scene and the city view… its quite different…even like this it's just photos but I can imagine the surrounds, sounds, noises.....and the noises even though cannot hear anything".

P11	P8
	

Figure 6.28. Pattern of visual scanning focusing on greenery and mountains.

During the interview Mona was asked which image she preferred the most to which she replied "Ok....May be this mountain view with lake ....Number 11 ....more peaceful and nice colour" (Figure 6.28, P11). Image P11 contained lots of greenery and colour which was liked by Mona.

Towards the end Mona was asked which image was her least favourite to which she replied "I think its number 8 (6.28, P8) and it is just simply really ugly...and they don't really look after the plants ... and also the motor way....its waste on the side of the road even". Mona finally concluded, "I think this is quite nice bunch you selected.....a mixture of everything".

It is interesting to note that when one observes the dot patterns on all twelve images viewed specifically by Mona, a visual signature emerges that is specific and unique to Mona.

The following is data from another participant who scored second highest in terms of CNS score.

6.10.2 Moo (second highest CNS score)

Moo is a male from Iran who is a researcher and painter by profession. Moo scored second highest in terms of connectivity to nature score with a score of 57. Moo spent more time on image 4 and 1 (Figure 6.29). Analysis of eye tracking and narratives data for Moo revealed that when moo scans through an image, he tries to focus on certain elements in the image. Unlike Mona, where her main focus elements were green trees and sky views as, Moo seems to focus on the deeper and meaningful elements of an image.

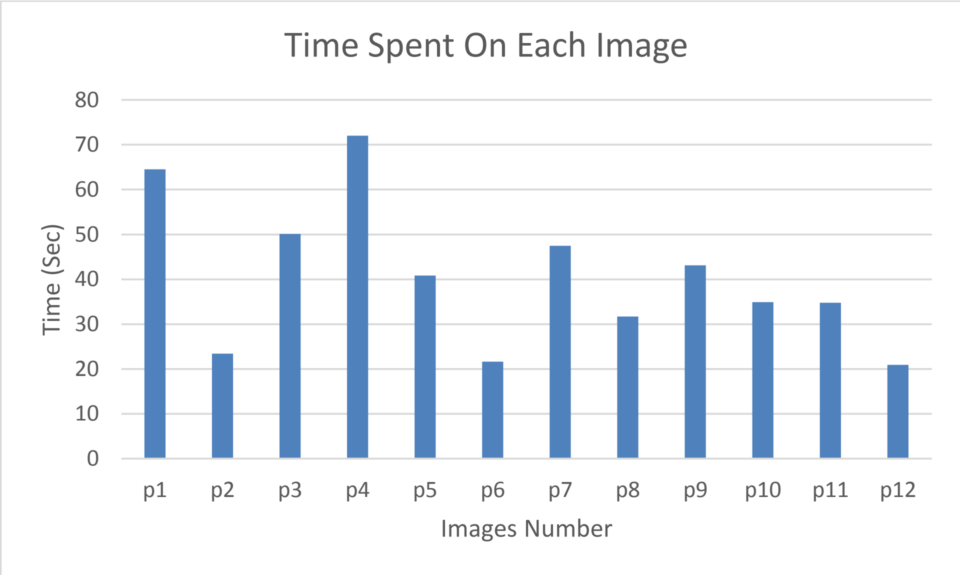


Figure 6.29. Duration of time spent by Moo viewing different images.

A certain visual behaviour is noticed whilst looking at eye tracking data; Moo seems to scan every image in his certain personal style. He starts scanning towards the middle and then down the image. This pattern of scanning is noticed throughout all twelve images scanned by Moo, whose scan paths co-ordinate with his narratives. Moo appears to focus more on the parts of the image where he has some interest. He seems to look for deeper meaning in the image relating it to his back ground and his past experiences.

For example, he likes image one (6.30) as he mentions later that it reminds him of his trip to Tunisia and Spain. A top down lead approach of navigation is noticed throughout.

P1

Figure 6.30. Pattern of visual scanning focusing on sea water.

Moo appreciates the beach (Figure 6.30) and comments:

"I like this image because it's got a *<u>very beautiful nice beach and this is quite safe for people swimming …</u>and the back view and beautiful nice mountains ..background and water. I also like it as it reminds me of holiday when I went to Spain and Tunisia".*

For the second image (Figure 6.31), Moo links this to his experience of home and comments:

"I like to see this image again, because sea side and a lot of palm trees remind me of my own home country and ...very nice beautiful view, sky, and very clean water and I like it".

P2

Figure 6.31. Pattern of visual scanning focusing on trees.

When looking at a built up area (Figure 6.32) on next page, Moo kept his style of navigation through various elements of the image, and also makes clear links to his daily life.

Moo tries to give some meaning to this experience of looking at this image (6.32) and comments:

"I quite like the architecture of this, but at the same time it's very crowded and seems to be lots of pollution there is........but I don't like it as much as I like the other two images......but at the same time I appreciated some of the architecture in the picture…not all of them, but it's not something I really prefer, or somewhere I prefer to live in any of those apartments".

P3

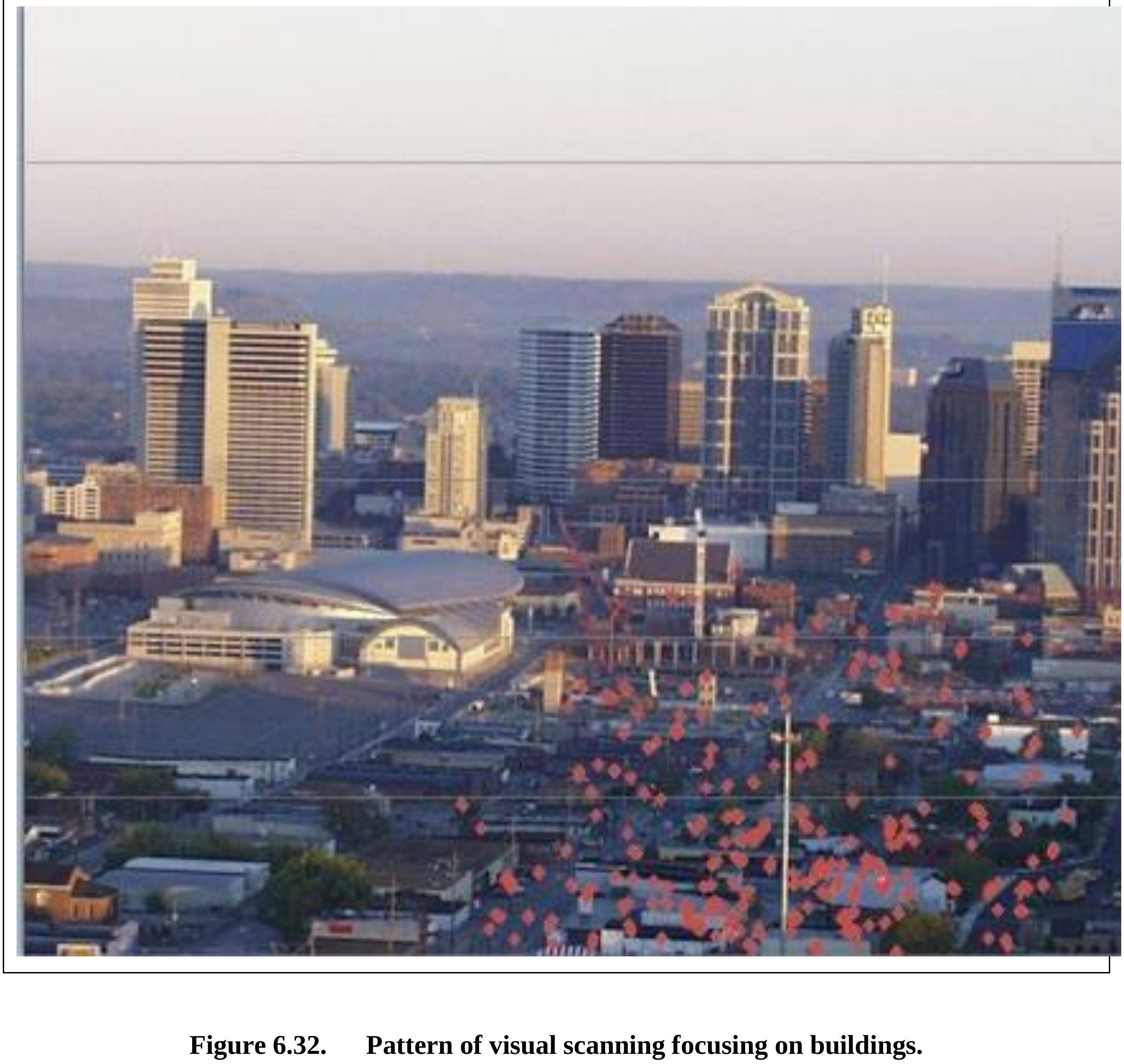


Figure 6.32. Pattern of visual scanning focusing on buildings.

When looking at an image of another built up area (Figure 6.33), Moo's main focus of attention was the church. When asked later why this was a key focal point, Moo replied "maybe religion plays an important role in their culture so that could be the reason".

Moo further commented about the image:

"Same thing I .....Just.... architectural wise is not too bad... But at the same time it look like a big block tower.... and if you look at that church in the middle ... or then you can see how actually small it is.... but where in some time ago centuries <u>*back some of the big cathedral, or the church or the mosque used to be biggest buildings, and you can see them from everywhere...but now you can see all the those big block tower ....*</u>*is just raising to the sky these religious places actually seem to be very small or comparing to other one is being ignored...... and ... I don't like to live any of those towers and it somehow remind me of ground zero as well which is quite scary as well".*

P4

Figure 6.33. Pattern of visual scanning focusing on a church in the scene.

Whist looking at the forest image (Figure 6.34), Moo mentioned his concerns regarding safety and said:

“I quite like this image as well but at the same time it seems to be lots of ...like a rain forest ... Like lots of rain there because of tress they covered with their grass.....and seems to be not very safe to go .. And make me lots of ...you know. Any more of snails anything there...same time I love it as it is untouched and no any human attraction in that you know place”.

Figure 6.34. Pattern of visual scanning mainly focusing on a foreground.

We can see Moo thinking of snails, but in the meantime he likes this image because he feels it’s an untouched, natural place. But again we can clearly notice his style of navigation, middle bottom of image. Later when asked why he focused on this region he explained that he was looking at dried green leaves on the ground.

Moo's narratives of the next image (Figure 6.35) were very interesting as he linked it to religion and mentioned paradise. Moo commented:

"I like this and it reminds me so beautiful and nice <u>and….I like to walk in between trees and so beautiful it is</u> <u>…. And just reminds me like paradise</u> ….and I like the greenery... and everything in that picture".

Point of note is the top down lead approach of navigation.

P6

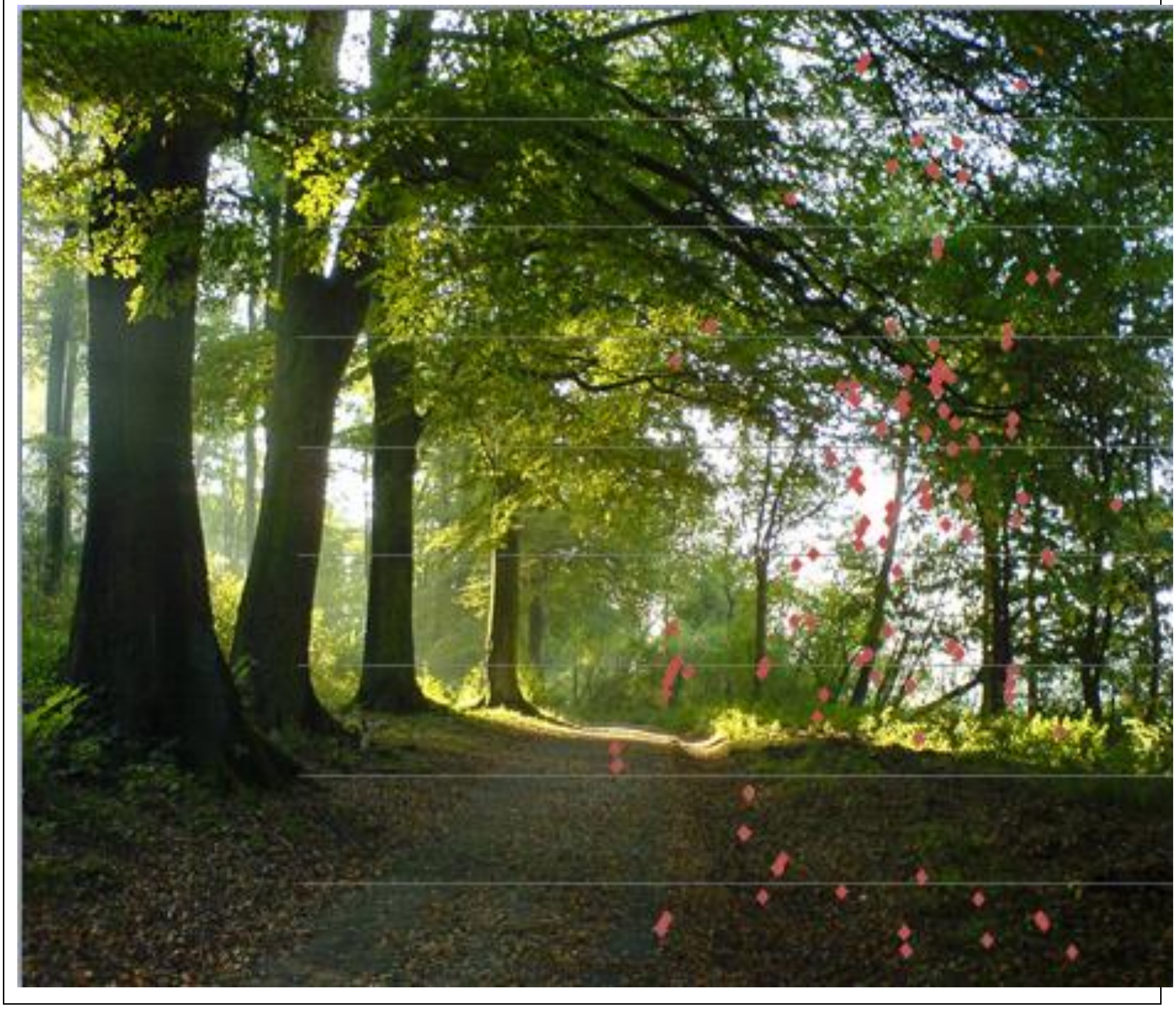


Figure 6.35. Pattern of visual scanning on a pathway between trees.

When looking at the highway going through the green environment (Figure 6.36), Moo commented:

"That is.... I am really... you know *... amazed by the ....in case of architectural design* *approach and I like it, it seems very beautiful and same time that is..... disturbing the landscape.. very unusual concrete made by human being.... and in you know disturbing your vision... and it is seem to be done..... Marvellous way... but at the same time I don't like this really in that landscape".*

Here Moo's opinion about the image 6.36, seems divided; he likes some aspects of the image and dislikes other aspects. He likes design elements of concrete structure but thinks it's a disgrace to nature at the same time.

P7

Figure 6.36. Pattern of visual scanning focusing on a motorway.

P8

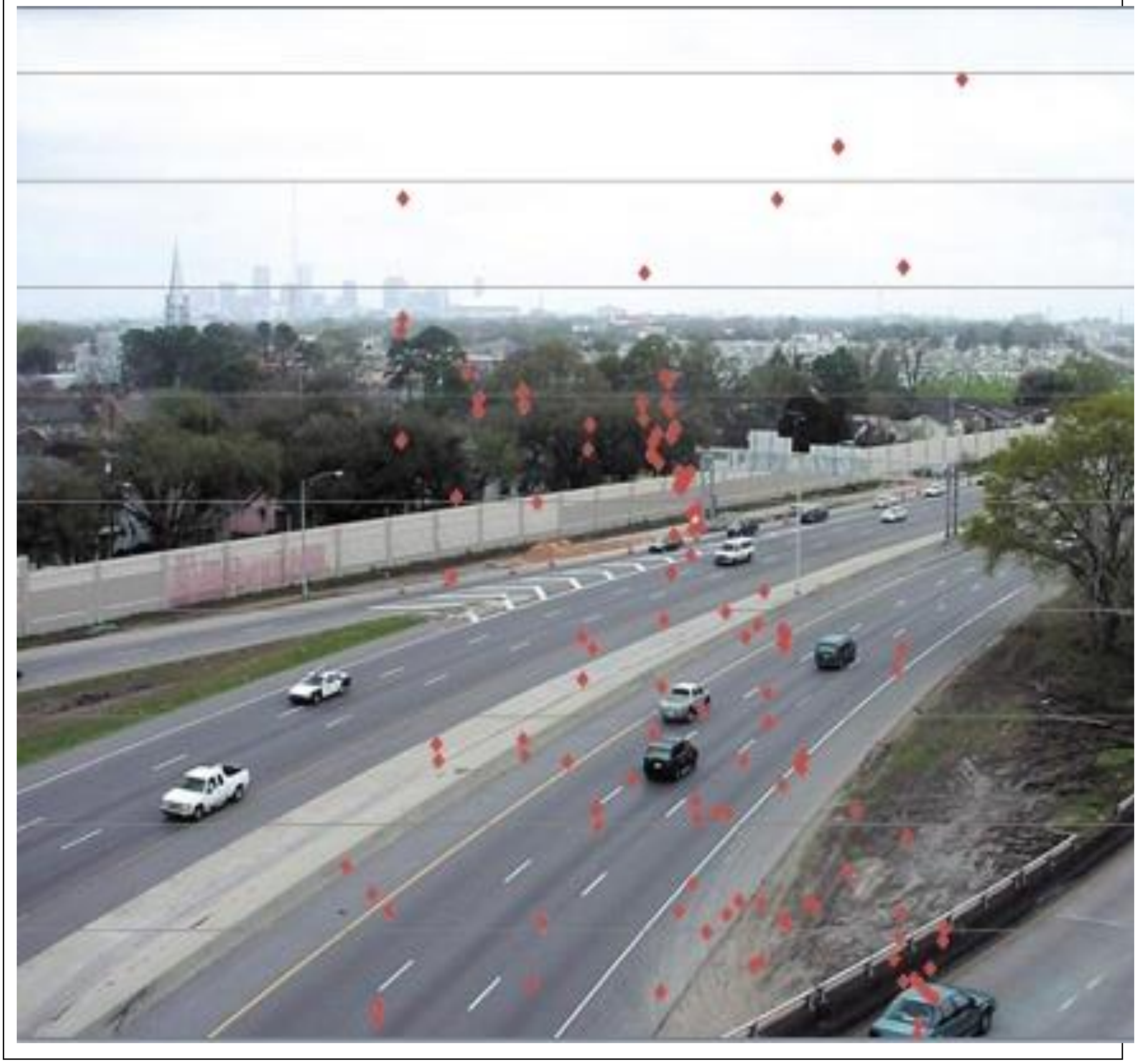


Figure 6.37. Pattern of visual scanning focusing on a motorway.

In the motorway image (Figure 6.37), Moo expresses a divided view once again:

"I know that is necessary to have like motorway and big road and at the same time it's done my .... I don't like it, it just reminds me of speed the motorway which even I don't like to drive on it and the back ground the city again, it seems to be very busy very polluted and it's not some where I like to live".

When looking at a factory scene (Figure 6.38), Moo commented:

"I don't like this at all and... its factory..... Source of pollution, noise and..... in case of images.... as well it is not very nice done, as, just too big.... to know ...may not like at all.. Tower or chimney one box in the middle lots of cars around it ... there this is somewhere I...... I always try to avoid".

Moo being artist may not be pleased with the size and distribution of different elements within the image. Moo again focuses in the middle and lower parts of the image. When asked later as to why this was the case he replied that he was "looking at the grass and road and both grass and road seemed unnatural because they were man-made.

P9

Figure 6.38. Pattern of visual scanning focusing on a green area.

When looking at another factory scene with a sunset (Figure 6.39), Moo commented

"The same thing is.... may be the oil company or something but... any other company I ...even I.... like the back ground, which is very nice sun set, the colour in the background ... but the same time that sun set will be nice, if you see it in the sea side...or even in the desert but not here with all those metals and these factories in front".

Here Moo again is not content with the combination of elements which may be linked to his artistic back ground. He clearly expresses his views that this sun set scene would look better in desert than within this factory view.

P10

Figure 6.39. Pattern of visual scanning over a factory.

In the next two images Moo kept his style of navigation and linked both the images to his past experiences mentioning places like Switzerland, Sweden, Italy and the Caspian Sea in Iran.

Upon viewing image eleven (Figure 6.40), Moo expressed his joy:

" I love this image I love the flowers.....the mountain and the snow there ,and the water coming down... and ... it's just remind me again of my home country and at the same time I went to back Switzerland and Sweden or in Italy you can see these images but .... This is some where you can breathe and you can walk freely...and I like that"

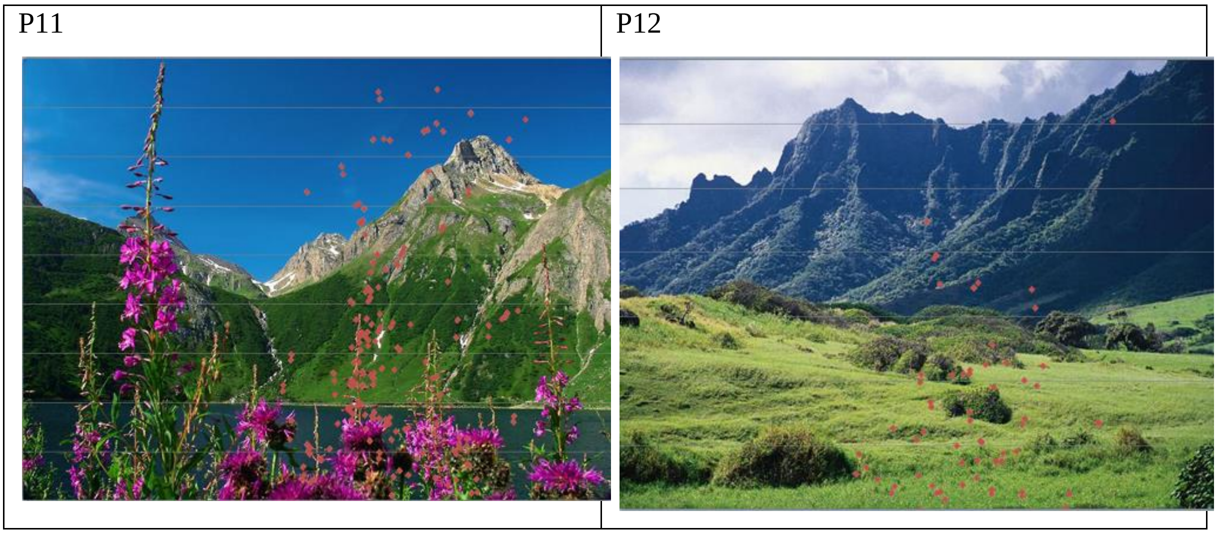


Figure 6-40. Pattern of visual scanning focusing on greenery and water.

Moo once again expressed his pleasure upon viewing image twelve (Figure 6.40),

"I love this again it's a beautiful mountain, forests lots of greenery and I like it ... it reminds me of the north of Iran by the Caspian Sea and I went there ... it's exactly the same ...it reminds me that".

During the interview Moo was asked," How did you feel about this task"? Moo replied,

"How I feel.. just ...It reminds me of something ....just took me to my background and also remind me of holiday I went I quite like some of the images "

Again this reinforces how he views images, his unique navigation style, linking elements to real life and past experiences. Later on when asked," What will you memorise the most about this task?" he replied, "Number 12... Number 6, 11... 12 ...and also number 9 which is the worse one. And also number 7 is because bridge I think always remain in my mind". Again all the numbers he mentioned here are linked to the resemblance of images to the places he visited in the past and images where the landscape resembled his home country.

When he was asked, “Which image would you prefer the most and why? he replied, “Number 12 because its forest ... beautiful...and it also it doesn’t to be very cold... Because .number 11 is beautiful. Nice... but it seems you know...in winter may be because ...lots of snow it can be very cold number 12 is because all the trees and forest ...it seems to be the ... just my.... you know ... the image..... Which I really prefer”. Here I would like to mention that number 12 is the image he linked to Caspian Sea which is in his home country in Iran.

When he was asked during the interview, “Which image is your least favourite and why?” He said, “Number 9 because just a factory and ...also number 10 as well ... but these two ... but number 9 is the worst one is just ...seems to me just a factory ... When its running all the pollution noises and lots of you know.... this is I don’t like it”.

He first mentioned that he did not like number 9 because of noise, but suddenly his artistic nature took over and he stated, *“Ahh ....Number six I like it because ....even it seems to be a bit.... artificial.. Because the trees in the line and the road.... at same time very nice green........... A couple of those cities as well... but.... you can see them every day you cannot avoid it... but at the same time....you really just get fed up and really....going and walking through the cities and see all those big you know ....block tower”.* He mentioned here that he did not seem to like this image because the trees were in a single line. It may be that Moo prefers natural environments and has little or no preference for manmade changes to natural environments.

6.10.3. Alan (third highest CNS score).

Alan is a 28 year old male who is a researcher and architect by profession. His country of origin is Kuwait. Alan scored third highest in terms of his connectivity to nature score with a score of 56. Analysis of Alan’s eye tracking data and narratives revealed that he tries to focus on certain elements within the image. Alan spent more time on images 5 and 8 (Figure 6.41).

Unlike other participants who focused on green trees and sky views, Alan focused more into selective elements of each image. A certain visual behaviour is noticed whilst looking at eye tracking data. He starts scanning towards the middle and then keeps his focus on certain special element in the image. This pattern of scanning is noticed throughout all twelve images scanned by Alan. Alan’s scan paths also co-ordinates with his narratives, where it appears that he focuses more on parts of an image which interests him and where he looks for a deeper meaning that is related to his past experiences, similar to other participants. For example, he like image one as he mentions later that it reminds him of his own country. Again a top down lead approach of navigation is noticed throughout all the images viewed by Alan.

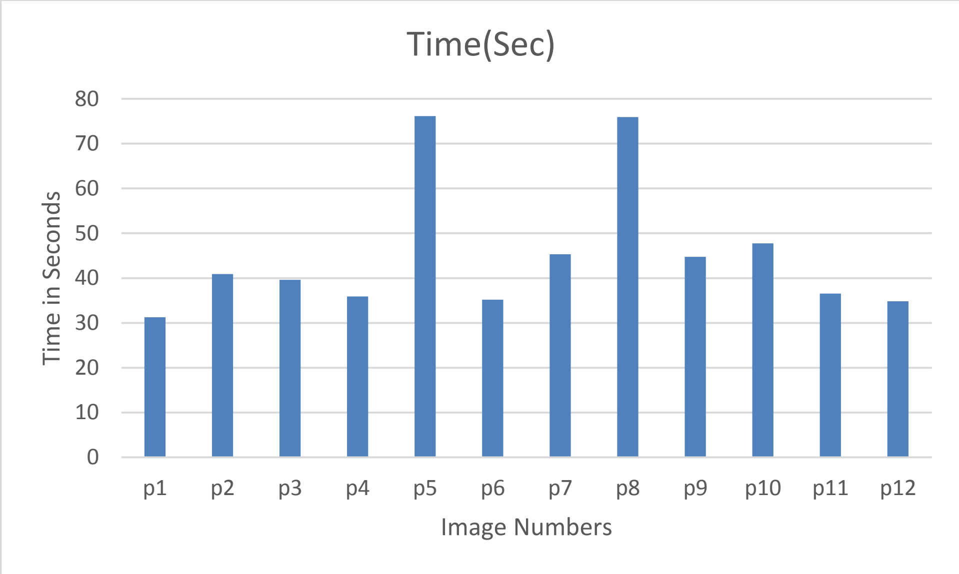


Figure 6.41. Duration of time spent by Alan viewing different images.

Alan liked the colour blue (Figure 6.42) and commented:

"With this image I like the blue colour in the scene, and it reminds me of my country… also I like the natural green which is in the middle of the photos, and also the most interesting is the children that are playing there in the left, whatever there is that is for totally for this photos".

Figure 6.42. Pattern of visual scanning focusing on people.

In the second image (Figure 6.43), Alan describes this image as:

> *"This photo reminds me with wall papers which I can take from the internet, and also I like the light blue colour for the sea. I think it has some language about that natural area and how it is clean you can see that underneath the sea, I think that is interesting".*

P2

Figure 6.43. Pattern of visual scanning focusing on the blue sea.

Like every other image analysis, Alan shows a repeated visual behaviour as well as a repeated narrative behaviour by linking the image (Figure 6.44) to a broad view of how it has been created and the purpose of the scene. Alan links the scenes to a social enterprise development concept which may be linked to his professional background of being an architect. Alan links the small and tall buildings to progress and the industrial development revolution. Participants who were non-professional disliked this image, thinking of it as a congested city where they would not like to live.

