

**Faculty of Business, Law &
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Exploring the Biological Foundations of Leadership Perception

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Abstract

Leadership is shaped by an interplay of cognitive, sociocultural, and biological factors. Stress, as a biological response, influences leadership perceptions and behaviours, with cortisol providing an objective marker of stress through its physiological fluctuations. This thesis examines how acute stress, indexed by cortisol reactivity, affects implicit leadership traits (ILTs) and motivation to lead (MTL), thereby integrating biological and psychological perspectives on leadership.

A total of 65 university and health professionals completed a number-tracking task designed to induce acute stress, with salivary cortisol levels measured using competitive ELISA assays across three phases (baseline, pre-task, post-task). Cortisol levels increased significantly from baseline and pre-task to post-task, confirming an effective stress induction, while gender and working experience did not significantly influence cortisol responses.

At the perceptual level, Dedication showed a significant decline under stress, whereas other ILT dimensions (Sensitivity, Intelligence, Dynamism, Tyranny, Masculinity) remained stable. Gender differences emerged only for the ILT traits of Masculinity (both phases) and Tyranny (Phase 1), while age was associated with higher Dynamism; working experience did not significantly affect ILT perceptions.

Motivation to Lead decreased significantly from pre- to post-stress, with no significant moderation by gender or age and only a non-significant trend for greater decline among participants with more than ten years of experience. Moderation and correlational analyses indicated that cortisol reactivity was selectively associated with specific traits, including Sensitivity and Masculinity, and with a small number of item-level demographic interactions.

These results suggest that stress does not disrupt leadership perceptions uniformly but selectively affects relational and motivational qualities, particularly Dedication and motivation to lead. The study contributes to theory by linking stress physiology with leadership schemas and identity, and to practice by emphasising the importance of stress management and resilience training to sustain effective leadership under pressure.

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Chapter 1 Introduction

1.1 Background

Effective Leadership is most visible during periods of uncertainty and pressure. Leadership effectiveness is often tested under such conditions, yet little is known about how acute stress reshapes the way people think about leadership and are motivated to lead. Despite the critical impact of acute stress on cognitive functions and decision-making processes potentially reducing decision quality and increasing self-focus (Aliqkaj & Carvajal 2024; Harms et al. 2016; Marques 2023), and in a multi crisis, decisions need to be fast at the same time it becomes significant to understand what motivates leaders and their motivations and emotions strongly influence the decisions they make (Krauter,2023). Research frequently highlights that periods of crisis and uncertainty are crucial tests for leadership. For example, studies emerging from events like the COVID-19 pandemic emphasize the unique opportunity to study leadership under extreme organisational stressors and how different leadership styles can mitigate negative outcomes for employees (Wittmer's & Maier, 2023; Czura et al., 2025; Njaramba & Olukuru, 2025). The effectiveness of a leader is often magnified in these challenging contexts, where critical tasks like resource allocation under pressure and clear communication are paramount (Schaedler, Graf-Vlachy & König, 2021). While organisations increasingly demand adaptive, resilient leaders (Sott and Bender,2025), research has largely examined leadership cognition and motivation in stable low stress contexts (Njaramba and olukuru,2025).

Academic literature confirms the profound impact of leader behaviour during crises. The effectiveness of crisis-leadership models, encompassing traits like compassion, openness, resilience, and decisiveness, is directly linked to an organisation's ability to handle crises effectively (Balasubramanian & Fernandes, 2022). Leaders constantly make decisions under stress, and the impact of acute stress on decision-making processes is a significant area of study, particularly in top-level management where decisions are often made under pressure (Iodice et al., 2022; Marques, 2023). The role of leadership is critical for organisational survival and effectiveness during such times (Njaramba & Olukuru, 2025).

Despite Extensive Behavioural and Psychological Research, Leadership Under Stress Remains Poorly Understood at the Biological Level. This is a central theme in recent leadership research. There is an increasing call to integrate knowledge from natural, biological, and social sciences to gain a more comprehensive understanding of leadership (Moe et al., 2021). While there is extensive work on the psychological and behavioural aspects, the biological underpinnings particularly concerning stress remain a developing field. The literature has often been fragmented, with limited integration of biological factors into

leadership-stress research (Harms et al., 2016). This growing recognition of leadership as a multi-dimensional phenomenon encompassing psychological, social, and biological factors has shaped the evolution of modern leadership theory.

Leadership is a fundamental and enduring topic that has been studied across various disciplines, including psychology, sociology, organisational behaviour, and more recently, biology. Leadership is the process by which an individual influences a group to achieve a common goal (Northouse, 2019). It encompasses a variety of attributes, including vision, communication, and the ability to motivate and guide others. This influence can manifest in various forms, from direct commands to subtle inspiration, shaping the direction and performance of a group. Effective leadership often involves a combination of personal qualities, learned skills, and situational awareness, which allows leaders to adapt their approaches to different contexts and challenges.

Classical Perspectives on Leadership

Leadership has been recognised as a critical factor in the success and cohesion of groups and organisations, influencing not only the outcomes but also the experiences of individuals within those groups (Bass, 1990). To understand how scholars have arrived at this recognition, it is important to trace the historical development of leadership thought. The significance of leadership can be tracked back to ancient times, when philosophers such as Plato and Confucius reflected on the traits and actions of leaders. However, it was not until the late 19th and early 20th centuries that leadership became the focus of empirical research. Initial studies predominantly centred on identifying inherent traits that distinguish leaders from non-leaders, giving rise to the "Great Man" theory (Carlyle, 1841). Over time, the scope expanded to include behavioural, situational, and contingency theories, reflecting the growing complexity of understanding leadership dynamics (Stogdill, 1948; Fiedler, 1967).

This historical evolution laid the groundwork for more contemporary perspectives, where leadership is examined not only as a trait but also as a set of behaviours and contextual practices.

Contemporary Organisational Perspectives

Building on the recognition of leadership's critical role, modern research has increasingly focused on leadership styles and their direct impact on organisational outcomes

Leadership significantly affects organisational success, with different styles influencing various outcomes in unique ways. Both transformational and transactional leadership styles have been identified as critical for improving organisational performance. Transformational leadership is associated with positive employee outcomes, such as increased motivation, job

satisfaction, and organisational commitment, all of which contribute to an organisation's success (Riyaz, 2024). Transformational leaders often inspire and intellectually stimulate employees to foster innovation and adaptability, which are essential for organisational resilience and continuous improvement (Bai et al.,2025). Research indicates that transformational leadership can help organisations adapt to adversity and enhance organisational resilience through intellectual stimulation, vision motivation and team building (Odeh et al.,2021). Effective leaders also engage in behaviours that foster innovation and embrace change within organisations (Fernandez,2008).

At the same time, scholars stress that leadership ambidexterity which refers to a leader's ability to balance and integrate transformational behaviours (that encourage creativity and change) with transactional behaviours (that ensure stability and performance). This balance enables leaders to foster both innovation and consistency within their organisations. (Baškarada et al.,2017). This interplay, for instance, improves innovation outcomes by fostering both exploration and exploitation (Klonek et al.,2020) and allows leaders to harness opposing capabilities simultaneously, fostering exploratory and exploitative behaviours in teams (Misbahuddin and Maarif,2024). The combination of transformational and transactional leadership can leverage their respective advantages and create synergistic, complementary for better development (Ouyang et al.,2022).

Leaders must assess situational variables, organisational culture, and individual employee needs to determine the most effective leadership approach (Kernic et al.,2023). Moreover, addressing leadership fears and fostering open communication, respect, and psychological safety within an organisation can significantly improve employee commitment and motivation, thereby enhancing organisational success(Paulus,2023).These developments in organisational contexts set the stage for even newer perspectives that extend beyond psychology and management theory into biology and neuroscience.

1.2 Key Concepts in Leadership Studies

Leadership studies have been shaped by several key concepts, each of which contributes to a more nuanced understanding of the phenomenon.

Trait theory

Building on the early "Great Man" perspective, which viewed leadership as an innate quality possessed by extraordinary individuals, early trait theories of leadership focused on identifying specific characteristics such as charisma, intelligence, and decisiveness, which were believed to inherently define effective leaders (Zaccaro, 2007).These studies laid the foundation for modern trait theories by proposing a link between certain stable personality attributes, such

as extraversion and openness, and leadership effectiveness (Judge et al., 2002). While traditional trait theories have focused on static lists of personality characteristics, modern approaches have begun to integrate new perspectives.

Modern trait theories of leadership have evolved significantly by integrating insights from cognitive psychology and cultural studies, thereby providing a more comprehensive understanding of leadership attributes and their contextual interactions. This is a significant shift from purely dispositional explanations to more interactional models that consider how traits operate within social and organisational context.

Recent models emphasise the reciprocal relationship between personality traits and leadership roles, proposing that traits not only influence leadership outcomes but are also shaped by them (Li, Zhang, & Zheng, 2025). Building on this, empirical evidence the role of openness, emotional stability, and agreeableness in enhancing leadership behaviours such as mentoring quality and job satisfaction, particularly across diverse cultural contexts (Kumari et al., 2022). Cross-cultural reviews further reveal that these traits manifest differently depending on organisational and societal norms, underscoring the need to examine trait–leadership interactions within specific contexts . Earlier meta-analytic findings similarly confirm that traits such as conscientiousness and openness are positively associated with leadership emergence, whereas neuroticism demonstrates a negative correlation (Judge et al., 2002).

Cognitive and cultural dimensions

The integration of cognitive psychology into trait theories emphasises the psychological mechanisms underlying leadership attributes. For example, evolutionary leadership theory posits that humans have evolved specialised psychological mechanisms to solve coordination problems, mechanisms that underpin leadership effectiveness (Van Vogt & Ronay, 2013). Such cognitive insights explain how traits such as extraversion and emotional stability aid leaders in navigating complex social challenges within organisations (Liegl & Further, 2023; Zhang, Yin & Li, 2022). Cultural studies also contribute to trait theories by examining how culture affects leadership traits and their efficacy. The integration of trait and cultural psychology has clarified that the cultural context moderates the expression of leadership traits (Rockstuhl et al., 2022). Moreover, cross-cultural reviews have demonstrated that the interplay between individual differences and cultural norms enhances the predictive power of trait approaches (Nwankwo et al. 2024). Together, these developments show how trait theories have expanded beyond simple lists of characteristics into more integrative models.

This integration allows for a more holistic view of leadership, recognising that traits interact with cognition and culture to shape how leaders behave and are perceived across contexts. However, despite these advancements, trait-based theories have been criticised for their

limited attention to situational and developmental factors. Leadership effectiveness depends not only on who leaders are, but also on what they do and how they adapt to their environments. These limitations prompted the emergence of behavioural and contingency theories, which shifted the focus from traits to actions and context.

Behavioural Approaches

The behavioural approach marked a pivotal shift in leadership theory during the mid-twentieth century. Instead of focusing on innate traits, scholars began examining the specific actions and patterns of behaviour that distinguish effective leaders. Early studies at the Ohio State University and the University of Michigan introduced two key behavioural dimensions: consideration (relationship-oriented behaviours) and initiating structure (task-oriented behaviours). These dimensions formed the foundation for subsequent frameworks such as Blake and Mouton's (1964) Managerial Grid, which proposed that effective leadership depends on balancing concern for people and concern for production (Stogdill, 1963; Blake & Mouton, 1964).

Fernandez (2008) demonstrated that task-oriented leadership enhances perceptions of unit performance, reinforcing the importance of development-focused behaviours. These findings inspired more comprehensive frameworks like the Full-Range Leadership Model, which integrates transformational, transactional, and laissez-faire styles for situational adaptability (Anderson & Sun, 2015). Cross-cultural studies further underscore that leadership behaviours are shaped by cultural norms and expectations (Littrell, 2002; Grobler & Koen, 2024). Recognising that no single leadership style fits all circumstances led scholars toward contingency perspectives, which emphasise that leadership effectiveness depends on the alignment between leader behaviour and situational variables. While behavioural models advanced leadership theory by identifying observable patterns of effective behaviour, they also faced important limitations. These models often implied that a single best leadership style could be applied universally, regardless of context. However, real-world leadership effectiveness varies widely across teams, tasks, and environments. This recognition prompted scholars to explore how situational factors interact with leader behaviour, giving rise to the contingency approach.

Contingency Theories

The contingency perspective marked another major evolution in leadership research, emphasising that there is no one best way to lead. Instead, leadership effectiveness depends on the fit between the leader's style and the specific characteristics of the situation (Fiedler, 1978; Kuhn, 2007). This shift introduced a more contextual understanding of leadership,

highlighting that the same behaviours can produce very different outcomes depending on factors such as task structure, follower readiness, and organisational climate.

Among the most influential models is Fiedler's Contingency Model, which proposes that leadership success depends on the match between a leader's motivational orientation, either task-oriented or relationship-oriented, and situational favourableness. Fiedler identified three situational variables that determine this favourableness: leader-member relations, task structure, and position power (Mendieta, 2016). Research has shown that task-oriented leaders perform best in highly favourable or unfavourable situations, while relationship-oriented leaders excel in moderately favourable contexts (Fernandez, 2008; Kernick et al., 2023).

Building on Fiedler's work, subsequent models such as Hersey and Blanchard's Situational Leadership Theory and House's Path-Goal Theory expanded this contextual lens by incorporating follower readiness, motivational needs, and environmental complexity. These developments collectively reinforced the view that leadership effectiveness arises from the interaction between leader behaviour, situational demands, and follower characteristics.

This growing appreciation of context and perception laid the foundation for cognitive and social-constructivist approaches, such as Implicit Leadership Theory (ILT), which explore how followers' mental models shape their understanding of what effective leadership looks like.

While contingency models advanced leadership theory by highlighting the critical role of situational factors, they primarily focused on external conditions that influence leadership effectiveness. However, leadership is not shaped by context alone it is also constructed through the perceptions, expectations, and interpretations of both leaders and followers. This recognition marked a pivotal turn toward cognitive and social-constructivist perspectives, which view leadership as a process of meaning-making rooted in mental representations and shared understanding.

Cognitive and Implicit Leadership Theories (ILTs)

The Implicit Leadership Theory (ILT) represents a major shift in leadership research from external behaviours and situations to internal cognitive processes. Originally developed by Lord, Foti, and De Vader (1984), ILT proposes that individuals hold internalised mental prototypes or schemas of what an effective leader should look like and how they should behave. These schemas influence how followers evaluate, accept, and respond to leaders, shaping leadership perception and legitimacy.

Unlike behavioural or contingency theories, which assume leadership effectiveness can be objectively assessed, ILT recognises that leadership is a socially constructed phenomenon

what makes someone appear “leader-like” depends largely on followers’ implicit beliefs and expectations (Lord et al., 2019). These beliefs are not static but evolve through experience, learning, and socialisation, making ILTs both dynamic and culturally sensitive (Scheens & Riggio, 2023).

Cultural and gender factors further shape these mental prototypes. For instance, collectivist cultures tend to value relational, participative leadership, while individualistic cultures favour autonomy and assertiveness (Weidner, 2012). Moreover, persistent gender biases often align leadership prototypes with masculine traits, influencing how female leaders are perceived (Braun et al., 2018).

The congruence between a leader’s behaviour and followers’ ILTs strongly determines perceived authenticity and effectiveness. When this alignment exists, followers tend to show greater trust, commitment, and satisfaction (Hemert & Vogel, 2023). Conversely, when there is misalignment such as when a leader violates followers’ expectations perceptions of effectiveness decline, even if objective outcomes remain strong.

These insights reframed leadership as a perceptual and relational process rather than a fixed attribute or context-bound behaviour. ILT therefore provides a cognitive bridge linking earlier behavioural and contingency models to modern integrative leadership frameworks that combine individual, contextual, and relational dimensions.

While Implicit Leadership Theory (ILT) advanced understanding by emphasizing the cognitive and perceptual foundations of leadership recognizing that individuals hold cognitive structures or prototypes of leadership categories that guide their perceptions (Epitropaki et al., 2013; Tavares et al., 2018; Lord et al., 2019), it also underscored a key limitation of prior models; their tendency to focus on isolated aspects of leadership in abstraction. Traditional leadership models have often been criticized for their individualistic interpretations of leadership and for failing to adequately consider contextual factors (Osborn, Hunt & Jauch, 2002; Latham, 2014; Fennell, 2021; Higgs, 2022). This reductionist approach limits the generalisability of findings and constrains the ability to fully explain leadership phenomena (Lindenbaum & Zundel, 2013; Higgs, 2022).

Indeed, no single theory fully accounts for the complex interplay between individual characteristics, follower perceptions, contextual demands, and cultural influences (Acton et al., 2018). The dynamic nature of leadership emerging from interactive processes across multiple levels of analysis (individual, relational, and collective) highlights the inadequacy of static or overly simplified models (Lichtenstein & Plowman, 2009; Wang, Zhou & Liu, 2014; Acton et al., 2018).

Consequently, contemporary research has increasingly moved toward integrative frameworks that synthesise these dimensions into more comprehensive and dynamic models of leadership (Dinh et al., 2013; Shaikh, 2018; Esenyel, 2024). These frameworks conceptualise leadership not as a static attribute or discrete event but as a multilevel, evolving process shaped by ongoing interactions between people and their environments (Kuper's & Weible, 2008; Lehtonen & Seeck, 2022; Gardner et al., 2023). Such approaches aim to capture the complexity of leadership as it unfolds over time and across diverse organisational and social contexts (Acton et al., 2018).

The Shift Toward Integrative Leadership Models

Building on trait, behavioural, contingency, and cognitive perspectives, modern leadership research has embraced integrative models that combine multiple theoretical dimensions into context-sensitive frameworks (Latham, 2014; Shaikh, 2018). This shift represents an effort to unify fragmented leadership theories and capture the complex, dynamic, and relational nature of leadership in contemporary organisations.

Integrative approaches merge elements of transformational, servant, authentic, ethical, and spiritual leadership to create values-based frameworks that balance performance, morality, and follower well-being (Latham, 2014; Anderson & Sun, 2015). For example, Latham (2014) argues that the shared emphasis on purpose, meaning, and values across these models provides a foundation for "leading transformation to performance excellence." These integrative models bridge the gap between traditional, performance-oriented leadership and the more humanistic approaches centred on service, ethics, and collective growth.

Leadership is now conceptualised as a dynamic and multilevel process that unfolds across individual, relational, and collective levels of analysis (Acton et al., 2018). Rather than being an individual attribute, leadership emerges through social interactions, collaboration, and shared sense-making among group members. Moreover, experiences of leadership can in turn shape personality and identity, creating a reciprocal relationship between the person and the process (Li et al., 2025).

Contemporary perspectives also emphasise the importance of context, culture, and relational dynamics in determining leadership effectiveness (Kernick et al., 2023). Leadership practices that succeed in one cultural or organisational setting may fail in another, underscoring the need for adaptability and cultural intelligence. Effective global leadership critically depends on cultural adaptability, requiring leaders to adjust their behaviour to specific circumstances and cultural values and expectations (Deal et al., 2004). The adjustment of leadership behaviours in diverse cultural contexts is crucial for leadership effectiveness (Tsai, 2022). While the phenomenon of leadership is considered universal, its operationalisation is often culturally

specific, highlighting varying perspectives on the transferability of leader behaviors across cultures (Ly, 2020). The increasing diversity of the modern workforce in a global environment further complicates the leadership task, necessitating an understanding of different cultures and political policies (Latham, 2014).

Models of shared, distributed, and relational leadership recognise that leadership is co-produced among multiple individuals rather than concentrated in a single figure. The core idea that leadership is a collective and emergent process is widely supported in academic literature. These approaches argue that leadership is diffused throughout the organisation, and no single individual is ideal for all situations (Fennell, 2021). Instead, leadership is seen as a multidisciplinary process that emphasizes co-production by multiple individuals, having an emergent and shared nature (Acton et al., 2018; Yammarino et al., 2012). Shared leadership theories highlight the relational nature of leadership, where both leaders and followers are active participants in a dynamic interaction (Higgs, 2022). Relational leadership specifically challenges traditional leader-centered theories, asserting that leadership is created through social interaction among team members (Engelsberger et al., 2022). Distributed leadership is conceptualized as a social construct emerging from the interaction between members and the organizational context, with leadership dispersed across individuals, organizations, and sectors (Cullingworth et al., 2022). In contexts like coproduction, models of co leadership and collective leadership are seen as better fitting the relational character of leadership, which involves complex interactions among people (Kjellström et al., 2024).

Collectively, these developments signal a paradigm shift from static, leader-centric approaches to holistic, adaptive frameworks that reflect the complexity of 21st-century organisations. By integrating traits, behaviours, cognition, context, and relationships, contemporary leadership theories provide a more realistic and inclusive understanding of how effective leadership emerges and evolves. Now that leadership is understood as a dynamic, multidimensional process influenced by traits, behaviour, context, and cognition, it makes sense to extend this integrative lens to include biological and physiological factors the inner mechanisms that shape how leaders respond to stress, emotion, and decision-making.

As leadership theory has evolved toward more integrative and context-sensitive frameworks, scholars have increasingly recognised the need to incorporate insights from the biological sciences. Leadership does not operate solely at the psychological or social level; it is also grounded in physiological processes that shape how individuals perceive, decide, and behave under varying conditions of stress and uncertainty. This recognition has given rise to the biobehavioural perspective on leadership, which seeks to understand how biological mechanisms such as hormonal regulation, neural activity, and genetic predispositions interact

with cognitive and social factors to influence leadership emergence and effectiveness. These advances mark the next step in leadership research: integrating the biological foundations of behaviour into established socio-cognitive and organisational frameworks.