P3

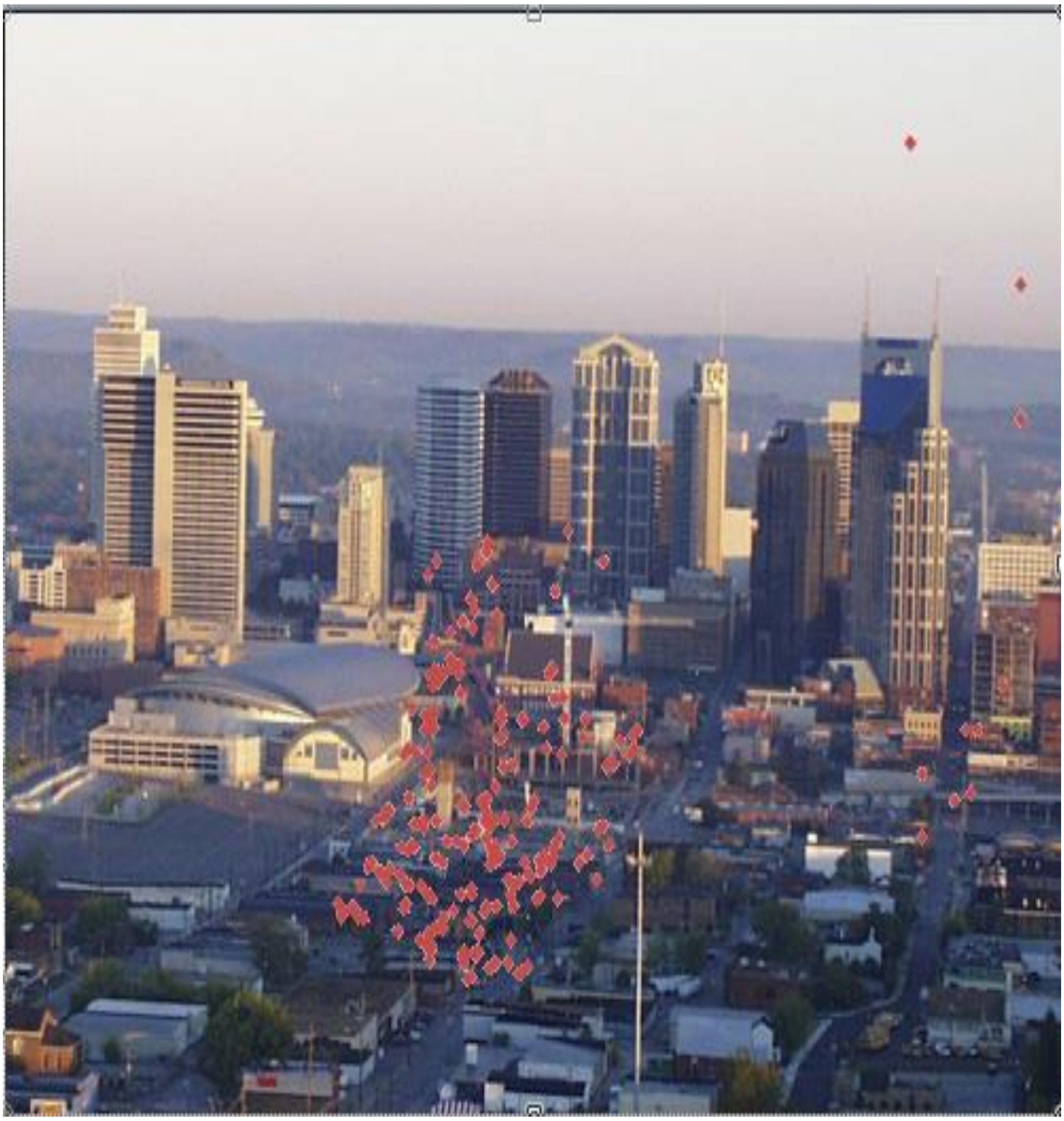


Figure 6.44. Pattern of visual scanning focusing on city streets and buildings.

With regards this image (Figure 6.44), Alan commented:

"This photo is talking about the development revolution in this century and huge building its going through and similar small building and huge building is communication with us about the revolution and about the future of our life".

Alan made similar comments with regards the additional image (Figure 6.45).

P4

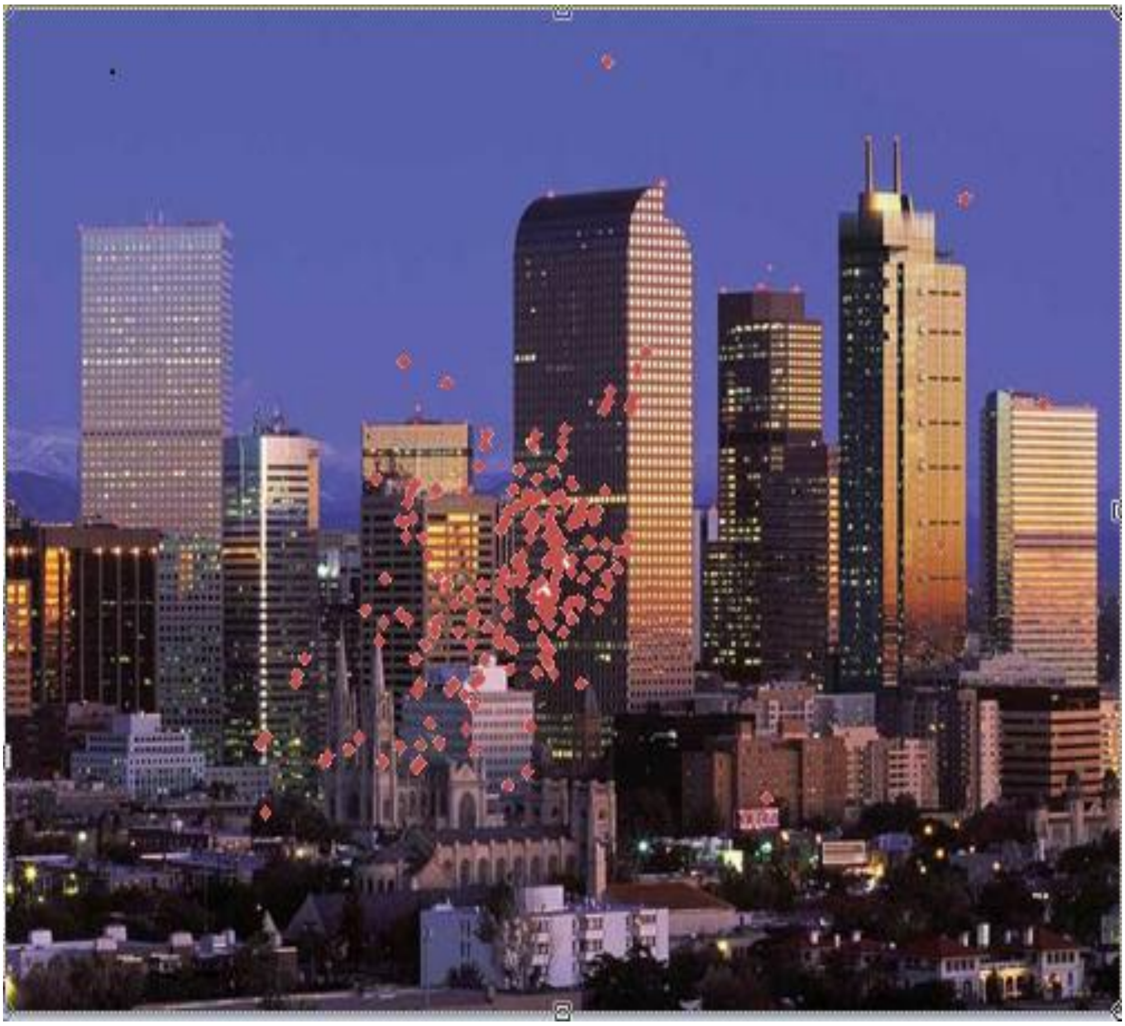


Figure 6.45. Pattern of visual scanning focusing on buildings.

Alan expressed (Figure 6.45):

"This as well, same as previous one I think it's taking about also the revolution with modern design, I like this sun shine which reflecting from buildings over there. I think it's so nice".

For the next image (Figure 6.46), Alan seemed to focus on the right corner which he liked as evident from his eye tracking data. Alan commented:

"This perspective I think is very nice, and especially in right corner…. up corner, I can feel about green perspective into the view".

P5

Figure 6.46. Pattern of visual scanning appreciating greenery.

When viewing the image below (Figure 6.47), Alan's body language made clear that he was thinking very deeply. When asked what he thought of this image, Alan related it to his life development in that he could see the light at the end of the path.

Whilst viewing 6.47 image, Alan commented:

"<u>I can't focus in the middle of this photo, I think it's talking about the story of everybody, there is a pathway…have to go through it. And there is a lot of interesting things in your right hand and right you to choice which one is supportive</u> and go through it, I think this photo is giving me some sense of self development of my life, how can I can develop my life actually".

P6

Figure 6.47. Pattern of visual scanning where participant talked about 'path of life' and choices.

When Alan looked at the next image of the motorway, he was very philosophical with a similar kind of behaviour displayed as in the previous image. He showed lots of interest in the image not due to the content but the meaning of the image to himself, that is, what did this image really mean to him? This kind of behaviour was noticed in all the participants where they looked at the images in a way that related to some meaning in their lives. Interestingly, a top down process was noticed each time participants navigated through different images.

With regards to the image (Figure 6.48), Alan commented:

"I think this is talking about complex relationship in our lives, this is through <u>I think this is like our life… there are lots of complex things in our lives… it's all make single together how can you find your way through it, I think all people have to find their way… how can we choose the right way which you have to go through it".</u>

P7

Figure 6.48. Pattern of visual scanning where Alan focuses on the motorway.

Alan looked at the image P8 (Figure 6.49) and rather than focus on the more visible aspects of the image, he focused on what was hidden behind the trees.

He also linked it to the development of different parts of the city which brings to the fore his architectural background as he navigates through the images.

He asks different questions to himself with why one part of a city is different. He commented about 6.49 :

"I think this is a normal photo, aha ....it's also I think there is in the left on the top there is a huge building, I think its hidden quite hidden, my eyes go through it because there are more interesting things in this photo. *<u>I am quite concerned why this side of the country is like this and that side is like that way</u>".*

We can also see from Alan's eye tracking data that he is more focused on the left side of the image and tries to look at the tall buildings behind the trees.

P8

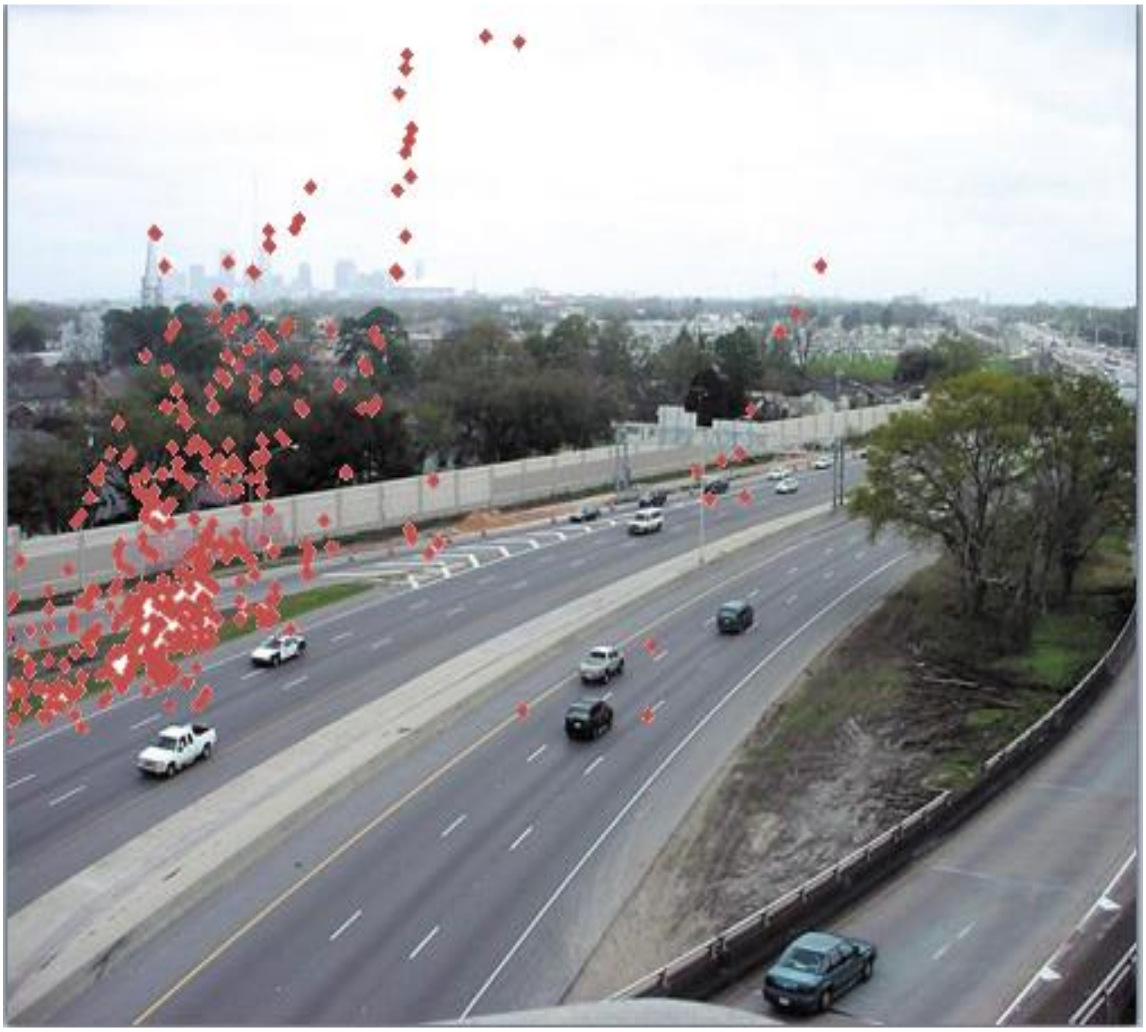


Figure 6.49. Pattern of visual scanning while Alan asks himself.

"Why all the tall building in this part of city not any in other part of city visible in image"?

Alan viewed the first image of a factory (Figure 6.50) in a different manner from the other participants.

Many other participants did not like the look of the factory, and in addition, related the factory to pollution. Alan however, looked the positive aspect of manufacturing and commented:

"I could feel about manufacturing and how they, how the architecture view in this photo is taking place right now. I do not know…I have no idea about this factory… about I have no idea what is made this factory. I could think they may be producing meter when I see this architecture and relation in the building without any care line. I think there is no care line in this photo, I could feel it's about meter manufacturing, something very solid".

When asked why he said meter manufacturing, he replied that he had seen such factories in his country.

P9

Figure 6.50. Pattern of visual scanning focusing on a factory and appreciating industry.

The same pattern emerged from narratives and eye tracking for the second factory image (Figure 6.51)

Alan looked at this image and explained that he likes progress and manufacturing but that progress comes at the cost of environmental damage. Alan commented:

> *"I am so worried of this photo, I have <u>developed in my country over manufacturing, and I think the colour of this photo I think colour scheme of this photo is very hot. I feel very hot when I see this photo. I think for yellow mixing with red.. I think getting sense of warm places or something very hot</u>".*

Alan showed mixed emotions being worried but liking the red colour in the image. Interestingly, this image was not liked by a majority of participants.

P10

Figure 6.51. Pattern of visual scanning focusing on a factory and appreciated industry and disliked sky color.

When looking at the next two images, Alan links his visual surfing trip to his past. A top down processing is dominant again which is opposite to market research claims that bottom up processing is dominant. It is also worth mentioning that most market research eye tracking is without backing from verbal narratives. Hence, we do not know exactly what participants thinkwhen looking at objects in the case of market research.

When looking at this image however (Figure 6.52), Alan is thinking about the things which are in fact not present within the image. He mentions about ‘Acoustics’. This makes clear that he is linking the scene to his past experiences.

Alan commented:

“I love this one and I could focus in the mountain in the middle of the photo. I could feel about acoustic the sound of this mountain. I think it’s so nice”.

P11

Figure 6.52. Pattern of visual scanning focusing on mountains.

The final image viewed by Alan (Figure 6.53) is linked to a childhood experience. Alan commented:

“I could remember some film when I see this photo, I think the film is the lord of rings when I see this photo it just reminds me of that film I do not know why”.

P12

Figure 6.53. Pattern of visual scanning focusing on the grass.

Upon completion of eye tracking and during the interview, Alan was asked how he felt about the task he had just completed? He replied, “Yes quite interesting and honestly there are various types of photos, I think there are three or four type of photos, you choose to show me”. He also said that he sorted all the images he has seen in three categories in his brain and said, “I sorted in different way. I sorted natural perspective and building and some sea perspective”.

When he was asked ‘what do you think you memorised the most about the task’ Alan replied; “Aha, I could memorize some photo,.. it has some memories able to my mind some photo is still just piece of paper, number six, because I use kind of photo when I done my plan. I like this kind of perspective when they capture this photo. I like it that way when you go through it… second one is number seven and also its clear when you look it that way and its very complex”. Here Alan explains that he likes the images because they are taken in a certain way which resembles his past experience.

When he was asked why he was very philosophical when talking about figure (6.48), Alan expressed “Because I work with this kind of photo and I find my way that is the reason these two affect my mind”. He mentioned about working with these sorts of images in his mind in real life.

Later on he was asked which image he liked the most and the reason, to which Alan replied, “Number six (6.47) and seven (6.48), because it has a language. When I see it I think my personal life there is way to our life.. all people have to go through it then at the finish of that when you go through it you will get what you done when you were walking in the way you will reach your destination yes yes”.

He also said, “The reason for choosing number seven and there is two destination, two roads you see, there you see two roads this connecting in the middle, that means when you go though one line you still have time to change you can just say the one is for the hell and the second is for the heaven and you will be in the middle of the way you will have chance to change.. very good very good”.

When asked which image is your least favourite and why, Alan replied, “Aha ....I think there are several but its number eight. I do not think so it’s interesting I do not see anything special just there is a few building over there I think its talking of about part revolution when you put like number three (6.44) or number four (6.45) its making scene more than so I could choose number eight (6.54) worse yea”.

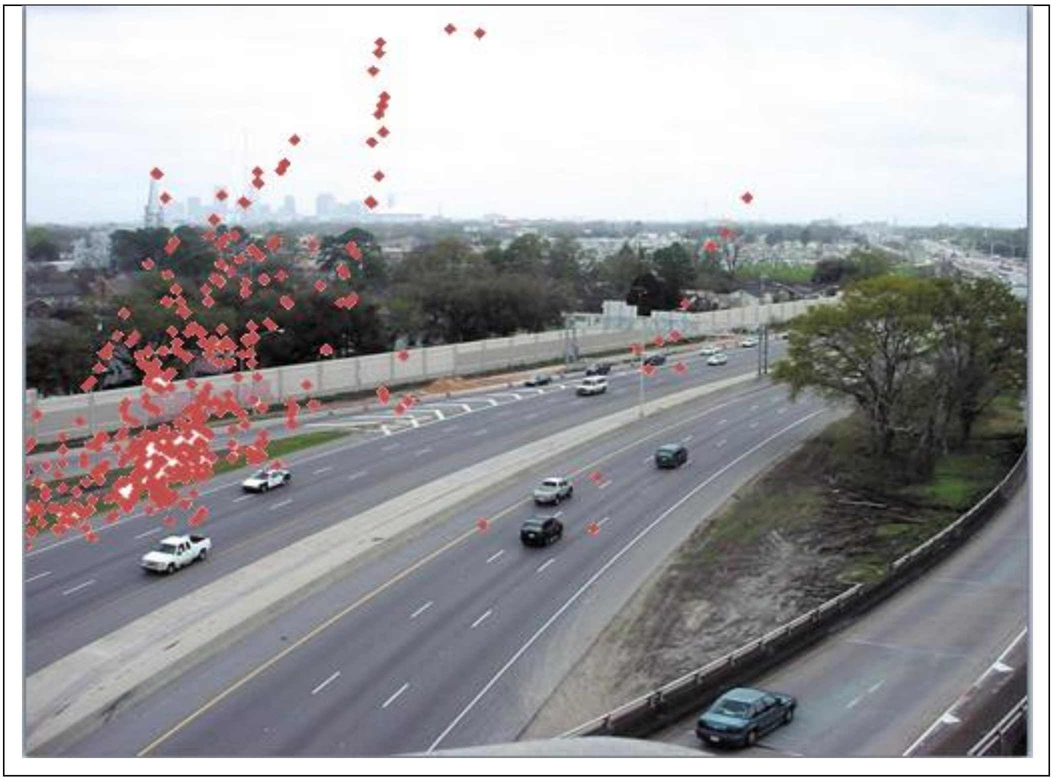


Figure 6.54. Pattern of visual scanning on an image the participant thought was the worst.

Again, Alan links this experience to his past and says, “Aha......Number 8 has some memorizing .... because this scene......... I could see in my country.. I saw it a lot, this a lot in my country but others not it’s not familiarize with me. For example Number 2 for example I think is not real,.. I think it’s any regular internet photo, it’s not real, it’s not have any language and I say number 8 I do not like very well”.

He is linking other experiences to his past: “About the architecture ......I think number 9 is so nice and others that’s completely same. Number 12 it reminds me of very interesting movie, I love it, lord of rings, all these colours I could remind me of when I was very young I use to see this movie. I could not switch off my TV...I use to see this movie again”.

What is apparent from the three cases discussed thus far is a dominant top down processing throughout the navigation experience. A clear visual signature of this individual was seen on all the twelve images (as was the case for the other participants discussed).

6.10.4. Romia (Participant with lowest CNS Score)

Romia is a 33 year old female and a health care student from Birmingham UK. Romia scored the lowest in terms of her connectivity to nature score with a CNS score of 29. Romia spent more time on image 12 than any other image with the least time on images in the beginning (Figure 6.55).

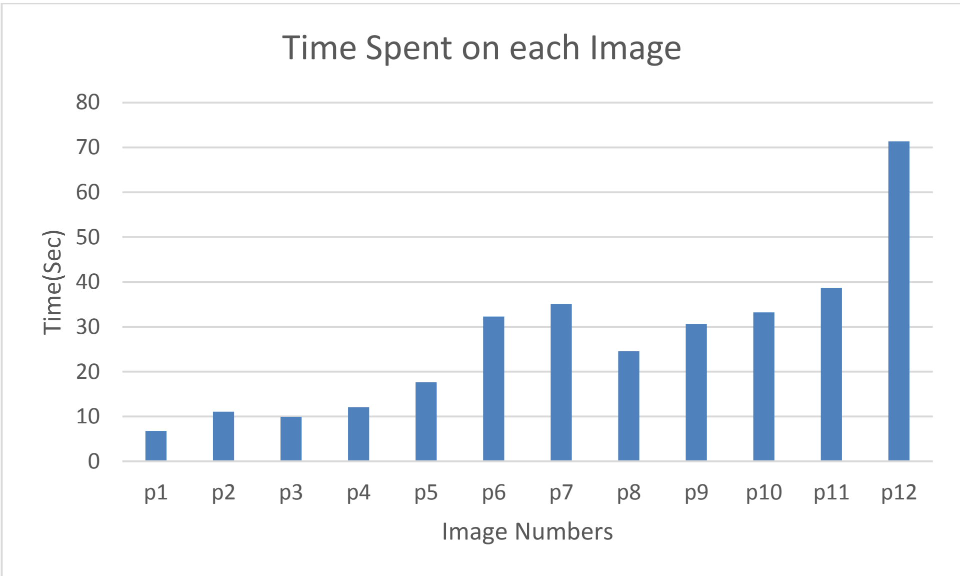


Figure 6.55- Duration of time spent by Romia viewing different images.

Whilst going through the data obtained for eye tracking and narratives, it became evident that when Romia scans through an image she tries to focus on the natural elements in the image. However, Romia was consistent in spending very little time on any image skipping through the images quickly. It was clear that this participant had very little interest in natural or built up environmental images. Her scans did show that she focused on some elements such as water views (Figure 6.56). Although she scored very low in terms of a CNS score, a unique visual behaviour is noticed displaying her own personal style. Romia starts from the left and scans towards the middle before scanning towards the right hand side of the images. This individual pattern of scanning is noticed throughout all twelve images.

Romia thinks the first image (Figure 6.56) is unusual as it has waves. Interestingly, Romia is the only participant who used terminology like ‘unusual’ for waves and the sea commenting:

“I think this picture looks a bit unusual because it’s got the wave things on the sea together”.

Figure 6.56. Pattern of visual scanning focusing and talking about waves.

The next beach image is very calming for Romia because of its colour and palm trees. Eye tracking results show that she is focusing on the palms trees and the blue sky. She focused very little on the right of the image. Romia expressed in her narratives:

“This picture is very calming........I like the blue sea.... I like palm trees”.

Although she scored less on the CNS she focused on natural elements in the image.

Figure 6.57. Pattern of visual scanning focusing palm trees.

Romia, like many other participants' linked the next image (Figure 6.58) to a place she had visited in the past. Top down processing seems to be dominant. Romia commented:

> *<u>"This picture is looks a bit like New York but probably not New York, I find the city quite</u> stressful...laugh... maybe I am stressed...laugh".*

Figure 6.58. Pattern of visual scanning focusing on buildings and likening it to NY City.

Like the previous image, a similar pattern emerged in this image (Figure 6.59) from the eye tracking results.

Romia is navigating on the left side and only focused little on the right side. Again she linked this image to a city she had visited in the past stating:

"This reminds of Frankfurt because it has got tall towers, it looks very pretty with the lights on in the darkness".

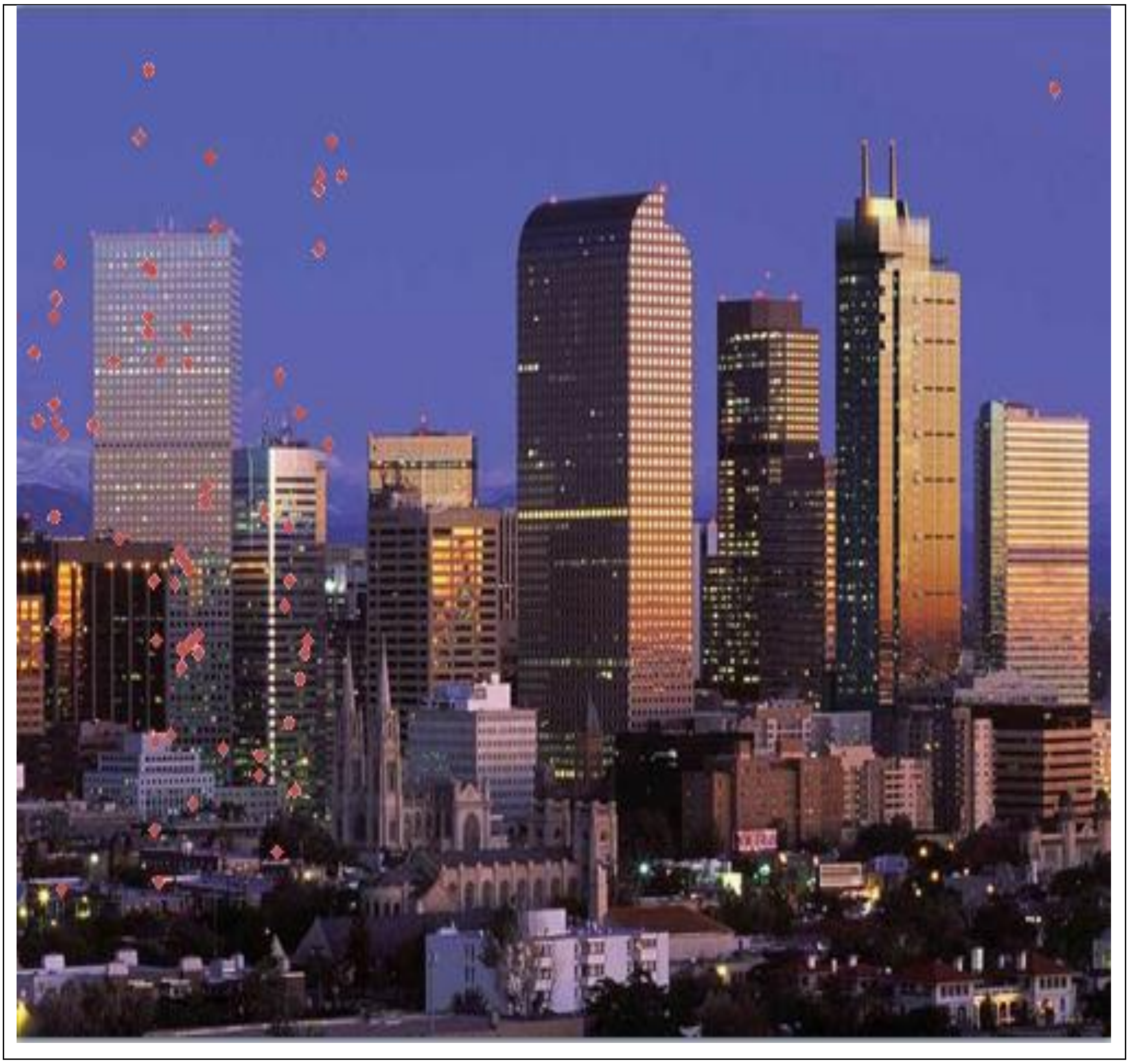


Figure 6.59. Pattern of visual scanning focusing on building and linking it to Frankfurt City.