Overall, the evolution from trait-based to integrative frameworks represents a paradigmatic shift in leadership theory from viewing leadership as something one is to understanding it as something one becomes through interaction, development, and context. These advancements continue to inform both theoretical research and practical leadership development, offering a more holistic view of how leaders emerge, evolve, and succeed across cultures and organisational settings.

1.3 Biological and Evolutionary Perspectives on Leadership

While integrative frameworks emphasise psychological and contextual adaptability, recent research extends this integration into the biological domain. The emerging field of biological and evolutionary leadership studies explores how hormonal, genetic, and neurophysiological processes contribute to leadership behaviour and effectiveness. This approach complements traditional psychological theories by examining how underlying biological systems influence cognitive functioning, emotional regulation, and decision-making in leaders (Arnsten, 2009; Sherman et al., 2012).

Extending beyond stress physiology, evolutionary perspectives suggest that leadership has adaptive value, emerging as a mechanism for group coordination, cooperation, and survival (Van Vugt et al., 2008). These views suggest that biological and evolutionary factors not only underpin leadership tendencies but also interact dynamically with cultural and environmental context reinforcing the need for a biopsychosocial model of leadership. Evolutionary theory positions leadership as an adaptive mechanism for group coordination and survival (Vugt and Ronay, 2015). These biological insights complement psychological models by grounding leadership in the body's stress and reward systems.

Biological and Neuroendocrine Perspectives of leadership

Since the mid-20th century, the study of leadership has grown exponentially through the integration of insights from various disciplines. This expansion is reflected in the dramatic increase in leadership scholarship, ranging from early personnel focused studies to sophisticated multilevel models and meta-analyses (Lord et al., 2017; Ribeiro et al., 2024). The multidisciplinary nature of leadership studies is a defining feature, drawing on psychology, sociology, and organisational sciences (Gutterman, 2023).

The advent of social psychology has introduced key concepts, such as group dynamics and prejudice reduction, which continue to inform leadership theory and practice (Lewin, 1943;

Hogg, 2012). More recent work on social identity approaches has explored how leaders shape group identity and cohesion, while other studies have highlighted cross-cultural and status-related group dynamics that affect leadership processes (Hoog,2012; Higgs,2022).

Lewin's foundational insights into group dynamics and prejudice reduction established a crucial framework for understanding human social behaviour (Lewin, 1943). His emphasis on the dynamic interaction between individuals and their social environments laid the groundwork for later developments in social psychology and leadership theory. Building on this foundation, contemporary research has expanded these ideas through biological and neuroendocrine perspectives, showing that group processes are supported by mechanisms regulating stress, emotion, and social bonding (Hopman and Walker, 2015). For instance, the neuropeptide oxytocin has been shown to promote trust, empathy, and cohesion qualities central to effective group functioning and leadership (Zak, 2009; Zak et al., 2004; Zak and Barraza, 2013). Thus, Lewin's historical theories continue to inform contemporary understandings of how social and biological systems interact, reinforcing the idea that effective leadership involves aligning psychological, social, and biological dimensions of human behaviour to promote group trust, cohesion, and resilience.

Building on these foundations, research in Organisational behaviour highlighted the role of leadership in driving performance and innovation. Advancements in biology and cognitive neuroscience have opened new avenues for understanding the interplay between biological factors, such as hormones, and leadership behaviours (Van Vugt & Ahuja, 2010; Vugt and Rueden,2020). Although leadership research has historically been rooted in psychological and sociological frameworks, recent developments have led to the emergence of biologically informed leadership approaches. These include hormone studies, endocrinological profiling, evolutionary psychology, twin studies, and neuroimaging techniques, which aim to uncover the biological underpinnings of leadership (Moe et al., 2021; Vugt and Sm,2019; Garfield et al.,2019; Yuwei et al,2021).

The interplay between biological factors, particularly hormones, and leadership behaviours has gathered significant attention in recent research. Hormones have long been recognised for their stimulating effects on behaviour, mood, and cognitive function, which in turn can influence leadership styles and effectiveness. (Vugt and Smith 2019; Moe et al. 2021; Goll et al. 2023). For instance, during adolescence, hormonal changes are closely tied to mood swings and behaviours, which can have long-term implications for leadership potential and style (Buchanan, Eccles and Becker, 1992).More recently, Del Río et al. (2024) found that hormonal imbalances in adolescents, such as increased free testosterone and disrupted oestradiol levels, were associated with mood disturbances, including depression, confusion,

and reduced self-esteem, highlighting the long-term implications of hormonal development for leadership potential and style.”

In the context of neuroendocrinology, hormones such as steroids and thyroid hormones play a critical role in behavioural regulation. The interaction between the brain and endocrine system, which hormones mediate, affects various behaviours, including those relevant to leadership (Heck et al.,2018). Specifically, hormones such as oestradiol and progesterone in women have been linked to functional cerebral asymmetries, suggesting that leadership behaviours could vary with hormone levels (Hausmann, 2016).

The interaction between the brain and the endocrine system is a fundamental regulator of social and organisational behaviours (Gore, Krishnan and Reily,2018). Research specify that oestradiol and progesterone are not only critical for reproductive health (Asokan and Falkner,2025) but also act as a potent neuromodulator that influence the motivations and cognitive processes required for status -seeking and decision making in leadership (Knight and Mehta,2014: Khosravi et al.,2023). In women, oestradiol is considered a primary driver of dominance motives and status seeking behaviours, playing a role like testosterone in men (Vongas,Hajjand Fiset,2020) higher levels of oestradiol are associated with an increased desire for social power and the emergence of leadership traits (Arthur and Blake ,2022). While as progesterone and its metabolites influence brain regions involved in reward processing and social cognition, such as prefrontal cortex and hippocampus. Fluctuations in these levels can impact performance in complex decision-making tasks which are central to effective leadership (Khosravi et al.,2023).

The Functional Cerebral Asymmetries refer to the cerebral lateralization, where the left and right hemispheres specialize in different cognitive processes (Hodgetts, Weis and Hausmann, 2017). For example, the left hemisphere is typically more dominant for verbal processing and analytical tasks, while the right hemisphere is often more involved in spatial reasoning and holistic emotional processing(Agcaoglu et al., 2014).

The Progesterone-Mediated Interhemispheric Decoupling hypothesis, primarily developed by Hausmann and colleagues, explains the influence of hormones on interhemispheric communication (Fernández et al., 2003;Hodgetts and Hausmann, 2018).Interhemispheric Decoupling means that High levels of progesterone (and to a lesser extent, oestradiol) are believed to reduce the synaptic efficiency of the bridge between the two hemispheres (the corpus callosum) (Hodgetts and Hausmann, 2018). This leads to a reduction in functional asymmetries, meaning the brain reduces hemispheric specialisation, potentially altering cognitive processing patterns during certain phases of the menstrual cycle (Fernández et al., 2003; Hodgetts and Hausmann, 2018).The shifts in cognitive strategy may happen because

the brain's organisation fluctuates with hormone levels, the cognitive strategies an individual uses also change (Scheuringer and Pletzer, 2017). During phases of high hormones (luteal phase), the reduction in lateralization may shift focus toward different social or verbal strategies and also during low hormone phase, (menstrual phase), women may show higher lateralisation favouring specific analytical or spatial strategies (Leeners et al., 2017). Leadership requires a dynamic mix of these cognitive styles such as analytical strategy (left-hemisphere) and empathetic social perception (right-hemisphere). If hormones modulate how these hemispheres communicate or which one is dominant, an individual's leadership style (e.g., more directive vs. more relational) and their perception of others' leadership may contribute to variability in leadership style and leadership perception (Hodgetts, Weis and Hausmann, 2017). In summary, oestradiol is associated with dominance and status-seeking behaviours in women, suggesting that endocrine states may influence the biological mechanisms underlying social hierarchy navigation (Vongas, Hajj and Fiset, 2020).

While much of the leadership hormone literature has focused on sex hormones such as oestradiol and progesterone, these findings illustrate a broader principle; endocrine states modulate neural systems involved in dominance, social cognition, and decision-making. Cortisol, as a primary stress hormone within the HPA axis, similarly influences prefrontal and limbic functioning under stress. Therefore, examining cortisol reactivity provides a mechanistic pathway through which acute stress may recalibrate leadership perception and motivation.

Extending beyond these specific hormonal effects, research on cognitive function has shown that hormonal fluctuations also shape neuronal networks, which influence cognition, emotions, and stress responses, all of which are crucial in leadership scenarios. These networks influence not only cognitive processes but also emotions and stress responses, which are crucial in leadership scenarios (James et al., 2023).

Research has further analysed the relationship between leadership styles (transactional and transformational) and outcomes such as innovation and organisational culture (Sethi & Steyn, 2017). Transformational leadership, for example, is characterised by interpersonal and visionary behaviours, which may be influenced by the hormonal regulation of mood and behaviour. Overall, understanding the neuroendocrine underpinnings of leadership behaviours provides a comprehensive view of the biological basis of leadership capabilities and adaptability.

As our understanding of leadership evolves, researchers are increasingly exploring the biological and neurological underpinnings of leadership behaviours, seeking to uncover how genetics, brain structure, and hormones may contribute to leadership potential and effectiveness (Edelson et al., 2018; Kernick, Elbe, and Richter, 2023). Integrating these

insights with organisational and psychological perspectives allows for a richer, interdisciplinary approach. The exploration of biological and neurological underpinnings of leadership behaviour is a rising field that integrates insights from various disciplines, including biology, neuroscience, and social sciences. This interdisciplinary approach seeks to explain how genetic factors, brain structures, and hormonal influences contribute to leadership effectiveness.

1.4 Biological Influences on Leadership

The Role of Cortisol in Leadership

Cortisol, is a key stress hormone, regulates both physiological and psychological responses to stress and serves as a reliable biomarker for confirming stress induction (Arnsten, 2009). Emerging research suggests that the relationship between cortisol levels and leadership is complex and multi-faceted. Leaders tend to exhibit lower baseline cortisol levels than non-leaders, a difference attributed in part to the greater psychological control that leaders experience, which acts as a buffer against stress (Sherman et al., 2012). However, this relationship is not explicit and varies depending on the leadership style. To further illustrate that the relationship between leadership and cortisol is not uniform and varies depending on the leadership style, several strands of research provide compelling evidence of this complexity. Studies on various leadership styles demonstrate a nuanced association between leadership behaviours and followers' stress levels, as reflected in physiological indicators such as hair cortisol concentration (Diebig, Bormann and Rowold, 2016). Their findings indicate that the impact of these leadership styles can be "double-edged," either alleviating or exacerbating stress depending on contextual factors such as the degree of role ambiguity created or reduced by the leader's behaviour.

In contrast, Autocratic Leadership has consistently been linked to heightened work stress and time pressure among subordinates (Broker, Walter and Cole, 2020; Aslan, Sönmez and Deniz, 2025). Although not all studies measure cortisol directly, increased psychological stress is a well-established precursor to increased cortisol secretion, implying a physiological cost associated with more controlling and authoritarian leadership styles.

Conversely, Ethical Leadership has been shown to mitigate job stress and enhance employee well-being (Schwenker and Dimitriou, 2021; Saleem, Bashir and Abrar, 2022). Such findings suggest that ethical leadership exerts a buffering effect on stress physiology, potentially fostering more adaptive cortisol profiles. Similarly, Servant Leadership which emphasises care, empowerment, and community has been positively associated with employees' psychological health and adaptive appraisal of stressors (Rivkin, Diestel and Schmidt, 2014;

Arell et al., 2024). This orientation likely contributes to reduced physiological stress responses, including moderated cortisol reactivity.

Finally, research on Ambivalent Leadership underscores the potential for contradictory leader behaviours to elicit physiological strain. When employees perceive their supervisors as simultaneously supportive and undermining, they experience greater distress and work-related stress, alongside a heightened cortisol awakening response and increased daytime cortisol secretion (Herr et al., 2018). These findings highlight how inconsistencies in leadership behaviour can amplify physiological stress, underscoring the dynamic and context-sensitive nature of the leadership–cortisol relationship.

Taken together, these studies reinforce the view that leadership style is a key moderating factor in the interplay between psychological stress and biological regulation, confirming that the effects of leadership on cortisol activity are complex, context-dependent, and far from uniform.

This counterintuitive finding is particularly evident among high-ranking officials such as military officers and government leaders, where a heightened sense of control appears to mitigate stress responses (Sherman et al., 2012). The interaction of cortisol with other hormones, such as testosterone, further influences leadership outcomes. Individuals with high testosterone and low cortisol levels are more likely to attain high-status positions, suggesting that effective stress regulation may enhance leadership potential (Sherman et al., 2015). These findings underscore the nuanced nature of stress responses in leadership, shaped by psychological and hormonal dynamics. This is further supported by the dual-hormone hypothesis, which proposes that cortisol modulates the effects of testosterone on social behaviours, such as risk-taking and leadership (Goll et al., 2023).

The dual-hormone hypothesis provides an important theoretical extension of this argument. This framework proposes that the behavioural effects of testosterone on dominance and status-seeking are contingent upon cortisol levels (Goll et al., 2023). Specifically, increased cortisol attenuates or constrains the dominance-enhancing effects typically associated with testosterone (Ponzi et al., 2016; Goll et al., 2023). Consequently, individuals characterised by a high testosterone and low cortisol profile are more likely to attain and maintain high-status positions (Sherman et al., 2015; Moe et al., 2021). These findings suggest that leadership emergence and maintenance depend not solely on dominance motivation, but critically on effective stress regulation.

Academically, this line of research extends leadership theory beyond trait-based and purely socio-cognitive explanations by highlighting leadership as a biosocial process in which physiological regulation shapes behavioural expression. Internal endocrine states may

influence how individuals perceive, evaluate, and enact leadership roles (Vongas, Hajj and Fiset, 2020). Practically, these findings suggest that stress management is not merely a wellbeing concern but may be central to leadership effectiveness. Chronic cortisol elevation may constrain assertiveness, risk-taking, and decision confidence, thereby limiting leadership performance (Sherman et al., 2015; Vongas, Hajj and Fiset, 2020).

These biological insights also inform the selection of moderators within the present model. Motivation to Lead (MTL) reflects an individual's psychological desire to attain leadership roles; however, this desire may be physiologically constrained under conditions of elevated stress, as heightened cortisol has been associated with reduced self-efficacy and diminished approach motivation. Implicit Leadership Theories (ILTs), representing cognitive prototypes of leadership, may similarly be influenced by endocrine states, such that acute stress alters the evaluative criteria individuals apply when assessing leadership traits. Working experience was included as an index of accumulated organisational exposure, capturing the extent to which individuals have encountered and adapted to professional stressors. Greater tenure may reflect the development of stress-regulation capacities that buffer cortisol reactivity.

The use of acute stress induction within the experimental design provides causal leverage in examining these mechanisms. By temporarily increasing endogenous cortisol levels, the study allows for observation of real-time shifts in leadership perception and motivation. This approach moves beyond correlational associations and enables a more precise examination of how transient biological changes interact with social-cognitive processes. In doing so, the present research contributes to a dynamic understanding of leadership as an interaction between endocrine regulation and social behaviour.

The effects of cortisol are also context dependent. In high-stress environments, such as policing, increased cortisol levels have been linked to improved performance, suggesting an adaptive function in acute stress scenarios (Regehr et al., 2008). Additionally, cortisol responses are influenced by individual differences, such as gender, where men generally exhibit higher cortisol reactivity to psychological stress than women, indicating varied stress perception and coping strategies (Kirschbaum et al., 1992). While basal cortisol levels can vary, research consistently indicates that men generally exhibit greater cortisol reactivity defined as a more pronounced increase from baseline to psychological stress compared to women (Kirschbaum, Wüst and Hellhammer, 1992; Juster et al., 2015).

This difference reflects varied stress perception and coping strategies, shaped by factors such as the type of stressor and, in women, hormonal fluctuations across the menstrual cycle (Hastings et al., 2018; Pruessner, 2018). For example, men often show a 1.5- to 2-fold higher

cortisol response during tasks such as public speaking and mental arithmetic (Kirschbaum, Wust, and Hellhammer, 1992).

In contrast, women's responses fluctuate across menstrual phases, with the luteal phase showing stress reactivity patterns like men, while the follicular phase shows significantly lower reactivity partly due to the moderating influence of oestrogens (Hastings et al., 2018). Although findings on basal cortisol are mixed, some studies report slightly higher resting levels in men, while others find no significant gender (Wang et al., 2024) the consensus is that sex-related differences are more pronounced in reactivity than in baseline secretion. Recent research has provided further insight into these gender differences. Although the relationship is complex and influenced by multiple factors, evidence indicates that men often exhibit a more robust cortisol response than women. For example, Reschke-Hernandez et al. (2016), in a study using both the Trier Social Stress Test and Iowa Singing Social Stress Test, to investigate these gender differences in stress reactivity, studies frequently employ standardized laboratory protocols such as the Trier Social Stress Test and the Iowa Singing Social Stress Test.

Both tests are designed to reliably induce acute psychological stress by eliciting what is known as social-evaluative threat the fear of negative judgment by others and uncontrollability, key components of hypothalamic–pituitary–adrenal axis activation. The TSST typically combines public speaking and mental arithmetic under evaluative scrutiny, while the I-SSST uses unexpected public singing to provoke performance anxiety (Reschke-Hernandez et al., 2016; Labuschagne et al., 2019; Kirschbaum, Pirke & Hellhammer, 1993).

Interestingly, cortisol not only influences individual stress regulation but also has broader organisational implications. Leaders with lower cortisol levels tend to foster healthier, more productive work environments by modelling resilience and emotional stability.

Stress-related hormonal changes also affect mood, cognition, and decision-making. Under high stress, leaders may gravitate toward dominant or authoritarian traits, diverging from their usual leadership style, as suggested by Implicit Leadership Theories (ILTs) (Sharma & Pearsall, 2016). Additionally, stress can reduce self-efficacy and intrinsic Motivation to Lead, impacting leadership emergence and effectiveness, particularly through the lens of motivation to lead (MTL).

The interplay between testosterone and cortisol provides a biological basis for understanding different leadership styles. Testosterone fosters assertiveness and risk tolerance, which are characteristics aligned with authoritarian leadership, found no relation between basal testosterone and leadership positions (Meij et al., 2016). Cortisol, on the other hand, moderates this effect by promoting cautious, cooperative behaviours under stress, potentially

resulting in more transactional leadership styles focused on structure and stability (Goll et al., 2023; Udin, 2024). Specifically, the dual-hormone hypothesis posits that individuals with high testosterone and low cortisol levels are more likely to thrive in leadership roles that require boldness and decisiveness, whereas high cortisol levels can suppress these traits in stressful contexts. This hormonal balance offers insight into why some leaders excel in volatile environments, while others succeed in predictable, routine settings.

Genetic predispositions play a significant role in shaping leadership tendencies. Twin studies have shown that approximately 30% of leadership role occupancy can be attributed to genetic factors, highlighting the influence of inherited traits on leadership potential (Arvey et al., 2006). These findings complement hormonal research by showing that both biological inheritance and environmental influences contribute to leadership development.

From an evolutionary standpoint, leadership is considered an adaptive mechanism that has evolved to solve group coordination problems such as conflict resolution and collective decision-making. Van Vugt et al. (2008) argue that leadership evolved to promote cooperation and consensus in situations requiring rapid action. Hormonal systems, including cortisol and testosterone, are believed to have co-evolved to support these leader-follower dynamics. Humans have also developed cognitive and behavioural adaptations, such as resistance to overly dominant leaders to maintain group balance, which varies across cultures and ecological conditions (Van Vugt & Tybur, 2015).

According to the dual-hormone hypothesis, testosterone is associated with dominance-oriented leadership in competitive settings, while oxytocin facilitates prosocial behaviours and group cohesion in cooperative contexts (Mehta & Josephs, 2010; Zak et al., 2011). Oxytocin is a neuropeptide hormone synthesized in the hypothalamus, widely recognized for its crucial role in modulating social behaviours beyond its initial identified functions in reproduction (Tarsha & Narváez, 2023). Often dubbed the 'love hormone,' oxytocin promotes social bonding, trust, and empathy, thereby facilitating prosocial behaviours such as generosity and cooperation (Jiang & Platt, 2018; Marsh et al., 2020). It also plays a significant role in stress regulation, capable of reducing stress responses and aiding recovery (Love, 2018; Takayanagi & Onaka, 2021).

In group dynamics, oxytocin fosters cohesion and in-group favouritism, although it can also contribute to defensive behaviours towards perceived out-group threats (Dreu, 2011). Thus, in the context of the dual-hormone hypothesis, oxytocin's influence on PR sociality and group affiliation provides a crucial counterbalance or complement to testosterone's effects on dominance and assertiveness, especially in cooperative environments.

These hormonal systems are context-sensitive and dynamic, allowing leaders to modulate their behaviour in response to situational demands. This perspective supports the notion that evolutionary processes have shaped hormonal systems to balance assertiveness and cooperation, traits essential for effective leadership. Thus, evolutionary theory offers a robust framework for integrating biological mechanisms into socio-cognitive leadership models (Van Vugt, Hogan, & Kaiser, 2008).

Integrating Biological and Socio-Cognitive Perspectives

Although this line of research offers valuable insights, it is crucial to avoid reductionist interpretations. Leadership is a complex and multidimensional phenomenon that cannot be fully explained by biological mechanisms alone. Therefore, integrating hormonal research into psychological, cognitive, and social frameworks is essential. Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL) provide key frameworks for understanding how leadership perceptions and motivation emerge. ILTs explain how people cognitively construct leadership schemas, whereas stress biology reveals how physiological states can modify these mental templates. In essence, cognitive models provide a framework for understanding leadership, whereas biological stress responses illustrate how real-world pressures can reshape that framework in action.

Building on this, recent research highlights that stress impacts emotional regulation, decision-making, and social evaluation, all of which are central to leadership behaviour. Cortisol, as the body's primary stress hormone, provides a reliable measure of the stress response (Arnsten, 2009). Shields et al. (2016), through a meta-analysis, found that acute stress impairs executive functions, such as working memory and inhibitory control, both essential for effective leadership. While leadership may act as a buffer against chronic stress by maintaining lower baseline levels, stress physiology can still acutely shape leadership perceptions.

This emphasizes the distinction between chronic (baseline) and acute (reactive) stress responses. It is important to clarify that the statement "leaders often exhibit lower baseline cortisol levels" refers to differences observed in resting or typical, non-stressed physiological states. In this context, baseline cortisol represents the body's standard level of circulating cortisol in the absence of acute stress. Empirical evidence suggests that individuals in leadership roles tend to display lower baseline cortisol compared to non-leaders, a pattern often attributed to the greater sense of control, predictability, and agency that leadership positions confer (Sherman et al., 2012).

However, this does not imply that leaders are immune to stress or that their cortisol levels remain stable across all situations. Cortisol levels naturally fluctuate in response to environmental and psychological demands a process referred to as cortisol reactivity. Even

among leaders, individual differences exist in the magnitude and duration of these stress responses. Thus, while leadership may buffer physiological stress at rest, acute stressors can still elicit measurable increases in cortisol, demonstrating that stress physiology continues to influence leadership behaviour and perception.

Despite these insights, a key gap remains in how stress-induced cortisol changes interact with psychological leadership models, particularly ILTs and MTL. Most studies have examined hormonal or cognitive models in isolation, without exploring their interactions. This study addresses this gap by examining how stress, validated through cortisol as a physiological marker, influences leadership perception and motivation. While cortisol measurement serves primarily to confirm stress induction, the core focus lies in understanding how stress, as a contextual factor, affects leadership dynamics through the lens of ILTs and MTL. It is grounded in two key theoretical frameworks.

Implicit Leadership Theories (ILTs) explain how individuals use cognitive schemas to evaluate and interpret leadership traits. (Rush, Thomas, and Lord 1977; Lord et al. 2019; Hemert and Vogel 2023). Implicit Leadership Theories (ILTs) refer to the cognitive schemas or mental prototypes individuals use to perceive, categorise, and evaluate leaders (Lord et al., 1984; Epitropaki & Martin, 2004; Lord et al., 2019). These schemas are deeply ingrained and largely unconscious representations of what a “typical” or “ideal” leader should be like. They are shaped through accumulated experiences, including cultural norms, early socialisation, prior interactions with leaders, and media portrayals of leadership (Offermann et al., 1994; Shondrick & Lord, 2010).

ILTs serve several psychological and social functions. First, they guide perception and categorisation, enabling individuals to quickly assess whether a person’s behaviours or characteristics align with their prototype of a leader. Second, they create expectations regarding appropriate leadership behaviours, traits, and values, such as intelligence, decisiveness, and empathy (Epitropaki & Martin, 2004). Third, they influence leader–follower dynamics by shaping follower satisfaction, trust, and willingness to comply. When a leader’s behaviour aligns with followers’ ILTs, they are more likely to be perceived as effective and legitimate; conversely, incongruence between actual behaviour and implicit expectations can reduce perceived effectiveness or legitimacy (Lord et al., 1984; Foti et al., 2017).

ILTs also affect performance evaluation, as followers may attribute success or failure based on how well the leader fits their implicit prototype rather than objective outcomes. Empirical research has identified several recurring dimensions of ILTs, including sensitivity (interpersonal awareness and compassion), dedication (task commitment), tyranny (dominance and control), masculinity (assertiveness and decisiveness), intelligence

(knowledge and articulation), and attractiveness (charisma and social appeal) (Epitropaki & Martin, 2004). Collectively, ILTs function as an internalised cognitive framework that both simplifies and biases the perception of leadership in social contexts.

Motivation to Lead (MTL) refers to the psychological processes that determine an individual's inclination to assume leadership roles, exert influence, and commit to leadership responsibilities (Chan & Darsow, 2001). MTL extends beyond the mere desire to hold a leadership position; it captures the underlying motives, attitudes, and expectations that drive individuals to pursue and sustain leadership engagement

Chan and Darsow (2001) conceptualised MTL as a three-faceted construct:

1. **Affective-Identity MTL** reflects an intrinsic motivation to lead, where individuals enjoy leadership, derive satisfaction from influencing others, and view leadership as part of their self-concept.
2. **Social-Normative MTL** reflects an extrinsic sense of duty or obligation to lead, often rooted in internalised social or organisational norms. Individuals with high social-normative MTL feel a moral or collective responsibility to assume leadership when required.
3. **Non-Calculative MTL** reflects the extent to which individuals are willing to lead without weighing personal costs against benefits. Those high in non-calculative MTL accept leadership responsibilities despite potential sacrifices, such as time demands, stress, or limited rewards.

MTL influences both leadership emergence the likelihood that an individual will seek and obtain a leadership position and leadership effectiveness, particularly under challenging conditions (Badura et al., 2020). Individuals with high affective-identity and non-calculative MTL, for example, tend to persist longer in leadership roles and demonstrate greater resilience in the face of stress (Auvinen et al., 2020; Doorn & Raz, 2023). MTL is also sensitive to contextual factors, such as organisational culture, leadership development opportunities, and prior leadership experiences, all which shape how individuals perceive and respond to leadership demands.

1.5 Problem statement

In recent years, there has been growing recognition within leadership research of the need to integrate insights from the natural, biological, and social sciences to develop more comprehensive explanations of leadership phenomena (Moe et al., 2021). This interdisciplinary perspective marks a shift from viewing leadership solely as a psychological

or social construct toward acknowledging the contribution of biological processes such as hormonal activity, genetic predispositions, and neurophysiological mechanisms. Although interest in this domain has expanded, the precise nature of the relationship between leadership and stress particularly among humans remains conceptually and empirically incomplete (Sherman et al., 2012). Comparatively fewer studies have explicitly examined how biological processes contribute to leadership perception, and the existing research remains fragmented across different theoretical and methodological traditions (Harms et al., 2016).

A central focus of this emerging body of work concerns biological stress markers, particularly cortisol, and their links to leadership and stress (Diebig et al., 2016; Marques, 2023; Moe et al., 2021; Shah et al., 2024; Sherman et al., 2012). Cortisol, a primary stress hormone, regulates attention, working memory, and decision-making (James et al., 2023). When cortisol levels rise sharply, these executive functions can be impaired, leading to increased emotional reactivity and cognitive rigidity (Saez-Sanz et al., 2023). Under such conditions, leaders may resort to rigid or dominant behavioural patterns that are not always aligned with effective leadership outcomes. Conversely, individuals in leadership positions often display lower baseline cortisol levels, suggesting that leadership itself can serve as a stress buffer (Gobel et al., 2025; Moe et al., 2021). Still, chronic cortisol dysregulation undermines attentional control and flexibility capacities essential for effective leadership (Saez-Sanz et al., 2023). Individual differences such as gender, work experience, and perceived control further moderate these stress responses, with experienced leaders exhibiting greater hormonal stability and resilience (Sapolsky, 2012).

Alongside these physiological findings, socio-cognitive frameworks provide valuable insight into how leadership is perceived and enacted. Implicit Leadership Theories (ILTs) explain how individuals draw upon internalised schemas or prototypes when judging leadership traits, especially under stress when cognitive resources are strained (Hemert & Vogel, 2023). For instance, in crisis contexts, directive or authoritarian traits may be judged as decisive, whereas in calmer environments these same traits may be perceived negatively (Wittmer's & Maier, 2023). Similarly, Motivation to Lead (MTL) theory explores how stress influences an individual's willingness to assume leadership roles. Factors such as self-efficacy, emotional regulation, and tolerance for ambiguity determine whether stress enhances or diminishes motivation to lead (Doorn & Raz, 2023).

Despite these advances, research in this area remains fragmented, with biological and socio-cognitive perspectives often examined in isolation. The interaction between physiological stress mechanisms, leadership perception, and motivation to lead has not been adequately explored. This study addresses this gap by integrating physiological stress markers

specifically cortisol with socio-cognitive frameworks, namely ILTs and MTL, to examine how stress shapes both leadership perception and motivation (Wittmer's & Maier, 2023; Moe et al., 2021).

In summary, this research develops a biopsychosocial model of leadership under stress, linking cortisol-based stress responses with ILTs and MTL to unify the physiological, cognitive, and motivational dimensions of leadership. This model seeks to bridge the disciplinary divide between biological and socio-cognitive research, offering a more integrative and empirically grounded understanding of leadership behaviour in stressful contexts.

Understanding how physiological stress (indexed by cortisol) shapes leadership perception and motivation is critical for high-stakes contexts where leaders operate under pressure, for example, clinical teams during surge events, incident command in emergency services, and corporate response cells managing cyber or supply-chain crises (Marques, 2023). If acute stress reliably shifts followers' preferred leadership traits (e.g., toward more directive or authoritarian profiles) and dampens some leaders' motivation to step forward, organisations can design evidence-based selection, training, and recovery protocols (e.g., stress inoculation, role rotation, and decision support) that protect decision quality and team wellbeing when it matters most (Harms et al., 2016). Research on the dual-hormone hypothesis further illustrates how cortisol modulates dominant behaviours and influences leadership potential, particularly showing that low cortisol facilitates the positive prediction of status by testosterone (Moe et al., 2021; Sherman et al., 2015).

1.6 Aim

Building on this justification, this study aimed to investigate how psychological stress, validated through cortisol levels, influences perceptions of leadership traits and motivation to lead. Drawing on Implicit Leadership Theories and Motivation to Lead (Auvinen et al., 2020; Doorn & Raz, 2023), this study examined how stress affected both how individuals perceived others as leaders and how they viewed themselves in leadership roles. Badura et al. (2018) also explored how individual differences such as gender and leadership experience moderated these effects.

Objectives

1. To integrate psychobiological and social-cognitive approaches by examining whether stress (measured through cortisol) influences leadership evaluation and motivation, drawing on ILTs and MTL frameworks.

2. To design and conduct a mixed-methods study that combines hormonal stress markers with psychometric assessments to capture both biological and perceptual dimensions of leadership judgments.
3. To assess whether stress (measured via cortisol) affects perceptions of six core ILT leadership traits: sensitivity, intelligence, dedication, dynamism, masculinity, and tyranny.
4. To evaluate whether increased cortisol levels impacted affective-identity Motivation to Lead (MTL).
5. To examine whether individual differences, such as gender and work experience, moderated the relationships between cortisol levels and (a) leadership trait perceptions and (b) affective identity motivation to lead.

Research Questions

1. How does stress measured by cortisol influence the perceptions of six ILT leadership traits (sensitivity, intelligence, dedication, dynamism, masculinity, and tyranny)?
2. How does physiological stress, as measured by cortisol levels, impact affective-identity motivation to lead?
3. Do gender and professional leadership experience moderate the relationship between cortisol levels and (a) ILT leadership trait perceptions and (b) affective identity motivation to lead?

The overarching aim of this study is to investigate how psychological stress, validated through cortisol levels, influences leadership perception and motivation to lead through the frameworks of Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL). Each research objective (RO) is operationalised through a corresponding research question (RQ) and related hypothesis (H1a–H3b).

Linking the aim, objectives, questions, and hypotheses. Each hypothesis directly tests its corresponding research objective and answers the associated research question. This ensures conceptual coherence and methodological alignment from the study's overarching aim (stress–leadership effects) to its testable predictions (H1a–H3b). Table 1.1 illustrates this alignment, showing how each hypothesis operationalises its objective and collectively addresses the central aim of the study.

Aim	Research Objectives (RO)	Research Questions (RQ)	Linked Hypotheses (H1a–H3b)
<p>To investigate how stress, validated through cortisol levels, influences leadership perception and motivation to lead (MTL) through the lens of Implicit Leadership Theories (ILTs).</p>	<p>RO 1: Examine how stress conditions influence perceptions of leadership traits (Sensitivity, Intelligence, Dedication, Dynamism, Masculinity, Tyranny).</p>	<p>RQ 1: How do stress measured by cortisol influence perceptions of specific ILT leadership traits?</p>	<p>H1a–H1d</p> <ul style="list-style-type: none"> • H1a Increased cortisol levels reduce the preference for all the ILT trait of Sensitivity. • H1b Increased cortisol levels reduce the preference for the ILT trait of Intelligence. • H1c increased cortisol reduces preference for motivational traits (Dedication, Dynamism). • H1d increased cortisol increases preference for dominant traits (Masculinity, Tyranny).
	<p>RO 2: Evaluate the relationship between stress and the affective-identity dimension of MTL.</p>	<p>RQ 2: How do increased cortisol levels affect affective-identity</p>	<p>H2 increased cortisol reduces affective-identity motivation to lead.</p>

		motivation to lead under stress?	
	RO 3: Assess the moderating effects of individual differences (gender, professional experience) on the relationship between cortisol and leadership perception.	RQ 3: Do gender and work experience moderate the relationship between cortisol levels and (a) ILT leadership-trait perceptions and (b) affective-identity MTL?	H3a Gender moderates the relationship between cortisol and leadership traits and MTL H3b Work experience moderates the relationship between cortisol and leadership traits and MTL.

Table 1.1. Alignment of Aim, Research Objectives, Research Questions, and Hypotheses.

1.7 Hypotheses Development

H1: increased Cortisol levels reduce preference for all ILT Leadership Trait Perceptions

H1a: Increased cortisol levels reduce the preference for all the ILT trait of sensitivity. Sensitivity reflects relational leadership. Stress impairs emotional and social processing, leading individuals to deprioritise their relational qualities. Research indicates that acute psychological stress might impair empathic processes to observed pain in another person (Buruck et al,2014). Moreover, acute stress, reorganises functional network dynamics in the brain, influencing social decision (Tomova et al 2019). Increased cortisol levels have been linked to diminished altruistic behaviour, suggesting a negative impact on prosociality (Schulreich et al., 2022). Additionally, acute stress has been shown to selectively impair frontal function, which underlies affective processing (Andersen et al., 2018), and is associated with diminished cognitive control and flexibility, and reduced regulation of negative emotion (Brown et al., 2017). These findings collectively suggest that during high-pressure conditions, the emotional and social processing necessary for valuing sensitivity in leaders may be compromised, potentially leading individuals to perceive relational traits as less functional in situations that demand quick or authoritative responses.

H1b: Increased cortisol levels reduce the preference for the ILT trait of intelligence. Intelligence reflects cognitive leadership capacity. Under stress, cognitive load and decision fatigue may cause individuals to devalue intellectually focused traits. Stress impairs executive functioning and attentional control, reducing the application of cognitive resources necessary for problem-solving and complex decision-making (Blair,2016). Such impairments may lead individuals to rely less on intelligence as a valuable leadership trait in high-pressure situations. Research consistently shows that stress affects prefrontal cortices which are crucial for executive control functions like learning, memory, problem -solving and adaptive behaviour (Girotti et al.,2017; Tsai et al.,2018)

H1c: Increased cortisol levels reduce the preference for ILT traits of dedication and dynamism. These traits reflect the motivational and energetic qualities of leadership. Stress can diminish the perceived value of highly energetic or emotionally committed leaders as such traits may be considered excessive or unstable in high-pressure contexts (Klebe et al.,2022). Dedication and dynamism represent the motivational and energetic qualities of leadership. The meta-analysis by (Shields et al. 2016) explicitly found that acute stress impairs executive control, specifically working memory and cognitive flexibility and Impairment of self-regulation and emotional control under stress is supported by other research saying that the depletion of limited mental energy resources by psychosocial stressors can impair self-regulation and self-control, leading to poor emotional control (Baumeister et al.,2018; Han et al.,2023)

Furthermore, interventions that have successfully reduced cortisol levels through mindfulness or relaxation have shown improvements in vitality and emotional resilience (Rogerson et al., 2023). Together, these findings suggest that in high-pressure contexts, leaders perceived as highly dedicated or dynamic may be devalued, as such traits may be seen as unstable or unsustainable under stress.

H1d: Increased cortisol levels increase preference for the ILT traits of Masculinity and Tyranny. Under stress, and uncertainty individuals may gravitate toward dominant and authoritative leadership traits, perceiving them as effective for control and decisiveness during crises (Kakkar and sivanathan,2017; Olsen et al.,2020). Masculinity and tyranny represent dominant and authoritative leadership traits that are often associated with control, strength, and decisiveness. Under high-stress conditions, individuals may rely more heavily on implicit leadership schemas that prioritise order, power, and assertiveness. Research suggest that in urgent or crisis situations, autocratic or directive leadership styles are perceived as more competent and capable ,reducing ambiguity and fostering a sense of control among followers(Oslen et al 2020; Rosing et al., 2022).Although the dual-hormone hypothesis posits that dominance behaviours are most strongly predicted by high testosterone in combination

with low cortisol (Mehta and Josephs, 2010), the context of acute stress appears to shift preferences towards leaders who embody these dominant traits, as they are seen as more effective in managing chaotic environments (Chen et al., 2022). This line of inquiry addresses a gap in the literature by examining whether acute stress, operationalised through increased cortisol levels can shift preferences towards dominant leadership styles in crisis like decision making context.

H2: Cortisol and Motivation to Lead

H2: Increased cortisol levels reduce affective identity motivation to lead. Affective-identity MTL reflects an internalised desire to lead. Increased cortisol has been demonstrated to reduce self-efficacy and leadership motivation by triggering withdrawal or avoidance tendencies (Dickerson & Kemeny, 2004).

H3a: Gender moderates the effect of cortisol on (a) ILT trait perceptions and (b) affective identity motivation to lead.

Men and women may differ in stress reactivity and social cognition under pressure, which can shape how leadership traits are evaluated and how leadership motivation is experienced (Lighthall et al., 2009).

H3b: Work experience moderates the effect of cortisol on (a) ILT trait perceptions and (b) affective identity motivation to lead.

Individuals with more working experience may demonstrate greater emotional regulation and resilience under stress, which can buffer the impact of cortisol on leadership evaluation. Prior research suggests that individuals with greater work experience tend to develop stronger emotional regulation and stress management capacities, which can mitigate physiological stress responses (Torrence & Connelly, 2019; Provorova et al., 2021; Lengua et al., 2024). Work experience has been associated with lower baseline cortisol levels and enhanced perceptions of control, reflecting a stress-buffering effect (Sherman et al., 2012). Given that cortisol influences emotional regulation and cognitive evaluations under stress experienced individuals may be better equipped to maintain composure and objectivity when assessing leadership traits or considering leadership roles. Therefore, work experience is expected to moderate the relationship between cortisol and both implicit leadership trait perceptions and affective-identity motivation to lead (Kravets et al., 2021).

1.8 Theoretical Framework and Model Justification

This study adopts a biopsychosocial framework that integrates biological, cognitive, and motivational mechanisms to explain leadership processes under stress. The model positions

cortisol as a biological stress marker influencing both cognitive evaluations (Implicit Leadership Theories; ILTs) and motivational drives (Motivation to Lead; MTL).

Cortisol captures the physiological underpinnings of stress that affect leadership cognition and motivation. These cognitive impairments directly affect how individuals perform and are perceived in leadership roles. (Arnsten and shanafelt, 2021; Rashid,2024; Sherman et al., 2012). ILTs represent the cognitive schemas through which individuals interpret leadership traits, which may become more rigid under stress. While Implicit Leadership Theories represent the cognitive schemas through which individuals interpret leadership traits (Lord et al., 2019), a substantial body of literature demonstrates that stress significantly impacts cognitive functions, suggesting that these schemas may become more rigid under pressure. This phenomenon can be understood through several interconnected cognitive processes:

Acute stress is consistently linked to impaired cognitive control and flexibility. Research indicates that acute stress influences cognitive flexibility (Knauff et al., 2021) and this impairment can be mediated by sympathetic arousal, further contributing to cognitive inflexibility under pressure (Marko & Riečanský, 2018). Moreover, acute cortisol administration has been shown to impair core executive functions such as working memory and set shifting (Shields et al., 2015). This can lead to an increased tendency to make perseverative errors repeatedly applying strategies that are no longer effective which is a key indicator of reduced cognitive flexibility (Knauff et al., 2021).

Under stress, cognitive processing tends to shift towards intuitive and heuristic thinking, moving away from deliberative, analytic reasoning. Exogenous cortisol, for instance, has been shown to cause a shift from deliberative to intuitive thinking, biasing responses toward intuitive, but incorrect, answers (Margittai et al., 2015). This effect is further supported by models proposing that stress potentiates decision biases by inducing a switch from an analytic reasoning system to intuitive processes (Yu, 2016). This means individuals are more likely to rely on ingrained mental shortcuts and pre-existing patterns, or schemas, rather than engaging in flexible, effortful processing. Such a shift can bias judgments and lead to less optimal decision-making, exacerbating risk-taking and impacting decision quality (Harms et al., 2016; Phillips-Wren & Adya, 2020).

Stress can also interfere with schema processing and the utilization of prior knowledge. Studies suggest that under demanding and stressful conditions, prior knowledge might be "eschewed" or utilized less effectively, potentially leading to a more fixed application of existing schemas rather than flexible adaptation (Trapp & Vilares, 2020). For example, acute stress has been shown to lead to aberrant hippocampal involvement when processing schema-

related information, interfering with the efficient use of prior knowledge during encoding (Vogel et al., 2017).

The impact on decision-making in leadership contexts is particularly significant. For leaders, stress impedes the ability to dedicate significant cognitive resources to problem-solving, complex decision-making, and considering alternative solutions (Harms et al., 2016). This can result in suboptimal decisions and a reduced capacity for complex cognitive functioning (Harms et al., 2016; Phillips-Wren & Adya, 2020). This reduced capacity for flexible thought, stemming from the cognitive effects of stress, can then manifest as rigidity in how leaders perceive and interpret leadership traits through their ILTs.