Romia provided a very brief narrative for each image. For example, with regards the next image (Figure 6.60) Romia commented:

"<u>This looks very spooky, looks like a spooky forest</u>".

She quickly moves to next image, but again it can be seen that the participant scans on the left of the image and only once focusing on the right. This pattern is evident in almost each image viewed by the participant.

Figure 6.60. Pattern of visual scanning focusing on the tree.

Like in the previous image, Romia scans on the left of the image (figure 6.61) with few fixations on the right of the image. This shows a consistent and individual scanning pattern. Romia commented:

"This looks really, really nice I like this because it's very relaxing".

Many other participants felt the same viewing this image.

Figure 6.61. Pattern of visual scanning focusing on a tree linking it to relaxation.

Romia relates the next image (Figure 6.62) to spaghetti linking it to the spaghetti junction system in Birmingham. The scanning pattern for Romia is again top down processing. She says:

"This reminds me of spaghetti junction in Erdington.......because it's very........ very .....it looks like spaghetti".

Figure 6.62. Pattern of visual scanning focusing on greenery but relating it to spaghetti.

Like every other image, Romia's narratives about this image (Figure 6.63) were very brief.

Romia is the only participant who noticed a police car. She commented:

"Here I can notice very fast cars on the motor way and the police car".

Again most of her points of interest (POI) are on the left side with only a few on the right of the image.

Figure 6.63. Pattern of visual scanning focusing on a police car.

The image displaying a factory scene (Figure 6.64) showed a similar pattern of navigation as in previous images.

Once again a brief narrative was supplied by the participant who commented:

"This picture looks really dull because it's like a factory...but I like the blue sky".

Like many other participants Romia liked the blue sky. Although she scored very low in terms of her CNS score and spoke briefly for each image, Romia does however refer to the natural elements.

Figure 6.64. Pattern of visual scanning focusing on greenery and factory. The participant thinks this image is very dull.

In this second factory image (figure 6.65) Romia is again brief in her narrative stating that:

"I like sky in this one but I do not like the fore ground".

Figure 6.65. Pattern of visual scanning focusing on the sky.

What was interesting whilst Romia was viewing the natural scene images was that her body language displayed that she was relaxed. Although the participant was brief in her verbal responses, she did seem to enjoy viewing the images. She expressed her views after long pauses and she spent more time on these particular images.

Romia was one of a few participants who mentioned flowers in this scene (Figure 6.66) stating:

"I like flowers.........., I like the sky and I like the mountains so this picture is quite relaxing".

Figure 6.66. Pattern of visual scanning focusing on flowers.

The next image (Figure 6.67) showed that the participants main POI was the green grass.

She navigated through the image but this time looked at the right side of image more so than in other images. Romia commented:

"This picture is quite green .....pause.......I like the green grass in this picture because it's nice".

Figure 6.67. Pattern of visual scanning focusing on green grass and appreciating it.

When Romia was asked how she felt about the task, she said, “I quite enjoyed it, looking at the different sceneries”.

When asked what her memorable moment of the task was she replied “Looking at the calming sceneries such as forest that one number 6.” (figure 6.68)

Figure 6.68. Pattern of visual scanning focusing on leaves and tress stating this is the most memorable image.

When asked which image was liked the most and the reason, Romia responded with “I like number six because..... It’s very calming and serene, where as other pictures like number one for example it has two different sceneries ....I like number 6”.

She further says, “The reason why I like number six, is because it’s simple and relaxing, straight forward and you can just see picture of trees with sun light coming through the trees”.

When asked which image was the least favourite and why Romia responded “ My least favourite has to be number.............................pause..............................number 5, because it looks like a really spooky forest ....big , big laugh ....looks like, a witch gone can come out of it”. (Figure 6.60)

She further mentions, “I think number 9 looks a bit or number 10 looks a bit stressful....it reminds me a bit dull.. It reminds me a bit dull........it looks working class...may be wrong word (6.58)........alienating environment. Number 4 reminds me of ....big cities like.......... New York, laugh......” (6.59)

6.11. Summary

The analysis of the data clearly shows a common trend for each participant, that is, a unique and clear visual signature formation for each image that is individual for each participant. This has been shown in four participants that have been discussed in this chapter.

The main aim of this research was to revisit existing environmental images research in light of eye tracking data. However, when data bases were explored only a few studies were found using eye tracking for environmental images. It was anticipated that previous experience and expectations influence the visual search behaviour of participants when visiting environmental images for the first time.

This was confirmed by the eye tracking study with many fixations on the top of the images where the sky is present. This study adds clarity that would complete the picture and bring an insight for future landscape researchers. This study suggests that an individual's dislike for images may conflict with the images' advantages in 'drawing in the eye'. All participants fixed on images, even those who disliked and claimed to ignore them. However, those who disliked the images gave short responses. Although this requires further investigation, the use of such images could be an obstacle in search efficiency for those who disliked them.

Overall, this study focused on initial impressions of environmental images with the help of eye tracking. Taking into consideration the importance of the image, this study explored the factors that influence initial fixations in relation to expectations and preferences. Chapter 7 will look at the individual surrogate landscape elements (SLE) in terms of participants' connections to these surrogate landscape elements, their visions and perspectives.

Chapter 7. Identifying Connections.

This chapter will discuss the scanning behaviour of participants in terms of participants' ability to identify and appreciate the elements presented in the images. In this chapter, the narratives are compared with scanning patterns. Due to the large data set, the software NVivo was used to go through the emerging themes and explore other findings from the narratives. These findings are linked to eye tracking data and other background data for the purpose of rigorous triangulation. At this juncture it is important to establish that POI (point of interest) are the areas of participants' fixation on the image during eye tracking session.

As described in Chapter four, eye tracking, narratives, interviews and personal profiles have been used to collect data using the concept of SOI (Sense of Image). Therefore, using NVivo™ all data was coded and transcribed so as to create a node structure (Figure 7.1).

This node structure will be used as a framework for presenting the data. There are three 'parent[28]' nodes (visions, connections, perspectives) and numerous 'child' nodes (for example, memory, cars, trees, and sky).

[28] Nvivo used term for common themes as nodes, which are subdivided by using term like parent nodes, expressing the link of emerging theme to the original themes.

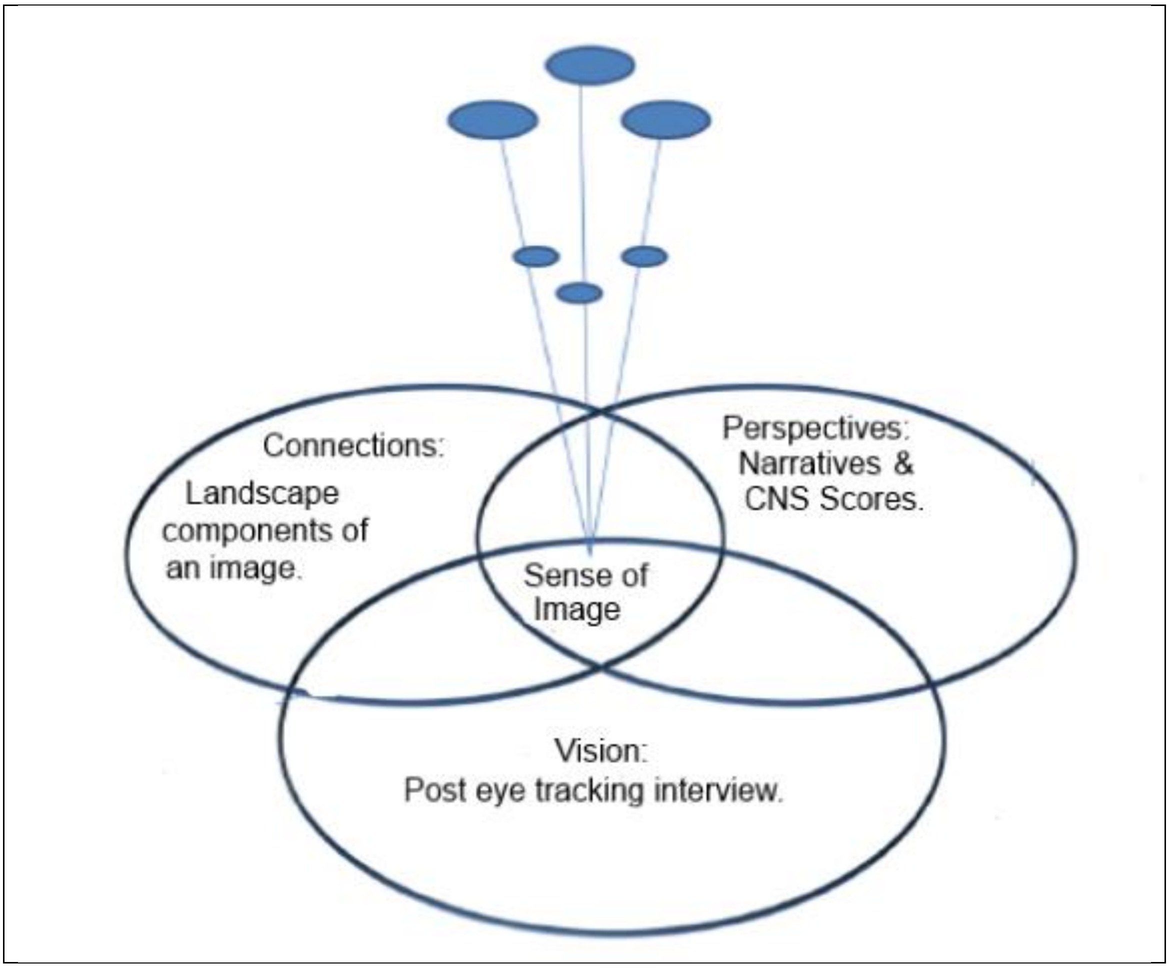


Figure 7.1. Sense of image model (SOI)[29] for data analysis.

Key aspects of analysis include:

- **Connections:** reveal representations of people's sense of image; i.e. factors connecting people to an image such as landscape components.
- **Perspectives:** outline people's individual views about landscape images; i.e. general running narration about any image during eye tracking session. Perspectives present the storylines related to the SOI.
- **Visions:** collected by asking specific questions at the end of each eye tracking session. These questions elicited people's ideas of their perception of the cause of visual attraction or conversely their reasons for liking or disliking.
    1. How did you feel about the overall task?

[29] This figure is a modification of two figures depicting the three "forces" affecting human action: Social and Political Processes, Social and Cultural Meanings, and Biophysical Attributes and Process. Each force is a circle and where the circles intersect is "place". (Cheng, Kruger and Daniels 2003, p. 90). I have also included aspects of Sack's (1997) figure depicting the relationship between "forces" and "perspectives" (p. 28). The terms I use are derived from my own reading of the literature leading me to speak of "factors."

2. What can you memorise about the task?
3. Here are the prints of images you just looked at during eye tracking. Have a look at them one by one and express your thoughts.
4. Which image do you prefer the most and why?
5. Which image is your least favourite and why? (Appendix A Post session questions).

This is explained by the SOI analytical framework which details how a person's sense of an image is more than an actual physical experience of a place. In other words, reading about an image could be an experience that has connected someone to a particular place.

Connections list factors and people's activities that link people to an image. Thus, these connections explore and recount stories of SOI type experiences: geographic (physical attributes of image, what is happening in the image), and personal factors i.e. memory.

Perspectives begin to explore a more layered understanding of how people relate to an image and how they describe their experiences. This was done by gathering narratives of people after their exposure to images and performing an eye tracking activity in the meantime. Here, the "northern lifestyle issues" as detailed by Halseth et al., (2006), became useful in attempting to classify the themes that arose through people's perspectives. A person's experience is understood as more than just an activity but rather in the larger context of what seems to be important to that person, for example, some participants used their connections to images causing them to respect a scene in a new way or, worldview taught them a deep respect for a specific image and their connection to this image is simply an extension of their belief. Either way, an aspect of this respect is featured in the discussion about image and their experiences and activities in which they had participated in the past.

Finally, Visions contains the answers to the specific questions. This node was not further broken into smaller categories as it was felt that it was not a purpose or objective to determine a vision for image, but rather to allow space in which visions could be heard.

An analysis of the visions, is integrated with connections and perspectives in order to elicit general themes (Figure 7.2), which seems to best reflect the researcher's intention.

The overall view of the presentation of the data is displayed in the Figure 7.2. In this section, there may be some overlap which is occurring, which is believed to be due to the highly interrelated and dynamic aspects of people's SOI viewed through Connections, Perspectives and Visions.

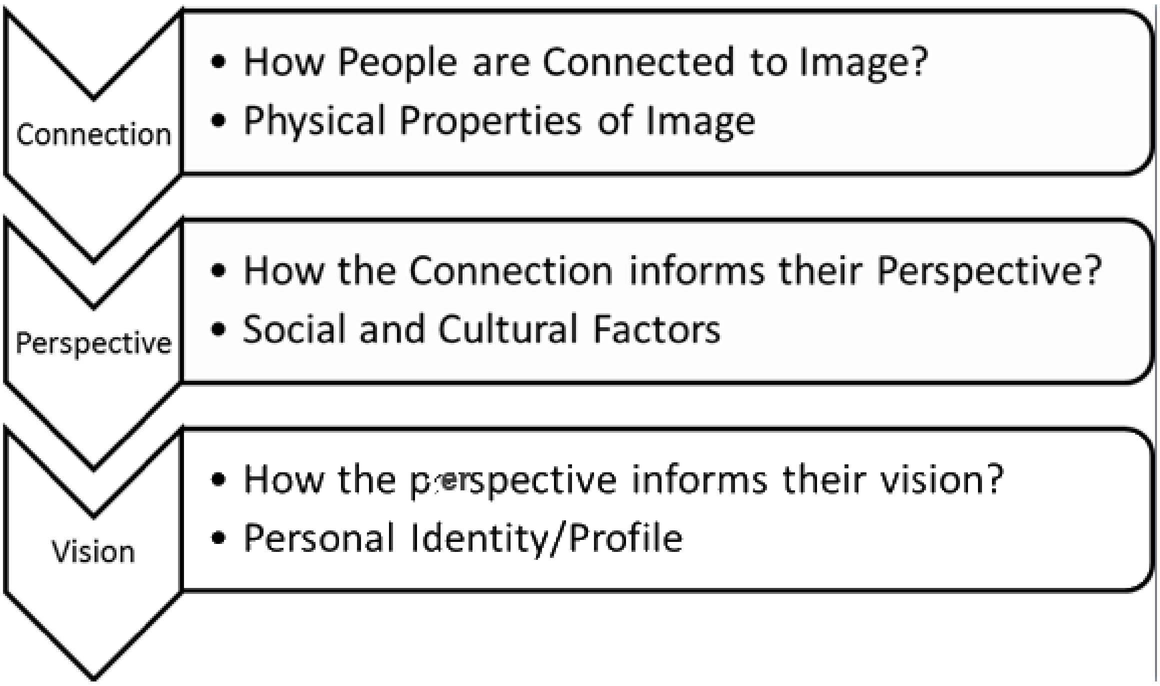


Figure 7.2. Definition of Connection, Perspective, and Vision for this research and how they may be integrated

In Figures 7.3 A and 7.3 B below, it can be seen how different nodes[30] are grounded in the data that was collected in this study which reveal results related to the main objectives.

7.1 Connections (Participants images data obtained during Eye Tracking).

A wide variety of connections became apparent during the narratives, the interviews and the eye tracking data analyses which were organized into activities, memory, and physical attributes. Here in Figure 7.3 A, B, connections is a parent node[31] which has three child nodes[32]- activities happening in the image, physical attributes of an image and memories related to the image. These have been further divided into sub-child nodes which can be seen in the figure below.

[30] Nodes are common themes that emerged using Nvivo to analyse data.
[31] The bigger node, see Figure 7.2 A and B, Physical attributes, connections and memory are parent nodes.
[32] See image 7.2, all the nodes other than Physical attributes, connections and memory are child nodes.

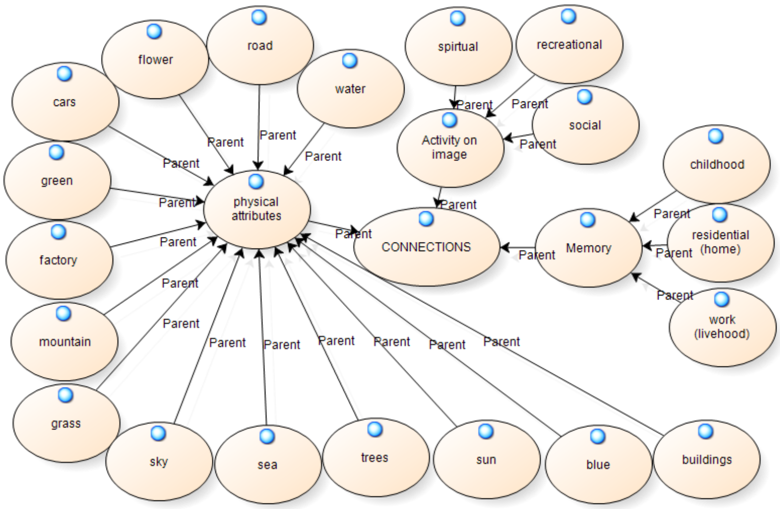


Figure 7.3 A. Examples of 'Connections' with related Parent and Children nodes that emerged using NVivo.

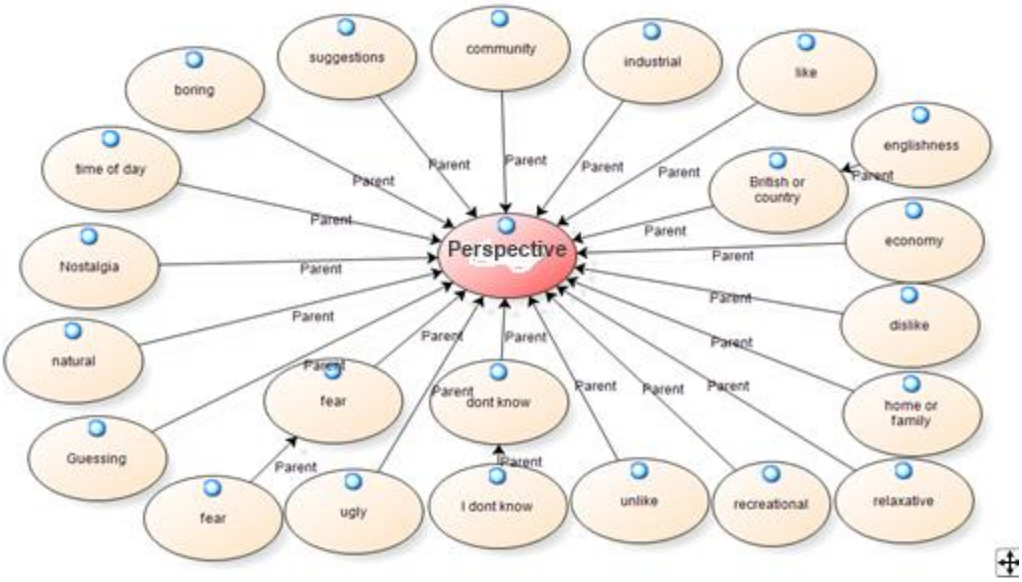


Figure 7-3 B. Examples of 'Perspectives' with related Parent and Children nodes that emerged using NVivo.

Three major types of connections emerged along with lots of perspective mentioned in Figure 7.3 A and 7.3 B. The narratives obtained for each image indicate clusters of connections which are related to:

A. Activities on images.
B. Memory linked to images.
C. Physical attributes of images (different environmental elements).

By analysing the narratives, it is possible to isolate these different components and to relate these to the pattern of fixation. However, the fixation patterns show associations with different narrative streams or elements as well as single elements, e.g. flowers and colour, water and sky, light and sunshine, beach and sunbathing, showing a complex of physical attributes, associated activities or possible activities as well as reference to personal memories which are offered as context. The following sections attempt to show how these elements interact.

7.1.1. Activities on images

As participants looked at the images during eye tracking sessions, they gave narratives. They mentioned different kinds of activities happening in the background or foreground of some images. These activities entailed connections that involve some kind of physical movement and include: Social, Recreational, and, Spiritual activities related to Sense of Image SOI as shown in Figure 7.4.

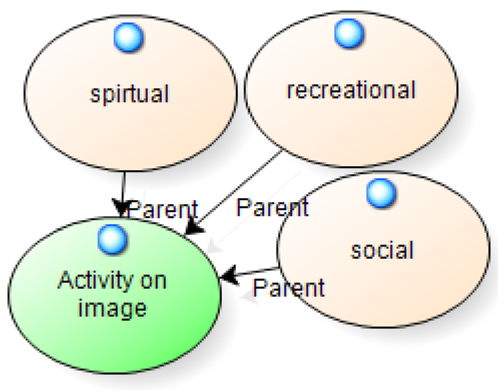


Figure 7.4. Activity on image' with parent node divided into three nodes. (See also Figure 7.3)

7.1.1.1. Social Activities.

Social activities include any reference to the purpose of the activity as social in nature. Examples of social activities include people walking and playing in an image, society development and its connection to images, and historical exploration such as industrial revolution. Social activities are separated from the pure recreational activities due to the fact that the goal, purpose and primary reason for these activities are social with a deeper meaning. By relating to certain images, many of the activities that take place are for social reasons. Participants mentioned in their narratives how they think these activities are for social purposes.

One participant (Alan) commented on image 7.5 as an "industrial revolution".

Figure 7.5. Participant discussing 'industrial revolution' whilst focusing on buildings during eye tracking.

He said "This photo is talking about the development revolution in this century and huge building its going through and similar small building and <u>huge building is communication with us about the revolution and about the future of our life</u>".

"This as well same as previous one <u>I think it's taking about also the revolution with modern design</u>".

7.1.1.2. Recreational Activities.

Recreational activities mentioned by participants after being exposed to an image suggests that they relate primarily to the physical and mental engagement received from spending time with the image. Participants spoke about recreational films and expressed mental satisfaction experienced from observing recreational activities on images through their body language. The image brought smiles on the participants' faces. For example, one participant linked his experience to the film 'Lords of the Rings' and another spoke about the recreational activity as an interesting feature of an image. The participant said "I could remember some film when I see this photo, I think the film is the lord of rings. When I see this photo it just reminds me of that film I do not know why". Alen (Figure 7.6).

Figure 7.6. Participant linked the image to a scene from the film 'Lord of the Rings'.

The participant talked about a pleasant memory and also focused on grass during eye tracking.

Alan also participant talked about people and also focused on activities such as walking and looking at birds during eye tracking.

Figure 7.7 Alen also liked children playing in the image.

Again Alen linked the images to different types of recreational activities as seen in the Figure 7.7 He says regarding recreational activities,

"The most interesting is the children that playing there in the left".

Another participant appeared to focus on the people and the flying birds in the image (Figure 7.8) and said, "It's quite interesting to look at people as they walking around .... The things they are pointing at...and the man with the green shot ... he is ... pointing at into the bay I think he is pointing at the seagull and I don't think there is anything else he could be pointing at ...ya..... That's about it with that one ". Zafira

Figure 7.8 Zafira linked the image to recreation activities.

Later on during the discussion he linked this seaside landscape image to how he spent his time when near a beach involved in similar recreational activities by the sea side. Although he cannot identify the children's game, he thinks that it is interesting. The participant is clearly focusing on part of the image where he can see some human activity.

7.1.1.3. Recreational & Social Activities mixed.

Here, a category is included that captured recreation but with a strong social aspect. It appeared that participants communicated a connection to images that reflected their own wishes which included their family and home recreational trips. Several participants spoke of a similar type of experience of being in a similar land scape whilst living in their own county. For example (Figure 7.9), one participant said, “Its ok ....it’s nice ...I really like to be in that first to go for a day trip....may be a bit cold ..... Very beautiful reminds me of Poland.....where I come from” Rina

Figure 7.9. Participant expressed a wish to visit a place like this.

Participant talked about cold and focused on sun during eye tracking.

Figure 7.10. Participants expressed a wish to visit places which look like the above.

Participant talked about natural resorts and also focused on plants during eye tracking.

Another participant linked the image to his wish of the kind of place (Figure 7.10) he would like to visit. For example, the participant replied, “I also like this picture, probably more than previous one, it’s very nice resort, I would like to go there to enjoy” Robert

It appears that comments are made which are connections to the images but that the actual physical prompt in terms of eye tracking dots are not in line with the given narrative. Here for example the physical prompt is not clear but the purpose is mentioned as recreational reasons for visit. There appears to be enough information in the initial photo to give a quick response. One can notice the cluster of fixations and that the viewer in this case does not reach anywhere near the edge of the image. This gives cues that here cognition is dominating the physical visual expression.

7.1.1.4. Spiritual Activities.

These activities might also be categorised as sacred rituals or activities relating to a belief, but it is felt that spiritual activities generally summarized a certain way in which participants connected to some of the images. Three participants described their association with a spiritual sense of a place. For example Alen expressed,

"I can't focus in the middle of this photo, I think its talking about the story of everybody, and there is a pathway to have go through it. And there is a lot of interesting things in your right hand and right you to choice which one is supportive and go through it. I think this photo is giving me some sense of self development of my life. How can I can develop my life? Actually, I think this is talking about complex relationship between in our lives, this is through I think this is like our life there is are lot of complex things in our lives it's all make single together. How can you find your way through? In it. I think all people have to find their way. How can we choose the right way which you have to go through it?" (Figure 7.11)

In the image below (Figure 7.11), it is evident how he focused on those two roads throughout this eye tracking session.

Figure 7-11. Image linked to "Pathway of Life."

Participant talked about two paths and also focused on it during eye tracking.

Participants associated this image with a spiritual experience, felt this connects them to the images. One participant explained, in a different way, his feelings whilst looking at the image (Figure 7.12), how he links it to religion? For him, religious places should be given importance in our lives and they should be built the best viewing location in any city, he said.

"Same thing I.....just.... architectural wise is not too bad... But at the same time it look like a big block tower.... and if you look at that church in the middle ... or then you can see how actually the small them is.... <u>but where in some time ago centuries back some of the big cathedral, or the church or the mosque use to be biggest buildings, and you can see from everywhere...but now you can see all the those big block tower .</u>...is just raising to the sky. <u>These religious places actually seem to be very small or comparing to other one is been ignored</u>...... and ... I don't like to live in any" Moo. (Figure 7.12)

Eye tracking data in the image (Figure7.12) shows how this participant focuses on a church building.

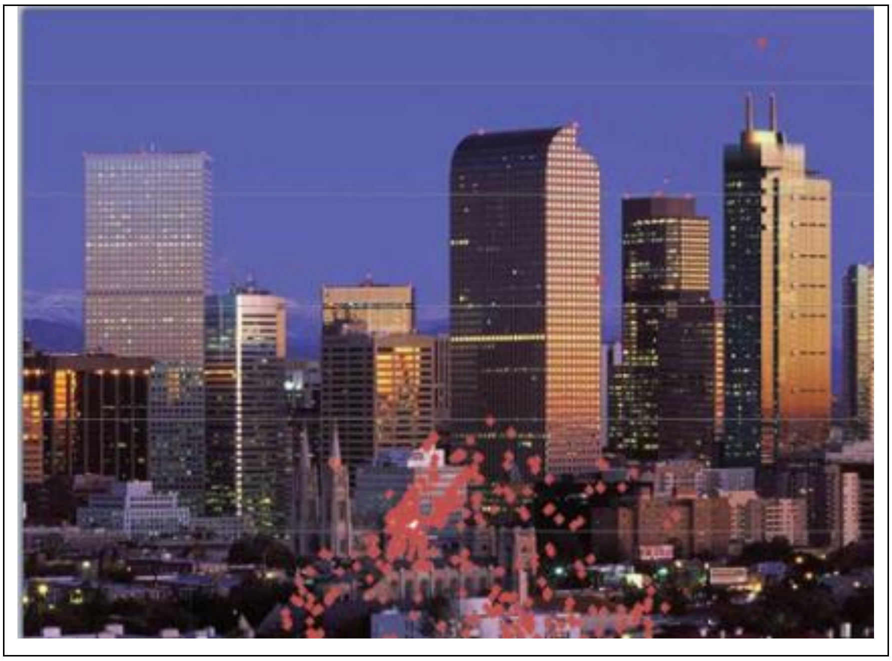


Figure 7.12. Image linked to 'Religion' by the participant.