MTL, particularly its affective-identity component, captures how stress and self-regulation shape the desire to assume leadership roles (Chan & Darsow, 2001). The study carried out by Harms et al., 2016, acknowledges that intuitive link between leadership and stress, noting that leaders face considerable stress and that stress can impact leadership.

Finally, gender and leadership experience moderate these processes by shaping both physiological reactivity and emotional regulation capacities. This is supported by previous discussions highlighted research by (Smeets et al., 2009) on gender differences in cortisol responses and empathic accuracy under stress, and (Nater et al., 2024) on how leader role framing differentially impacts women's physiological stress responses. Further studies also show gender differences in the physiological effects of emotional regulation (Mink et al., 2022) and how emotion regulation moderates' mental distress with gender differences (Haver et al., 2021). Leadership experience moderation is supported by (Sherman et al., 2012) found that leadership experience is associated with lower cortisol levels and enhanced perceptions of control, acting as a stress buffer. Together, these elements form an integrative framework linking stress physiology to leadership cognition and motivation.

1.8.1 Integration into the Conceptual Model

The proposed framework integrates biological, cognitive, and motivational mechanisms to explain leadership under stress. Cortisol serves as a physiological marker that influences cognitive schemas (ILTs) and motivational drives (MTL). Gender and work experience act as moderators that shape the strength and direction of these relationships. This biopsychosocial integration provides a novel contribution to leadership theory by bridging the previously disconnected domains of biological stress research and socio-cognitive leadership models.

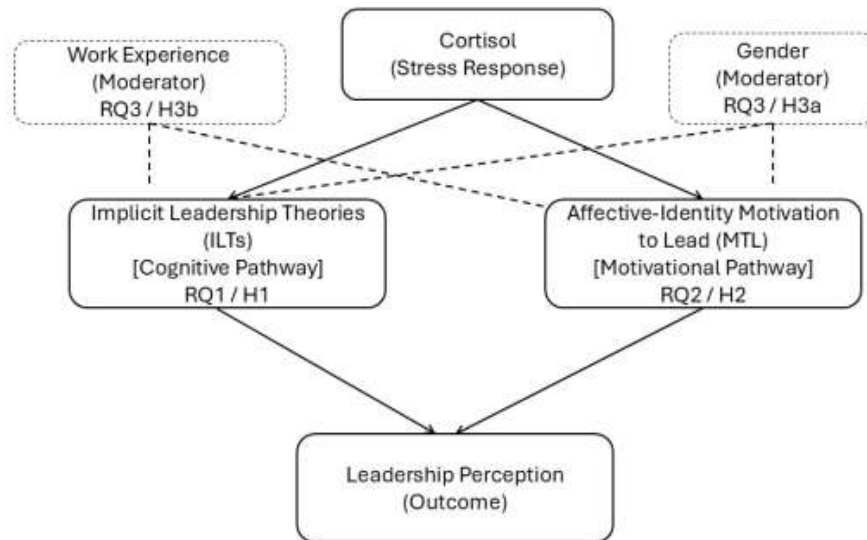


Figure 1. Conceptual model of the study.

The model illustrates the biopsychosocial framework linking cortisol (stress response) with leadership perception through two distinct pathways: the cognitive pathway (Implicit Leadership Theories; ILTs) and motivational pathway (Affective-Identity Motivation to Lead; MTL). Gender and work experience acted as moderators, influencing the strength of these relationships.

Summary

In summary, Chapter 1 established the conceptual foundations and theoretical rationale for this study, identifying a persistent gap in leadership research the limited integration of biological mechanisms particularly stress physiology with socio-cognitive frameworks such as Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL). By introducing a biopsychosocial model that connects cortisol-based stress responses with leadership perception and motivation, the chapter positioned this study within an emerging interdisciplinary agenda that unites biological, psychological, and social perspectives on leadership. The following chapter builds on this foundation by critically reviewing the relevant literature, examining prior empirical findings on ILTs, MTL, and stress physiology, and outlining how these inform the development of the present study's hypotheses and methodological design.

This study responds to a key gap in the leadership literature by integrating physiological stress responses with established cognitive–motivational leadership models. While prior research has treated Implicit Leadership Theories (ILT) and Motivation to Lead (MTL) separately, this study unites them within a stress framework to examine how acute cortisol elevation affects

leadership prototypes and motivation. This integration advances both theory and practice by linking biological and psychological processes in leadership perception and self-regulation setting the stage for the literature review in Chapter 2

Chapter 2 Literature review

2.1 Statement of Purpose and Scope of Review

This literature review aims to explore and critically assess the interdisciplinary relationship between biological stress regulation, particularly cortisol levels, and leadership perception and motivation to lead. Traditionally, leadership research has been rooted in psychological, behavioural, and socio-cognitive paradigms. However, recent advancements in neuroendocrinology and behavioural genetics provide novel insights into how stress-related hormonal mechanisms may influence leadership cognition, emergence, and development (Stalder et al., 2024; Tronstad Moe, Strand, and Norcom, 2021).

This review focuses on the interaction between cortisol, a key hormone of the hypothalamic-pituitary-adrenal (HPA) axis, and two socio-cognitive constructs that are central to leadership research: Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL). It draws on insights from leadership studies, psych neuroendocrinology, organizational psychology, and behavioural neuroscience to explore how biological and psychological mechanisms shape leadership behaviour in stress-inducing contexts (Hosmer and Vogel, 2023).

This review includes both foundational and emerging literature addressing genetic predispositions, epigenetic plasticity, stress physiology, and socio-cognitive processes. Broader contextual influences such as cultural norms, gender, and organizational settings have also been examined as potential moderators of the relationship between cortisol regulation and leadership outcomes (Sherman et al., 2012). Attention is given to methodological limitations in the current body of research, particularly the overreliance on static cortisol measurements, lack of causal research designs, and underrepresentation of diverse demographic samples in leadership and stress studies (Stalder et al., 2024).

This review aimed to identify theoretical and empirical gaps and propose a biologically informed conceptual framework to better understand how cortisol influences leadership perception and motivational readiness in high-stress environments. This integrative approach sets the foundation for the empirical investigation presented in subsequent chapters and highlights the importance of bridging biological and psychological paradigms in leadership research.

2.2 Nature of Leadership

Leadership is widely regarded as a dynamic process of social influence, whereby an individual guides and motivates others to achieve collective goals (Yukl & Gardner, 2020; Northouse, 2021). This understanding has evolved from earlier conceptions of leadership as a function of

innate traits, natural abilities, or predispositions such as intelligence, confidence, charisma, or decisiveness that early theories, particularly trait theory, identified as essential to leadership success (Zaccaro, 2007; Northouse, 2021). Leadership was also traditionally linked to formal authority, meaning influence derived from an individual's official position or title within an organisation, rather than from personal qualities or relationships (Mintzberg, 1973; Yukl and Gardner, 2020).

Contingency and situational theories have led to a paradigm shift. These models emphasise that leadership effectiveness depends on the interaction between a leader's style and a specific situational context (Jerab, 2023). This shift introduced a more flexible, adaptive view of leadership, recognising that no single style is universally effective. Fiedler's Contingency Theory (1967) is one of the most influential models in this domain. It posits that the effectiveness of a leader hinges on the match between their leadership style, task- or relationship-oriented, and key situational variables: leader-member relations, task structure, and position power. Task-oriented leaders tend to perform best in highly favourable or unfavourable situations, whereas relationship-oriented leaders excel in moderately favourable contexts (Weidner, 2012). This model underscores the importance of diagnosing contextual conditions before determining the most suitable leadership approach. Contemporary research continues to support this view, emphasising that effective leadership is inherently contextual and nonprescriptive (Coleman et al., 2024). Similarly, situational leadership theories argue that behaviour is shaped not only by individual traits but also by situational demands, further challenging universalist notions of leadership (Kernick et al., 2023).

The situational approach emphasises that effective leaders must alter their leadership style based on the prevailing circumstances. Research indicates that task-oriented autocratic styles, relationship-oriented democratic styles, or a combination of both, are differentially effective depending on the specific context (Rosing et al., 2022). This framework suggests that leaders must possess a repertoire of behaviours and diagnostic skills to discern which behaviours are most appropriate for a given situation (Sudaryanto and Lestari, 2020).

Studies have also demonstrated that adapting leadership styles to the developmental levels of followers yields superior outcomes, suggesting that leaders should adjust their approaches based on the competence and commitment of their team members. The size of the organisation, the social and psychological climate, and working conditions are significant situational factors influencing leadership dynamics (Kernick, Elbe, and Richter, 2023). For instance, a leader might adopt a more directive style when guiding inexperienced team members through a novel task, gradually transitioning to a more supportive or delegative approach as their proficiency increases (Morton et al., 2018). Hersey and Blanchard's

situational model introduced four distinct leadership styles, advocating flexibility based on follower readiness (Rodic and Maric,2021). This flexibility allows leaders to optimise team performance by aligning their approach with the unique characteristics and needs of their subordinates and the organisational environment.

Moreover, transformational leadership, refined by Bass and Avolio (1994), extends situational adaptability by incorporating factors such as charisma, inspirational motivation, intellectual stimulation, and individualised consideration. Transformational leadership is effective in dynamic environments requiring innovation and change, as it promotes commitment, trust, and performance by aligning followers' goals with organisational values (Dong, 2023).

Modern leadership theories emphasise relational, adaptive, and socially constructed dimensions. Relational leadership is built through ongoing interactions between leaders and followers (Uhl-Bien, 2006). Adaptive leadership refers to the capacity to respond to dynamic, complex challenges with flexibility and resilience (Heifetz, Glashow, and Linsky, 2009). Socially constructed leadership is shaped by shared beliefs, norms, and expectations within specific cultural and organisational contexts (Haslam, Reicher, and Plato, 2020). Consequently, leadership is increasingly viewed as a collaborative and participatory process in which influence arises through a shared purpose rather than positional authority (Liden et al.,2024).

The emergence of distributed and shared leadership models further challenges top-down leadership paradigms. These perspectives recognise leadership as a collective process distributed across multiple actors, often depending on the task, group dynamics, and situational demands (Bolden, 2011). Other research also highlights distributed leadership as a shared collective practice that improves corporate change capacity (Barattucci et al.,2020). This evolving understanding reflects broader shifts in organisational practice towards agility, multiculturalism, and hybrid work environments, highlighting leadership as both culturally situated and context sensitive. In addition to social and psychological dimensions, researchers have explored the biological factors that influence leadership. These include hormonal, neurological, and evolutionary mechanisms (Nofal et al.,2017). Evolutionary perspectives suggest that leadership behaviours may possess adaptive value shaped by ancestral environments. The study discusses how evolutionary thinking influences cognitive neuroscientists in studying the neural underpinnings of leadership and followership (Vugt and Rueden,2020). It also refers to the "Evolutionary leadership theory" that analyses leadership from evolutionary perspective, focusing on psychological mechanisms evolved for survival and reproduction (Kenney,2012). Thus, effective leadership is multifaceted, combining relational,

adaptive, and evolutionary elements. As organisations evolve, leadership paradigms must keep pace with shifting expectations and research advancements.

The next section explores how leadership is influenced by evolutionary, socio-cognitive, and biological factors, including hormonal mechanisms such as cortisol and testosterone, which play a role in stress regulation, dominance, and social perception.

2.3 Evolutionary Approach to Leadership

From an evolutionary standpoint, leadership is seen as an adaptive solution to collective problems, such as group coordination, conflict resolution, and resource distribution. Van Vugt, Hogan, and Kaiser (2008) argue that leadership emerged in ancestral environments to improve survival and reproductive success by facilitating group cohesion and efficient decision-making. Similarly, King, Johnson, and Van Vogt (2009) identified five key transitions in the evolution of leadership, from rudimentary coordination in prehuman species to cognitively sophisticated, formal leadership structures in complex societies. These transitions reflect changes in group size, environmental demands, and social complexity, necessitating different leadership traits and mechanisms at each stage.

Within this framework, certain traits, such as dominance, extraversion, intelligence, and physical health, are hypothesised to have conferred fitness advantages, making individuals more likely to emerge as leaders (Zaccaro, 2007; Van Vogt and von Rueden, 2020). These traits are not solely psychological; rather, they are closely linked to biological systems, particularly endocrine responses. For instance, the dual-hormone hypothesis proposes that high testosterone supports dominant or assertive leadership behaviours, but primarily when cortisol (a stress biomarker) is low (Mehta and Josephs, 2010; Mehta and Prasad, 2015). Recent evidence by Goll et al. (2023) supports this hypothesis in naturalistic settings, showing that the interaction between testosterone and cortisol predicts leadership behaviour even in social animal groups. This hormonal interplay influences not only who becomes a leader but also how leaders behave under pressure, highlighting the deep interconnection between evolution, biology, and modern leadership processes.

Given these biological foundations, it is important to reflect on how such evolved traits function in the present day. Although this integrated model advances our understanding of leadership dynamics, it is essential to critically assess the limitations of applying evolutionary assumptions to modern contexts. One key concern is the evolutionary mismatch hypothesis, which suggests that traits that are adaptive in ancestral environments, such as physical dominance, aggression, or threat sensitivity, may be less functional or even counterproductive in today's leadership settings (Van Vogt and von Rueden, 2020). Modern organisations often

value leaders who demonstrate emotional intelligence, collaboration, and ethical decision-making qualities that may not have been favoured by ancestral selection pressures.

This mismatch shows the need to reconsider how evolved human traits function in today's multicultural and digitally connected world. This supports the importance of examining how cortisol, a stress biomarker, may influence modern leadership expectations. These may include individuals' internalised leadership prototypes, confidence in leading, or willingness to take on leadership roles in high-pressure environments. Bringing together biological, cognitive, and cultural perspectives is essential for developing a well-rounded understanding of effective leadership in the 21st century.

In addition to physiological responses, evolved perceptual cues such as voice and facial structure continue to influence leadership judgments. Kolstad, Anderson and Peters (2016) argue that voice pitching significantly influences perceptions of leadership, with lower-pitched voices being unconsciously associated with authority and competence. Similarly, Stoker, Gessner, and Ferris (2016) demonstrated that facial appearance, including symmetry and dominant facial features, can shape how individuals are perceived as leaders. Other studies also show facial features, including perceived height and dominance predict perceived leadership (Alrahjih and ward.,2013; Re et al.,2013) These traits, which may have conferred survival advantages in ancestral environments, continue to inform Implicit Leadership Theories (ILTs) in modern contexts. However, reliance on such evolutionary heuristics can perpetuate biases in leadership selection, particularly for disadvantaging women and minority candidates whose attributes may not align with these historically embedded cues (Egaly and Karau, 2002).

Although evolutionary leadership theory offers a compelling explanation for the origins of leadership traits, it has been criticised for the risk of biological determinism. Researchers argue that it may downplay the role of sociocultural and institutional factors in shaping leadership emergence (Avolio, 2007; Alvesson & Spicer, 2012). Leadership behaviours are not only shaped by evolved predispositions but also by social norms, organisational roles, and historical conditions that influence who emerges as a leader and under what circumstances. This multifaceted perspective highlights that leadership is not merely an innate trait, but a dynamic process influenced by complex interactions among leaders, followers, and their specific environments (Acton et al.,2018).

Moreover, the empirical basis of evolutionary leadership research remains limited. Much of the evidence is drawn from Western, Educated, Industrialised, Rich, Democratic (WEIRD) populations or simplified laboratory tasks, which raises concerns about the general applicability of findings to complex, real-world leadership contexts. These limitations suggest

the need for more diverse and ecologically valid research to understand how evolutionary, biological, and cultural variables interact with each other. This critique aligns with broader concerns in the field, emphasising the importance of avoiding overgeneralisation based on culturally narrow datasets (Van Vugt and Rueden, 2020). Additionally, as highlighted earlier, traits once adaptive, such as physical dominance or aggression, may no longer align with contemporary leadership expectations, particularly in inclusive, multicultural, and collaborative environments.

Combining evolutionary and biological perspectives offers an integrated approach that highlights the dynamic interplay between natural selection, hormonal mechanisms, and sociocultural influences. While evolutionary pressures may have laid the foundational architecture for leadership behaviour, cultural evolution continues to shape and refine leadership in response to the demands of contemporary society. As discussed, modern leadership often rewards emotional intelligence, ethical reasoning, and collaborative capacity, traits not necessarily selected for in ancestral environments. This integrated framework not only helps explain the origin of leadership traits but also provides valuable insights for leadership development and inclusive selection practices in modern organisational settings.

Building on evolutionary leadership theory, contemporary research has explored the biological mechanisms that underpin leadership emergence and perception. A key area involves hormonal interactions, particularly the dual-hormone hypothesis, which posits that testosterone promotes dominance and leadership behaviour, but primarily when cortisol (a stress hormone) is low. Mehta and Josephs (2010) provided foundational evidence that testosterone predicts dominance only among individuals with low cortisol levels. This finding has since been supported by ecologically valid studies in non-human animals (Goll et al., 2023), although human results have been more nuanced and context dependent. In addition to ecological validity, Goll et al. (2023) studied wild rock hyraxes and found that individuals with high testosterone and low cortisol levels were significantly more likely to lead group movements in risky environments, offering compelling support for the dual-hormone model in natural leadership settings. However, the findings from human studies are more nuanced. For instance, Moe et al. (2021) found no significant interaction between cortisol and testosterone in predicting leadership behaviours during negotiation and team-based tasks. Nonetheless, a meta-analysis by Dekkers et al. (2018) confirmed a small but consistent moderating effect, suggesting that cortisol often inhibits testosterone's influence on status-seeking behaviours, including leadership.

These hormonal insights inform leadership cognition through the lens of Implicit Leadership Theories (ILTs), mental prototypes that individuals hold about ideal leaders (Lord, Foti, and De

Vader, 1984; Epitropaki and Martin, 2004). Traits associated with low stress, such as composure and emotional steadiness, may align more closely with ILTs, improving how individuals are perceived and accepted as leaders, particularly under observation or evaluation.

Similarly, Motivation to Lead (MTL) which includes identity-driven, normative, and non-calculative motives to assume leadership roles (Chan and Darsgow, 2001), may be moderated by biological stress systems. Increased cortisol levels are known to suppress risk-taking, persistence, and proactive behaviours, potentially weakening the translation of MTL into actual leadership enactment under pressure.

In sum, cortisol may serve as a biological moderator, shaping how internal leadership motivation (MTL) is expressed and how leadership behaviours are cognitively evaluated via ILTs. Mapping this physiological, psychological, and social interface offers a promising integrative framework for future leadership research.

While evolutionary perspectives explain the adaptive origins of leadership traits, they are less equipped to account for how leadership is cognitively represented, socially constructed, and enacted in contemporary organisations. Evolutionary models provide the biological and ancestral foundations of leadership, but they cannot fully explain how individuals perceive, evaluate, or motivate themselves to lead within modern, multicultural contexts. Consequently, the following section turns to socio-cognitive approaches, which emphasise the mental schemas, identity processes, and motivational factors that shape leadership perception and behaviour in real-world organisational settings.

2.4 Socio-Cognitive Approach to Leadership

The socio-cognitive approach views leadership as a dynamic and reciprocal process shaped by cognitive schemas, social interactions, and situational context. It moves beyond traditional trait- or behaviour-based models by emphasising how individuals mentally construct and interpret leadership within particular social and situational environments.

A central concept in this approach is Implicit Leadership Theories; the internalised beliefs individuals hold about what constitutes effective leadership. These implicit theories play a crucial role in shaping how individuals perceive and respond to leaders, driving expectations and influencing workplace relations (Hemert & Vogel, 2023). When leaders expressed beliefs and behaviors align with followers' expectations, it can foster stronger trust and facilitate early leader–follower congruence, particularly in newly formed teams (Schyns et al., 2020). This congruence between self-theories and implicit leadership theories is also vital for an individual's motivation to lead.

Motivation to Lead (MTL) is another key construct, Chan and Drasgow (2021) found that individuals are more likely to pursue leadership roles when motivated by affective-identity and social-normative values (e.g., a sense of purpose or duty), rather than by personal gain or external rewards.

The socio-cognitive approach also acknowledges the impact of cognitive biases, such as confirmation bias and overconfidence, on leadership perception and decision-making. Berthet (2022) highlights how these biases can distort how leaders assess followers and how followers evaluate leadership competence, ultimately influencing group effectiveness and fairness. Furthermore, leadership is conceptualised as a co-constructed process. According to DeRue and Ashford (2010), leadership identity develops through ongoing social negotiation, where leaders and followers mutually shape one another's roles, behaviours, and expectations.

In summary, the socio-cognitive perspective positions leadership as a socially embedded and cognitively mediated process shaped by shared meanings, identities, and interactions. It provides a valuable lens for understanding leadership in today's complex, multicultural, and adaptive organisational settings.

While biological and evolutionary theories offer insights into the innate and adaptive roots of leadership, such as hormonal responses (e.g. cortisol, testosterone) or evolved tendencies to follow dominant individuals, the socio-cognitive approach brings attention to the mental representations and social processes through which leadership is interpreted and enacted in modern contexts.

Together, these perspectives provide a comprehensive view of leadership. Biological mechanisms may shape tendencies toward dominance or stress regulation, while cognitive frameworks and social norms influence how those behaviours are perceived. For instance, while high cortisol levels may biologically suppress risk-taking, whether such caution is perceived as effective leadership depends on how well it aligns with followers' ILTs. Likewise, an individual's Motivation to Lead (MTL) may stem from internal predispositions, but how it manifests is filtered through cultural expectations and interpersonal dynamics.

This integrative perspective underscores the importance of multi-level frameworks in leadership research, where biology sets the potential, and socio-cognitive processes determine interpretation, enactment, and outcomes.

Building on the socio-cognitive approach, the two key constructs central to this study are Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL). These cognitive frameworks play a significant role in shaping how leadership is perceived, enacted, and sustained in

organisations. The following sections provide a focused discussion of each concept, outlining its definitions, dimensions, and relevance to leadership emergence and effectiveness.

2.4.1 Implicit Leadership Theories (ILTs)

Implicit Leadership Theories (ILTs) refer to cognitive schemas that individuals hold about what constitutes effective leadership. These internal representations shaped by social learning, media portrayals, organisational experiences, and cultural norms serve as perceptual filters through which leadership behaviour is interpreted and evaluated (Lord et al., 1984). ILTs operate largely at a preconscious level, shaping expectations and influencing how individuals make sense of leaders' actions, particularly in ambiguous or uncertain contexts (Antonakis & Day, 2018).

Originally conceptualised by Lord et al., ILTs have since been shown to influence not only the perceptions of others but also individuals' self-concepts as potential leaders. For example, Foti et al. (2017) highlight how alignment with ILTs affects leadership aspirations and self-selection into leadership roles. Epitropaki and Martin's (2004) six-dimensional ILT model, sensitivity, intelligence, dedication, dynamism, masculinity, and tyranny remains foundational, illustrating how both positive and negative prototypes shape evaluate judgements. These dimensions also reflect the cultural, contextual, and situational plasticity of ILTs, which are subject to reinforcement or revision over time (Weidner, 2012). ILTs do not function in a neutral vacuum. They embed and reproduce gendered, racialised, and class-based leadership stereotypes. For example, traits such as assertiveness, independence, and control, often coded as masculine, are more likely to align positively with traditional leadership prototypes, disadvantaging women and minority leaders whose leadership styles may be more communal or collaborative (Lux et al., 2025). This systemic misalignment reinforces a "think-leader-think-male" heuristic that persists across organisational contexts (Koenig et al., 2011).

Schyns et al. (2011) stress the importance of reflexivity in leadership practice, noting that leaders who understand the ILTs held by their followers can more effectively adapt and align their behaviours. However, this also carries the risk of performative conformity, in which individuals feel compelled to mirror dominant expectations rather than enact authentic or context-appropriate leadership. Thus, while ILTs can facilitate cognitive efficiency in decision-making, they also risk reinforcing outdated exclusionary leadership norms.

In summary, ILTs are powerful socio-cognitive mechanisms mediating the construction, perception, and reproduction of leadership. A critical understanding of ILTs is essential for developing inclusive leadership frameworks that move beyond stereotype-driven assumptions and better reflect the pluralistic and dynamic nature of contemporary organisations.

2.4.2 Implications of ILTs for Leadership Development and Inclusion

The socio-cognitive lens of leadership has significant implications for leadership development and organisational inclusion. Because ILTs act as unconscious templates that influence both self-perception and the perception of others, they exert a subtle yet pervasive influence on leadership emergence, development, and evaluation (Foti, Hansbrough, and Coyle, 2017). These effects are especially pronounced in ambiguous performance situations, where observers rely heavily on cognitive heuristics to make leadership judgements (Antonakis and Day, 2018).

A major concern is that ILTs often reinforce exclusionary leadership norms. Empirical studies show that individuals whose traits align with dominant prototypes typically characterised by charisma, confidence, or physical presence are more likely to be perceived as competent leaders, regardless of actual effectiveness (Eagly and Karau, 2002; Ryan et al., 2016). This creates a double bind for women, people of colour, and those with alternative leadership styles, who may be judged more harshly or deemed “unfit” due to prototype mismatch.

Addressing these biases requires a deliberate shift in the leadership development framework. Instead of focusing narrowly on trait acquisition, organisations must adopt reflexive and culturally responsive strategies that recognise and challenge the implicit norms embedded in ILTs. Schyns et al. (2011) advocate for structured feedback mechanisms that surface discrepancies between leaders’ self-perceptions and followers’ expectations. Such feedback loops can foster greater awareness, adaptability, and inclusion in leadership behaviour.

At a systems level, talent identification and succession-planning processes should be critically evaluated to ensure they are not implicitly privileging conformity to dominant implicit leadership theories (ILTs). Given that ILTs often operate unconsciously as cognitive filters (Hiller, 2005; Lord et al., 2019), selection practices may inadvertently favour individuals who align with conventional prototypes, such as those who display overconfidence or charismatic dominance (Sim and Bierema, 2024). These risks exclude highly competent but modest individuals, or those whose leadership capital is expressed relationally rather than instrumentally (Handbook of Research on Educational Leadership for Equity and Diversity, 2013).

Embedding inclusive leadership metrics, such as collaboration, ethical reasoning, and emotional intelligence, can diversify the criteria by which leadership potential is recognised and rewarded (Hiller, 2005). As ILTs are socially constructed and shaped by cultural values and past experiences (Weidner, 2012), expanding the evaluative framework can help mitigate bias and foster a more inclusive leadership pipeline.

Furthermore, training initiatives should incorporate modules on ILTs and cognitive bias, equipping leaders and HR professionals with tools to identify and address their influence (Sim & Bierema, 2024). As categorisation based on ILTs is often automatic and lacks conscious reflection (Lord et al., 2019), structured education and reflexivity are key to disrupting these patterns. Promoting a broader repertoire of leadership role models, particularly those who challenge traditional stereotypes, can also help reshape prevailing ILTs and broaden perceptions of effective leadership (Handbook of Research on Educational Leadership for Equity and Diversity, 2013).

Confronting the hidden influence of ILTs is essential for building equitable leadership cultures. By foregrounding leadership as a co-constructed, context-sensitive, and culturally situated process (Schyns et al., 2011; Hiller, 2005), organisations can create more inclusive pathways to leadership and align talent development with the diverse realities of today's workforce.

Prototype-based leader evaluations refer to the cognitive process by which individuals assess leadership potential and effectiveness based on internalised mental prototypes or schemas commonly known as Implicit Leadership Theories (ILTs). These mental models serve as benchmarks that influence decisions related to selection, promotion, and performance appraisal (Lord et al. 1984; Epitropaki and Martin 2004). While such evaluations provide cognitive shortcuts in complex social environments, they also perpetuate significant bias with implications for inclusion and leadership development.

As highlighted by Antonakis and Day (2018), observers, especially under ambiguity, draw more heavily on prototypical fit than on measurable performance. These shared ILTs often privilege traits like confidence, assertiveness, and decisiveness characteristics traditionally associated with masculine or agentic leadership (Triana et al., 2023). Consequently, leaders who do not conform to dominant prototypes, such as women, individuals from collectivist cultures, or those with more relational leadership styles, may be systematically undervalued or overlooked, even when their performance is comparable or superior.

Moreover, cross-cultural research has revealed that ILTs are not universal. For example, Tsai and Qiao (2017) demonstrate that expectations for leader behaviours vary significantly across cultural groups, affecting how leadership is evaluated in multinational contexts. This underscores the inadequacy of one-size-fits-all evaluation metrics and highlights the need for context-sensitive leadership assessments.

These prototype-based evaluations also influenced self-perception. Individuals who sense a misalignment between their style and prevailing ILTs are less likely to pursue leadership roles or behave authentically (Foti, Hansbrough, and Coyle, 2017), reinforcing exclusionary norms and diminishing diversity in leadership pipelines.

Furthermore, reliance on prototypical evaluations can create a mismatch between perceived and actual leadership effectiveness. Antonakis and Day (2018) note that perceptions often undervalue leaders who excel in transformational or collaborative styles when observers favour archetypal charisma. In high-stress or crisis contexts, followers may default on authoritarian prototypes, even when a more inclusive leadership approach may be more effective.

Organisational strategies must broaden evaluation frameworks by incorporating diverse leadership exemplars, promoting reflexivity in leader assumptions, and deploying assessment tools that extend beyond surface traits. Leadership development programs should include education on ILTs and cognitive bias, combined with feedback loops that reveal leaders' implicit assumptions. Visible role models that challenge stereotypical prototypes can further shift collective perceptions of effective leadership.

Individual leaders also benefit from cultivating awareness of their own ILTs and understanding how follower perceptions might be shaped by culturally rooted expectations, particularly in diverse or international settings. In summary, prototype-based leader evaluations highlight the powerful yet often unconscious influence of ILTs in shaping leadership perceptions. A critical awareness of these dynamics is essential for creating fairer, more inclusive assessment practices that value diverse leadership styles and accurately reflect leadership effectiveness across varied cultural and organisational contexts.

2.4.3 Motivation to Lead (MTL)

While ILTs shape how leadership is perceived and evaluated, another key dimension of leadership emergence is individuals' willingness to step into such roles. Motivation to Lead (MTL) refers to an individual's intrinsic desire to assume leadership roles, shaped by personal aspirations, societal expectations, and self-perceptions of leadership capability (Chan and Dargow, 2001; Hiller, 2005). The MTL is typically defined along three dimensions:

Affective-Identity MTL

Affective-identity MTL has consistently been found to be a robust predictor of leadership emergence. Unlike the other two dimensions, it has been shown to predict why individuals occupy leadership roles (Auvinen et al., 2021). This dimension plays a central role in driving willingness to pursue leadership training, assume responsibilities, and persist in leadership aspirations (Auvinen et al., 2020). Moreover, individuals with high affective-identity MTL tend to report lower burnout when job demands are not excessively intensified, indicating a positive impact on sustained leadership engagement (Lehtiniemi et al., 2023). It is also associated with

leader efficacy and identity development, as individuals who enjoy leading are more likely to cultivate stronger leadership self-views over time (Kwok et al., 2020).

Despite these strengths, emphasis on self-identity risk privileges individualistic leadership prototypes. In collectivist cultures, distinctiveness is often constructed through social positioning rather than individual separation (Becker et al., 2012), which can limit the translation of affective-identity MTL into leadership emergence. Furthermore, the relationship between narcissism and affective motivation to lead has been shown to vary across cultures (e.g. the UK versus China), suggesting that cultural context moderates this association (Schyns et al., 2023). If not balanced by prosocial values, strong affective-identity MTL may foster agentic or dominance-driven leadership, particularly in individualistic societies.

Social-Normative MTL

Social-normative MTL emphasises duty, obligation, and culturally embedded expectations as motivators for leadership. Individuals with strong social-normative MTL lead because leadership is perceived as a valued responsibility (Auvinen et al. 2020; Hiller 2005). This dimension conceptually aligns with servant leadership, which emphasises self-sacrifice for the group's benefit and promotes ethical, collaborative practices. Social norms also function as powerful drivers of positive behavioural change, encouraging adherence to collective practices (Sparkman et al., 2020). Furthermore, leaders themselves play a role in influencing and reshaping moral norms, suggesting a reciprocal relationship between leadership motivation and societal expectations (Spinosa et al., 2022).

However, social-normative MTL has been criticised for potentially encouraging compliance with existing structures rather than fostering innovation. This risk reinforces the status quo, even when current systems are dysfunctional or inequitable (Jost et al., 2018; Diefenbach and silence, 2011). In rigid hierarchies, a duty-driven leadership style may inadvertently perpetuate existing power relations, thereby impeding progressive change. Moreover, the inherent normative pressure to report duty-based motivations raises the possibility of inflated self-reported scores, posing challenges for measuring validity.

Non-Calculative MTL

Non-calculative MTL contributes a conceptual nuance to the model by differentiating selfless from purely instrumental orientations. This reflects a willingness to assume leadership without prioritising personal costs or benefits (Auvinen et al., 2020;).

However, empirical evidence for this dimension is weaker and less consistent compared to affective identity and social-normative MTL. Studies have demonstrated that non-calculative MTL does not predict leadership role occupancy (Auvinen et al., 2021), supporting claims of

its limited predictive value. Its connection to leadership identity has also been described as “tenuous” (Hiller, 2005), with some analyses revealing negative associations when controlling for other variables. Such inconsistencies raise questions regarding construct validity and practical utility. Additionally, the notion of leading “without regard for personal costs” may be idealistic or maladaptive in contemporary organisations, where sustainable leadership requires balancing personal well-being with group needs.

Research suggests that hormonal influences play a significant role in leadership perception and behaviour, particularly involving testosterone, cortisol, and oxytocin.

Testosterone is often linked to dominance-style leadership and status-seeking behaviours (Vogt & Smith, 2019). Studies indicate that high testosterone levels can predict better performance in high-status leadership roles (Van Vugt, 2020). and is associated with attained status, particularly in men (Moe et al., 2021; Sherman et al., 2015). However, the influence of testosterone on status-seeking behaviour is often moderated by cortisol levels, as described by the “dual-hormone hypothesis” (Knight et al., 2019; Mehta & Josephs, 2010). This hypothesis suggests that high testosterone levels are more strongly associated with dominant leadership behaviours and attained status when cortisol levels are low (Goll et al., 2023; Knight & Mehta, 2014; Moe et al., 2021; Sherman et al., 2015). This indicates a complex interplay in which the physiological stress response (cortisol) can regulate the expression of dominant, pro-self-behaviours associated with testosterone.

Oxytocin, a neuropeptide, is increasingly being recognised for its role in prosocial behaviours, empathy, and social bonding (Marsh et al., 2020; Statik et al., 2018; Tarsha & Narváez, 2023). While testosterone is linked to dominance and individualistic leadership styles, oxytocin appears to be more closely associated with prestige-oriented leadership, fostering cooperation, and altruism (Marsh et al., 2015; Vogt & Smith, 2019). Nonetheless, inconsistencies remain due to the challenges in standardising oxytocin measurements in human studies (Tabak et al., 2022).

Although these studies provide valuable insights into the biological underpinnings of leadership, scholars increasingly emphasise the need to integrate perspectives from biological, psychological, and social sciences to develop more comprehensive explanations (Moe et al., 2021). Further longitudinal research is required to fully capture the dynamic interplay between hormonal mechanisms and social contexts (Kragt & Day 2020). Such studies can track changes over time and provide a richer understanding of how biological and social factors interact to shape leadership development and effectiveness.

Women frequently demonstrate high motivation to lead, particularly in affective-identity MTL, but encounter systemic barriers, such as gender stereotypes and cultural ambivalence, that

limit their advancement (Chaudhary and Dutt, 2020; Hopkins et al., 2021; Mohamed et al., 2023; Zheng et al., 2018). This incongruity between gender roles and leadership expectations constrains opportunities for leadership emergence (Zheng et al., 2018). Cultural contexts can also amplify certain MTL dimensions, such as the collectivist emphasis on social-normative MTL, while simultaneously constraining their behavioural expression through entrenched structures and hierarchies.

MTL has been shown to predict leadership training effectiveness, as individuals with higher motivation to lead are more likely to acquire leadership competencies and exhibit effective behaviours (Stiehl et al., 2015). This underscores the importance of assessing and cultivating MTL in leadership development programs. Affective-identity MTL can be leveraged in innovation and strategy-focused initiatives, whereas social-normative MTL aligns more effectively with ethics and resilience training (Auvinen et al., 2020). In contrast, the practical applicability of non-calculative MTL remains contested and requires further empirical attention.

In summary, MTL is a multifaceted construct that intersects personal motivation, social norms, and biological predispositions. Integrating affective identity and social-normative dimensions into leadership development not only enhances theoretical understanding but also offers practical strategies for nurturing diverse and resilient leaders.

Both ILT and MTL frameworks converge around the cognitive–motivational mechanisms underlying leadership emergence. ILTs shape how individuals define leadership prototypes and evaluate themselves relative to these schemas, while MTL determines the motivational drive to assume leadership roles based on this self–prototype alignment. When individuals perceive congruence between their self-concept and leadership prototypes, affective-identity MTL is strengthened; when incongruence arises such as under stress this motivation may diminish. Thus, integrating ILT and MTL provides a cohesive lens for examining how cognitive schemas and identity motivations jointly inform leadership behaviour before introducing biological moderators such as cortisol.

2.4.4 The Role of Culture in Leadership Perception

Building on the psychological mechanisms underlying Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL), this section examines the sociocultural forces that shape leadership perceptions and biases. Cultural norms and values significantly influence how leadership is understood, enacted, and evaluated. The foundational Global Leadership and Organizational Behavior Effectiveness (GLOBE) project (House et al., 2004) demonstrates substantial cross-cultural variation in leadership preferences and culturally endorsed attributes. Nevertheless, leadership research and practice often continue to rely on implicit assumptions rooted in

Western, individualistic leadership prototypes, generating structural mismatches in increasingly diverse, globalised organisations (Dorfman et al., 2012).

Cultural Biases in ILTs

ILTs operate as internalised cognitive schemas shaped by cultural conditioning, which tend to privilege traits aligned with dominant societal values (Epitropaki et al., 2013). In individualistic cultures, leadership prototypes emphasise autonomy, assertiveness, and innovation, whereas collectivist cultures place greater value on relational traits such as harmony, humility, and consensus-building (Ruckstuhl et al., 2022). These contrasts highlight the cultural specificity of leadership cognition and expose the limitations of applying universalist leadership frameworks across contexts. The practical consequences are well documented: leaders who are effective in one cultural environment may be perceived as ineffective in another (Reiche et al., 2017). For example, decisiveness that is praised in Anglo-American settings may be interpreted as authoritarian in East Asian or Latin American contexts, potentially reducing trust, weakening cohesion, and impairing leadership effectiveness in multicultural teams (Jong et al., 2020).

Gender Biases in ILTs

Gendered ILTs constitute another major source of bias. The prototype of the “ideal leader” remains strongly masculinised, privileging traits such as assertiveness, competitiveness, and decisiveness (Eagly & Carli, 2007; Ryan et al., 2016). Women face a well-established “double bind”: adopting agentic, masculine-coded behaviours risks backlash for violating gender norms, while adopting communal behaviours risks being perceived as weak or ineffective (Vial & Napier, 2018). This misalignment not only distorts evaluations but can also discourage aspiration. When women perceive a mismatch between their identities and dominant leadership schemas, they become less likely to pursue leadership roles (Hoyt & Murphy, 2016). Consequently, these dynamics continue to hinder women’s progression into senior leadership positions (Brands & Fernandez-Mateo, 2017).

Biases Based on Physical Traits

ILTs are influenced not only by cognitive expectations but also by somatic cues. Physical characteristics—including height, facial symmetry, and vocal tone—have consistently been linked to leader emergence, even when competence is controlled for (Re et al., 2013; Yu et al., 2014). Recent work shows that these appearance-based biases persist in virtual and hybrid work environments, indicating that physicality continues to shape leadership judgments despite the availability of performance information (Bravo-Duarte et al., 2025; Hooijberg, 2021). These biases reflect evolutionarily rooted associations between physical dominance

and leadership authority (Van Vugt & Ahuja, 2011). In contemporary organisations, however, such heuristics lead to superficial decision-making and systematically disadvantage capable individuals who do not conform to narrow physical leadership prototypes (Rule & Ambady, 2010; Olivola & Todorov, 2009).

Ethnic and Racial Biases in ILTs

Ethnic and racial biases embedded in ILTs contribute to the persistent underrepresentation of minority leaders. Research indicates that leadership continues to be implicitly associated with White identities, with Black, Asian, and other racially minoritised leaders facing heightened scrutiny and narrower margins for error (Rosette et al., 2008). These “racialised prototypes” raise expectations for competence while reducing tolerance for mistakes. Biases are also intersectional, compounding disadvantages for women of colour who face both gendered and racialised leadership mismatches (Galinsky et al., 2015). Addressing these inequities requires more than awareness; it demands a critical redesign of talent identification, evaluation criteria, and leadership development pipelines (Mobasser et al., 2023).

Confirmation Bias in ILTs

Confirmation bias further reinforces ILT-driven inequalities by causing individuals to interpret behaviour in ways that confirm their pre-existing leadership prototypes. This bias privileges extroversion, charisma, and highly visible confidence (Foti & Hauenstein, 2007; Junker & van Dick, 2014). As a result, alternative but effective leadership styles—such as introverted, facilitative, or process-oriented approaches—are often undervalued (Grant et al., 2011). Without structured, evidence-based evaluation mechanisms (e.g., 360-degree feedback or behavioural assessments), confirmation bias perpetuates homogeneity and limits leadership diversity (Ayman-Nolley & Ayman, 2005; Devine et al., 2022). The cumulative impact of these biases undermines both equity and organisational effectiveness.

Organisations that rely on narrow, prototype-driven ILTs risk overlooking valuable talent and reinforcing monocultural leadership pipelines. Importantly, ILTs are not fixed; they are socially constructed and therefore open to change. Organisations can broaden their leadership schemas by integrating traits such as cultural intelligence, emotional regulation, and ethical reasoning. Bias-interruption tools including behavioural interviews, blind assessments, and AI-supported performance audit systems offer practical mechanisms for reducing skewed evaluations (Fath et al., 2023; Mujtaba & Mahapatra, 2024). Targeted development programmes for underrepresented groups also help challenge dominant prototypes and provide more diverse leadership models (Ely & Thomas, 2020). While ILTs provide valuable insight into leadership cognition, their embedded biases must be critically examined. Without

systemic intervention, ILTs risk perpetuating exclusionary standards that are misaligned with the complexity and diversity of contemporary organisations.

Although socio-cognitive theories illuminate how leadership is interpreted and enacted through perception and motivation, they often overlook the biological mechanisms that shape leadership behaviour under stress. Understanding how physiological systems interact with cognitive and motivational dynamics is especially important in high-pressure contexts where leadership decisions occur under acute strain. The next section therefore introduces biological and neuroendocrine perspectives on leadership, examining how hormonal, neural, and genetic factors contribute to leadership emergence, resilience, and performance.