Participant talked about church and also focused on it during eye tracking.

Finally, one participant experienced something that she related to either a positive or negative encounter with a spiritual presence (Figure 7.13) and replied,

"O this is odd, is it ....? I don't like that building in the middle..... it's weird ... it does not even look like a photo, looks like a composite picture like something of a post card ....or something ....o...

there is an interesting looking church ..I wonder where it is.?...erm....... that's European looking church. Isn't it... Looks kind of gothic ....although, It could late gothic revival...."Zafira (Figure 7.13).

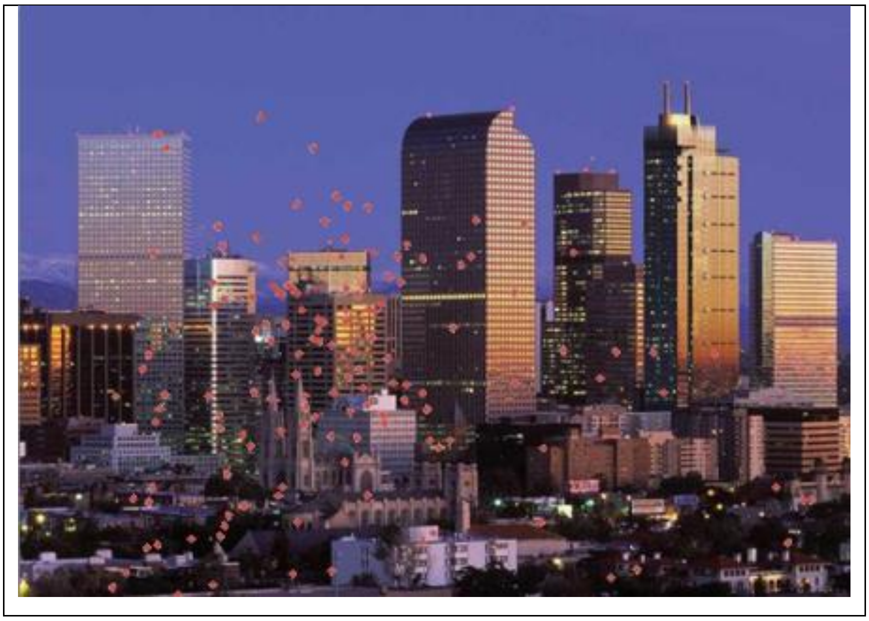


Figure 7.13. Image linked to 'Religion' by another participant.

Participant talked about a gothic church and also focused very diffusely over the image during eye tracking.

7.1.2. Memories.

This emerged as the second most important category in terms of connections to the images. Memories involve connections that link to some kind of relationship to the past and include: home, childhood, and work related memories influencing participants' future choices whilst, making sense of an image (SOI). (Figure 7.14).

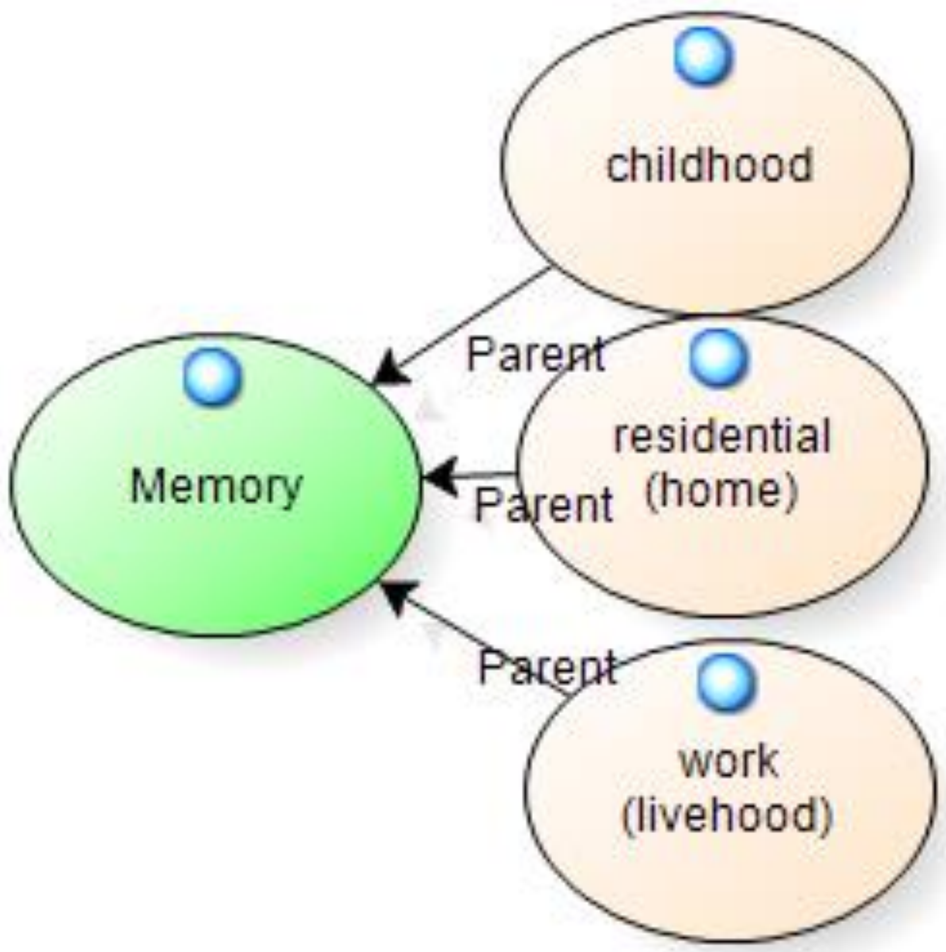


Figure 7.14. Showing how three kinds of memories emerged.

7.1.2.1. Memories related to home.

This category outlines activities of those participants that linked images to their home or residential place in the past. Most participants liked images when they resembled their home land.

For example one participant commented,

” Yeea....sure.... for the sea ....I like this ... the... the reason why I like photo number 2 is about my life one of my house that I ever told you before. We have a house not too far from the sea...when I see that photo is look similar to the beach that not too far from my home… laugh....” Nini (Figure 7.15).

P2

Figure 7.15. Links images to memories from home town.

Participant talked about sea and also focused on the beach and water during eye tracking.

From participant’s non-verbal behaviour, it seemed that looking at these images filled her with immense pleasure. Another participant even became very patriotic when talking about the images (Figure 7.16) and said, “Just the one ... just one ahh.... well...I think it’s ... I think its number 6 there is something, it’s funny. Actually, I like walking through wood land, but I think it’s, right me or wrong me, to me that look most like English country side, and of those images, because ..... I do like certain areas of European country side ...of those images, I think I prefer it the best ...because of its Englishness, if there was picture, photograph of English coastline...” Jamela (Figure 7.16).

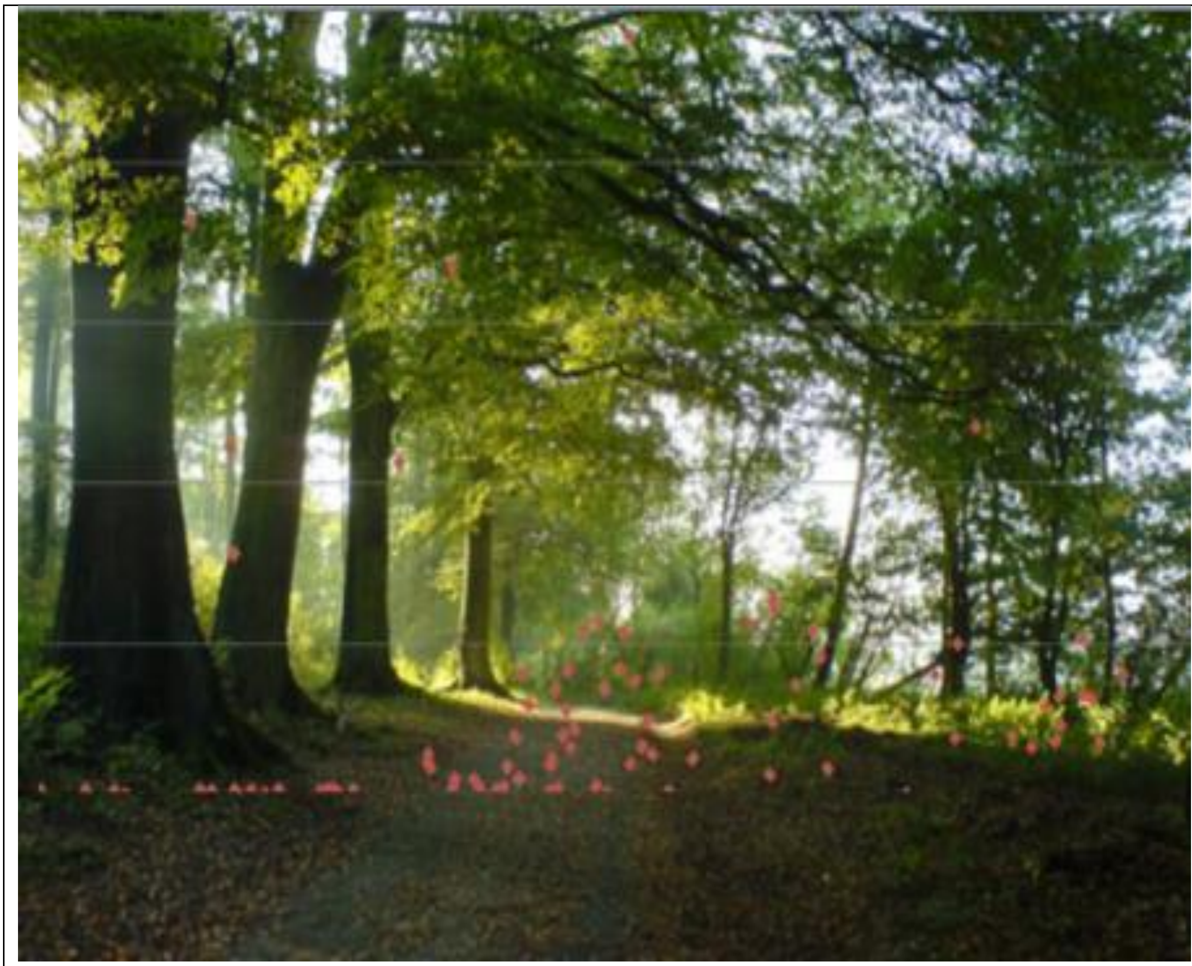


Figure 7.16. Links due to patriotic emotions of Englishness.

Participant also talked about waking and focused on the track during eye tracking.

For some participants, they liked the images for the reason that it reminded them of freshness (Figure 7.17), of being close to nature and atmosphere similar to their home land as Moo said, “I like to see this image again, because seaside and a lot of palm trees remind me of my own home country and ...very nice beautiful view, sky, and very clean water and I like it” Moo, (Figure 7.17).

Figure 7.17. Links due to memories of experiencing Freshness.

Participant talked about water and also focused on trees and water during eye tracking

7.1.2.2. Work related and bad memories.

Not many participants linked images to their work related memories except one who linked it to a place where he lives only because of his work linked commitments. This may be the reason why a majority of participants do not want to link to stressful memories, however, these negative associations are looked into in detail under the next heading of ‘connection disconnections’.

Again, here a very stressful pattern of eye tracking data is obtained. The participant is only focusing on certain elements and then moving away to focus on natural elements such as the sky (Figure 7.18).

Commenting on the image below he said, “These are even worse it looks like Birmingham; there is big motor way with lots of cars, that exit to big city” Robert (Figure 7.18).

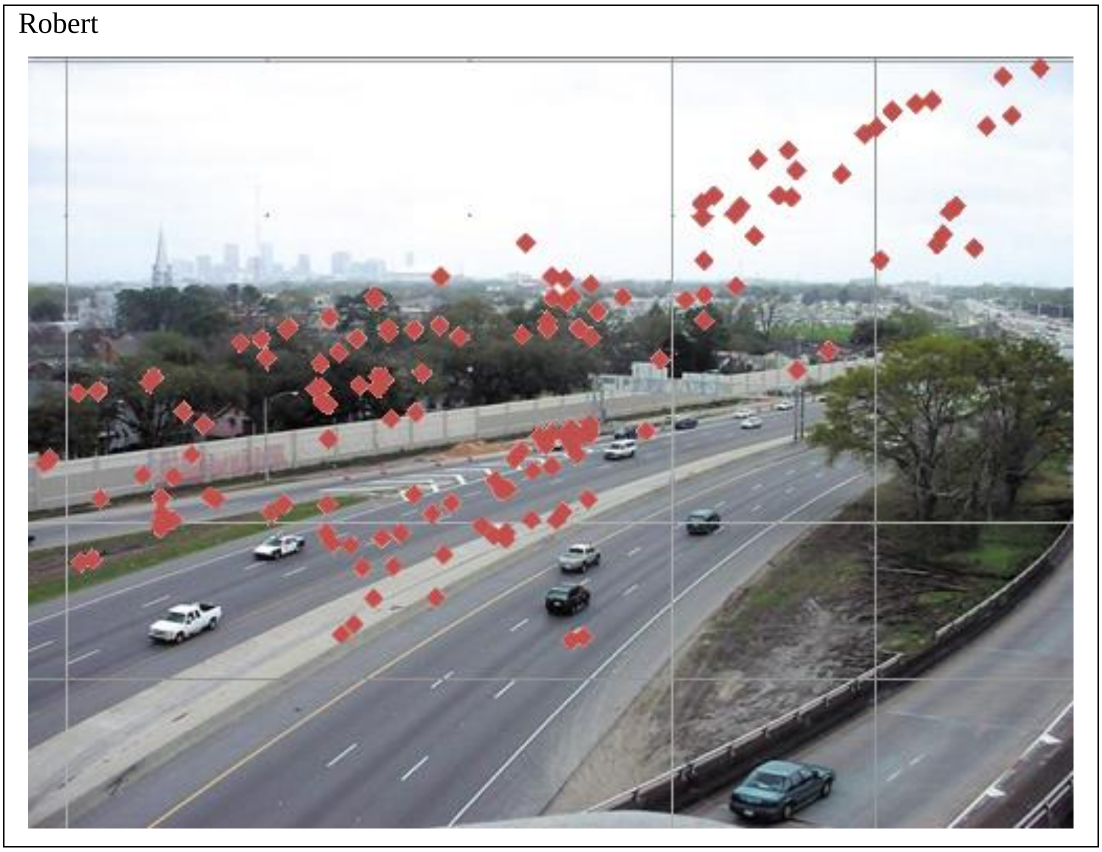


Figure 7.18. Participant linking image to a negative memory.

Participant linking it to a city where he lives for work reasons. Participant talked about the motorway and also focused on it during eye tracking.

7.1.2.3. Recreational or good Memories.

Many participants are connected to images though their recreational memories. For example, when Moo was looking at an image he linked it to memories of past excursions to other counties as well as his country of origin (Figure 7.19).

" I love this image, I love the flower...the mountain and the snow there, and the water coming down... and ... it's just remind me again of my home country and at the same time I went to back Switzerland and Sweden or in Italy you can see these images but .... This is somewhere you can breathe and you can walk freely...and I like that" Moo, (Figure 7.19).

Figure 7.19. Memories due to past trips, holiday and home land connection.

Participant talked about flowers, snow and water and also focused on these elements during eye tracking.

In the image (Figure7.19), it is evident that the participant is focusing on the elements he mentioned in his narratives, i.e. flowers, mountains and snow. These elements provoked his memory of past trips.

Similar patterns emerged when another participant commented about two images (Figure7.20 and Figure 7.21 next page) and used recreational memories;

"Oh this is ....erm....this makes me think of summer times walks. ...and holidays in like French countryside"... Zafira, (Figure 7.20).

"Ermm..... I don't know what to say about this one ...it's just a sort of...erm. Just like... Standard country side with a bit of mountain behind.....it kind of reminds of walking holidays of Scotland something. I been on hiking holidays... lot of tugging across wet fields ...and then you know kind of.......scrambling of mountain paths ....it's quite nice. Over ground ....very relaxing and tanned ....no people there." Zafira (Figure 7.21).

Figure 7.20. Memories due to past trips and holidays connection linking to French countryside.

Participant talked about summer and also focused on sunlight during eye tracking.

Figure 7.21. Memories due to past trips, holiday's connection linking to Scotland.

Participant talked about scrambling on mountains and also focused on mountains during eye tracking.

Many of the participants who recognised a connection with the images remembered their past connection when they were exposed to a similar kind of environment. Almost all of these stories reflect past experiences of play or relaxation, but with the exception of a few they linked it to negative experiences described under connection disconnection.

7.1.2.4. Negative memories or Connections or links as a result of 'Disconnections' from Images.

A consideration of the data related to negative memories and personal disliking revealed a theme or storyline that seemed an important aspect towards connection activities. These were activities/events which connected people essentially through disconnecting them or through some kind of disconnection event that was a part of their connection story.

Similar storylines were heard from participants who were quite actively connected with a landscape type image for several very different reasons. This connection can be understood as a kind of hate relationship where they are connected to images because of some negative factors. Jamela was the participant who expressed the most negative connections to images. No attempt was made to identify the reason for these negative views about most of the images by Jamela as this was not the aim of the study.

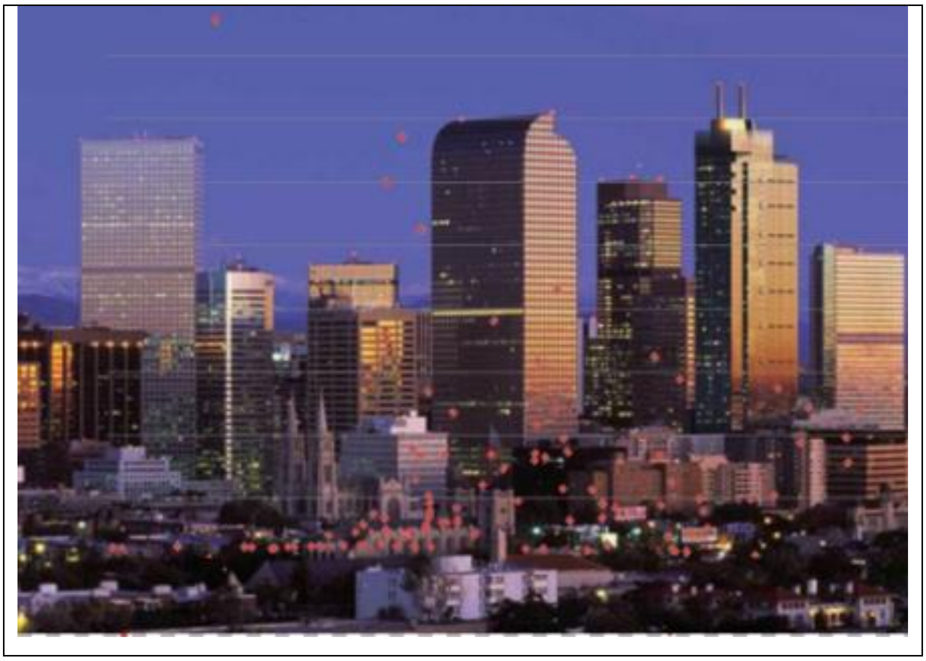


Figure 7.22. A negative link established due to expecting 'phonetic noise' in the area.

She said about image (Figure 7.22), "I don't like this photo graph so much, I think interesting architecture being dwarfed by ugly tall buildings. I can imagine there is sort of phonetic noise at ground level whether that is accurate or not, I don't know, but quite an interesting photo graph, but not somewhere I particularly want to be". Jamela.

Participant talked about city noise and also focused on buildings during eye tracking.

Figure 7.23. A negative link made because she thinks the image as a 'shame scar going through landscape'.

Participant talked about road and also focused on it during eye tracking.

For the above image (Figure 7.23), Jamela felt differently from others and mentioned her connection in these words, "As a photograph I think this is a huge shame, and the road looks like a scar going through the landscape. I rather suspect if you are on the road, that it's rather stunningly beautiful because it's so dramatic and you are not aware of what the picture of the road looks like, as a photograph I think it's ugly". Jamela 7.

When looking at the next two images (Figure 7.24 and 7.25), Jamela blamed the photographer for the desertedness and emptiness, allowing a negative view.

When asked which image she disliked the most, she said, "I think it's number 9 (Figure 7.24), and I think I made that clear at the time,...I think, it's an ugly image, I think I mean you can make power stations, or whatever that is , its factories or something, you can make power stations look beautiful ... actually it, depending on .... How you take a photograph?   I think ……it's an ugly photograph of an ugly thing, so I don't like it and it makes me feel very uncomfortable and. It's also partly to do with the fact that its deserted even though there are cars there but no people or anything, so it feels like some slightly sinister ...aha thing going on." (Figure 7.24).

Figure 7.24.   A negative link and described it as 'Ugly and uncomfortable'.

Participant talked about power station and did not focus on it during eye tracking.

Afterwards, when Jamela was asked as with the other participants for her individual feedback, this was more revealing than that received from the other participants' suggestions because of Jamela's individual way of connecting to the images. Jamela thought it depends on a photographer how he takes an image, as was suggested; (figure 7.25)

I just.....I think it's very very interesting actually.......I also think.........how the photograph is being set up.......how the components parts of photograph have been done ....may have effect on whether you like it or not ....because the road number 8 (Figure 7.25) for example I think it's quite ugly...but you can ....I have seen the photographs of roads which somehow look exciting and glamorous ....and you know ....just because of the way the photograph has been taken, so I do think that is an interesting dimension to whole thing.. Thanks.....no it's absolutely fine"..... Jamela, (Figure 7.25).

Jamela 8

Figure 7.25. A negative link established and blamed 'emptiness' in the image on the photographer.

Participant talked about the road and also focused on it during eye tracking.

Jamela's response was very detailed which showed her interest in the images. She had also tried to explain her point of view and gave suggestions about how to develop or improve this research in the future.

Another participant spoke of a wrong mixture of environmental elements, the way they are presented in the image and the reasons why she disliked the image.

Mona has negatively connected to the an image (Figure 7.26) and said, "This one is a motorway photo, two tunnels makes me feel a bit stressful......about these two roads may because its hanging in the air not on the ground, there are quite a few cars going through the mountains and there are a few floors above the tunnels. I do not know what is the purpose for building? These floors? but sure they look quite ugly ...the concrete colour and does not really fit into the green environment" Mona.

Figure 7.26. Participant did not like 'hanging motorway made of concrete in the green environment.

Participant talked about the road and also focused on the road and greenery during eye tracking.

Yet again she spoke poignantly about this disconnection as she expressed her views about the image (Figure 7.27).

"I think it's number 8 (Figure 7.27) and it is just simply really ugly...and they don't really look after the plants ... and also the motor way....its waste on the side of the road even" Mona.

Figure 7.27. Participant is linked to image because she feels "plants on the side are not well looked after".

Participant talked about the road and also focused on the road and side area during eye tracking.

Nicklus was another participant who became connected to the images through his personal like and dislike of shapes and colours and expressed about an image (Figure7.28).

”Quite an ugly looking building...it’s some kind of industrial building... Philips lighting ...quite boring looking ...a grey...not very pleasant, kind of interesting the shape on right hand side of building” Nicklus.

Figure 7.28. Negative link established because of ugliness of image.

Participant talked about the factory but did not focus on it during eye tracking.

Again Nicklus’s eye tracking data shows his clear preference for the green patch in the image.

The next storylines include very different views, for Rina when looking at images (particularly Figure 7.29), she believed that she had a form of ‘eye opening’ experience in the process as she had discovered certain facts about herself. She said,

“Erm.....it is interesting for me that .....just to take this exercise ......I even more realise that landscapes which involve roads and cars too much ......yes sorry.....basically I think about this........I did not like the roads and all of this sets I think roads are the most ugly ones.........on the other hand I really like industrial architecture ....so I cannot say that human people make bad changes to environment.....I also admire building architecture...but.....can you ask this question again". Rina.

Figure 7.29. 'Eye opening experience' for participant, first time she found out she did not like roads.

She said about one image (Figure 7.22), "I don't like this photo graph so much, I think interesting architecture being dwarfed by ugly tall buildings<u>. I can imagine there is sort of phonetic noise at ground level whether that is accurate or not, I</u> don't know, but quite an interesting photo graph, but not somewhere I particularly want to be". Jamela.

Participant talked about the road and also focused on it during eye tracking. During post eye tracking interview participant expressed this as eye opening experience because first time in life the found out that she did not like roads.

7.2. Summary:

Within this chapter the scanning behaviour of participants is discussed and presented in terms of participants' ability to identify and appreciate the elements of nature present in the images and making connections to images. As these connections are linked to many factors for example past memories, country of origin, CNS[33] scores, perspectives and visions of participants. In this chapter three main types of connections are identified (figure 7.3 A). Connection related to activity on images and memories are discussed in detail in chapter 7, for connections related to point of interest on images see chapter 8.

- Activity on image (figure 7.4)
- Memory linked to images (figure 7.14)
- Physical Attributes of an image or Point of interest (POI): This is described in detail in chapter 8.

[33] Connectivity to nature score of participants

Chapter 8. Points of interest on the images and Connection.

8.1. Points of interest on images.

Physical attributes involve connections that involve some kind of relation to the actual physical content of image and participant, including image content such as: water, colour, mountains, roads and many others described later in this chapter in relation to SOI.

When participants talk about images, physical attributes seem to play a very important role. In this study, when images and participants narratives were replayed repeatedly, as the study progressed, data collection and analysis progressed following different physical attributes and entailing connections emerged. (Figure 8.2 A and Table 8.1). These physical attributes are actually points of interest on the image (POI). During eye tracking, it is noticed that, every image has some points of interests (POI). With images with more than one type of POIs, the stronger POI gets more attention and fixations. For example, with image (Figure 8.1), Edvina described the presence of water as the reason for her pleasure and preference for the image;

<u>"Number 11 because its sun, colour, water, everything in it to make you happy".</u>

Again this is evident in the eye tracking data which shows how Edvina scans over the image. She seemed to be focusing on all other elements she had mentioned in her narratives except water. The reason could be other elements i.e. sun colour liked by participant may be more powerful linking elements. (Figure 8.1).

P11

Figure 8.1. Participant talked about water but did not focus on it during eye tracking.

Again due to the presence of other elements in the image the stronger elements took attention. Participant is focusing on sky which is again a positive element.

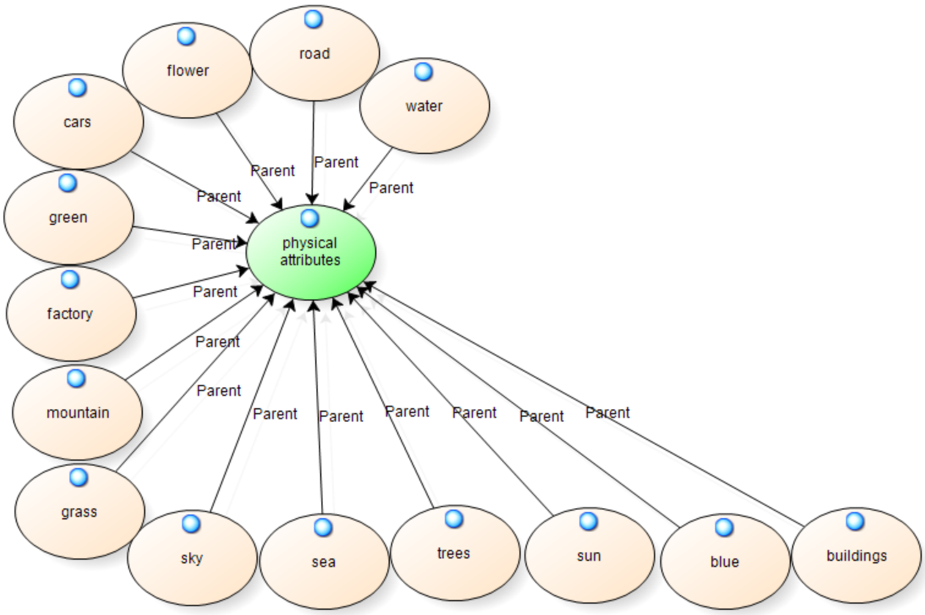


Figure 8-2 A. Most noticeable physical attributes (POI) of surrogate landscape images.

Positively Linked	Negatively linked
Water	Cars
Flowers	Factories
Sky	Roads
Sunlight	Buildings
Trees	
Grass	
Blue & Green colours	
Mountains	

Table 8.1. Showing predominantly negatively linked and positively linked environmental elements identified by participants in their narratives.

Below are six important environmental elements, three positively linked POIs and three negatively linked POIs which emerged from narratives and eye tracking results. These will be described in detail (Table 8.1).

8.2 Three positively linked points of interests.

8.2.1. Water

Perspectives are an evolutionary basis for the natural response, often drawing upon the intuitive notion that humans' long term evolution in natural environments must have resulted in some physiological and perhaps psychological 'adaptation' to natural, as opposed to urban settings. Central to this argument is the position that humans have an unlearned predisposition to respond positively to natural content (e.g. vegetation, water) and to configure characteristics of settings that were favourable to survival or to ongoing well-being during evolution (e.g. Sevenant 2009; Herzog 1985, Appleton, 1975; Dorte 2011; Kaplan & Kaplan, 1989; Ulrich 1983; Ode 2008).