The extensive body of research on biases within ILTs demonstrates that they do not reflect universal leadership prototypes. Instead, ILTs are deeply shaped by sociocultural, gendered, physical, and racialised schemas that influence both leadership perception and enactment. Cultural conditioning produces distinct leadership prototypes in individualistic versus collectivistic contexts, illustrating the context dependence of leadership cognition (Epitropaki et al., 2013; Ruckstuhl et al., 2011). Gendered expectations further reinforce masculine-coded leadership ideals, generating double-bind dynamics that constrain women's evaluation, aspiration, and advancement (Eargly & Carli, 2007; Vial & Napier, 2023; Hoyt & Murphy, 2016). Appearance-based biases, rooted in evolutionary associations between dominance and authority, similarly privilege individuals who conform to narrow physical prototypes (Van Vugt & Ahuja, 2011). Racialised leadership schemas further marginalise ethnically minoritised leaders, particularly women of colour who face compounded stereotypes (Rosette et al., 2008). Confirmation bias amplifies these inequities by filtering behavioural interpretations through dominant leadership schemas and undervaluing alternative leadership styles (Junker & van Dick, 2014; Grant et al., 2011).

Overall, ILTs are best understood as socially constructed frameworks shaped by intersecting biases rather than as universal cognitive structures. Recognising this complexity underscores the need for inclusive, contextually grounded conceptions of leadership that embrace diversity in identity, style, and cultural expression. While socio-cognitive theories emphasise how perception and motivation shape leadership, they provide only part of the picture. The following section therefore turns to biological and neuroendocrine perspectives, exploring how hormonal, neural, and genetic mechanisms interact with socio-cognitive processes to influence leadership emergence, resilience, and performance.

2.5 Biological Aspects of Leadership

Leadership has been studied through the prisms of psychology, sociology, and management science; however, in recent decades, a new and compelling dimension has emerged:

biology (Moe et al., 2021; Nofal et al., 2017; Vugt & Rueden, 2020). This expanding body of research does not seek to replace classical leadership theories, but rather to enhance them by situating leadership within the broader framework of human biology. Biological perspectives provide critical insights into how genetic predispositions (AKSOY et al., 2023; Arvey et al., 2005) hormonal regulation (Moe et al., 2021; Vongas et al., 2020), neural architecture (AKSOY et al., 2023; Bennett et al., 2024; Boyatzis et al., 2014) and environmental feedback loops (Li et al., 2025; Nofal et al., 2017; Vugt & Rueden, 2020; Zhang et al., 2009) shape leadership emergence, behaviour, and effectiveness.

Far from promoting deterministic interpretations, the biological perspective emphasises the dynamic interplay between innate predispositions and experiential learning. While some individuals may be biologically primed for leadership through heritable traits or neurochemical profiles, their actual leadership capacity emerges through contextual, developmental, and psychosocial experiences (Ilies, Arvey, and Bouchard, 2006; Dias Pereira et al., 2022). This aligns with contemporary models of human behaviour as the outcome of gene–environment interactions (G×E), epigenetic plasticity, and neurobiological adaptation (Dias Pereira et al., 2022; Alves, 2022; Eisen et al., 2024; Wang, 2024)

Biological science offers a multilevel framework for examining leadership. Behavioural genetic studies have demonstrated the moderate heritability of leadership traits, with twin studies estimating that genetics accounts for up to 30% of the variance in leadership emergence (Arvey et al., 2007). Complementing these findings, epigenetic mechanisms, including DNA methylation and histone modification, highlight how environmental exposures, such as stress, social support, and leadership training, can modulate gene expression, potentially shaping emotional regulation and decision-making capacities over time (Zhang et al., 2009).

Neuroscientific research has further mapped leadership behaviours to specific brain structures and neurochemical systems. For example, the prefrontal cortex is linked to executive function and moral reasoning, while the amygdala regulates emotional salience and social threat detection, both critical in high-pressure leadership contexts (Sherman et al., 2012; Nofal et al., 2012). Hormonal studies, particularly those focusing on cortisol, have suggested that biological stress responses significantly influence leadership efficacy and resilience under volatile or evaluative conditions (Mehta and Josephs, 2010).

Despite its promise, the biology of leadership remains a relatively nascent field, often fragmented across disciplines such as cognitive neuroscience, behavioural genetics, and endocrinology. While leadership is a prominent topic across biological, social, and cognitive sciences, these literatures have often evolved independently, indicating a need for synthesis (Vugt & Smith, 2019). The conceptual promise of this convergence is substantial; however,

empirical work remains limited in scope and methodological integration, more longitudinal, diverse, and ethically grounded studies are required to synthesise findings and translate them into practice, moving beyond predominantly cross-sectional designs (Higgs, 2022; Latham, 2014; Nofal et al., 2017).

This section builds the foundation for examining the neuroendocrine dimension of leadership with a focus on cortisol as a biomarker of stress responsiveness and leadership effectiveness. By situating biological mechanisms within a biopsychosocial framework, we move toward a more integrative model of leadership that accounts for the reciprocal relationships between genetic makeup, environmental exposure, and psychological motivation. This lens provides new theoretical and practical pathways for leadership development, assessment, and intervention in complex organisational contexts.

2.5.1 Genetic Perspectives on Leadership

The role of genetic factors in leadership research is an emerging yet increasingly significant domain, particularly considering advances in behavioural genetics and large-scale genome-wide association studies (GWAS). Early empirical work, such as Arvey et al. (2007), estimated that approximately 30% of the variance in leadership emergence could be attributed to genetic influences, based on findings from twin studies. Building on this foundational work, Zhao and Seibert (2018) found that traits associated with entrepreneurship, such as proactivity and risk-taking, are moderately heritable and overlap with leadership tendencies.

Importantly, heritability estimates refer to population-level variance and not individual-level prediction. In other words, a heritability figure of 30% does not imply that an individual's leadership capacity is genetically determined to be 30%. Rather, this means that 30% of the observed differences in leadership across a population can be statistically linked to genetic variation. This distinction is critical in avoiding genetic determinism and must be clearly understood when applying such findings to leadership theory or practice.

Beyond heritability estimates, genome-wide association studies have begun to identify specific genetic variants associated with leadership-related traits. For instance, De Neve et al. (2013) identified *rs4950*, a single nucleotide polymorphism (SNP) associated with leadership role occupancy, that is, whether an individual holds or has held a formal leadership position. This SNP is located near the *CHRNA6* gene, which is involved in neural signalling pathways related to attention and decision-making. While this discovery provides a tangible genetic marker, *rs4950* accounts for only a small fraction of the variance, reinforcing the view that leadership is shaped by a constellation of genetic factors rather than any singular determinant.

Consequently, the field has shifted toward polygenic models, which recognise that leadership-related traits such as extraversion, cognitive control, and novelty seeking arise from the cumulative effect of numerous genetic variants, each exerting a small influence. Polygenic models emphasise that leadership is not determined by a single gene but emerges from the complex interaction between many genes and environmental factors, including social context, upbringing, and life experiences.

Earlier genetic studies often focused on specific “candidate genes” thought to influence behaviour. Two notable examples are *DRD4* and *COMT*. The *DRD4* gene encodes a dopamine receptor involved in the brain’s reward system and has been linked to traits such as novelty-seeking and risk-taking characteristics commonly associated with entrepreneurial and transformational leadership styles (Ebstein et al., 1996; Krammer and Goren, 2021). In contrast, *COMT* encodes an enzyme that regulates dopamine levels in the prefrontal cortex, a brain region essential for decision-making, emotion regulation, and executive functioning. Variations in *COMT* have been linked to differences in stress tolerance and cognitive flexibility, which are crucial to effective leadership in complex, high-pressure environments (Barnett et al., 2007; Montag et al., 2012).

The exploration of leadership through the lens of genetic and epigenetic mechanisms offers a compelling perspective on the multifaceted nature of leadership emergence and behaviour (Van Vugt and Rueden, 2020). The interplay between genetic predispositions and environmental factors encapsulated in concepts such as gene–environment interaction ($G \times E$) and gene–environment correlation (rGE) provides a more nuanced understanding of how leadership qualities manifest (Jaffee and Price, 2008). $G \times E$ suggests that genetic influences on behaviour are not universally expressed but depend on specific environmental conditions. For example, a genetic inclination toward assertiveness may only emerge under high-stakes or competitive scenarios (Nofal et al., 2017). Conversely, rGE refers to the phenomenon in which individuals actively select or shape environments that align with their genetic predispositions, thereby reinforcing behaviours.

The debate has moved beyond simple percentages to focus on Gene-Environment interaction ($G \times E$) and Gene–Environment Correlation (rGE). A key finding is that the heritability of leadership is not constant across different social contexts. Research shows that “enriched” environments characterised by high socioeconomic status, parental support and low conflict have diminished the relative influence of genetic factors on leadership emergence (Zhang, Ilies and Arvey, 2009; Liu et al., 2020). In these supportive settings, environmental developments takes lead. Conversely, in high conflict environments, genetic predispositions become much stronger predictors of who will occupy a leadership role (Liu et al., 2020). Some individuals

may possess "plasticity genes" that make them more sensitive to both positive and negative leadership experience (Slavich and Cole, 2013).

Phenotypic plasticity alleles are genetic variants that increase individuals' sensitivity to environmental conditions, conferring adaptive advantages in supportive contexts while increasing vulnerability in adverse environments. These alleles have likely remained polymorphic throughout human evolutionary history because they produced a balance of fitness costs and benefits across diverse and fluctuating ecological conditions (Cole, 2012; Finch, 2010; Gibson, 2008, 2009; Maranville et al., 2011; Richerson et al., 2010). Emerging evidence suggests that plasticity alleles are associated with a wide range of phenotypic outcomes, including emotion perception, neural system activation, life history strategies involving reproductive and antisocial behaviour, the development of social networks, socioeconomic influences on depression, and processes of gene–culture coevolution.

Collectively, these findings raise the possibility that some individuals are genetically more sensitive to transcriptional regulation by the social environment, resulting in biological responsiveness that is shaped by the interpersonal and social contexts in which individuals are embedded. However, alleles that broadly enhance adaptive capacities, such as anticipatory stress regulation or efficient deployment of physiological defences would likely have undergone positive selection and swept to fixation over evolutionary time (Gibson, 2008, 2009; McEwen, 2007; Sabeti et al., 2006; Sterling, 2004). Consequently, a substantial portion of the genetic basis underlying transcriptional sensitivity to social context may now reside in nonpolymorphic regions of the genome. Because such loci would not be detectable in conventional polymorphism-based association studies, it remains possible that key genetic contributors to biological sensitivity to social-environmental experience have yet to be identified (Gibson, 2008).

The integration of genetics into action-based research provides a framework for "precision" leadership development. The sociogenomic model views leadership not as fixed trait but as a dynamic process where environmental "actions" such as high-stakes projects or behavioural training can trigger epigenetic changes (Spain, Harms and Jackson, 2014). For researchers, this means that the "action" phase of a study can be evaluated not just by behavioural output, but by changes in an individual's biological stress markers or gene expression.

Stress and Psychological Resilience

The biological response to stress represents a central mechanism underlying effective leadership, particularly through regulation of the Hypothalamic–Pituitary–Adrenal (HPA) axis. Leadership roles are typically associated with heightened responsibility, uncertainty, and performance demands. However, research suggests a paradoxical pattern often referred to

as the “lead–stress paradox.” Although leadership positions increase objective demands, studies of military and governmental officials indicate that higher-level leaders frequently exhibit lower levels of the stress hormone cortisol and reduced anxiety compared to non-leaders (Sherman et al., 2013). This phenomenon has been attributed to a perceived sense of control, which functions as both a psychological and biological buffer against stress reactivity. A strong sense of control appears to attenuate HPA-axis activation, thereby reducing physiological stress responses despite elevated situational demands.

Individual differences in stress resilience are also shaped by genetic variation within key regulatory systems. The NR3C2 gene, which encodes the mineralocorticoid receptor, plays a critical role in determining the activation threshold of the HPA axis (Lin et al., 2023). By influencing how readily the stress system is initiated, NR3C2 contributes to variability in stress sensitivity. Similarly, variation in genes such as FKBP5, which regulates glucocorticoid receptor sensitivity, affects the efficiency of negative feedback within the HPA axis and thereby shapes cortisol recovery following acute psychosocial stress (Mahon et al., 2012; Lin et al., 2023). Together, these genetic mechanisms influence not only immediate stress reactivity but also longer-term resilience in high-demand leadership contexts.

Beyond genetic variation, stress exposure can also produce epigenetic modifications that alter gene expression over time. Chronic leadership-related stress has been associated with DNA methylation of stress-regulatory genes, potentially impairing long-term adaptive capacity and increasing vulnerability to burnout (Qing et al., 2020). Importantly, epigenetic processes are dynamic rather than fixed. This plasticity suggests that leadership development interventions particularly those focused on stress management, cognitive reframing, and physiological regulation may help recalibrate stress-response systems and mitigate maladaptive epigenetic signatures (Gottschalk, Domschke and Schiele, 2020; Stoffel et al., 2020). Consequently, resilience in leadership should be conceptualized not as a static trait but as a biologically embedded yet modifiable capacity shaped by ongoing interactions between genetic predisposition, stress exposure, and environmental intervention.

Taken together, genetic research indicates that leadership is neither wholly inherited nor entirely socially constructed. Rather, leadership emergence and stress regulation reflect a dynamic interplay between biological predispositions and environmental experience. Within this framework, cortisol reactivity can be understood as a proximal physiological mechanism through which stress exposure shapes leadership-related cognition, affect, and motivation. By linking genetic variation in stress-regulatory systems to observable behavioural and socio-cognitive outcomes, cortisol functioning provides an important bridge between biological sensitivity and the psychological processes underlying leadership performance.

Epigenetics further extends the gene–environment framework by providing a molecular explanation for how environmental experiences influence biological functioning without altering DNA sequences (Collins et al., 2020). Through mechanisms such as DNA methylation, histone modification, and non-coding RNA activity, environmental stimuli can dynamically regulate gene expression, allowing lived experiences to leave enduring biological marks (Mirkovic et al., 2020; Gottschalk et al., 2020). These processes offer a mechanistic bridge between external context and internal biological adaptation, thereby transcending the traditional nature–nurture dichotomy.

Within leadership science, this perspective aligns with contemporary scholarship that conceptualises leadership as a dynamic, relational process rather than a fixed set of traits (Gigliotti and Spear, 2022). Leadership effectiveness depends upon the alignment between individual dispositions and situational demands (Coopersmith, 2023), while distributed leadership models emphasise the shared and contextually embedded nature of leadership processes (Acton et al., 2018; Fennell, 2021). Epigenetics enriches these frameworks by suggesting that environmental contexts may not only shape leadership behaviour psychologically, but also biologically, through experience-dependent gene regulation.

The broader academic discourse increasingly recognises epigenetics as a paradigm shift in understanding human development. Rather than viewing DNA as a static determinant of behaviour, scholars argue that the epigenome regulates gene expression in ways that reflect environmental input (Charney, 2012). Similarly, developmental systems perspectives highlight the interdependence of organisms and their environments, challenging simplistic dichotomies between genetic inheritance and social influence (Witherington and Lickliter, 2017). Kenney (2012) explicitly applied this argument to leadership science, suggesting that epigenetic processes offer a framework for moving beyond reductionist interpretations of leadership potential.

Empirically, however, studies directly linking epigenetic mechanisms to leadership remain limited. Challenges include small sample sizes and a reliance on WEIRD populations, which constrain statistical power and cultural generalisability (Finkel and Jaffe, 2023; Henrich et al., 2010). Nonetheless, related research in developmental psychology and behavioural neuroscience provides valuable insights. Environmental exposures such as early life adversity, maternal care, job demands, and autonomy have been associated with epigenetic modifications in stress-regulatory systems, particularly within genes linked to glucocorticoid functioning (Radtke et al., 2015; Nofal et al., 2017). Chronic psychosocial stress can induce epigenetic changes that reshape neural circuits involved in executive function and social cognition (Stankiewicz et al., 2013; Zannas and West, 2013). Such modifications may either

enhance or constrain leadership-relevant capacities, depending on the timing, intensity, and context of exposure.

The concept of allostatic load is particularly relevant in this regard. Repeated or chronic stress can accumulate into a physiological burden that promotes maladaptive epigenetic alterations, especially within systems regulating the hypothalamic–pituitary–adrenal (HPA) axis and cortisol production. These changes may impair emotional regulation, cognitive flexibility, and social judgement competencies central to effective leadership. Conversely, supportive environments and protective experiences may foster adaptive epigenetic regulation that enhances resilience (Cheri and Carrión, 2023; Smeeth et al., 2021). Research also indicates that epigenetic patterns may predict responses to psychotherapy and resilience interventions, suggesting that stress-related biological signatures are dynamic and potentially modifiable (Vaisman, 2014; Schiele, Gottschalk, and Domschke, 2020).

Neuroscientific evidence further supports this position. Experience-dependent epigenetic modifications in the central nervous system demonstrate how environmental input can produce long-term changes in gene transcription underlying behavioural adaptation (Zovkic et al., 2013; Sweatt; Karsten and Baram, 2013). These findings reinforce the notion that leadership capacity is not biologically fixed but embedded within an ongoing dialogue between genome and environment.

In sum, epigenetics provides a promising avenue for advancing leadership research beyond static trait models and simplistic nature–nurture binaries. Although specific epigenetic markers associated with leadership effectiveness remain to be identified, existing evidence indicates that environmental exposures can induce biologically meaningful changes affecting executive function, emotional regulation, and stress resilience. Future research should prioritise longitudinal and experimental designs capable of tracking biological adaptation in relation to leadership roles and contextual demands (Nofal et al., 2017; Miller, 2021). Such approaches hold potential not only for refining theoretical models of leadership but also for informing ethically grounded, biologically informed leadership development strategies.

2.5.2 Neuroleadership

The emergence of neuroleadership represents a growing interdisciplinary effort to bridge neuroscience and leadership studies, offering a biologically grounded understanding of leadership behaviour, cognition, and emotion. Early conceptual frameworks, such as those proposed by David Rock (2010), laid the foundation for neuroleadership by integrating principles from cognitive neuroscience with established leadership theories. These frameworks emphasise that understanding brain mechanisms, particularly those underpinning

self-regulation, empathy, and social decision-making, may enrich models of leadership effectiveness and development. (Bennett et al.,2024; Boyatzis et al.,2014).

Recent studies continues to validate the promise of neuroleadership as a legitimate interdisciplinary field. Work like “The Neuropsychology of leadership” by (Bennett et al.2024) and “The Emergence of Neuroleadership in the Knowledge Economy” by (Bratianu and Staneiu,2024) outlines the theoretical evolution and neurobiological grounding of leadership behaviour. Furthermore, the role of stress physiology in digital leadership contexts, further extending the application of neuroendocrinological approaches were highlighted in systematic reviews such as “leadership and technostress a study carried out by (Rademaker et al.,2023). Other research emphasised leadership behaviour adapted to be digitalised workplace to reduce employee stress (Rashi,2024).

However, it is important to distinguish between visionary accounts that popularise in neuroscience and those grounded in empirical neurobiological evidence. For instance, Goleman, Boyatzis and McKee (2009) helped popularise the notion of emotionally intelligent leadership by linking emotional regulation and interpersonal effectiveness to brain function. Although conceptually compelling and widely cited, such accounts often lack direct neuroscientific data and are best viewed as heuristic models rather than empirically validated frameworks (Goleman et al.,2009).

In contrast, Sherman et al. (2012) employed physiological measures to examine leadership under stress, demonstrating that leaders with lower baseline cortisol levels and greater prefrontal activation are more resilient and perform better in high-pressure situations. Cortisol, a key hormone released by the hypothalamic-pituitary-adrenal (HPA) axis of the body’s central stress response system, has been widely studied in relation to emotional regulation and adaptive performance.

Neuroleadership research has begun to explore how specific brain regions contribute to leadership behaviours. For example, the prefrontal cortex has been implicated in executive function, moral reasoning, and emotion regulation, which are key components of effective leadership, whereas the amygdala plays a central role in threat detection and emotional reactivity. Balthazard et al. (2013) provided some of the first empirical evidence using electroencephalography (EEG), a non-invasive technique that records the brain’s electrical activity through scalp-mounted sensors. Their study demonstrated that leaders with higher complexity in brainwave patterns tended to perform better in strategic thinking and creativity-related tasks.

Despite notable advancements, the field of neuroleadership continues to face important methodological and conceptual limitations. A recurrent critique concerns the limited empirical

depth and small sample sizes that characterise much of the existing research, particularly studies employing functional neuroimaging methods. Functional Magnetic Resonance Imaging (fMRI), while offering detailed spatial resolution of brain activity, is costly and logistically demanding, leading to underpowered studies that struggle to generate replicable findings (Turner et al., 2018; Demidenko et al., 2024). These constraints hinder the generalisability and robustness of conclusions drawn from neuroimaging data in leadership contexts. Other studies also reinforces the challenges of small samples in neuroimaging studies, impacting replicability and generalisability (Costa et al.,2024, Li et al.,2024).

Moreover, ethical concerns persist regarding the use of neuroscientific data in personnel selection, profiling, or predictive analytics. As noted by Muhi and Andorno (2023), the application of neurobiological metrics in high-stakes decision-making, such as executive hiring or leadership assessments, raises questions about privacy, informed consent, and biological reductionism. These issues are especially pressing considering emerging technologies that allow continuous or wearable brain monitoring. These issues are especially pressing considering emerging technologies that allows continuous or wearable brain monitoring (Muhl,2024; Yuste,2023). To address these limitations, recent research has shifted towards more accessible and ecologically valid techniques, such as electroencephalography (EEG) and neurofeedback. EEG allows for real-time recording of electrical brain activity and has been utilised in leadership studies to explore cognitive flexibility, attentional control, and emotional regulation (Adamczyk et al,2025). One promising avenue involves neurofeedback training, whereby individuals learn to modulate their brainwave patterns through feedback-based interventions. This technique has shown efficacy in enhancing self-regulation and resilience attributes central to leadership effectiveness (Iodice et al.,2022; Sitaram et al., 2016).

In parallel, the integration of EEG with machine learning has enabled researchers to identify neural signatures associated with adaptive leadership behaviours in dynamic environments. Eyvazpour et al (2023) demonstrated how machine learning algorithms could classify EEG signals linked to risk taking tendencies in managers. While Torres et al (2020) used EEG and machine learning to analyse mental states and their impact on performance, noting that EEG could be ideal for measuring stress due to its effect on neural activity. These provide scalable tools for leadership development. Additionally, recent advancements in multimodal approaches, such as the simultaneous use of EEG and fMRI, offer a more comprehensive understanding of the neural correlates of leadership by combining temporal and spatial brain data (Chang and Chen,2021; Ebrahimzadeh et al.,2022; Fleury et al.,2023).

The development of wearable technologies has expanded the frontier of neuroleadership. For instance, Huh et al. (2025) introduced a wireless forehead electronic tattoo (e-tattoo) capable

of monitoring mental workload indicating its potential for real time cognitive state decoding. These technologies hold significant promise for leadership training, offering continuous, non-invasive feedback to support performance under pressure (Cannard et al.,2020; Huh et al.,2025), However, their application must be carefully managed within robust ethical and legal frameworks. (Muhl and Andorno,2023).

In conclusion, neuroleadership is still evolving, it contributes valuable insights into the biological substrates of leadership behaviour. Future research must prioritise larger, cross-cultural, and longitudinal designs while maintaining caution against reductionist interpretations. An interdisciplinary and ethically grounded approach is essential for translating neuroscience into meaningful leadership theories and practices. The inclusion of emerging domains, such as neuroendocrinology in virtual leadership (Girardi et al., 2025) and the formalisation of neuroleadership as a field (Aithal and satpathy,2024; Gocen,2020; Rosa,2023), signals a maturing paradigm ripe for empirical expansion.

While the field has enriched leadership theory through constructs such as emotion regulation and executive function, it remains constrained by small sample sizes, limited use of advanced imaging technologies, and overreliance on conceptual extrapolation. This study builds on these developments by empirically examining the neuroendocrine dimension of leadership, specifically the influence of cortisol on cognitive and motivational mechanisms that shape leadership perception. To capture the evolution of research across time, **Table 2.5.3** presents a year-wise matrix (1990–2025) of key studies examining genetic, hormonal, and neuroleadership influences. Each entry outlines the study's aims, methodology, theoretical framework, findings, limitations, and thematic contribution.

Table 2.5.3: Structured Literature Matrix of Biological Influences on Leadership (1990–2025) — Study Details, Frameworks, and Thematic Contributions

#	Paper Title and Author	Year of Publication	Research Aim and Objective	Methodology	Key Findings	Theoretical Framework	Limitations	Contribution to Field	Theme
1	Rushton (1990) Galton, Epigenetics, and Human Life-History	1990	To revisit Galton's legacy and propose a biological and evolutionary model for personality and behavior.	Theoretical review and synthesis of genetic, epigenetic, and evolutionary psychology literature.	Traits are embedded in reproductive strategies; epigenetic rules shape behavioral development.	Evolutionary psychology; epigenetic rules; r/K theory	Controversial; theoretical with ideological implications.	Provides macro-level biological framing for behavior and personality development.	Genetics
2	The Determinants of Leadership Role Occupancy: Genetic and Personality Factors Arvey et al.	1994	To investigate the extent to which genetic and personality variables influence the likelihood of individuals occupying leadership roles.	Quantitative twin study using Minnesota Twin Registry data; behavioral genetic analysis.	Approximately 30% of variance in leadership role occupancy explained by genetic factors; extraversion mediates part of this effect.	Behavioral genetics; trait theory of leadership.	Leadership measured through role occupancy (not performance or perception); limited to male twins.	Pioneering evidence for heritability of leadership traits and tendencies; foundational in leadership genetics research.	Genetics
3	Bouchard (1994) Genes, Environment, and Personality	1994	To explore the genetic and environmental influences on personality development.	Review of twin studies, adoption studies, and molecular genetics.	Approximately 40-50% of personality variation is attributable to genetic differences.	Trait theory; behavioral genetics	Based largely on Western samples; environment often underdefined.	Established foundational estimates of heritability in personality traits.	Genetics
4	DNA and Personality Plomin & Caspi (1998)	1998	To explore new genetic methods identifying genes for personality and their implications for personality research.	Review of molecular genetics approaches including QTL (quantitative trait loci) and candidate gene studies.	Hereditly significantly influences personality. QTL mapping and gene-association studies (e.g., DRD4 with novelty-seeking) open new research avenues.	Quantitative genetics; molecular genetics; QTL model.	Early-stage methods; effect sizes small; inconsistent replication.	Pioneered linking specific genes to personality traits; promoted molecular methods in personality psychology.	Genetics

5	Nature vs Nurture: Are Leaders Born or Made? A Behaviour Genetic Investigation of Leadership Style - Andrew M. Johnson, Philip A. Vernon, Julie M. McCarthy, Mindy Molson, Julie A. Harris, Kerry L. Jang	1998	To investigate the heritability of leadership style using behaviour genetic methods and assess the extent to which transformational and transactional leadership are influenced by genetic and environmental factors.	Quantitative twin study involving 247 adult twin pairs using MLQ, LAE, and ACL questionnaires; univariate and multivariate genetic modelling.	Transformational leadership demonstrated non-additive heritability (~59%), while transactional leadership showed additive heritability (~48%). Significant shared genetic variance found across leadership measures.	Trait theory; transactional, transformational leadership model; behavioural genetics.	Self-report bias; gender imbalance in sample; lack of behavioural or subordinate evaluations; exploratory study.	First empirical behaviour genetic study of leadership style; provides foundational evidence for genetic influences on leadership traits.	Genetics
6	Johnson et al. (1998) A Behaviour Genetic Investigation of Leadership Style	1998	To assess the heritability of leadership styles using twin study methodology.	Twin study of 247 pairs using MLQ, Leadership Ability Evaluation, and Adjective Checklist.	Transactional leadership is 48% heritable; transformational leadership 59% heritable (non-additive genetic variance).	Behavioural genetics; transactional-transformational leadership theory	Self-reported measures; results based on Canadian population.	One of the first empirical demonstrations of heritable components in leadership styles.	Genetics
7	Plomin (2000) Behavioural Genetics in the 21st Century	2000	To outline future directions and key trends in behavioural genetics.	Theoretical review	Future behavioural research will focus more on gene-environment interplay and trait development.	Behavioural genetics; gene-environment interaction	Not empirical; conceptual projection of trends.	Seminal perspective on integrating genetics in behavioural science.	Genetics
8	Three Laws of Behaviour Genetics - Turkheimer (2000)	2000	To summarize and interpret the core findings of behaviour genetics in understanding human traits.	Theoretical analysis and summary of empirical twin studies.	All human behavioural traits are heritable; shared environment has less impact; nonshared environment contributes substantially.	Behaviour genetics paradigm based on twin studies.	Does not specify developmental mechanisms; primarily statistical inferences.	Established 'three laws' of behaviour genetics; shifted debate from nature vs. nurture to mechanisms of development.	Genetics
9	The Heritability of Emergent Leadership: Age and Gender Moderation allies, Gerhardt, & Le (2004)	2004	To examine the genetic and environmental influences on emergent leadership, including the moderating roles	Quantitative twin study using data from the Minnesota Twin Registry and structural equation modelling.	Heritability of emergent leadership was significant (~39%); genetic influences more pronounced in men and older individuals.	Behavioural genetics and leadership trait theory.	Relies on self-report and peer nominations; results may not generalize beyond twin populations.	Expands the understanding of leadership heritability by incorporating demographic moderators.	Genetics

			of age and gender.						
10	A Behaviour Genetic Investigation of the Relationship Between Leadership and Personality Johnson et al.	2004	To explore genetic links between personality traits and leadership styles.	Twin study using MLQ and PRF on 247 adult twin pairs (183 MZ, 64 DZ).	Transformational leadership correlated positively with extraversion, conscientiousness, and openness at genetic level; transactional leadership correlated with disagreeableness.	Trait theory; behavioural genetics.	Based on self-report; possible sample biases.	First demonstration of genetic overlap between personality and leadership styles.	Genetics
11	Implicit Power Motivation and Testosterone Schultheiss et al. (2005)	2005	To test if implicit power motivation influences learning and hormonal changes after social competition.	Two experimental studies with male and female participants measuring testosterone, learning tasks, and implicit motives.	Power-motivated individuals learn better after victories and worse after defeats; testosterone mediates effects, especially in men.	Implicit motivation theory; hormonal modulation of behaviour	Laboratory-based; limited to short-term contests and physiological proxies.	Links power motivation, behaviour, and biology; supports nonconscious learning processes.	Hormonal Influences
12	Job Preferences, Personality, and Genetics: A Behavioural Genetic Analysis of Work Motivations Arvey et al.	2006	To investigate the heritability of job preference dimensions such as autonomy, variety, and pay using behavioural genetic analysis.	Twin study using multivariate genetic modelling based on the Minnesota Twin Registry data.	Significant heritability was found for job preference dimensions; personality traits partially mediated genetic influences.	Behavioural genetics and work motivation theory.	Limited generalizability due to cultural and sample specificity; job preference measures may not fully capture real-world choices.	Provides empirical support that work motivation and job preferences have a genetic component influenced by personality traits.	Genetics
13	Neuroscience and Human Attachment Schore (2006)	2006	To review neurobiological evidence linking early attachment experiences with brain development and emotional regulation capacities.	Theoretical review synthesizing neurodevelopmental, psychodynamic, and affect regulation models.	Attachment experiences influence the development of the right brain, critical for emotional processing, stress regulation, and social functioning.	Affective neuroscience; attachment theory; right brain development model.	Lacks direct leadership application; primarily focused on early childhood and clinical contexts.	Provides neurobiological basis for emotional regulation and interpersonal behaviour, relevant for leadership under stress.	Neuroleadership
14	Moffitt et al. (2006) Gene-Environment Interaction in	2006	To assess how genetic risk interacts with life stress to predict	Longitudinal twin study using behavioural, genetic, and environmental measures.	MAOA gene moderates the impact of childhood maltreatment on	Gene-environment interaction model	Focused on antisocial behaviour; generalizability to	Landmark study showing how genes and environment	Genetics

	Psychosocial Development		antisocial behaviour.		later antisocial outcomes.		leadership limited.	jointly shape behaviour.	
15	Is the Tendency to Engage in Entrepreneurship Genetic? - Nicos Nicolaou, Scott Shane, Lynn Cherkas, Janice Hunkin, Tim Spector	2008	To investigate whether the tendency to engage in entrepreneurship is influenced by genetic factors using a behavioural genetics framework.	Quantitative twin study using a sample of 3,000 twin pairs from the UK; univariate genetic modelling applied to self-employment data.	Genetic factors account for more than 48% of the variance in the tendency to engage in entrepreneurship. Environmental influences were also significant but less so.	Behavioural genetics; entrepreneurship theory.	Entrepreneurship measured only via self-employment; UK-only sample limits generalizability.	First behavioural genetic study to empirically examine the heritability of entrepreneurship.	Genetics
16	Nicolaou et al. (2008) Is the Tendency to Engage in Entrepreneurship Genetic?	2008	To empirically investigate whether the tendency to engage in entrepreneurship is heritable.	Twin study using 609 MZ and DZ twin pairs; behavioural genetic modelling.	Heritability of entrepreneurship estimated at 48%; shared environmental factors not significant.	Behavioural genetics	Sample based on UK twins; limited to self-reported entrepreneurship.	Empirical demonstration of genetic contribution to entrepreneurial behaviour.	Genetics
17	The Biology of Leadership Bennis, Goleman & O'Toole	2009	To explore how biological systems, especially neural and hormonal pathways, influence leadership capabilities and development.	Theoretical and narrative synthesis with anecdotal and expert commentary; draws on neuroscience and behavioural biology.	Biological traits such as emotional intelligence, stress regulation, and empathy are grounded in brain function and hormonal systems; leadership capacities may be biologically predisposed but developed over time.	Integrative neurobiological and emotional intelligence theory.	Non-empirical; relies heavily on conceptual synthesis and expert views.	Popularized the idea that biology, particularly brain-based mechanisms, can inform leadership theory and practice.	Neuroleadership
18	Nicolaou & Shane (2009) Can Genetic Factors Influence the Likelihood of Engaging in Entrepreneurial Activity?	2009	To explore how genetic variation may influence the tendency to engage in entrepreneurship.	Conceptual review of genetic influence on psychological traits relevant to entrepreneurship.	Proposes that genetic factors affect entrepreneurship via traits like extraversion, risk-taking, and innovativeness.	Behavioural genetics; biosocial perspective	Non-empirical; theoretical assumptions based on twin studies.	Links entrepreneurship to inherited personality traits, extending biological leadership theories.	Genetics
19	Beyond Genetic Explanations for Leadership - Zhang et al. (2009)	2009	To investigate how social environment moderates genetic effects on	Twin study with behavioural genetic modelling and moderation analysis.	Genetic effects on leadership are moderated by adolescent family	Gene-environment interaction (GxE) theory.	Possible gene-environment correlations; limited generalizability	Demonstrates importance of social context in genetic influence on leadership.	Genetics

			leadership role occupancy.		environment (SES, support, conflict).		beyond twin samples.		
20	When are low testosterone levels advantageous? - Mehta, Wuehrmann, & Josephs	2009	To test whether testosterone's effect on performance depends on the type of competition: individual vs. intergroup.	Experimental design with 60 participants (50% female); analytical reasoning tasks; salivary testosterone measures.	High testosterone improved performance in individual competition; low testosterone improved performance in intergroup settings.	Status-seeking vs. cooperation motivations; social modulation of hormonal effects.	Lab-based setting; moderate sample size; task type limited to cognitive performance.	Shows context-dependent effect of testosterone on performance.	Hormonal Influences
21	Testosterone responses to competition predict future aggressive behaviour - Carr, Putnam, & McCormick	2009	To examine how trait dominance and testosterone changes predict aggression after competition.	Behavioural experiment with 99 participants; PSAP aggression task after rigged competition; salivary testosterone and trait dominance measures.	Aggression post-defeat linked to testosterone rise; baseline testosterone not predictive.	General Aggression Model (GAM); dynamic hormone-behaviour relationship.	Gender differences not deeply explored; artificial setting.	Demonstrates state hormone effects on future aggression; bridges personality and endocrinology.	Hormonal Influences
22	It Is Not Just About Testosterone - Lienesch & Josephs (2010)	2010	To explore the physiological mediators and moderators influencing testosterone's effects on social behaviour.	Theoretical review of biological systems including hormone interactions and genetic moderators.	Testosterone's influence is affected by vasopressin, cortisol, estradiol, serotonin transporter genes, and monoamine oxidase A expression.	Social endocrinology; biopsychosocial model of hormone behaviour interaction.	Conceptual; lacks new empirical data.	Provides a nuanced understanding of testosterone's behavioural effects within complex biological systems.	Hormonal Influences
23	Testosterone and cortisol jointly regulate dominance: A dual-hormone hypothesis - Mehta & Josephs	2010	To test whether testosterone predicts dominance only when cortisol is low.	Two studies: leadership (mixed-sex sample) and competition (male-only sample) with hormone assays and behavioural ratings.	Testosterone predicts dominance when cortisol is low; reversed or null when cortisol is high.	Dual-hormone hypothesis; interaction of HPG and HPA axes.	Hormonal influences vary by stress context; limited generalizability.	First empirical support for dual-hormone hypothesis in humans.	Hormonal Influences
24	Neuroscience and the emergence of neuroleadership Waldman et al.	2011	To outline the emergence of neuroleadership as a field and assess its methodological and theoretical challenges.	Conceptual paper with critical review of neuroscience applications in leadership.	Neuroleadership integrates neuroscience into leadership studies to enhance understanding of decision-making and behaviour; calls for	Cognitive neuroscience; integrative leadership theory.	Limited empirical backing at the time; potential overreach without interdisciplinary collaboration.	Frames the intellectual foundation for neuroleadership; sets agenda for future empirical work.	Neuroleadership

					methodological caution.				
25	Genetic Underpinnings of Transformational Leadership: The Mediating Role of Dispositional Hope Chaturvedi et al.	2011	To investigate whether dispositional hope mediates the genetic influence on transformational leadership behaviour.	Twin study with 392 female twins (107 monozygotic, 89 dizygotic) from the Minnesota Twin Registry; structural equation modelling.	49% of variance in transformational leadership and 53% in hope was genetically influenced; dispositional hope mediated ~21% of the genetic effect on leadership.	Behavioural genetics; transformational leadership theory; positive organizational behaviour.	Focused on a female-only sample; self-reported leadership behaviour; cross-sectional design.	First empirical study linking dispositional hope as a mediator between genes and leadership; highlights psychological mechanisms of genetic influence.	Genetics
26	Leader Emergence and Variation Across Nations Zhaoli Song et al.	2011	To explore genetic and environmental influences on leadership emergence across cultures.	Behavioural genetics twin study using Chinese and American samples.	Leadership emergence moderately heritable (~32%); shared environment more influential in China than USA.	Behavioural genetics; cross-cultural leadership theory.	Small Chinese sample; cross-sectional; no exploration of leadership effectiveness.	Introduces cultural moderation in genetic influence on leadership emergence.	Genetics
27	Genetic and neurological foundations of customer orientation Bagozzi et al.	2011	To examine biological (genetic and neurological) bases of customer vs. sales orientation.	Three-part study: field survey, genetic testing (DRD4 gene), and fMRI analysis.	Customer orientation linked to DRD4-7R gene variant and higher mirror neuron activation.	Neurobiological and genetic underpinning of sales behaviour.	Limited generalizability; focus on salespeople; self-report measures.	Links leadership-oriented selling traits with neurological and genetic markers.	Neuroleadership
28	The Role of Testosterone in Social Interaction - Eisenegger, Haushofer, & Fehr	2011	To review and evaluate testosterone role in human social behaviour including dominance and aggression.	Review of experimental and correlational studies across humans and animals.	Testosterone affects dominance and status-seeking more than aggression per se; causality confirmed in experimental hormone administration.	Status-seeking motivational model; Challenge Hypothesis.	Review article does not provide new empirical data.	Synthesizes recent evidence for status-related functions of testosterone in humans.	Hormonal Influences
29	The Nature of Leadership (Antonakis & Day (Eds.))	2012	To offer a comprehensive synthesis of leadership theories, research, and biological, psychological, and contextual influences.	Edited volume compiling empirical and conceptual chapters from leading scholars across subfields.	Leadership is a multidimensional phenomenon shaped by individual traits (e.g., intelligence, personality), context, and potentially biological foundations such	Integrative leadership theory; trait and contingency models; biological underpinnings discussed in some chapters.	Conceptual breadth limits empirical specificity: multiple authors yield variable depth across chapters.	Seminal volume consolidating diverse approaches to leadership science; sets agenda for interdisciplinary inquiry.	Genetics

					as hormones and heritability.				
30	Genetic Underpinnings of Transformational Leadership: The Mediating Role of Extraversion - Sankalp Chaturvedi, Michael J. G. Pflughoeft, Stacie F. Williams	2012	To examine whether genetic influences on transformational leadership are mediated through personality traits, particularly extraversion.	Behavioural genetics approach using twin study design; biometric modelling to analyze genetic and environmental influences.	Transformational leadership is heritable. Extraversion significantly mediates the genetic effects on transformational leadership.	Behavioural genetics and personality theory (Big Five model).	Sample limited to twins from a single database; cross-sectional design; generalizability concerns.	Offers empirical evidence linking genetics, personality, and leadership; enhances understanding of trait-based leadership development.	Genetics
31	A Discovery Genome-Wide Association Study of Entrepreneurship - Lydia Quaye, Nicos Nicolaou, Scott Shane, Massimo Mangino	2012	To identify specific genetic variants associated with the tendency to engage in entrepreneurship using genome-wide association methods.	Genome-wide association study (GWAS) using 3,933 Caucasian females from the TwinsUK cohort; analysis of SNPs using GWAF with logistic regressions.	No SNPs reached genome-wide significance, but suggestive associations were identified for variants in OPCML, KIAA1199, SYT13, and PARD3B. Each SNP had small effects, accounting for <1% of variance in entrepreneurship.	Behavioural genetics; genome-wide association methodology.	No associations met genome-wide significance; small sample size; phenotype operationalization based on self-report; female-only sample limits generalizability.	First published GWAS of entrepreneurship; demonstrates complexity and small effect sizes of genetic influences on entrepreneurial behavior.	Genetics
32	Genetic Underpinnings of Transformational Leadership: The Mediating Role of Extraversion - Sankalp Chaturvedi, Michael J. G. Pflughoeft, Stacie F. Williams	2012	To examine whether genetic influences on transformational leadership are mediated through personality traits, particularly extraversion.	Behavioural genetics approach using twin study design; biometric modelling to analyze genetic and environmental influences.	Transformational leadership is heritable. Extraversion significantly mediates the genetic effects on transformational leadership.	Behavioural genetics and personality theory (Big Five model).	Sample limited to twins from a single database; cross-sectional design; generalizability concerns.	Offers empirical evidence linking genetics, personality, and leadership; enhances understanding of trait-based leadership development.	Genetics
33	A Discovery Genome-Wide Association Study of Entrepreneurship Quaye et al.	2012	To identify genetic variants associated with entrepreneurship using GWAS.	GWAS using 3,933 women from Twins UK; logistic regression on SNP data.	No genome-wide significant SNPs; suggestive associations found; SNP effects small.	Behavioural genetics; entrepreneurship genetics.	Female-only sample; no SNP reached genome-wide significance; phenotype	First GWAS on entrepreneurship; shows complexity of genetic contributions.	Genetics

							measured by self-report.		
34	The Hidden Dimensions of the Competition Effect - Zilioli & Watson	2012	To test the dual-hormone hypothesis in a videogame competition and assess testosterone reactivity based on pre-existing hormone levels.	Experimental study with 70 male participants; Tetris competition with hormone sampling before and after.	Only participants with high baseline testosterone and low baseline cortisol showed testosterone increases after winning.	Dual-hormone hypothesis; biosocial model of status.	Male-only sample; artificial setting of videogame task.	Provides additional empirical support for dual-hormone interaction in dominance contexts.	Hormonal Influences
35	An ACE in the Hole: Twin Family Models for Applied Behavioural Genetics Zyphur et al.	2013	To demonstrate how extended twin family models can improve behavioural genetic estimates for leadership and personality traits.	Conceptual and empirical paper using structural equation modelling on the Virginia 30,000 twin family dataset.	Standard twin models may underestimate shared environmental effects; extended models offer better estimates by incorporating parent-child transmission and gene-environment correlation.	Behavioural genetics; ACE and ADE modelling framework.	Relies heavily on structural modelling assumptions; application focused on extraversion rather than direct leadership behaviours.	Introduces advanced twin family modelling for more accurate heritability estimates in leadership and personality research.	Genetics
36	Trait and behavioural activation system responses to rewarding and frustrating leadership situations Ellingson & Sheldon (2013)	2013	To examine how leadership-relevant traits interact with the Behavioural Activation System (BAS) and Behavioural Inhibition System (BIS) in response to leadership challenges.	Experimental vignette study with personality and motivation assessments based on trait activation theory.	Individuals with high BAS sensitivity responded more positively to rewarding leadership scenarios, while high BIS individuals were more reactive to frustration or conflict.	Dual-system theory (BAS/BIS); trait activation theory.	Limited ecological validity: leadership contexts are hypothetical.	Demonstrates that leadership perception and behaviour are mediated by neurobiological motivational systems; supports integration of traits and situational factors.	Neuroleadership
37	Zovkic et al. (2013) Epigenetic Mechanisms in Memory and Cognitive Decline	2013	To examine how epigenetic regulation affects memory processes and cognitive aging.	Review of molecular and neuroepigenetic studies in animal models.	Epigenetic changes influence memory encoding and consolidation; potential for reversibility.	Epigenetic regulation in neuroscience	Animal-focused, limited direct leadership application.	Links molecular biology to behavioural outcomes like memory foundational for learning-based leadership.	Neuroleadership