With regards to water, people spoke about images p1,p2 and p11 as shown below displaying interesting narratives and two streams of data, such as eye tracking and narratives are compared. (Figure 7.26)[34]

P1	***P2***	***P11***
		

Figure 8.2 B. The images with water as a natural element. (p1.p2.p11).

A few participants referred to the presence of water and snow as the reason they felt connected to the image. For example, Casey presented the following description of image (Figure 8.3); "Now this is absolutely beautiful, this is lovely, the colours, the differentiations, the waterfalls, sorry not waterfalls, the rivers, the snow, the green, the water, the rocks, the green vegetation, the colour of plants, this looks very relaxing and welcoming and very nice" (Figure 8.3).

[34] For full list of images see chapter 5 image 5.5.

An analysis of eye tracking data reveals the connection is evident as well. Casey again said,

"What's most memorable for me, it's some of pictures; for example number 11, it offers a contrast, so it had me looking at mountains, it had me looking at water and snow, it had me looking at probably falling or running water, it had me looking at lake, it had me looking at flowers in the fore front and its somewhat similar to picture number 2 because you see sky, and it's really a scene of relaxation obviously wanting to be there, yes". (Figure 8.3)

P11

Figure 8.3. Participant talked about water, flowers and mountain and also focused on these elements during eye tracking.

Moo seems to be delighted by flowing water down the hills. It provoked his memories, "I love this image, I love the flower...the mountain and the snow there, and the water coming down... and ... it's just remind me again of my home country and at the same time I went to back Switzerland and Sweden or in Italy you can see these images but .... This is somewhere, you can breathe and you can walk freely...and I like that" (Figure 8.4 left).

Again similar reactions are noticed when looking at images one and two narratives when Moo mentioned, "p1 I like this image because it's got very beautiful nice beach and this is quite safe for people swimming and the back view and beautiful nice mountain background and water. I so like to it and it reminds me of holiday I went to Spain and Tunisia." (Figure 8.4 right)

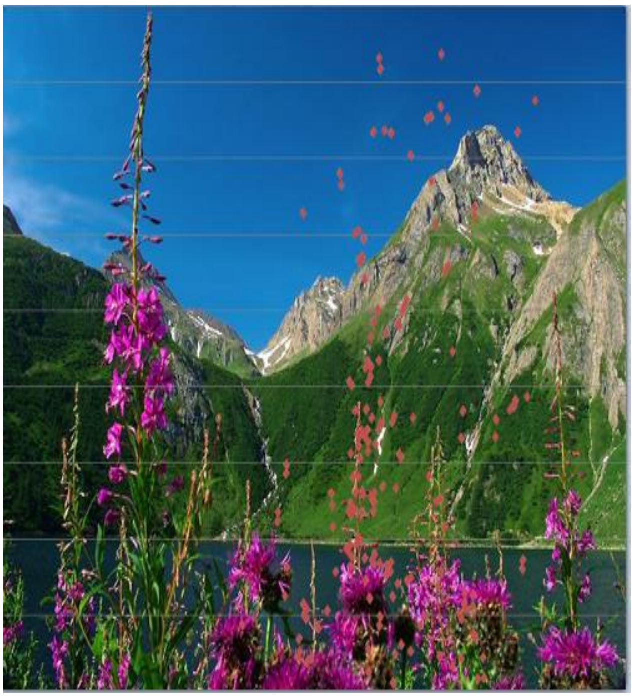
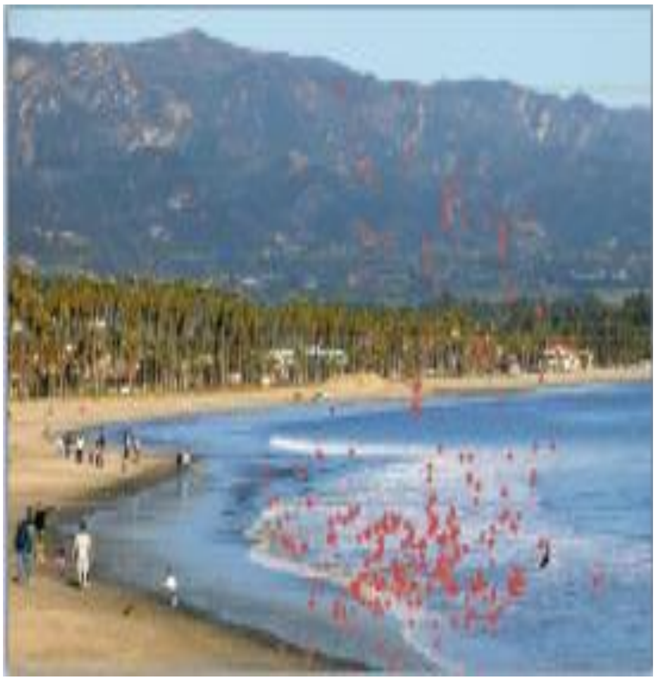
Left	Right
	

Figure 8.4. Images showing water and flowers as a focus of attention for Moo.

Moo liked the presence of water in image 2 (Figure 8.4 left); and linked it as a reminder of his home. Later in discussions he mentioned another image (Figure 8.4 right) reminded him of the Caspian Sea. Moo says about the above image;

"I like to see this image again, because sea side <u>and a lot of trees remind me of my own home country</u> and ...very nice beautiful view, sky, and <u>very clean water</u> and I like it" (Figure 8.4 right).

Some participants linked the presence of water to feelings of calmness, and as well as linking it to their holiday breaks in the past. According to Nicklus for example,

"p11 <u>This is very pleasant photo, mountain side, the lake water fall</u>, snow up there... very nice definitely reminds me something I see if I was on holiday ....very relaxing .. Nice flowers at the front as well.....I definitely like to go there where ever it is" Nicklus (Figure 8.5).

P11

Figure 8.5. **Participant talked about water and focuses mainly on flowers and water during eye tracking.**

Similar feelings were mentioned by Nini for images Figure 8.6, 8.7 and 8.8.,Nini says, “p2 Wow..This is quite nice though it like it’s a lot of green that make you feel fresh and feel... have feeling of water and fresh air in this place” (Figure 8.6).

P2

Figure 8.6. **Participant talked about water and focuses mainly on beech and water during eye tracking.**

Nini mentions, "p11 Wow This is contrast from the last one.... it ... the photo is very nice it has water... have the green forest ... and also have the purple... the purple flower that I like it ...and also when you see the water come down from the mountains that's through the .. That there ... it's looks very nice though... and make me feel relax calm and tranquil, something like that" Nini, (Figure 8.7).

P11

Figure 8.7. Participant talked about water and focuses mainly on flowers and water during eye tracking

P1

Figure 8.8. Participant talked about water and focuses mainly on trees and water during eye tracking.

It is evident from the data that the presence of water in any scene can make it seem more favourable for some participant but when water is not present, its absence is noticed. Robert noticed the presence of water as major element (Figure 8.8)

”Can I say two, probably number 2 and number 11, cause I do not see any houses and people ,they just probably are natural, <u>do not see any people in both you have water, trees and flowers,</u> two my favoured ones, They are alike, but both have water in them” Robert, (Figure 8.9).

2 | 11

Figure 8.9. Participant talked about water and focuses mainly on flowers, trees and water during eye tracking.

Shahzadi and Zoi also admired the presence of water which is evident in their eye tracking data.

Shahzadi expressed, “p1 I like this picture because there are mountains, the weather is sunny, there are some trees and there is water and the beach. I think the beach is not as clean as I would have liked it to be. Although I think this picture is not that spectacular because the beach is not very clean”.

“p2 I like this picture because there are palm trees, blue water and the sand and blue sky”. (Figure 8.10).

“p11 I love this picture because the weather is sunny and the sky is blue and the flowers are pretty. And I love the water and I love the mountains”. (Figure 8.10)

P1	P2	P11
		

Figure 8.10. Shahzadi focusing on p1, p2 and p11 from left to right on environmental elements.

Participant talked about water and focuses mainly on beech, flowers and water during eye tracking.

Similarly, Zafira (Figure 8.11), admired a scene without water but suggested that if she had seen water in it, it would have been even better.

“p11 O.... bit like 3 D... Gosh...This is very alpine. This is got to be like Switzerland or something..ahh.... it’s got nice stream going down to the I don’t know it is a ... A lake ....it’s got nice purple flowers. I can’t see any bees… it’s a shame because ... I like bees ..and sky is very blue its nice mountain shape, very typical mountain shape and it’s got bit of snow on the top and it’s got a bit of snow on the top. It’s very green ....lots of tree cover. And....it’s quite nice... in a way it is a bit annoying because the flowers are in the fore ground because.. I want to see a bit of the water. But interesting ....there is hardly any cloud in the sky... I bet it’s hot.” (figure 8.11)

P11

Figure 8.11. Participant not focusing on water likes water.

Overall presence of water in any scene emerged as a powerful surrogate component of natural environment for getting participant's attention in the scene.

8.2.2. Flowers

According to Ottosson and Grahn (2005), gardens which have old fruit trees and a variety of flower species helped increase people's powers of concentration more after they had rested in a garden outside a geriatric home, in comparison to resting indoors in their favourite room.

Nini and Moo mentioned flowers in their narratives, and if we look at eye tracking results from Nini and Moo, we can see these participants focus on flowers (Figure 8.12). This shows the presence of flowers in any scene attracts lots of fixations.

According to Nini, "Wow this is contrast from the last one.... it ... the photo is very nice it has water... have the green forest ... and also have the purple... the purple flower that I like it ...and also when you see the water come down from the mountains that's through the .. That there ... it's looks very nice though... and make me feel relax calm and concisions something like that"

According to Moo when speaking about Figure 8.12, "I love this image, I love the flower ...the mountain and the snow there, and the water coming down."

Left Moo	Right Nini
	

Figure 8.12. Moo on the left focuses on flowers. Nini on the right focuses on flowers.

A few participants mentioned the presence of flowers in the images as a reason they felt connected to the image. For example, Mona mentioned the importance of flowers in a scene while looking at image 11 and 12, (Figure 8.13).

Mona p11 Left	Mona p12 Right
	

Figure 8.13. Image on left showing flowers as a focus of attention. Participant showed a wish to see flowers in the image on the right.

Mona says “p11 This is a photo of a lake surrounded by the mountains, the mountains are rocky but covered with grass and trees and there is a bit of snow on the mountains.... looks quite nice and there is vivid coloured flowers in the front makes it ... even better, it’s a nice photo” (Figure 8.13).

“p12 And here is a mountain view......... the nice photo ...there is grass ...and..... I don’t see any flowers, I think flowers do make photos look more pretty….and .....so in the same colour background and the mountains makes it is a bit boring to me”. Mona (Figure 8.13).

From the eye tracking results, although Mona mainly focused on mountain views in image 11, it is seen that Mona only focuses on a few flowers although she mentioned the importance of flowers. In her eye tracking of image 12 (Figure 8.13), she mentioned that she thinks a mountain view is boring because there are no flowers in the view.

It has been noticed that the presence of flowers in a landscape image make people think of visiting that landscape site. According to Nicklus,

”p11 This is very pleasant photo, mountain side the lake water fall, snow up there.. Very nice. Definitely reminds me something I see if I was on holiday ....very relaxing... nice flowers at the front as well.....I definitely like to go there wherever it is” Nicklus (Figure 8.14).

Nicklus p11

Rosy p11

Rina p11

Figure 8.14. Images showing flowers as a focus of attention, for Nicklus, Rosy and Rina.

Due to presence of flowers, Figure 8.14 shows how image 11 was found interesting by many participants. Below are some positive views by these participants:

“I think it’s number 11, the mountains, flowers and ....because quite lots of going on, it’s quite interesting landscape “Nicklus (Figure 8.14).

“p11 I like flowers.........., I like the sky and I like the mountains so this picture is quite relaxing.” Rosy(Figure 8.14).

“p11 Very beautiful,. Beautiful mountains ....green grass.......flowers ....beautiful” Rina (Figure 8.14).

It is evident that there are contrasting views about the presence of flowers in a landscape image. On the one hand, some participants like the presence of flowers whereas for others it is an annoying phenomena. When Rina and Shahzadi clearly liked presence of flowers, Zafira felt annoyed and wanted to see water in the landscape image. (Figure 8.15).

When asked about the favourite image, Rina replied,

“Which I like the most ....number 11...........because its mountains showing mountains I love mountains and .... also compositions are very good and colours........ I like number 12 as well but I prefer 11.... Because flowers and fountains they make picture more interesting.....” Rina (Figure 8.14).

Shahzadi said about image 11,

“I love this picture because the weather is sunny and the sky is blue and the flowers are pretty.” Shahzadi (Figure 8.10, right p11).

However Zafira mentioned about wishing to see water instead of flowers in the landscape scene in (Figure 8.15),

“p11 O.... bit like three D... Gosh...This is very alpine. This is got to be like Switzerland or something. Ahh....**...** in a way it is a bit annoying because the flowers are in the foreground because... I want to see a bit of the water. But interesting ....there is hardly any cloud in the sky... I bet it’s hot”

Zafira

Figure 8.15.   Images showing Zafira's focus of attention away from flowers.

In Figure 8.15, Zafira's eye tracking results are very interesting in that she did not like flowers on the front of the image. Zafira focused initially on the front of the image, then moved her focus to the background.

8.2.3. Colour

Topophilia hypothesis (Tuan, 1974, Ogunseitan 2005) focuses on personal attributes, for examples, age, gender, occupation, hobbies, academic background and familiarity as being important for the forming of landscape preference. Specific domains underlying Topophilia hypothesis are cognitive challenge (e.g., complexity and coherence), synesthetic tendency (e.g., colours and sounds), ecodiversity (e.g., water bodies and trees), and familiarity (e.g., identifiable and privacy) (Ogunseitan, 2005).

Colours emerged as an important factor to connect participants to images with most participants talking about blue and green (may be due to water, sky and trees present in the images). These colours emerged as the colours most liked. The themes that relate to a preference for the colour blue, then blue and green together and finally only green will be discussed. Some people liked the images just because of the colours as one participant describes, “This image, I like the blue colour which is in the scene, and it reminds me of my country. Also I like the natural green which is in the middle of photos ,and also the most interesting is the children that playing there in the left...whatever there is that is for totally for this photos” Alen (Figure 8.16).

Alenp1

Figure 8.16. Images showing Alan’s focus of attention on people and mountains when he also liked the green in the middle.

For other participants, the blue colour of the ocean is relaxing and that is the main reason to be linked to the image,

”This photo, I can see many trees and this ocean is blue its more relaxing than the previous photo, there are rocks by the same beach and I don’t see any people in the photo still it’s a nice photo, makes me feel more <u>relaxed and sky is blue with white cloud</u>” Mona (Figure 8.17).

Figure 8.17. Monas’s focus of attention with a few fixations on clouds.

From the eye tracking and narratives, it’s quite evident how both participants scanned through different elements in the image, but the common thing is both participants spoke of their liking of the blue colour.

On the other hand, for a few participants, blue and green are natural colours and this is the reason they liked the images, As Nicklus described when viewing an image (Figure 8.18),

"It's very nice picture, very natural very green and blue natural colour, no buildings and people".
"Nicklus p2

Nicklus p2

Figure 8.18. Nicklus's focus of attention on blue sky and green trees.

A relationship between relaxation and the colour blue emerged repeatedly, as one participant mentioned, (Figure 8.19), “Yea this is very nice photo... I like it ... it make me feel relax ...it’s just like you see ....the blue sky the sea and coconut tree and you gonna have the feeling of the wind blow along the tree.”Nini p2

Figure 8.19.Nini’s focus of attention on blue colour water and brown beach.

In the eye tracking data it is seen that both participants focused on the blue and green colours and appreciated them in the images. The importance of a blue sky was described, as this participant linked this with a state of mind i.e. ‘feeling down’ as follows,

”O this is more than bad........ Look at the sky........ This is not blue sky it is yellow sky...yellow and the brown sky............which show that it have pollution in here, even though it’s not ...it will make you down…if you feel.... If you see. Like anywhere like this ....it will make you feel sad.... and also have impression of very bad pollution in this photo.” Nini (Figure 8.20).

Nini p10

Figure 8.20. Nini's focus of attention, but the participant mentioned about the absence of blue colour.

Again Nini mentions,

"Number 10....... I ...... to be honest with you……Number 10 make me feel down a bit look ...at the sky, it's not blue sky, its brown, and like.....I am not sure that photo is gonna take nearly dark…. or something like that ....but when you see that ....you will think woo... it make you feel down a bit ... it make me feel sad and also this building in this photo is look like a factory that gonna make very bad pollution to city ....or something "Nini (Figure 8.20).

Eye tracking results in all the images in this section are very interesting. The data always shows that there has been a decrease in the number of fixations in that area, when the participant does not like an element in the image. The colour of the sky is not liked by Nini, so fixations are seen away from the sky, whereas in the same image, when participants liked the sky, they focused on it.

For some, looking at the colour blue in an image is calming, which is the reason why they liked the colour.

”This picture is very calming........I like the blue sea.... I like palm trees” Rosy (Figure 8.21 right)

“This picture looks really dull because it’s like a factory...but I like the blue sky”. Rosy (Figure 8.21 left)

Figure 8.21. Image showing Rosy’s focus of attention. The participant mentioned the blue colour of the sea.

Similarly Rina and Shahzadi mentioned, “This is quite nice........I like industrial architecture ......I like white sky ......blue sky”. Rina (Figure 8.22 left).

“I like this picture because there are palm trees, blue water and the sand and blue sky”. Shahzadi (Figure 8.22 right)

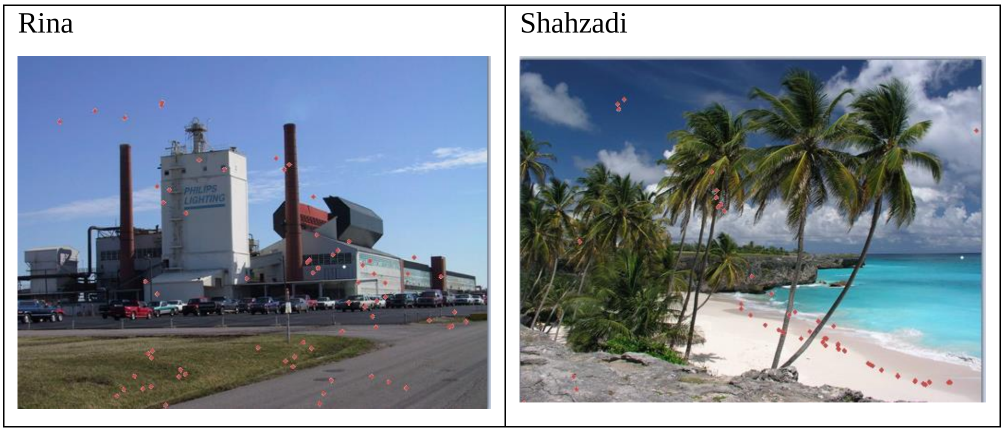


Figure 8.22. Rina and Shahzadi’s focus of attention; The participants mentioned the colour blue.

Although some participants liked the blue colour of the sea, many still remained unsure if that was the kind of place they wanted to visit. As Rosy expresses,

”Typical holiday photograph scene, trees, beach, clear blue sea, not my type of photograph, image probably nice place to go holiday” Rosy (Figure 8.23).

Rosy p2

Figure 8.23. Rosy’s focus of attention on a green tree.

The same participant replied later that she likes the blue sky, when a day is sunny, that shows perception changes because of different combinations of elements in an image.

” I love this picture because the weather is sunny and the sky is blue and the flowers are pretty. And I love the water and I love the mountains” Rosy (Figure 8.24).

P11

Figure 8.24. Rosy’s focus of attention.

From eye tracking data, it is evident that Rosy left a very typical visual signature on the two images, as she fixed on the elements of her choice in the images. Since blue water and sky appeared as important ingredients for participants to like any landscape scene, when water was missing some participants mentioned if they could have seen water in a scene that would have been even better. Zafira also likes blue sky and mentions,

“It’s got nice purple flowers...I can’t see any bees.. ..It’s a shame because ... I like bees ..and sky is very blue, its nice mountain shape very typical mountain shape and it’s got bit of snow on the top and it’s got a bit of snow on the top. It’s very green ....lots of tree cover and....it’s quite nice in a way it is a bit annoying because the flowers are in the foreground because .. I want to see a bit of the water ..but interesting ....there is hardly any cloud in the sky... I bet it’s hot.” (Figure 8.11).

Green

Some participants even mentioned the importance of the colour green as well as the blue colour in a landscape image. According to Alan,

"I like the natural green which is in the middle of photos, and also the most interesting is the children that playing there in the left." Alan. (Figure 8.25).

P1

Figure 8.25. Alan's focus of attention. He mentions the colour green.

Casey commented,

“Now this is absolutely beautiful, this is lovely, the colours, the differentiations, the waterfalls, sorry not waterfalls, the rivers, the snow, the green, the water, the rocks, the green vegetation, the colour of plants. This looks very relaxing and welcoming and very nice” Casey (Figure 8.26).

P11

Figure 8.26. Casey’s focus of attention.

On the other hand, some people seem to be unhappy about different colour combinations (Figure 8.27). Mona expressed, “p7 This one is a motorway photo, two tunnels makes me feel a bit stressful......about these two roads, may because its hanging in the air not on the ground, there are quite a few cars going through the mountains and there are a few floors above the tunnels. I do not know what is the purpose for building these floors but sure they look quite ugly ...the concrete colour and does not really fit into the green environment” Mona.

P7

Figure 8.27. Mona’s focus of attention.

Looking at the image (Figure 8.28), Mona said,

“p12 And here is a mountain view......... the nice photo ...there is grass ...and..... I don’t see any flowers, I think flowers do make photos look more pretty and .....so in the same colour background and the mountains makes it is a bit boring to me” .Mona (Figure 8.28).

P12

Figure 8.28. Mona’s focus of attention on green grass.

This eye tracking data clearly shows how people fix on green patches in the images. Even when different sets of data are brought together, this preference for green always emerged.

8.3 Three negatively linked points of interests.

8.3.1. Roads.

The evolutionary perspective has been furthered by speculation that natural content may be processed with relative ease and efficiency because the brain and sensory systems have evolved in natural environments in a parallel manner (Carr 1969, Wells 2000, Wohlwill, 1983; Hughes 2001). The evolutionary tuning is lacking in urban or built environments, which when encountered in such settings, places greater demands on processing resources, and may overload the individual or require more coping or adaptation effort (Sandstorm 2002).

Connections to an image while focusing on the presence of roads in a scene emerged as a prominent feature through eye tracking data and analysis of interviews. This connection in some cases is a positive one whereas in others it emerged as negative reaction. Most of the participants showed a connection in a negative expression, for example, according to Jamela when talking about an image (Figure 8.29), she said:"p7 As a photograph I think this is a huge shame, and the road looks like a scar going through the landscape, I rather suspect if you are on the road, that its rather stunningly beautiful because it's so dramatic and you are not aware of what the picture of the road looks like, as a photograph I think it's ugly". Jamela, (Figure 8.29).

Jamela p7

Figure 8.29. Images showing the highway as focus of attention, but the participant did not like highways.

Jamela described her slightly negative view about roads whilst looking at an image (Figure 8.30), and said,

"The road in number 8 for example, I think it's quite ugly...but .you can ....I have seen the photographs of roads which somehow look exciting and glamorous ....and you know ....just because of the way the photograph has been taken, so I do think that is an interesting dimension to whole thing.. Thanks.....no it's absolutely fine." (Figure 8.30).

P8

Figure 8.30. Jamela's focus of attention on highway.

Eye tracking data revealed that Jamela scanned the images quickly and on image 8 (Figure 8.30), only a few fixations can be identified which is an indication of her not liking the scene. Other participants simply did not like roads because they thought that people had damaged the natural habitat to construct them and expressed their views like Mona, "I think its number 8 and it is just simply really ugly...and they don't really look after the plants ... and also the motorway....its waste on the side of the road even" Mona (Figure 8.31).

There are similar kind of eye tracking patterns between Mona and Jamela as they both scanned image 8 quickly. (Figure 8.30 and 8.31).

Mona p8

Figure 8.31. Image showing a city motorway and cars as focus of attention for Mona, although she did not like it.

Although a few participants preferred motorways and big roads, Moo was concerned and expressed it by saying,

"<u>I don't like it, it just reminds me of speed the motor way which even I don't like to drive on it</u>" Moo, (Figure 8.32).

In Moo's case, clusters of eye tracking data (Figure 8.32) are seen on the green patches such as trees on the side of the motorway, although many on the motorway itself. This participant appears not to avoid fixating on landscapes for which apparently he has negative views. The reason for this connection can be seen as memories attached to it as he mentioned in his narratives. Moo's eye tracking data shows how he moves between two green patches on each side of the road.

Figure 8.32. Images showing city motorway, cars and sky as focus of attention for Moo.

Unlike Moo, Nicklus seems to avoid the road in image 8 (Figure 8.33), and focused on the green areas. Nicklus expressed contrasting positive and negative views about motorway images 7 and 8 (figure 8.33), "p7 It's like a big bridge... motor way sort of thing....... quite like this photo, ..it's quite interesting not kind of road you see every day... and it's got quite interesting like construction, it's nice mountain side background .. Of the photo like that". (Figure 8.33).

"p8 I don't really like this photo it just a motor way very boring.. nothing really going on its just road and some cars reminds me of stuck in traffic. ...Definitely number 8 side of road and a few cars...it's very boring and something I could see every day, when I looked out of the window ... does not inspire me, make me feel any positive emotion at all ...it's quite boring". Nicklus (Figure 8.33).

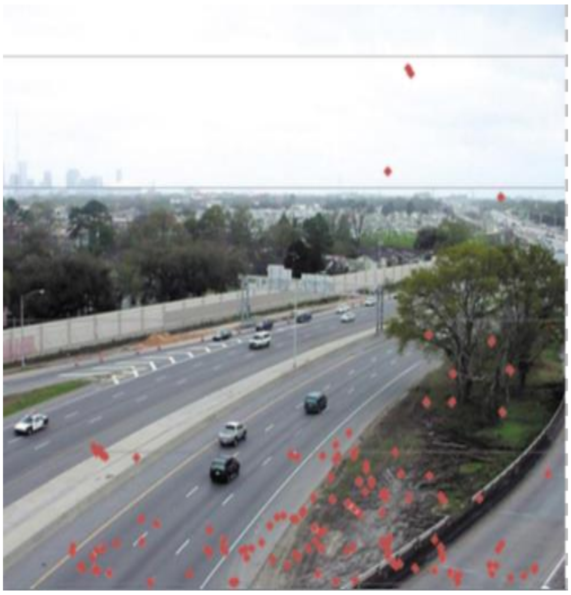
Nicklus p7	Nicklus p8
	

Figure 8.33. Images showing motorways and a patch of mud as focus of attention.

Nini gave a negative view on an image (Figure 8.34). She thought the road scene made her feel dry, she felt that she was in desert, so it appears clearly that she is not focusing on the road. This shows that if a participant likes some surrogate environment element, more fixations can be seen.

“p8 I do not like this photo, it has nothing ... it’s only the road and the car its make me feel dry, like I am staying in the desert ... not make me like ...feel bit straight and tired”. (Figure 8.34).

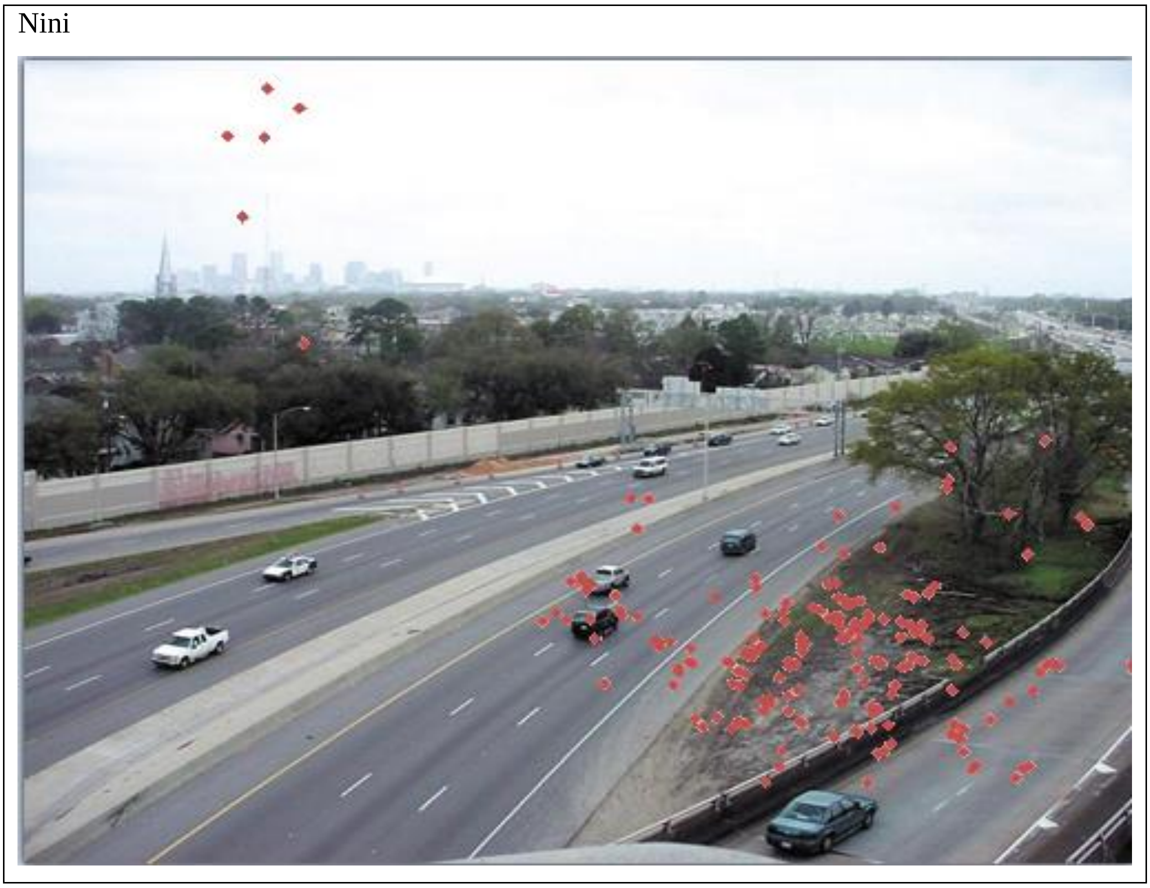


Figure 8.34. Images showing a motorway with a very few fixations. Nini is focusing away from the motorway.

Repeatedly participants gave contrasting views about the presence of roads. These contrasting views show another common feature that when roads are surrounded with green habitat, people tend to focus on the greenery, but sometimes they think the natural habitat is being destroyed.

However, some simply did not like the roads because of traffic on them. It is evident from Rina and Zafira’s comments and eye tracking data that if participants do not like something, they do not focus on it. (Figure 8.34 and 8.35).

Rina commented about the image (Figure 8.35),

"Number 8 because it's very bad picture ...it does not show anything interesting ....nobody really wants to spend anytime on the road .....Everybody wants to just go in the car as fast as possible". Rina.

P8

Figure 8.35. Image showing a motorway with many of fixations.

Zafira said about Figure8.36, "It happens a lot ....maybe I don't know .....no grass...it's all mud ...and it's all sort of braked up.....oh...there looks like some sort of road works or something like a pile of sand or something at the side....... I can see some housing through the trees.... it must me horrible to live there....with that massive road" Zafira.

Zafira p 8

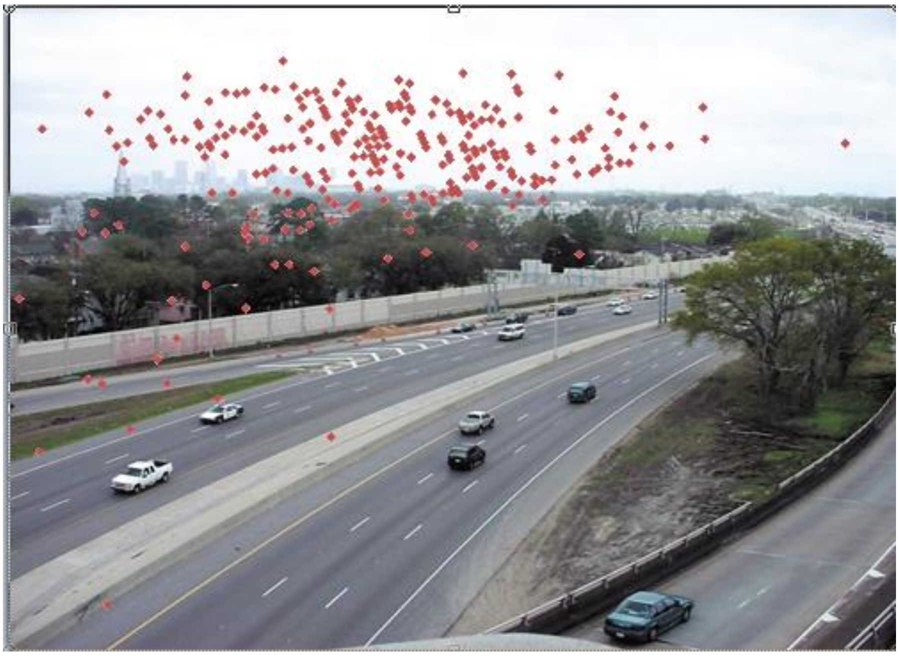


Figure 8.36. Image showing participant is focusing away from the motorway.

The overall majority of participants did not like the road views images. Their attachment to the image was due to this hate relationship to road, which they express quite vividly in their narratives.

8.3.2. Cars.

According to the Institute for Road Safety research (2009), negative emotions like anger and frustration occur in daily traffic and can give rise to aggressive behaviour. However, motor vehicles play a conspicuous role in the modern industrial economy—and in shaping our natural and built environment (Harrington and McConnell, 2003).

Cars make an important constituent of our lives. This research has shown that people who mentioned cars felt connected to images due to the presence of cars in the images. Some talked about the organisation of car parks and another commented that cars made her feel dry, for example according to Mona, "p9 This one looks cycle factory I don't see smoke coming out, and the air quality seems quite nice.. and there is green land to the factory and car park is quite well organised ...I don't feel bad about this place. It's quite well organised and neat". (Figure 8.37),

Mona p9

Figure 8.37. Images showing Mona's focus of attention on car park and factory. She is one of a few people who liked factories and cars.

While Mona likes the organisation of the car park in the image, another participant Nini disliked the image and commented, “p8 I do not like this photo, it has nothing ... it’s only the road and the car its make me feel dry, like I am staying in the desert ... not make me like ...feel bit straight and tired”. (Figure 8.38).

P8

Figure 8.38. Nini’s focus of attention whilst avoiding focus on cars.

From the eye tracking results of both Nini and Mona, although they both mentioned cars in their narratives, they did not focus too much on cars within the image. We can only see a few fixations which resemble results from other participants. When a participant did not like a particular component in an image, this was represented by a small number of fixations on that component.

As mentioned earlier cars felt dry for some, others visualised the number of people sitting in the cars and expressed, “p7... lots of evidence of people and not actual people walking around..... it’s quite a populated picture...... when you imagine all the people who sitting in the cars” Zafira (Figure 8.39).

Zafira p7

Figure 8.39. Zafira’s focus of attention, imagining lots of people sitting in cars.

Some participants commented about the speed of cars and felt connected to the image due to the speed factor. According to Romia,

”p8 here I can notice very fast cars on the motorway and the police car ....” Rosy(Figure 8.40).

P8

Figure 8.40. Romia’s focus of attention on a car she thinks is a ‘police car’.

It is yet again interesting that the eye tracking results for both Zafira and Rosydo not show many fixation on the cars present in the images even though they give their views on cars. Others simply did not like the cars and this dislike made them connect to the images in a different way. This phenomena has been mentioned under the heading of ‘Connection disconnections’ earlier in this chapter. For example according to Rina, "Number 8 because it's very bad picture ...it does not show anything interesting ....nobody really wants to spend daytime on the road.....Everybody wants to just go in the car as fast as possible." Rina (Figure 8.41).

Rina 8

Figure 8.41 Rina's focus of attention avoiding direct foci on cars.

Rina's results are unique and interesting; it can be seen how she fixates very close to cars but not on the actual cars. There is not a single fixation on any car. This shows once again, if a participant does not like a surrogate environmental element, they avoid fixating on that element in the image. Overall participant have negative views about cars presented in any image.

8.3.3. Factory.

Residents of urban areas typically close to industry encounter environments with minimal vegetation. Therefore, access to a green urban park will significantly enhance their lives, build social capital and provide an opportunity for exercise (Byrne, 2010; Ward-Thompson, 2002).

Participants focussed on the image of a factory in the scene, but the findings are very contrasting and can be divided into positive, negative, and neutral links.

Unexpectedly, the participants belonging to industrialised countries seemed to prefer these scenes more than the participants from the developed countries. Some even thought that the factories are not even polluting the environment. According to a participant from China,

"p9 This one looks cycle factory I don't see smoke coming out, and the air quality seems quite nice.. and there is green land to the factory and car park is quite well organised ...I don't feel bad about this place. It's quite well organised and neat". Mona (Figure 8.42).

P9

Figure 8.42. Mona's focus of attention on the side of a factory.

This participant also said, "p10 I suppose this is factory as well and there is sun set in the background makes it look a bit warm. You can see a bit of smoke in the back ground and it seems it's a heavy industrial factory. Even this photo is quite peaceful I still assume... ... this photo produce a lots of pollution which is big mass... mass of....machines Mona (Figure 8.43).

Mona 10

Figure 8.43. Mona's focus of attention away from the industrial component of the image.

Eye tracking data of both images tells a contrasting story to the narratives. Although the narratives are positive, Mona did not fixate on the industrial component of the images. This could suggest that the natural reaction of the participant is still a negative one about the image.

Some even liked image because of its background. Contrasting views from Nicklus about two industry images, "p9 Quite an ugly looking building,... it's some kind of industrial building... Philips lighting ...quite boring looking ...a grey...not very pleasant, it kind of interesting the shape in right hand side of building" (Figure 8.44).

"p10 This photo quite nice ..It is like. Good colour ...still have some industrial look building ... factory or something ...its looks quite nice...just cause of background.... Without sun light it probably look like just very boring factory. I guess I quite interested in ...the way the photos are taken, for example like that number 10 which is a factory but it is nice you can't probably see what it is ... it's like.... at... makes something normally very boring looks actually quite nice (the way photo is taken important)" Nicklus (Figure8.44).

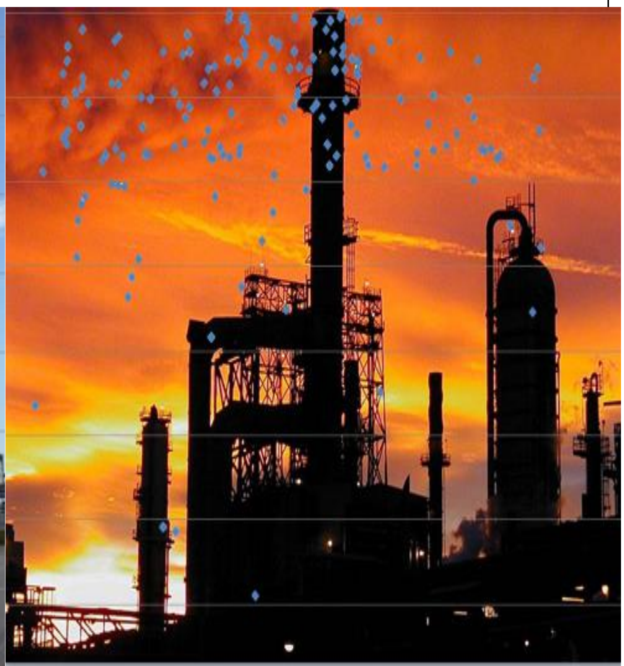
Nicklus 9	Nicklus 10
	

Figure 8.44. Nicklus's focus of attention away from industry in both images.

Very interesting eye tracking results are seen here. The participant is positive about industry in his narratives, however, eye tracking results show his reaction is not to focus on the industry. This could suggest that his natural reaction is still negative about the image.

One of the Eastern European participants liked the industrial architecture. She commented about Image 9 (Figure 8.45), “This is quite nice........I like industrial architecture ......I like white sky ......blue sky.” Rina9.

Rina commented again about another industrial image 10 (Figure 8.45).

“This is also nice.....nice sky........ Beautiful industrial architecture.” Rina10

Rina9	Rina 10
	

Figure 8.45. Rina’s focus of attention away from industry in both images.

Rina’s eye tracking results appear to coincide with her narratives, which suggested that she was the only participant who has expressed a positive reaction to industrial architecture. Other participants were interested in both the industrial architecture and design elements in the images and used terms like chumminess, rectangular windows, and blobby to explain design and shape of elements (Figure 8.46).

Zafira says, “p9 Ok so this is Phillips lighting ....factory I assume , big chumminess, I quite like chimneys ....I don’t like the bit, white bit in the middle saying Philips lighting ...it’s really blocky.. I quite like windows on the factories ....little rectangular windows”. Zafira (Figure 8.46).

Zafira expresses about other industrial image, “p10 Ammm....what is this? ...looks like it looks like oil rig or something... or some sort of power plant or something ...it’s got a light on the top actually it’s got lights all over... little ones ....I quite like the shape of big blobby...I don’t know what it is .. It looks like a tank...that’s quite nice ... it’s quite nice accelerated against sky ... is it water I don’t know...is it all sky or is it any water. And I can see clouds I wonder what it is......” (Figure 8.46).

Zafira 9	Zafira 10
	

Figure 8.46. Zafira’s focus of attention away from industry in both images with more fixations on the sky.

However eye tracking results of above two images of industry show Zafira focus away from the factory structure in the image. Again this shows the natural reaction of Zafira is to focus away from the factory with more fixations on the sky.

There are participants who associated with the scene because of the image of the factory but they did not have any positive or negative reactions (Figure 8.47). According to Alan, “I could feel about manufacturing and how they, how the architecture view in this photo is taking place right now. I do not know, I have no idea about this factory…. about…. I have no idea what is made this factory I could think they may be producing meter. When I see this architecture and relation in the building, I could feel it’s about meter manufacturing, something very solid” Alen (Figure 8.47).

Figure 8.47. Alan’s focus of attention on foreground.

Negative Link: There were three main reasons that emerged to explain why some of the participants did not like an industrial image.

a) Noise
b) Environmental pollution
c) Design elements.

Some participants were not interested in architecture and did not like factories for their own reasons. For example Moo did not like images of factories because he thought they may be noisy (Figure 8.48). He said, "P9 I don't like this at all and... its factory..... Source of pollution, noise and..... in case of images.... as well, it is not very nice done, as just too big.... to know ...may not like at all... Tower or chimney, one box in the middle, lots of cars around it ... there, this is some-where I...... I always try to avoid". Moo (Figure 8.48).

"Number 9 because just a factory and ...also number 10 as well ...but these two ... but number 9 is the worst one, is just ...seems to me just a factory. When its running all the pollution noises and lots of you know.... this is I don't like it" .Moo (Figure 8.48).

P9	P10
	

Figure 8.48. Moo's focus of attention.

Nini's eye tracking results are almost similar to those of Rina (Figure 8.44). In one image she fixed her gaze on the factory and in other she did not, but in contrast to Rina in both images she communicated negative narratives and a negative connection to the image (Figure 8.49).

Nini says, "p9 This is some kind of factory....which is make like everyone .... I think not only me, other people see this photo will feel a bit straight, like you gonna a go to work somewhere, it's should a be very hard working and have to look at that ...they should have bad pollution from the factory" Nini (Figure 8.49).

Again she says, "Number 10....... I ...... to be honest with you number 10 make me feel down a bit Look ...at the sky, it's not blue sky its brown .and like.....I am not sure that photo is gonna take nearly dark. Or something like that ....but when you see that ....you will think woo... it make you feel down a bit ... it make me feel sad and also this building in this photo is look like a factory that gonna make very bad pollution to city ....or something" Nini (Figure 8.49).

Nini 9

Nini 10

Figure 8.49. Nini's focus of attention.

From eye tracking results it is evident that the above mentioned three participants fixed more on the sky; both Rosy and Zafira referred to the sky in their narratives. Rosy commented on Figure 8.50, "p9 <u>This picture looks really dull because it's like a factory</u>...but I like the blue sky" Romia.

P9

Figure 8.50. Romia's focus of attention.

Similarly according to Robert, "<u>P9 these are not nice at all a big factory,</u> some of grass not very nice" Robert (Figure 8.51).

When asked which the worst image is, Robert replied, “Number...probably number 9 ...massive factory just disturbing the environment.” Robert (Figure 8.51).

P9

Figure 8.51. Robert’s focus of attention.

Zafira commented about image shown in Figure 8.52,

“Then there are lots of cars in their park again ...no people again...but you know there must be people in there...it’s not a very nice place, imagine, it’s not a nice place as well because the lawn isn’t really ...can’t see any bit of green there...just a bit of scrappy lawn ....it’s not like you can go and sit there and have your sandwich....it’s right next to the road ...no..I don’t like it. Nice sky though” Zafira.

P9

Figure 8.52. Zafira’s focus of attention.

Overall the majority of participants did not like the image of a factory view and in their eye tracking results, most of them fixed on sky or the grass to avoid fixation on the factory. Reasons for not liking the factories were related to pollution, noise and design elements.

8.4 Summary

The data and themes above present the main perspectives obtained from when participants described the images during narratives and interview. It would be incorrect to understand each vision as an idea or plan put forward by participants, rather they should be viewed holistically. Each vision is intertwined with the next and presents general ideas**.**

It is clear that there are a large variety of connections and perspectives held by the participants who took part in this research. Many of the connections are related to content of image like activities, what people are doing in that image. Most of these connections are quite simple, not requiring a lot of items or planning ahead, and many of these develop within a few seconds as evident from eye tracking data when participants look at an image. Other connecting factors include childhood memories and connections through past visits to similar landscape, and are layered with more complexity and point to connections that might not include a direct experience of similar landscape. Instead of being routine occurrences they are more related to contextual circumstances. The perspectives, stemming from these connections, tell stories that are even more contextual in that they begin to reveal how the person understands an image. Through the perspective of like, dislike, and boring we are given a glimpse into differing worldviews about these landscapes and how they are seen. The perspective on Nostalgia describes what is in the image, how it has affected participants, and what the contributing factors are. The vision themes echo these perspectives and perhaps also provide a window into participants' desires and how they would like to see an image.

However, these are not static results and neither is this research conclusive as to participant's SOI (sense of image) of SLI (surrogate landscape images). These results are representations of the wide diversity of perspectives that are communicated during the process of inquiring about people's sense of a particular landscape image. They reveal, in a clear and fairly concise way, the plethora of stories heard during this study, about SLIs. If researchers were to conduct subsequent interviews of the same people or perhaps more of the same kind of interview on other people connected to SLI, we would probably find more types of connections and perspectives. As a researcher it is not seen as being a disadvantage to the data already gathered, but simply an indication that inquiring into SOI about SLI allows for the collection of a rich data set. In the following chapter, the conclusions drawn from these results will be discussed.

Chapter 9. Conclusions and further work

The purpose of this chapter is to review and reflect upon the conclusions drawn from this research, and to propose future research topics and directions.

This chapter starts with a brief overview of the structure of the research. Then the research questions will be revisited, showing how they have been addressed in the research. There follows a brief discussion of directions for further work. The chapter closes with a summary of the conclusions of the reported research.

9.1. Recap of overall research structure.

This study used a methodological framework, as explained in Chapter 4, combining eye tracking with more conventional techniques such as background questionnaires and post-session interviews. The analysis was both quantitative and qualitative and took into account performance, visual search behaviour, and user experience, expectation, and preferences. The intention was to triangulate among sources and analyses in order not only to reveal relationships between surrogate landscape environment image (SLI) components and participants visual behaviour, but also to explicate how different factors shape their visual search behaviour.

The main focus of this study was to talk to people who are exposed to images, hear their stories (narratives) of connection and their proposed visions and link it to eye tracking data. In this study, data is collected from twenty participants using mixed methods such as narratives, semi structured interviews and eye tracking data. The study is drawn on the concept of 'Sense of Image' (SOI) to form a theoretical foundation for questioning and analysis and will report on conclusions in this final chapter.

Table 9.1 provides a reference to purpose and objectives and will refer to each objective and overall purpose in turn which will relate to results and conclusions. A discussion on sense of image research and also the literature for the landscape research is also included. Finally, a few recommendations are suggested following the results and conclusions of this work.

Proposal & Objectives
Purpose: To understand how different people connect with image and how engaging with this connection informs their vision and ability to imagine.
1. To explore, through engaging their sense of image, peoples' past and present perspective of, and connection to the different landscape images.
2. To investigate how sense of image changes, individually and collectively, regarding surrogate landscape images.
3. To discern peoples' vision for the surrogate landscape images.
4. To determine how perspective of the image impacts an individual's vision for this landscape image.

Table 9.1. A reference to purpose and objectives of study.

9.2 Answering the research questions

The overall aim of the research was to empirically test existing environmental research from a human perspective. The main research question was – What factors influence users' visual search behaviour and performance when they look at a surrogate environmental image, and what is the impact of expectations and previous experience on visual search behaviour?. The main outcomes regarding the influence of both surrogate environmental image component layout and previous experience for the study are presented in Table 9.2.

Throughout this study, the researcher examined a number of factors and articulated what effects on behaviour are associated with those factors that most influence visual search behaviour with respect to viewing surrogate environmental images.

It related those findings to existing environmental research, suggested refinements, and hence showed how eye tracking studies can add value to Environmental evaluation. When Eye tracking data was collected and analysed two types of responses observed:

iii. Immediate Involuntary Response (Figure 9.1)
iv. Delayed Learned Response (Figure 9.2)

In this study, it is noticed that the first 3-5 seconds on each image are very important to describe scanning behaviour of individuals which is described as a 'Visual Signature' in this study. However, in terms of liking or disliking any elements of nature in surrogate images, previous experiences play an important role which is a delayed response.

Figure 9.1. Immediate Visual Response: Emergence of individual scanning behaviour immediately after initial exposure.

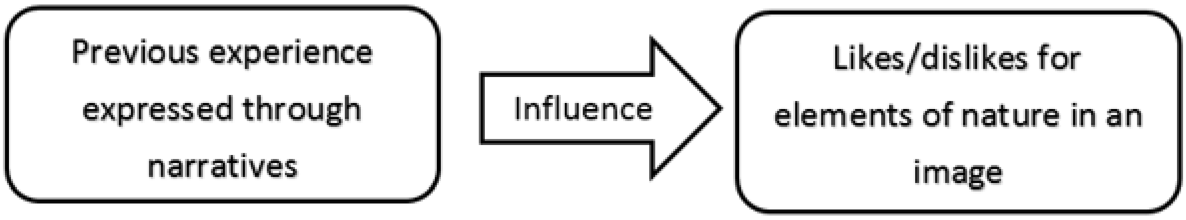


Figure 9.2. Delayed Visual Response: Influence of previous experience and exposure expressed through narratives.

Name Of Study	**Seeking target information**	**Which design elements attract attention**
Study 1(Immediate Involuntary Response) **Chapter 6** Individual Participant Study • To capture the relationship between users' previous experiences and expectations, and their scanning behaviour. **Study 2 (Delayed learned response)** **Chapter 7/8** Individual Landscape Study To explore the participants' scanning behaviour and their ability to identify different elements of nature in surrogate images.	Innate individual thought process and deep rooted autonomic visual response influenced initial fixations. Previous experience of similar kind of landscape influences later Scanning behaviour. Participants adapt quickly to new SLI However, this adaptation does not completely override the effect of previous experience, which Influences where participants look for typical landscape features.	Visual Signature (first 3-5 seconds fixation on each image) List of delayed responses below (plus mention liked and disliked elements)

Table 9.2. **Brief view of the outcomes of the study.**

9.2.1. Immediate Involuntary Response.

More details of 'visual signature' are given in chapter 6 where individual eye tracking data is analysed in detail. In this study, a visual signature is defined as,

"An individual pattern of fixations emerging as a result of involuntary initial response in the first 3 to 5 seconds after exposure to a naturalistic image."

In the eye tracking results shown below in Figure 9.4, we can clearly see individual visual signatures of the participants. Figure 9.3 briefly shows the mechanism by which visual signatures develop.

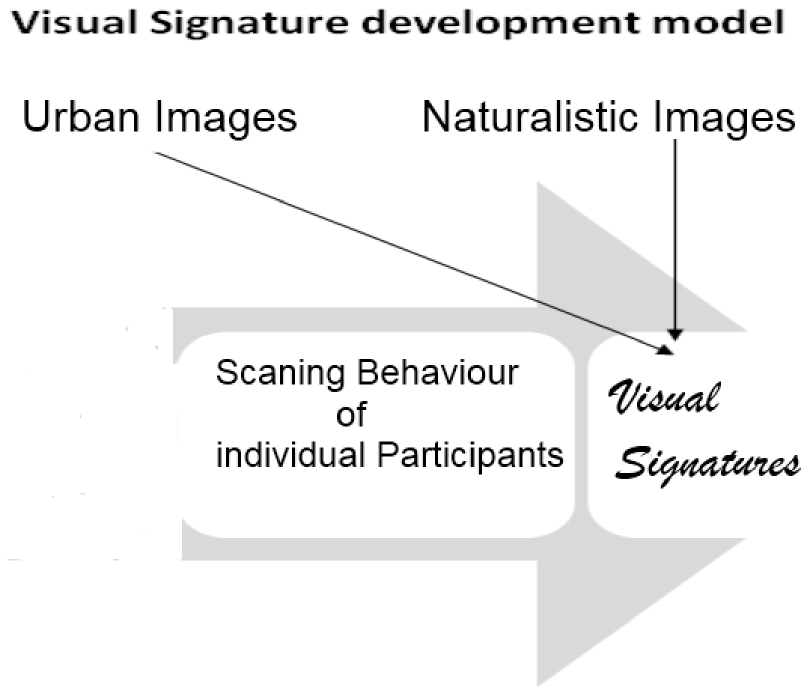


Figure 9.3. Mechanism behind Visual Signature formation process.

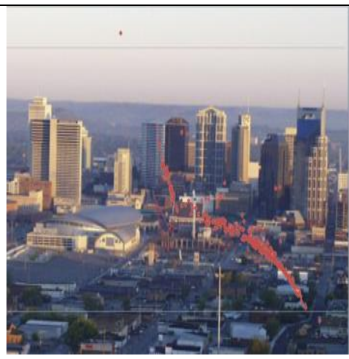
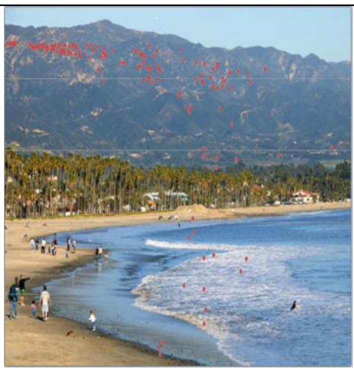
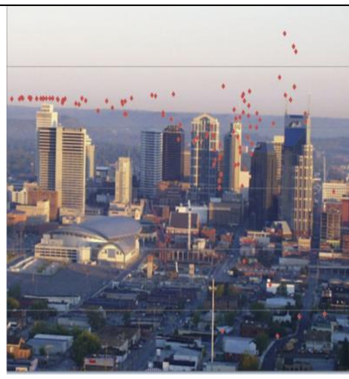
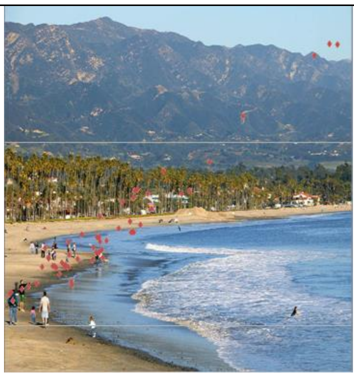
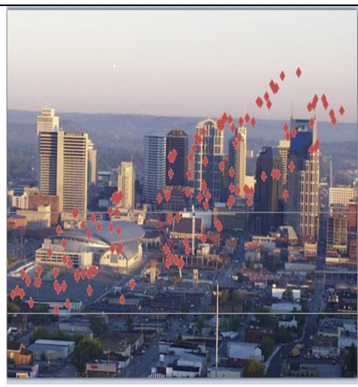
Participants	Image 1	Image 2	Image 3
Rosy			
Mona			
Robert			

Figure 9.4. Pattern of visual scanning figure for 'visual signature'.

The process of identifying the favourable environment image for an individual takes place during the first few seconds of visiting that image (Henderson, 2003). During these first few seconds of participants glancing at the image, the image would communicate to the participants. For example, the location of the first fixation on an image indicates where the participant expects to find the interesting features about the environmental image. Russell (1976) found that first fixations concentrate on distinctive design elements such as pictures and logos. If, for example, the first fixation focuses on the expectations of the participants, such as what part of that environmental image the participant would like to look at, a bottom up processing can lead first fixation, which is an immediate involuntary response due to strong design element of that environmental image. The following fixation may be

due to previous experiences and expectations as expressed during narratives. During eye tracking in this research this process is observed repeatedly. When the numerical data obtained during eye tracking was plotted on images, it is noticed that a pattern of scanning behaviour emerges as dots on an image, and is always unique for individuals (Figure 9.4), so it is identified as '*visual signatures'.* In this figure, we can notice how three participants focused on three images forming a similar signature on each of the three images. This unique phenomena (immediate involuntary response) is noticed for all the 20 participants in this study. However it was noticed that initial scanning, regardless of any other influential factors was very spontaneous. This was individual behaviour for each participant which tends to leave an individual visual signature on each image. Again this can be seen in more detail in chapter 6 under the heading of visual signatures on page 91 of this thesis.
Typical scanning behaviour involving 'initial gaze' was in the middle of the screen (60% top middle portion, 40%, bottom middle) across all different environmental images (on or near the boundary between areas B and E in Table 6.1, p 91). 30% adopted different behaviours (Table 6.1, p 91). The two participants who classified themselves as 'landscape artists' looked at the top left corner (area A) or top middle (area B) of most of the images.

9.2.2 Delayed Learned Responses.

When exploring the influence of previous experiences on visual performance, this study suggested the following:

9.2.2.1. Expectation and first impressions.

It has been noticed that participant's decide within the first few seconds of exposure whether they like an image or not. When the eye tracking data was broken into chunks of seconds and compared with narratives obtained, it was noticed that the first few seconds are very important. Their first impression is the lasting impression. If the participant likes or dislikes a scene they decide in the first few seconds. This phenomenon is quite evident from the first few words of narratives of participants as well. For example Zafira looked at the an image (Figure 9.5) and said,

"O this is odd, is it ....? I don't like that building in the middle..... it's weird ... it does not even look like a photo, looks like a composite picture like something of a post card ....or something ....o...

there is an interesting looking church ..I wonder where it is.?...em....... that's European looking church. Isn't it. Looks kind of gothic ....although. It could late gothic revival...."Zafira

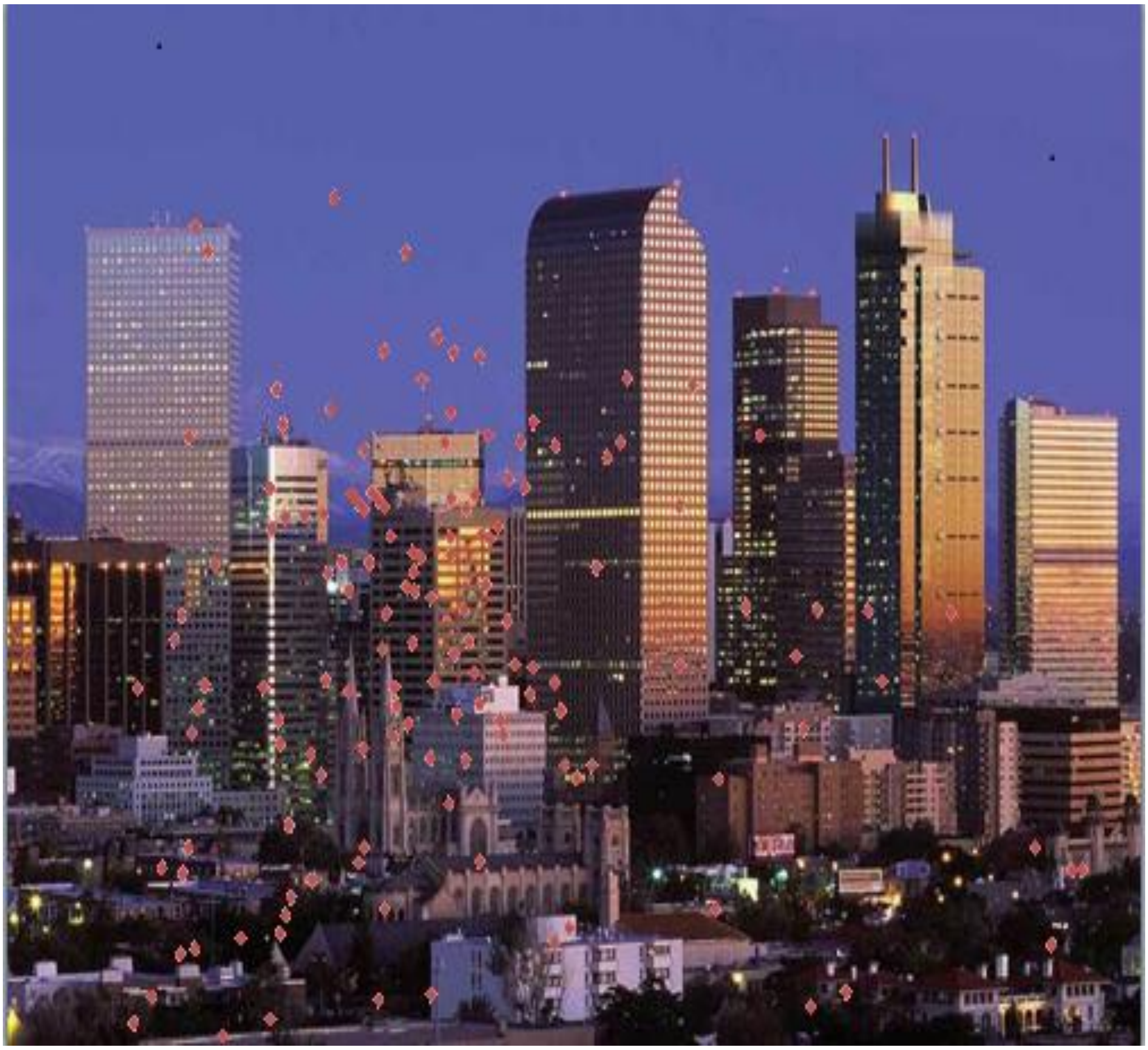


Figure 9.5. Zafira is decisive about the image in the first few seconds.

The same phenomenon is evident in another example where Julie says, "Don't like this at all, makes me uncomfortable, it looks noisy and urban". And again Julie used word s like "Don't like" in the beginning of her narratives (Figure 9.6).

Figure 9.6: Julie is decisive about image in first few seconds.

It is thought that humans may scan environments very quickly for reasons linked to innate survival response. To survive in an ever changing environment, one needs to be quick and accurate to find out if this is a favourable environment for survival. Although human reactions to landscapes undoubtedly involve both innate and learned components (Purcell, 2001; Henderson 2003), in recent years the perspective that sees environmental preferences as a by-product of human evolution has been growing in popularity (Ulrich, 1977, 1983; S. Kaplan, 1987, 1995; Kaplan and Kaplan, 1989). According to this view, human preferences have developed because they have been crucial for our survival as individuals and as a species.

9.2.2.2. Participant adaptability.

Participants 'learn' where to look over repeated exposures, but the effect of their previous experience overrules their quick adaptation to a specific type of environment. Some participants who were exposed to images prior to the eye tracking exercise focused in the middle of images and did not tend to move on different quadrants of an image to find out more information of the environment. This is evident by examples of individual participants given in chapter 6, where Moo and Alan were pre exposed to images and tended to focus in the middle of most of images, whereas Romia and Julie were not exposed to images before, so they tended to focus away from centre as well. It has been noticed from the background information that participants tend to like the environmental images which resemble closely the kind of environment with which they are familiar. It has also been noticed that participants always link to environment images positively if they have some good memory or childhood link closely resembling that environment. Participants who grew up in a sea side environment tend to like such images and participants who grew up in mountainous environments prefer those images which have more mountains in them.

For example, Nini linked one of the beach image shown below (Figure 9.7) to her home, and says,”Yeea....sure.... for the sea ....I like this ... the... The reason why I like photo number 2 is about my life one of my house that I ever told you before we have a house not too far from the sea...when I see that photo is look similar to the beach that not too far from my home laugh....”

Figure 9.7. Nini linked this image to her memories of her home.

Again this can be noticed if we see in chapter 6, Figure 6.21, how Moo links images of mountains to his past.

9.2.2.3. Importance of task.

The purpose, relevance and familiarity of the task itself influence users’ behaviour. For example, some participants seem to be keener than others in this study from the beginning. It has been noticed that participants who had higher scores in nature profile and who were very enthusiastic about the research spent more time on each image and tended to scan each image with great detail. For example, if we look at the data presented in chapter 6, where there were three participants with higher scores to nature and one with the lowest score presented, it is noticed that the participant with higher scores spent more time on images than participants with over all low scores. This can be seen from the graph of time spent by a high scoring participant and a low scoring participant. Graph shown in Figure 9.9 shows a kind of disinterest in the beginning expressed by Romia as she spends less time on the images in the beginning of task, her time increases significantly towards the end of task. She spends less than 10 sec. on the first image and 70 sec. on the last image.

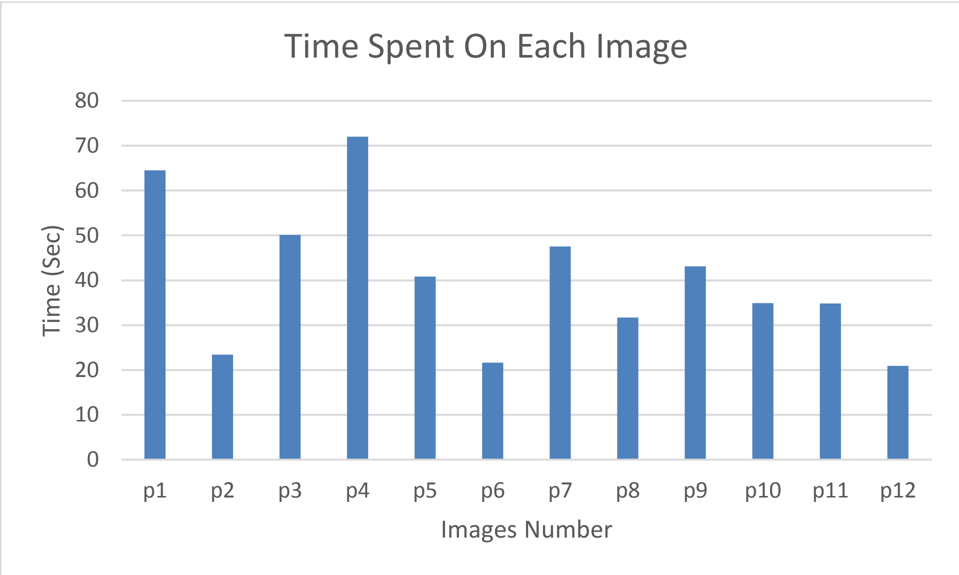


Figure 9.8. Duration of time spent by Moo on each image.

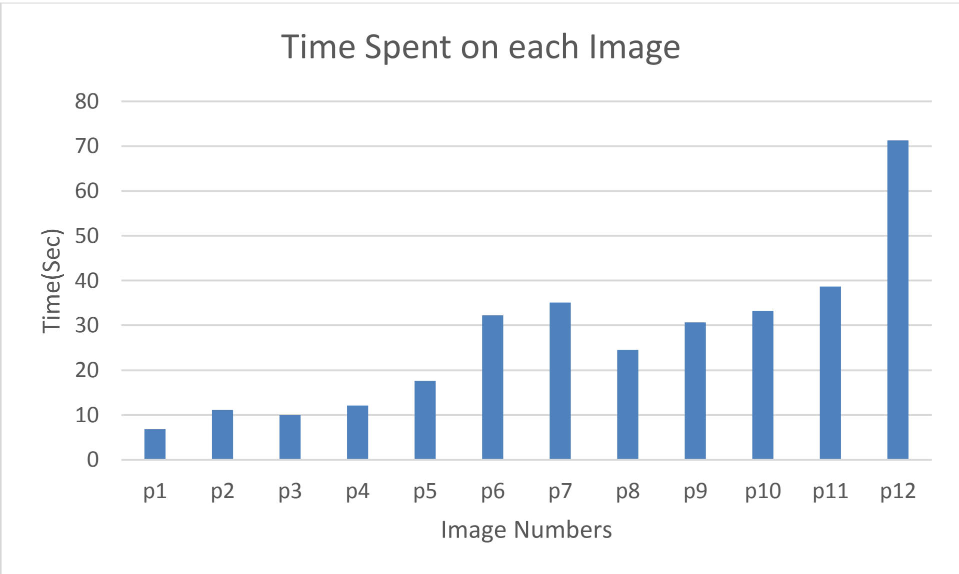


Figure 9.9. Duration of time spent by Romia on each image.

9.2.2.4. Pattern of Gaze.

Eye gaze patterns can be used to classify the type of task the participant is performing. Our results showed that each participant has a unique signature of eye movement. Other than participant's unique signature, from eye tracking we can observe from the data whether their search behaviour is

- 'exploratory' or
- 'focused'

According to Iqbal (2004),

"If there is prior knowledge about the categories of tasks a user typically performs and training sets of eye movement data for those tasks are available, then we can develop a system for classifying user tasks." In this research it is noticed that participants who were exposed to images prior to taking part in eye tracking showed a more 'exploratory' pattern of data. Participants who were new to the task showed more of a 'well focused' pattern in the data. (See Figure 9.10 as an example of exploratory and focused data obtained).

	
Exploratory with spread dot pattern	Focused with dots very closed at certain points

Figure 9.10. Showing data from a new participant (previously unexposed) on the left and pre exposed participant on the right.

9.2.2.5. Complexity of Image.

Previous research shows that eye gaze patterns are affected by the difficulty of the task. There was a significant difference noticed in eye gaze patterns when participants looked at natural and urban images. Urban being unnatural are anticipated as complex images by many researchers. According to Iqbal (2004) "patterns of eye movements can be used to highlight moments in a user's task sequence where they may have problems understanding the needed information". Therefore the difference in the pattern sequences among natural and non-natural images are linked to the complex nature of urban images (Iqbal 2004). This can be seen in one example in (Figure 9.11).

Our study showed that participant's eyes did not always remain focused in an area on the image. Often the eyes would move around different areas of the screen. However, this was more of an issue for natural images (easy tasks), where a participant would look at the areas of interest less than 50% of the total time on average. For the difficult tasks a participant would look at the screen 70% of the total time. This suggests that the more complex the image is (unnatural, urban), participant tend to concentrate more on specific areas of the screen compared to easier images (natural).

	
Natural	Urban
	

Figure 9.11. Two natural and two urban images. Participants show more focused pattern in urban, and more exploratory (spread out) patterns on natural images.

9.2.2.6. The amount of time.

As explained above, the amount of time is linked to the importance of task for the individual. Other interesting findings about the amount of time, is the time a participant's eyes are fixated on each area of interest which relates to the complexity of that area. The results showed that participants spend more time on AOIs, located on urban images, in other words more AOI (area of interest) were located on urban images and more time is spent on them. This observation is consistent with the observations made above. According to Iqbal (2004), the amount of time a participant's eyes are fixated on any AOI can provide a metric on the complexity of that area and how much mental workload it is inducing. This can be used to evaluate the cognitive complexity of an urban scene.

9.2.2.7. Areas of non-interest.

These areas are also important in terms of information we receive. Participants do not always look at all areas of interest on an image. Our results showed that participants occasionally ignored certain important areas of an image. This means either those parts are considered not important based on pervious experiences of participant or, there must be more visual emphasis on those parts of the image which draw a participant's attention to them. This observation has implications for evaluating any environmental scene. It is noticed that these areas of non interest can sometimes give important information about a scene. These areas are referred to in this research as 'redundant areas of an image'. These are important to see relative importance of any element of an environment in an image. For example, in the image below (Figure 9.12), we can see that although blue sky is an important natural element in any scene mentioned by a few participants, the presence of water is found to have more importance than blue sky in any scene. That is why the sky appeared as 'redundant areas' in this image.

Figure 9.12. Showing relative importance of blue colour water than sky. Sky appeared as 'redundant areas' in this image.

Based on the above results, it can be concluded that eye gaze provides a valuable source of information on the complexity of the environment and what areas of the image the participant is focusing her/his attention on. This can help guide the design of the visual layout of an environment in the field of architecture and town planning.

9.2.2.8. Which environment elements attract attention?

When exploring the effects of the environmental layout and specifically which environment component elements attract participants' attention the most, the study suggested that if we look at the connections mentioned in the last chapter, we can see which environment components are important in detail, (Table 9.3 and Figure 9.13A) list important elements of the environment).

Positively Linked POI	Negatively linked POI
Water	Buildings
Flowers	Cars
Sky	Factories
Sunlight	Roads
Trees	
Grass	
Blue & Green colours	
Mountains	

Table 9.3. Negatively and positively linked POI, similar to environmental elements identified by participants in their narratives. POI (Point of interest)

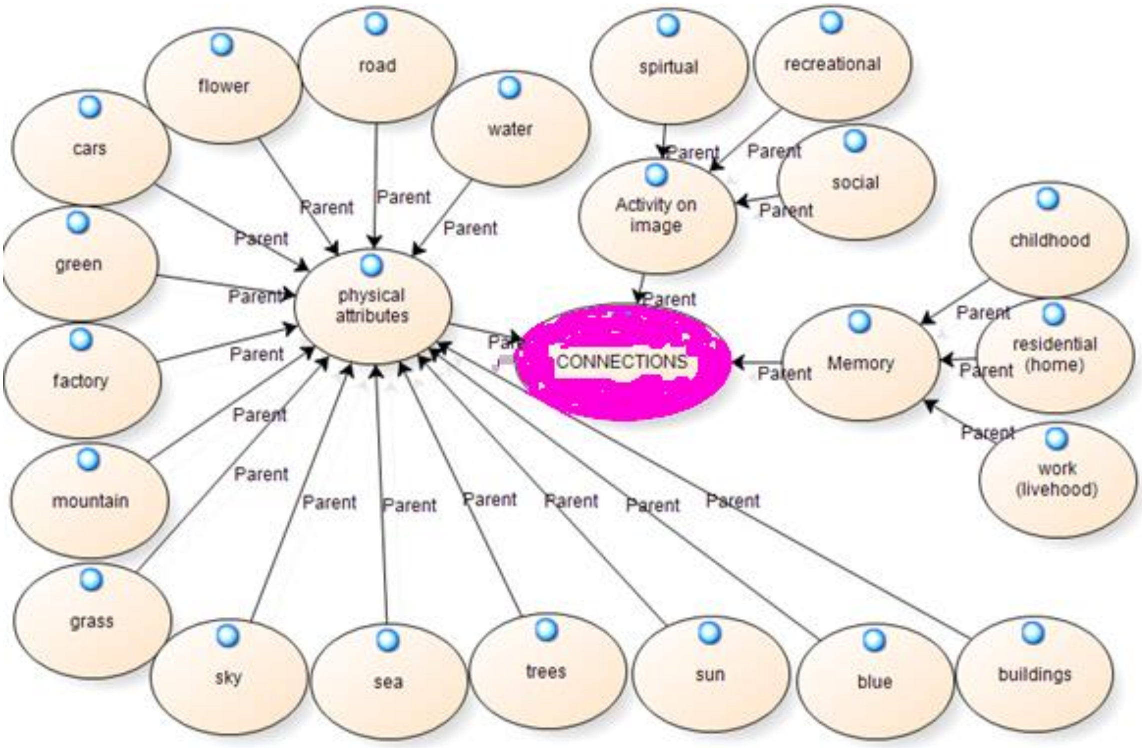


Figure 9.13 **Examples of 'Connections'; with related Parent and Children nodes emergent using NVivo.**

9.3. Development of a new framework to describe perspectives and connections to surrogate landscape images.

The first objective related to sense of an image (SOI) is achieved in every aspect of this research through narratives, post eye tracking interviews, literature review, participant observation and eye tracking. In the interviews, direct questions were based from SOI literature. The main directions for formulating connections and perspectives and linking them to memory, activity on images and physical attributes were taken from Andrew (1989).

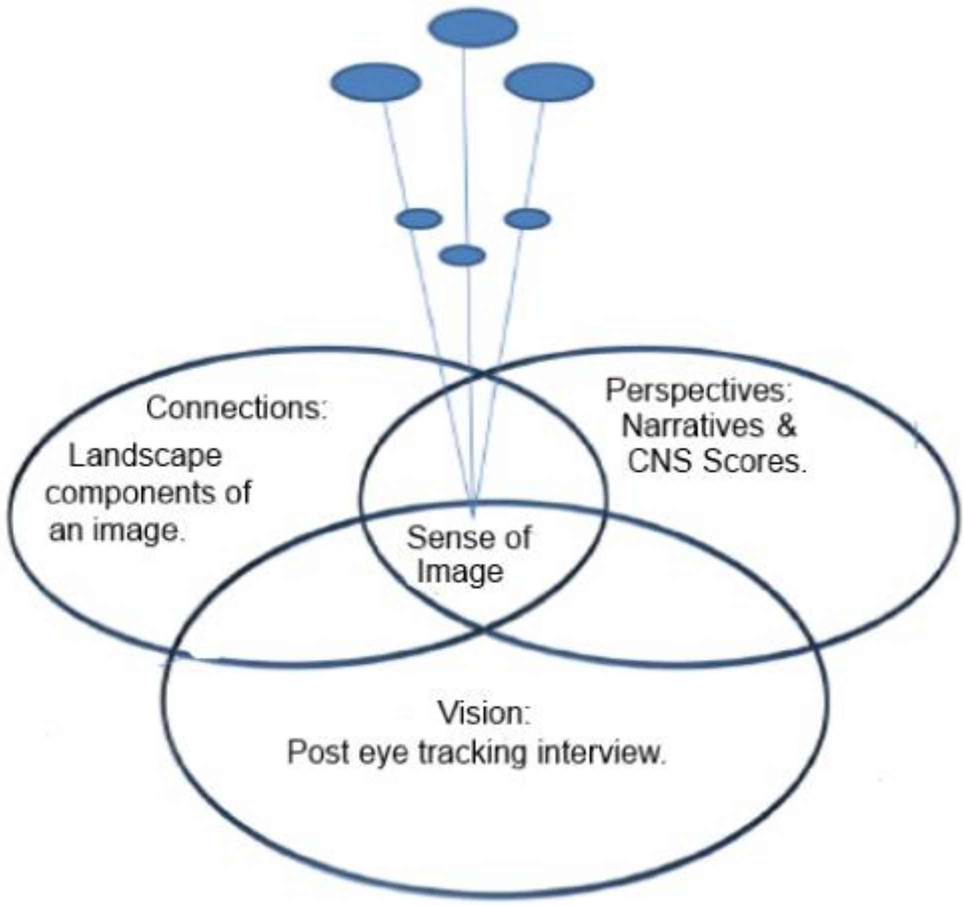


Figure 9.14. Sense of Image Framework (SOI)[35] developed to analyse different sets of data.

During the research, a framework was developed (Figure 9.13B) by the researcher which showed the three interrelated aspects of SOI (Sense of Image) and how perspectives are formed by these. Using SOI questions in semi-structured interviews and the narratives allowed the development of a rich collection of qualitative data regarding surrogate landscape images (SLI) and their importance to people. These narratives are representations of the dynamic SOI connections to SLI that people have, which continue to grow and expand. In conclusion, there are strong connections between participants who have had experiences on SLI type real landscapes. Throughout this research it is noticed that these connections were almost always regarded as being positive, healthy, and/or encouraging. These connections and the resulting perspectives were quite diverse, but the importance of SLI related landscape was not limited by the length of time people had spent there. People who had spent much of

[35] This figure is a modification of two figures depicting the three "forces" affecting human action: Social and Political Processes, Social and Cultural Meanings, and Biophysical Attributes and Process. Each force is a circle and where the circles intersect is "place". (Cheng, Kruger and Daniels 2003, p. 90). I have also included aspects of Sack's (1997) figure depicting the relationship between "forces" and "perspectives" (p. 28). The terms I use are derived from my own reading of the literature leading me to speak of "factors."

their life living on SLI type or similar kind of landscape certainly had more stories, but people who had only visited a few times still spoke of their connection as being very important.

These conclusions relate to surrogate landscape literature in the following ways: that surrogate landscape research allows a "dynamic intersection between participants self and the physical environment," that connection to places can promote positive self-identity, community engagement, and care for one's surroundings (Coles 2000; Halena 2009; Scott 2002; Relph 1976; Tuan 1974,Tveit 2006), and that environments can hold a wide diversity of perspectives, which is especially reflective of surrogate environment literature (Coles 2000; Cathrine 2012; Mayer 2004; Millman 2011; Yerrell 2004).

In this study, the definition of SOI is based on work by geographers such as Andrew, Walker and Rosalind, Kimball (1989) who see places as dynamic intersections of relationships and interactions between people and places. This relates to the conclusion that people hold strong connections (of different SOI factors) because they have relationships with SLI. This understanding about the SOI process, drawn from the literature and articulated in the researchers definition of Image and SOI, is not concerned with degrees of attachment or how attachment is made, but rather looks at the connections created through experiences and how they influence and are influenced by a broad understanding of people's lives.

Figure 9.15. Romia's scanning behaviour over the image related to above narrative.

Statements in the data expressed emotional stories of connection that are felt and then described in these ways, for example, it has been seen (on previous page) how some participants are linked to the images with Rosy saying, “This picture is very calming........I like the blue sea.... I like palm trees.” (Figure 9.14).

Shahzadi expressed her attachment as, “p11 I love this picture because the weather is sunny and the sky is blue and the flowers are pretty. And I love the water and I love the mountains”. Shahzadi (Figure 9.15).

Figure 9.16. Shahzadi’s scanning behaviour over the image related to above narrative.

Zafira said, “p11 O.... bit like three D... Gosh...This is very alpine. This is got to be like Switzerland or something..ahh.... it’s got nice stream” Zafira (Figure 9.16)

Figure 9.17. Zafira’s scanning behaviour over the image related to above narrative.

The perspectives and connections explored (defined on p.183) in Chapter 7 and 8 described a diversity of experiences and different things that were seen as important to people. This SOI research as a platform for participation did not distinguish these connections by degree, but rather created room for all types of connections and perspectives to be heard. This reflects the notion developed early on in SOI literature by geographers such as Andrew and Rosalind (1989) and reflection of self. Furthermore, there was much evidence presented in Chapter 7 to conclude that connection to images promotes positive self-identity, community engagement and, essentially, care for one’s place. Every perspective and vision spoke, in some manner, of the importance of surrogate landscapes and linked images to individual and communal health or wellbeing, to learn valuable lessons and to bring people together in different ways. The evidence of this was especially noted in the visions, which were all concerned with how to, essentially, *take care* of landscapes in a way that enhances it *as it is*. The anxiety expressed by participants, again and again, regarding possible disconnection to nature also leads to conclusion that these connections with SLI were extremely important to participants. This is confirmed when looking at eye tracking data along with narratives. (See Figure 9.11).

As noted in the diagram of SOI, people are not only connected via physical or geographical attributes of image but also through social/cultural discourse and personal identity. Herzog (2002) cautioned that places and inquiring into people's connections will bring up both shared but also divergent perspectives and these are just as important if connection and engagement is to be maintained. During this research both shared and divergent perspectives were expressed.

9.4. Changing SOI Perspectives

Investigating how SOI changes over time during the task, regarding SLI, the second objective did not yield such direct data. However, different aspects of this can be seen throughout, especially in connections and perspectives dealing with *change*. The precise mechanisms that cause SOI to change were not investigated. However, one strong commentary on the possibility for SOI to change in a way that would produce negative connection, or disconnection, can be seen in the *disconnection* vision. For example, the first is a storyline heard from participants who were quite actively connected, for several very different reasons. This connection can be understood as a kind of hate relationship; they are connected to images because of some negative factor. Jamela was the participant who expressed the most negative connections to the images.

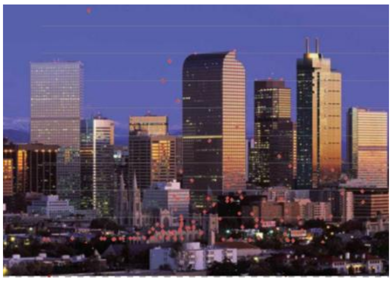
Jamela 4 (A)	Jamela 7 (B)	Jamela 9 (C)
		

Figure 9.18 A. Link established due to expecting 'phonetic noise' in the area. B. Link made because thinks image as 'shame scar going through landscape'. C. Described it as 'Ugly and uncomfortable'

Jamela comments on the image, "I don't like this photograph so much, I think interesting architecture been dwarfed by ugly tall buildings I can imagine there is sort of phonetic noise at ground level whether that is accurate or not, I don't know , but quite an interesting photo graph, but not somewhere I particularly want to be".Jamela4.

For another image Jamela felt again very different and mentioned her connection in these words," As a photograph I think this is a huge shame, and the road looks like a scar going through the landscape, I rather suspect if you are on the road, that its rather stunningly beautiful because it's so dramatic and you are not aware of what the picture of the road looks like, as a photograph I think it's ugly". Jamela 7

Again Jamela expressed a connection as disconnection (negative attraction or attention) through a negative relationship as, "I think this is really ugly photograph, I think the subject is really ugly, and not somewhere I would wish to be at all, it makes me uncomfortable. I think as photograph, I think this is rather good it's quite dramatic with the sunset but the subject again is ugly and it's not somewhere make me want to be there" Jamela 9

The third objective was thoroughly discussed in Chapter 7 through the four vision themes. This discussion is taken up again in the final objective that feeds directly into this proposal. As answer to this question, *'Does perspective of image impact a participant's vision'*? This research concludes visions themselves are a certain kind of perspective, thus the name "vision perspectives." It became evident that peoples' opinions were influenced by different categories. The perspectives from the results section are as follows: (Dislike, Like, I don't know, Nostalgia, Natural, Industrial, and economy). A fairly clear pattern of people speaking about those things that were important to them was evident.

Within a *nostalgic* perspective the correlation is even stronger as the way people remembered certain SLI or, the stories people knew about things that happened on similar landscape became an important part of their idea of what should happen on image in terms of interpretation. The visions articulated to respect the memories, in other words both memories and visons of participants are linked. Other examples are of participants who had such positive memories of childhood experiences on similar landscapes that they wished for everyone to be able to experience in such a way as they experienced.

Overall however, there is a definite relationship between perspectives and visions. It is complex – there is no formula for perspective to vision. There are correlations with the possibility that understanding or articulating one's perspective can also make the reasons for a particular vision more obvious.

Finally, drawing on the above, we come to the discussion of the purpose. This is the last linkage: Does a person's sense of image connections relate to vision? Again, it's concluded "yes". This, in fact, is already clear in much of the literature. It's believed this is because there *is* a definite relationship between a person's connection to an image and their perspective on it.

One example of this, from the data, were stories from participants whose connections were very recreationally wilderness based, spending lots of time and observing. As these participants described their activities, they often mentioned the need for preservation to allow further opportunities for observation of the events of nature. Thus, their activities were closely tied to their vision for what could happen as they had expressed through narratives and eye tracking data.

Another participant very clearly explained how she became connected to the road landscape land and hoped that other people might experience the place in the same way. Rina said “Number 8 because its very bad picture ...it does not show anything interesting ....nobody really wants to spend anytime on the road .....Everybody wants to just go in the car as fast as possible”. The vision as described then, can be a desire for other people to see the same vision for themselves.

The above desire was actually quite common, but often less clearly stated. A pattern emerged of every one desiring the way they look at an image, that other people should experience the same image in a similar fashion. For example, if it was a place they used for walking, they hoped that to continue for themselves and others should do the same. If it was a place they camped at as an adult for example as Moo says, ” I love this image I love the flower...the mountain and the snow there, and the water coming down... and ... it’s just remind me again of my home country and at the same time I went back to Switzerland and Sweden or in Italy you can see these images but. .... This is somewhere you can breathe and you can walk freely...and I like that”. It is clear, the participant hoped other people to be able to experience the image or place in a similar way. For example, the participant used the term, “you can breathe” and “you can walk freely” which shows the above mentioned desires that other people should feel in same way.

These conclusions reinforce the framework of SOI. There is a relationship, indeed, between SOI connections and vision, which could be unique to the SLI, unique because the participants have quite positive connections and often wanted these kinds of connections to continue. Thus, their SOI connections could be used as a foundation for their imaginings of what they would like to see happen because it was good for them. This was also true for the few negative experiences, which created disconnection as the data was explored in Chapter 6 under *connections disconnections*. For these participants, there was a desire for a vision that reconciles those disconnections or at least, makes people aware of them, so that they do not happen again. Again, the relationship between connection and subsequent vision perspective was clear.

One hopeful conclusion from the data, however, does point to the sharing of vision through the four themes that overlap. Especially noticing that all of the participants liked natural images and non-natural images were disliked in the majority of cases, as aspects of their vision perspective. However, only a few participants were not sure about their views for example according to Rina;

“,Amm.....it is interesting for me that .....just to take this exercise ......I even more realise that landscapes which involve roads and cars to much ......yes sorry.....basically I think about this........I did not like the roads and all of this sets I think roads are the most ugly once.........in the other hand I really like industrial architecture ....so I cannot say that human the people make bad changes to environment...........I also admire building architecture...but.....can you ask this question again”.

Also, the process does and did create an arena for discussion and the researcher still believes that, for some participants, these type of processes did change the way they imagine landscapes in future.

So this conclusion is based, not on the researchers own work to engage people SOI of SLI but rather on participants relating stories of earlier SOL (sense of landscape) type processes they experienced.

Summary findings:

- Initial response (Visual Signature): the involuntary response that emerges in first 2-3 seconds of exposure
- Delayed responses: the behaviour that is linked to previous exposure and experiences of the individuals.
- Sense of image framework formation: Framework designed to analyse data for this study and bringing four streams of data together, i.e. narrative data, eye tracking data, CNS scores along with individual profiles and post exposure interviews data.

9.5. Further directions.

Several issues arose in this doctoral research that warrant further investigation. The combination of evaluation techniques used has successfully contributed to the analysis and further development of existing environmental research. However, the richness of the data collected by the different techniques suggests further possible ways of analysing the data, depending on the various aspects of interest. Suggestions of further directions are listed below:

9.5.1. Realistic tasks

In this research we collected natural response of participants to SLI with the help of eye tracking. According to the results, visual search behaviour was not task sensitive. Participants were given a free hand to look at images as long as they wanted to. Unlike this study, future research can be conducted as task centred and two types of tasks can be given to individuals:

- ‘exploratory’ asking participants questions prior to data collection, for example to have a look at the image and describe the image’s certain aspects.
- ‘target oriented’ to find the favourite elements (as mentioned in connection), in an environmental image and look to see if they are able to search them easily or with difficulty in a scene, whether that effects their visual behaviour and also introducing different quantities and amounts of favourite elements in images.

Most of the literature in visual search starts with the participant knowing the specific target. There is a need to conduct more basic research in visual search when the target is not completely known. A more realistic search task would be to look for a tool that would help you do a specific task, without having seen the tool before. For example, capturing the experience of a participants when using a real environment instead of surrogate images.

9.5.2. Use in Architecture and Urban design

Eye gaze can determine where and how to present different elements of nature in a built up area as eye gaze data indicates where a participant is focusing her/his attention and also how complex the scene is. Therefore, it can be used in architecture and town planning to determine where to display certain elements of natural environment. The viability of any urban plan or design can be checked prior to implementation with the help of eye tracking.

9.5.3. Advanced eye tracking devices

The eye tracking devices used in this research study restricted the participants from making major head movements. Users who wore spectacles for viewing computer displays were excluded from participating. It is promising that developers of eye tracking devices are making great progress in reducing such physical constraints (for example Tobii Ltd). Enabling the collection of eye movement data in natural settings, such as the work place, and without constraint on the participant’s movement, add to the external and ecological validity of the eye tracking study.

9.5.4. Different user groups

This research involved adults from diverse cultures. It is important to consider representative samples of different groups, such as participants who are not familiar with a particular environment. As was discussed earlier, previous exposure to certain environments was found to be an influential factor in the participants’ expectations of where to look more. Exploring how participants with less experience of a certain environment search visually on exposure to real environment is a matter for future research.

9.5.5. Complex tasks Multiple Images

The stimuli used in the reported study were static environmental images. The participants were asked to look at single environment images, each from a different type of environment, and were therefore not allowed further interaction within any other type of environment at the same time. Participants reacted with the environment image, looked at different things and when satisfied moved to the next image. Future research might explore the effect of more complex tasks across multiple environment images of different environment set ups shown at the same time, which can give a compare and contrast view of participants'.

9.6. Contributions of the thesis

Previous research on landscapes provides a few examples where eye tracking has been used (examples in Chapter 3). However, most studies have focused on the study of the effectiveness of eye movement-based metrics. When dealing with eye movement data it is crucial to know what metrics to use and what information can be reached by applying them. In this sense, the focus on the use of eye tracking for surrogate image evaluation has been extremely valuable for forthcoming research. Knowing what metrics to use to identify cause and effect has advanced and proven the potential of eye tracking in the field of landscape exploration and usability testing. This research used previous knowledge about the appropriate eye movement-based metrics (timings, saccades, fixations, cluster analysis) from past work but it suggests a more advanced methodological approach where eye movement data are supported with data from other techniques (Chapter 4). Only a few other studies have demonstrated the benefits of combining eye tracking with other techniques such as, for example, log event recording (Narayanan and Schrimpsher, 2000).

In this research eye tracking revealed the visual search behaviour. The narratives and interviews connected the visual search behaviour to participant's perception and experience. As demonstrated in the conclusion of this research, eye tracking can be used to mediate contradictions between previous landscape studies. It can expose trade-offs between competing factors, such as expectation and salience, layout, long-term and short term exposure to landscape images. Moreover, it was observed that each technique used in this reported research (see Chapter 4), was able to detect different aspects of the participant's behaviour, which would not have been possible by only applying one single technique. For example, when asking the participants to report where they thought they looked on the screen while completing a task, their responses in many cases were different from what they actually looked at as shown by the eye movement data. The importance of eye tracking can only be understood if we focus on it, as eye movements are so rapid and happen subconsciously, it is difficult to report where one has looked at. Therefore, only eye tracking can capture this fine detail in an objective way.

Overall, the application of the combined methodology revealed aspects of the landscape research that had not been addressed by existing methods of landscape research. The detailed information of the shifts of visual search behaviour on the stimuli landscape images gave an insight of which design elements attract attention and about where on the certain landscape image, the participants astronomically would focus (Ainul 2012). As discussed earlier, the majority of existing landscape preference research has been derived by personal reviews and anecdotes without reporting the involvement of human participants. This research tested and elaborated the existing landscape research by capturing visual search behaviour with the help of eye tracking and other methods. The findings are expected to benefit HEI researchers, as they will learn about the potential use of eye tracking for evaluations of landscapes.

9.6.1. Relationship between task and scanning behaviour

This study highlighted the likely importance of the nature of the task on visual search behaviour. Different results regarding the impact of layout conventions for images suggest that 'recognition' strategies may be different than 'simple scanning' strategies as performed in this study. Furthermore, the evidence that peripheral vision is exploited in some tasks raises questions about the relationship between tasks and visual search behaviour – clearly a matter for further, detailed task based study, but more caution is required in drawing inferences from eye tracking data alone. However, the observations in this study demonstrate a new role for eye tracking in the context of this combined approach. It illustrates the power of the combined techniques to reveal new discoveries and account for them.

9.6.2. Relationship between performance and scanning behaviour

In this study the research has taken place to look at scanning behaviour, where participants were given free hand to look at the images as long as they liked and no tasks were assigned. So the behaviour captured was very natural. Each participant used his/her own natural search strategy, 'individual visual signature' is prime example of this natural search strategy for individuals. Further exploration of the relationship between scanning behaviour and performance might answer questions such as: Are some visual search strategies more efficient, and, if so, under what conditions? Can they be taught? For example, airline pilots are taught systematic scanning behaviours in order to ensure that they notice changes in the airplane's state (Hayhoe et al., 1999).

9.6.3. New analysis methods

The qualitative analysis of scan path patterns in this study provided insights in the interpretation of visual search behaviour. However, such data analysis is labour-intensive. This could be ameliorated by software which could help identify and classify different visual search strategies at different levels of granularity, which could aggregate scanning patterns across participants as well as across different stimuli. Collecting such data automatically with the use of software would make it possible to conduct larger studies involving longer observation periods and more complex tasks.

9.6.4. Relating eye tracking to other domains

While eye tracking has been applied in the domain of surrogate images in this research, it could also be applied in other architecture and landscape research. This research demonstrates ways of complementing eye movement data with data from other techniques. Such a methodological approach could be used for example, in marketing research for the exploration of the customer in real settings. At the moment it is noticed that in market research, combination of data collecting techniques is not used very often. For example, market researchers rarely use eye tracking data in combination with participant narratives. Where as in this study it has been noticed that this combination gives much enriched data.

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Glossary

A

Accessibility

The extent to which an application can be used by a variety of people, especially those with disabilities.

Accuracy of task responses

The ability of a measurement to match the actual value of the quantity being measured, in this case the participants' response to the task.

B

Bright pupil

A bright pupil image is seen by the camera when a light source is placed very close to its optical axis. This effect is well known as the red-eye effect from flash photographs.

C

Calibration

The process or procedure for removing the effect of these subject and set-up differences. A calibration procedure usually requires the subject to look at a certain number of predetermined target points. The relation between the raw measured value (for example separation between pupil and corneal reflection image) and the final device output is adjusted manually or automatically by a computer. It is very advantageous for the calibration procedure to be quick and easy for both the equipment operator and the subject.

Cognitive processes

In psychology it is used to refer to the mental processes of an individual, with particular relation to a view that argues that the mind has internal mental states (such as beliefs, desires and intentions) and can be understood in terms of information processing, especially when a lot of abstraction or concretization is involved, or processes such as involving knowledge, expertise or learning for example are at work.

Conventional evaluation techniques

Conforming to established practice or accepted standards; traditional evaluation techniques such as, interviews, questionnaires, user-observation, think-aloud protocol and so forth.

Corneal Reflection

Also called the first *Purkinjie* image, the corneal reflection or corneal reflex, is the reflection of a light source on the outer surface of the cornea.

Connectivity to Nature Score (CNS)

Shows inclination of participants to like natural environments.

E

Eye movement-based metric

A term used to define the measurement of information or a process. More specifically it relates to measuring what happens within an interface either on an adhoc or ongoing basis based on eye movement data.

H

Human Environment Interaction. (HEI)

It describes how human react when exposed to natural environment, through a window view, real one to one exposure, or through an image.

I

Infra-red light

Light with wavelengths from 0.7 micron to about 0.1 millimeter is called infrared light. The band of infrared light is a thousand times wider than that of visible light. All of it is invisible to our eyes.

P

Pixel

A pixel is one of the many tiny *dots* that make up the representation of a picture in a computer's memory. Each such information element is not really a dot, nor a square, but an abstract sample. With care, pixels in an image can be reproduced at any size without the appearance of visible dots or squares; but in many contexts, they are reproduced as dots or squares and can be visibly distinct when not fine enough. The intensity of each pixel is variable; in color systems, each pixel has typically three or four dimensions of variability such and Red, Green and Blue, or Cyan, Magenta, Yellow and Black.

Point of regard

The correlation of the raw eye position to the precise position on the scene, in real time.

Post-cognitive modelling

A computational approach to the exploration and modelling of cognition.

Appendices

Appendix A: Consent Form

Appendix B: Information Sheet for participants.

Appendix C: Questions used in interview.

Appendix D: Images presented to participants.

Appendix E: Connectivity to nature (CNS) score form.

Appendix F: Example of eye tracking data.

Appendix G: Example of use Nvivo 10.0 for data analysis.

Appendix A

BIRMINGHAM CITY University

Consent Form **Date & Version: 27.02.2012, V1.6**

Using narratives and eye tracking to investigate visual behaviour in perceiving images of the environment.

Please initial each box and then print your name and sign at the bottom.

1. I confirm that I have read and understand the information sheet dated 27/02/2012 (version 1.6) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I agree to wear eye tracking equipment. ☐

3. I agree to recording of interviews and narratives. ☐

4. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason. ☐

5. I understand that data collected during the study may be looked at by individuals from Birmingham City University, where it is relevant to my taking part in this research. ☐

6. I understand that some of what I say may be included anonymously in publications and conference papers. ☐

7. I agree to take part in this study. ☐

Volunteer:

Name	Signature	Date
________________________	__________________________	____________

Researcher:

Name	Signature	Date
________________________	__________________________	____________

when completed: 1 for participant; 1 for researcher.

Appendix B

PARTICIPANT INFORMATION SHEET: PRIMARY INFORMATION

Date & Version: 27.02.2012, V1.6

Investigation Title: Using narratives and eye tracking to investigate visual behaviour in perceiving images of the environment.

Dear Volunteer,

You are being *invited* to participate in this research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. You can discuss this with people whom you are comfortable with (for example: friends, relatives, your GP, etc.) and do not hesitate to contact me if you have any other questions. Please take as much time as you like to decide.

Please find below further details associated with this research.

1. Purpose of this study

I am undertaking this study as a doctoral student supervised by Professor Richard Coles in BIAD and The aim of study is to determine whether looking at environmental images make people feel better.

2. Who can volunteer?

Anyone aged 18years or over. You will be able to participate in this study as long as you do not have any previous history of recent eye surgery, glaucoma or wear high power spectacles (i.e. thick lenses)

3. Where the research will take place?

This research will be performed in a room setting in BIAD Campus of Birmingham City University, where variables such as temperature, light, noise, atmospheric odour and environment as a whole can be fully controlled. This will allow for measurement of responses (Verbal and Visual) whilst you look at a range of images of the environment.

4. What will I have to do?

You will be asked to come to BIAD at a time and date convenient to you. You will be asked to wear an eye tracking head gear and sit 3m (10ft) distance from a 40 inch image computer screen. The head gear will be adjusted until it is completely comfortable for you. Images of the landscape will be projected randomly for 10 seconds each on the screen. While each image is shown on the screen you will be asked to talk about the image, for example, I like/dislike this view because …… Your comments will be recorded on a digital recording device. The head gear will help to collect eye tracking data.

After this you will be asked to take part in a short structured interview about your experience of what you were asked to do earlier. This process as a whole will take approximately 30minutes.

5. Do I have to take part?

It is entirely up to you to decide whether or not to take part in this study. If you do decide to take part then you will be given a copy of the information sheet, the whole procedure will also be verbally explained and you'll be asked to sign the consent form. You can discuss this study with anyone whom you are comfortable with and take your time to give your consent for this study. You are still free to withdraw at any time, without giving any reason.

6. Will there be any side-effects as a result of taking part in this study?

It is most unlikely. Since the experiment does not involve any invasive procedures or administration of drugs, you should not suffer from any harmful side-effects as a result of participation in this study.

7. What if there is a problem?

If you experience any discomfort as a result of taking part in this study then the procedure will stop immediately and the you will be referred immediately to the 'University student health services and will be supported with additional medical assistance if necessary. However, no such physical risks /events have been reported in the literature and so the risk is considered minimal.

If a problem arises as a result of, or in connection, with this research please contact me first and I will try to sort the matter out.

Khizar Zaman Choudhry
Research Student,
Faculty of Health,
Ravensbury house,
Birmingham City University,
Westbourne road - Birmingham – B15 3TN

Telephone: 01213315000

Email: khizar.zaman@bcu.ac.uk

If you feel that this does not resolve the problem please contact my research supervisor at.

Professor Richard Coles
BIAD, Birmingham City University
Gosta Green
Corporation Street
Birmingham
B4 7DX
Tel: 0121 331 5155
Email: Richard.Coles@bcu.ac.uk

Or the research sponsor at:
Ms L. Land

Faculty of Health
Birmingham City University
City South Campus
Westbourne Road
Edgbaston
Birmingham B15 3TP
Tel: 0121 331 6196
Email: lucy.land@bcu.ac.uk

8. What happens when the research study stops?

The results of this study will be used to formulate a model that identifies what aspects of natural environment, are vital for urban development, especially regarding their contributions to the health and well-being of individuals. If you are interested in knowing the overall outcome of the research, please leave contact details, these will be kept confidential.

9. Will I benefit from taking part?

There is no advantage to you specifically from taking part in this research study but the study outcomes are very important as a baseline for future studies.

10. What if I change my mind and decide to withdraw after the experiment has taken place?

You are free to leave the study at any time. Even If you decided to leave after the experiment has taken place, all the data contributed by you will be withdrawn from the study.

11. Will my participation in the study be kept confidential?

All the information that you provide will be anonymised and treated confidentially. The information will be stored securely and only me and my supervisor will have access to it. Publications and conference presentations arising from this research will not contain any information that may identify you in any way.

12. Who has reviewed the study and who is funding the research?

This study has been reviewed and approved by the Faculty of Health Ethics Committee – Birmingham City University and is sponsored by the Faculty of Health – Birmingham City University. The project is funded by the Centre for Health and Social Care Research collaborated with BCU Institute of Art and Design Additionally, this study has been reviewed by an advisor from Aston University.

Thank you for taking time to read this leaflet. If you decide to take part please complete the consent form and return it to my address given below.

Research Team

Mr Khizar Zaman Choudhry is appointed by Birmingham City University as a full-time doctoral Research student. The principal investigator of this study is Prof. Richard Coles – Birmingham Institute of Art and Design School of Architecture, who can be contacted through email Richard.Coles@bcu.ac.uk.

- If you have any queries about this study, please telephone me: 01213315000 or mail to: khizar.zaman@bcu.ac.uk
- I hope that this information sheet has told you what you need to know before deciding whether or not to take part in this study.

Khizar Zaman Choudhry
Research Student,
Faculty of Health,
117 Ravensbury house,
Birmingham City University,
Westbourne road - Birmingham – B15 3TN

Many thanks for taking time to read the information about this study.

Appendix C

Post-session questions for Study: 29.09.2011, V1.4

First of all how did you feel about the task?

What can you memorise about the task?

Here I have print outs of the images you just saw. Have a look and tell me what do
You think about them?

Which image do you prefer the most and why?

Which Image is your least favourite and why?

Appendix D

Image Beach 1

Image Beach 2

Buildings 1

Buildings 2

Forest 1

Forest 2

Highway 1

Highway 2

Industry 1

Industry 2

Mountains 1

Mountains 2

Appendix E

Pre-sessional Assessment: 29.09.2011, V1.4

Connectedness to Nature Scale (CNS) Measure

Name:...Age:.......... Gender: M/ F

Please tick the appropriate boxes.

Please answer each of these questions in terms of the way you generally fell. There are no right or wrong answers. Using the following scale, in the space provided next to each question simply state as honestly and candidly as you can what you are presently experiencing.

1	2	3	4	5
Strongly Disagree		Neutral		Strongly Agree

_____1. I often feel a sense of oneness with the natural world around me.

_____2. I think of the natural world as a community to which I belong.

_____3. I recognize and appreciate the intelligence of other living organisms.

_____4. I often feel disconnected from nature.

_____5. When I think of my life, I imagine myself to be part of a larger cyclical process of living.

_____6. I often feel a kinship with animals and plants.

_____7. I feel as though I belong to the Earth as equally as it belongs to me.

_____8. I have a deep understanding of how my actions affect the natural world.

_____9. I often feel part of the web of life.

_____10. I feel that all inhabitants of Earth, human, and nonhuman, share a common ‘life force’.

_____11. Like a tree can be part of a forest, I feel embedded within the broader natural world.

_____12. When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature.

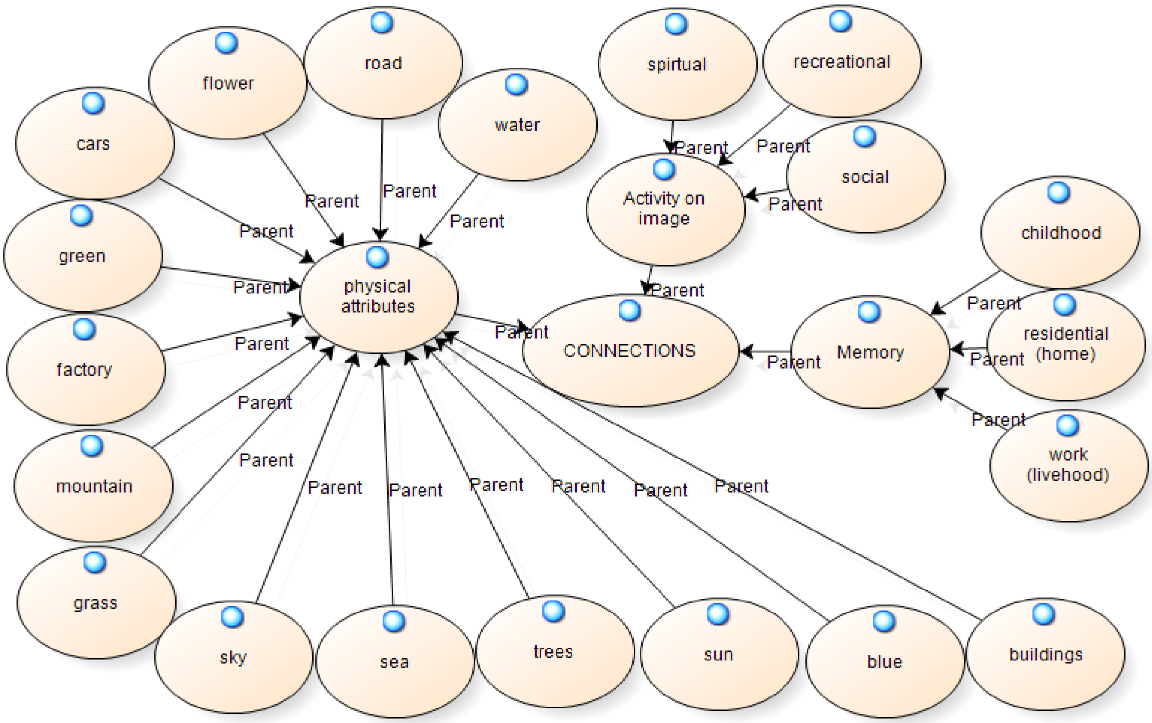
_____13. I often feel like I am only a small part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.

_____14. My personal welfare is independent of the welfare of the natural world.

Note: Higher scores reflect a higher degree of affective connectedness to nature

Time(s)	Gaze Point x (pixels)	Gaze Point y (pixels)	Pupil Point x (pixels)	Pupil Point y (pixels)	Pupil Radius (pixels)
0	552.406	-118.216	331.578	19.723	81.407
0.194	755.145	-27.532	292.548	34.283	84.144
0.31	760.399	-31.982	292.246	34.081	85.338
0.737	572.813	70.47	327.984	32.979	91.678
0.915	549.722	139.407	331.859	38.619	74.724
1.088	542.541	39.191	334.129	29.158	87.289
1.209	491.872	93.091	343.836	32.336	88.107
1.297	491.872	93.091	343.989	32.104	89.704
1.583	428.086	82.557	357.14	29.102	88.783
1.73	465.113	222.978	348.524	44.854	85.827
1.888	425.471	226.204	357.344	44.134	87.894
2.032	418.405	85.515	358.892	28.539	88.267
2.195	369.288	24.807	369.052	23.132	85.175
2.4	292.066	113.458	386.182	29.235	86.081
2.529	288.096	125.133	386.738	29.542	88.707
2.689	394.312	218.189	364.088	42.454	91.904
2.802	415.83	228.937	358.96	43.75	91.885
2.992	403.71	66.944	362.284	26.765	87.363
3.203	588.526	-9.363	325.284	26.972	85.717
3.295	692.207	17.94	305.185	33.706	85.111
3.493	702.642	46.252	302.536	37.276	87.039
3.698	702.508	67.93	303.146	38.507	85.826
3.825	623.893	88.304	317.681	36.815	86.743
4.002	517.057	196.045	337.68	43.891	88.422
4.194	557.78	198.399	330.497	45.759	93.58
4.423	639.224	198.994	313.577	50.038	82.582
4.593	618.811	155.493	317.924	43.692	80.786
4.799	722.796	116.388	299.02	45.304	81.994
4.903	732.042	147.934	296.646	49.211	88.079
5.088	730.309	189.054	296.316	53.555	87.708
5.206	725.489	191.673	296.578	53.588	90.882
5.329	724.409	183.143	297.354	52.792	93.614
5.488	291.358	176.627	387.374	34.503	95.351
5.636	286.2	167.421	387.69	34.131	95.699
5.791	136.371	169.067	422.459	34.47	91.826
6.011	96.507	264.546	433.738	43.967	88.117
6.207	74.857	260.499	439.043	43.616	92.115
6.423	47.5	243.225	445.157	42.974	92.94
6.531	34.495	238.528	448.359	42.635	93.307
6.687	24.458	223.453	450.413	41.728	95.722
6.835	20.12	221.313	451.193	41.919	95.678
6.994	23.106	211.521	449.512	41.471	98.158
7.101	-100.707	460.822	491.095	76.395	98.118
7.295	-48.326	450.038	476.663	71.046	94.107
7.494	94.228	480.723	444.034	70.578	92.835
7.634	76.971	479.199	447.7	71.049	98.802
7.793	152.059	232.555	419.529	39.649	95.717
8	272.862	169.198	390.668	34.038	102.199
8.103	180.518	252.034	413.689	42.046	95.185
8.338	240.866	358.099	403.936	55.296	87.409
8.512	213.037	414.631	413.495	61.929	92.494
8.695	169.022	431.764	423.681	63.968	95.115
8.896	357.076	228.558	372.904	41.671	94.844
9	357.076	228.558	373.242	41.542	96.598
9.207	404.285	121.639	362.47	31.569	97.005
9.394	418.218	62.669	359	27.217	89.46
9.493	418.218	62.669	359.071	26.913	86.997
9.703	342.652	104.812	375.047	29.482	87.083
9.827	338.009	105.758	375.542	29.007	88.81
10.002	333.772	117.594	377.424	30.2	89.453
10.198	337.644	94.532	375.596	28.003	88.382

Appendix G



road
flower
cars
water
spirtual
recreational
social
Activity on image
childhood
green
physical attributes
CONNECTIONS
Memory
residential (home)
factory
work (livehood)
mountain
grass
sky
sea
trees
sun
blue
buildings
Parent