38	Biology, Neuroscience, and Entrepreneurship - Nicolaou & Shane (2013)	2013	To advocate for the integration of neuroscience into entrepreneurship research.	Conceptual essay and literature review.	Genetics and hormones influence entrepreneurship; neuroscience offers new insights into entrepreneurial cognition.	Biological and cognitive psychology perspectives.	Lack of empirical neuroscience studies in entrepreneurship at the time.	Call to broaden methodological approaches in entrepreneurship research.	Neuroleadership
39	Endogenous testosterone and cortisol jointly influence reactive aggression in women - Denson et al.	2013	To test the dual-hormone hypothesis by examining interactions between baseline testosterone and cortisol on reactive aggression in women.	Laboratory experiment with 53 female undergraduates using a competitive aggression paradigm and hormonal assays.	Testosterone predicted aggression and dominance only when cortisol was high; aggression increased after provocation and was influenced by hormonal interaction.	Dual-hormone hypothesis; biosocial model of status.	Small sample; limited to women; artificial aggression task.	Demonstrates hormonal interaction effects in female aggression, extending dual-hormone theory.	Hormonal Influences
40	Testosterone dynamics and psychopathic traits predict antagonistic behaviour - Geniole et al.	2013	To assess how testosterone changes and psychopathic traits influence antagonistic behaviour after competition.	Experimental study with 201 undergraduates using saliva sampling and personality inventories before and after a rigged competitive task.	In men, testosterone reactivity and fearless dominance predicted antagonism; no endocrine predictors in women; no cortisol interaction found.	Challenge hypothesis, biosocial model of status, dual-hormone hypothesis.	Self-report biases: rigged competition may reduce external validity.	Highlights individual differences and hormonal responses as predictors of post-competition behaviour.	Hormonal Influences
41	The Biology of Leadership - Richard D. Arvey, Nan Wang, Zhaoli Song, Wendong Li	2014	To summarize biological factors associated with leadership emergence and effectiveness, and to provide directions for future research.	Literature review across domains: behavioural genetics, evolutionary psychology, hormonal/neurological studies, comparative animal studies.	Leadership is moderately heritable (~30%). Biological factors such as genetics, hormones (e.g., testosterone), neurotransmitters, and physical traits influence leadership emergence. Interactions between genetic and environmental factors are significant.	Trait-based and evolutionary psychology perspectives; behavioral genetics models.	Limited empirical research directly linking biology to leadership effectiveness; conceptual ambiguity; interdisciplinary challenges.	Establishes biological basis for leadership; integrates diverse research strands into organizational behaviour.	Neuroleadership

42	A Phenotypic Null Hypothesis for the Genetics of Personality - Turkheimer et al. (2014)	2014	To critically evaluate the role of heritability in understanding personality.	Review of quantitative genetic literature; twin studies.	Personality traits are heritable; shared environment has negligible effect; emphasizes phenotypic over genetic explanations.	Phenotypic null hypothesis in behavioural genetics.	Challenges the utility of heritability coefficients; does not provide causal pathways.	Encourages a shift from heritability to phenotypic and mechanistic models.	Genetics
43	Dominant, cold, avoidant, and lonely: Basal testosterone as a biological marker - Turan et al.	2014	To explore interpersonal personality traits associated with basal testosterone using a circumplex interpersonal model.	Correlational study with 85 male undergraduates completing personality inventories and saliva assays.	High testosterone associated with dominance, interpersonal coldness, avoidance, and loneliness.	Interpersonal circumplex theory, attachment theory.	Correlational design; limited demographic (young male students).	Identifies testosterone as a marker for a specific interpersonal style involving low communion and high agency.	Hormonal Influences
44	Competition Outcomes and Testosterone Change in Men and Women (Apicella et al., 2014)	2014	To analyses how competition outcomes affect testosterone changes and subsequent risk-taking.	Behavioural economic tasks with hormonal assays.	Testosterone changes correlate with risk behaviour in men post-competition; no consistent effect in women.	Biosocial status model.	Limited sample size; indirect behavioural measurement.	Adds evidence for gender differences in hormonal-behavioural links.	Hormonal Influences
45	Testosterone, cortisol, and psychopathic traits in men and women Welker et al.	2014	To examine independent and interactive effects of testosterone and cortisol on psychopathic traits.	Correlational study with 237 adults using saliva samples and psychopathy scales.	Testosterone and cortisol correlated with psychopathy in men; cortisol moderated the T-psychopathy link.	Dual hormone hypothesis.	Cross-sectional design; limited generalizability beyond university sample.	Supports interaction of hormones in predicting antisocial traits in non-clinical population.	Hormonal Influences
46	Phenotypic, Genetic, and Environmental Relationships Between Self-Reported Talents and Measured Intelligence - Julie Aitken Schermer, Andrew M. Johnson, Kerry L. Jang, Philip A. Vernon	2015	To examine the relationships between self-reported talents and measured intelligence at phenotypic, genetic, and environmental levels.	Quantitative twin study using 516 participants (twins and siblings); intelligence assessed with the Multidimensional Aptitude Battery; self-report talent scale adapted from Lykken et al. (1993); genetic modelling using ACE, AE, and CE models.	Self-reported talents showed modest correlations with measured intelligence; many of these relationships had shared genetic or environmental bases. Heritability estimates ranged from 42% to 68% for ability factors	Behavioural genetics; self-assessed intelligence and ability; ACE genetic modelling.	Small sample size; gender imbalance; potential response bias in self-assessment; limited generalizability.	Provides empirical evidence for genetic and environmental influences linking self-perceived talents and cognitive ability.	Genetics

					and up to 83% for intelligence subtests.				
47	Heritability Estimates of the Big Five Personality Traits Power & Pluess	2015	To assess heritability of Big Five traits using common genetic variants via GREML.	Genomic GREML analysis using 5011 UK participants and 527,469 SNPs.	Openness (21%) and neuroticism (15%) showed significant heritability; full genetic overlap ($r_G=1.0$) between them.	Personality genetics; GREML heritability estimation.	Only two traits significant; limited power to detect small effects; GREML captures common variants only.	First GREML-based shared and unique heritability estimate for all Big Five traits.	Neuroleadership
48	The Heritability of Job Satisfaction Hahn et al.	2015	To reassess the heritability of job satisfaction and its overlap with personality traits using refined genetic modelling.	Behaviour genetic twin study with 622 German twins (185 MZ, 126 DZ); multivariate modelling of genetic/environmental paths.	28% of variance in job satisfaction explained by genetics via personality; remaining variance due to unique environment.	Behavioural genetics; interactionist job satisfaction model.	Sample limited to German twins; relies on self-report measures; generalizability may be constrained.	Clarifies earlier mixed findings; shows heritability of job satisfaction mediated entirely by personality.	Genetics
49	Yarnall (2015) Shedding New Light on the Genetics of Leadership	2015	To explore the implications of genetic research for leadership development and HR practices.	Narrative review and conceptual synthesis of existing genetic studies on leadership.	Identifies SNP rs4950 linked with leadership role occupancy; advocates caution in interpreting genetic data for HR use.	Behavioural genetics and epigenetics integration	Non-empirical; conceptual with speculative insights.	Highlights ethical and practical implications of applying genetics in leadership identification.	Genetics
50	Low free testosterone is associated with hypogonadal signs and symptoms in men with normal total testosterone levels Antonio et al.	2015	To determine whether low free testosterone (FT) is associated with hypogonadal symptoms even in the presence of normal total testosterone (TT).	Cross-sectional study involving 3369 European men aged 40-79; hormonal levels and symptoms assessed using questionnaires and blood tests.	Men with normal TT but low FT had significantly more symptoms of androgen deficiency than those with both normal TT and FT; FT was a better indicator than TT.	Endocrine diagnostic guidelines; hormonal basis of androgen deficiency.	Cross-sectional design; limited to older European males.	Supports including FT in diagnostic criteria for hypogonadism.	Hormonal Influences
51	The Interaction of Testosterone and Cortisol Is Associated with Attained Status in Male Executives Sherman et al.	2015	To test whether testosterone and cortisol jointly predict real-world status attainment among male executives.	Correlational study measuring hormone levels and number of subordinates in 57 male executives.	Executives with high testosterone and low cortisol held more subordinates, supporting the dual-hormone hypothesis.	Dual-hormone hypothesis; biosocial model of status.	Cross-sectional; male-only sample; correlational limits causality.	Links hormone profiles to leadership attainment in organizational contexts.	Hormonal Influences

52	Competing Sexes, Power, and Testosterone Vongas & Al Hajj	2015	To propose a biopsychosocial model linking competition, testosterone, and empathy.	Theoretical model and literature synthesis.	Competition affects testosterone and subsequent empathic responses, moderated by implicit power motivation.	Biopsychosocial model; implicit power motivation theory.	Theoretical model; lacks empirical testing.	Introduces a novel integrative framework to examine hormone-empathy link in organizations.	Hormonal Influences
53	Exogenous testosterone in women and competitive decision-making Mehta et al.	2015	To test causal impact of testosterone on competition decisions in women.	Experimental hormone administration with 54 female participants.	Testosterone enhanced competitive behaviour after victory among dominant women; reduced it after defeat across all.	Challenge hypothesis; biosocial model of status.	Small, female-only sample; lab-based competition context.	Evidence for contextual and personality-moderated hormonal effects on behaviour.	Hormonal Influences
54	Testosterone and cortisol jointly modulate risk-taking Mehta et al.	2016	To test whether the dual-hormone hypothesis explains risk-taking behaviour using testosterone and cortisol interactions.	Experimental lab study measuring hormone levels and risk preferences using behavioural tasks.	Testosterone predicted risk-taking only when cortisol was low, supporting the dual-hormone hypothesis.	Dual-Hormone Hypothesis (testosterone \times cortisol interaction).	Limited generalizability; sample from controlled lab environment; narrow behavioural domain.	Empirical support for dual-hormone hypothesis in predicting behavioural tendencies relevant to leadership and dominance.	Hormonal Influences
55	It Is Also in Our Nature: Genetic Influences on Work Characteristics Wen-Dong Li et al.	2016	To examine genetic influences on work characteristics and their links to well-being.	Behavioural genetic twin study; US national twin sample using structural equation modelling.	Job demands, control, and complexity showed genetic influences; well-being links partly genetic.	Job demand-control-support model; behavioural genetics; core self-evaluations.	Cross-sectional; self-report bias; generalizability limited.	Highlights individual genetic contribution to job perceptions and well-being.	Genetics
56	The Biology of Leadership Richard D. Arvey & Wen-Dong Li	2016	To summarize findings on biological underpinnings of leadership behaviours using genetics and neuroscience.	Literature review and integration of twin studies, molecular genetics, and neuroimaging.	Leadership traits and emergence show heritability (30-60%); specific genes (e.g., rs4950) implicated; brain structure and hormone levels also relevant.	Behavioural genetics; neurobiological leadership models.	Limited causal inference; complexity of gene-environment interaction; need for replication.	Integrates biology into leadership models; proposes holistic biopsychosocial frameworks.	Neuroleadership
57	Basal testosterone, leadership and dominance – van der Meij,	2016	To examine the relationship between basal testosterone and leadership or dominance in	Field study with 125 male employees; salivary testosterone sampling; leadership self-assessment;	Testosterone was weakly linked to dominant styles in non-leaders, but unrelated to actual leadership or	Biosocial model of status; dominance-prestige theory; challenge hypothesis.	Gender-limited sample; only basal hormone levels measured; cultural context limited to	Refines understanding of hormone-leadership link, separating dominance from	Hormones and Leadership

	Schaveling & Van Vugt (2016)		organizational settings, and to validate through a meta-analysis.	meta-analysis across 9 studies (n=1103).	income. Meta-analysis showed no significant association between testosterone and leadership.		Netherlands; self-report bias.	leadership capacity in modern organizations.	
58	Peplonska et al. (2016)	2016	To assess association between specific genetic polymorphisms and elite athletic performance.	Genotyping study of 413 elite athletes and 451 controls in Poland.	Certain genetic variants (e.g., ACE, FAAH) are associated with endurance/power traits and leadership-linked behaviours.	Genetic determinism in physical and psychological traits.	Population-specific findings; results may not generalize beyond Polish athletes.	Links specific genes to elite performance and psychological traits related to leadership.	Genetics
59	It Is Also in Our Nature: Genetic Influences on Work Characteristics Wen-Dong Li et al.	2016	To examine genetic influences on work characteristics and their links to well-being.	Behavioural genetic twin study; US national twin sample using structural equation modelling.	Job demands, control, and complexity showed genetic influences; well-being links partly genetic.	Job demand-control-support model; behavioural genetics; core self-evaluations.	Cross-sectional; self-report bias; generalizability limited.	Highlights individual genetic contribution to job perceptions and well-being.	Genetics
60	Individual Differences as Antecedents of Leader Behaviour - Tunçdoğan et al. (2017)	2017	To classify and integrate leadership literature on individual differences and their effects on multilevel leadership outcomes.	Theoretical review and model development based on Antonakis et al. (2012) framework.	Physiological and psychological traits significantly influence leadership behaviours and multilevel outcomes; fragmentation in the field hinders integration.	Leadership Process Model (Antonakis et al., 2012)	Conceptual integration; lacks primary empirical data.	Provides a structured research agenda; helps unify fragmented leadership trait literature.	Genetics
61	Hormonal underpinnings of status conflict: Testosterone and cortisol are related to decisions and satisfaction in the hawk-dove game Mehta et al.	2017	To explore the role of testosterone and cortisol in status-related decision-making using the hawk-dove game.	Lab-based behavioural experiment with 98 undergraduate students measuring hormone levels and decisions across 10 game rounds.	Higher testosterone and lower cortisol were linked to dominant (hawk) strategies and increased game satisfaction; supported the dual-hormone hypothesis.	Challenge hypothesis; dual-hormone hypothesis; game theory.	Student sample: artificial lab setting may limit ecological validity.	Demonstrates hormonal influence on status competition and strategy choice.	Hormonal Influences
62	Nofal et al.	2017	To conduct a systematic review of the emerging	Systematic review of 291 papers published in 133 journals over	Presents an organizing framework for the	Biological perspective in management.	Comprehensive review but does not present new	Provides a broad overview and research agenda	Genetics, Hormonal

			literature on the biological perspective in management, investigating research spanning genetics, physiology, and neuroscience.	85 years, plus conference papers and books.	biological perspective in management, explains mechanisms through which biological factors relate to management, and discusses implications for theory and practice		empirical findings.	for biological factors in management, including leadership	Influences, Neuroleadership
63	Sanchez-Roige et al.	2017	To review recent developments in identifying genetic variants that influence personality.	Review of twin studies, linkage studies, candidate gene association studies, genome-wide association studies, and polygenic analyses.	Genetic variants that influence personality are increasingly being identified. Personality has a highly polygenic etiology, like neuropsychiatric diseases	Behavioural genetics, molecular genetics.	Focuses on personality generally, not specific to leadership.	Updates understanding of the genetic etiology of personality, which is foundational to leadership	Genetics
64	Edelson et al.	2018	To identify the effects of responsibility on leaders' choices at the behavioural and neurobiological levels.	Behavioural and neurobiological studies.	Document the widespread existence of responsibility aversion in leaders, a reduced willingness to make decisions if the welfare of others is at stake. This is driven by an increased demand for certainty about the best choice	Neuroeconomics, decision-making under responsibility.	Not specified in excerpt.	Identifies a neurobiological and computational foundation for leadership decisions, particularly aversion to responsibility	Neuroleadership
65	Zwir et al.	2018	To uncover the complex genetic architecture of human character, specifically self-regulatory personality traits.	Machine learning method for genome-wide association studies applied to Temperament and Character Inventory data.	Self-regulatory personality traits are strongly influenced by organized interactions among more than 700 genes, explaining 50-58% of character heritability. These	Behavioural genetics, molecular genetics.	Early stage of GWAS; complex interactions among many genes	Identifies specific gene networks influencing self-regulatory personality traits relevant to leadership	Genetics

					genes modulate brain processes for goal setting, self-reflection, empathy, and learning				
66	Dimitriadou et al.	2019	To investigate the heritability of leadership tendencies in non-human animal groups and how it influences other behavioral traits.	Selective breeding experiment with Trinidadian guppies over three filial generations.	Heritability was investigated for leadership tendencies in guppies during predator inspection. Higher leadership was associated with willingness to accept risk (boldness) and low sociability	Behavioral genetics, animal behavior.	Animal study: generalizability to human leadership needs careful consideration.	Demonstrates heritability of leadership traits in a non-human species, providing an evolutionary context	Genetics
67	Luria et al.	2019	To test the moderating role of group properties in the relationship between leadership attributes (cognitive ability and adjustment) and leadership potential.	Trait activation theory framework, investigating organizational and social cues.	Leadership attributes are more likely to be activated (leading to leadership potential) in more centralized groups and in groups where others have lower levels of the studied attribute	Trait activation theory.	Not specified in excerpt.	Highlights how contextual factors moderate the expression of leadership potential based on individual traits	Neuroleadership
68	Are Identical Twins More Similar in Their Decision-Making Styles? Saad et al.	2019	To assess genetic influence on decision-making styles using twin methodology.	Two twin studies using psychometric scales (GDMS, MAX) and computerized behavioural choice tasks.	MZ twins showed significantly greater similarity than DZ twins in decision-making styles and behaviours, suggesting a genetic component.	Behavioural genetics; decision theory.	Small sample sizes; potential power limitations for some subscales.	Provides evidence that decision-making tendencies may have genetic underpinnings.	Genetics
69	Hormonal Contraceptive Use Affects Women's Endocrine Response to Status Competition	2019	To examine how hormonal contraceptives modulate testosterone responses in women during competition.	Experimental study comparing naturally cycling women and contraceptive users in competitive tasks.	Contraceptive use blunts testosterone reactivity; natural cycling women show increases tied to competitive outcomes.	Challenge hypothesis in gendered hormonal context.	Focus on hormonal data; may overlook psychological variables.	Highlights influence of hormonal contraceptives on competitive hormonal dynamics.	Hormonal Influences

	(Mehta et al., 2019)								
70	Nicolaou & Shane (2020)	2020	To determine the genetic contribution to general and domain-specific risk-taking preferences and behaviours.	Twin study using 1898 MZ and 1344 DZ twins from the UK.	Substantial genetic overlap between general and specific risk preferences and behaviours.	Behavioural genetics; biosocial perspective.	Sample limited to UK twins; generalizability may be constrained.	Supports a genetic basis for risk-taking, extending to financial and entrepreneurial behaviour.	Genetics
71	Li et al.	2020	To examine if becoming a leader can change an individual's personality.	Two three-wave longitudinal studies using a quasi-experimental design.	Individuals promoted to leadership roles experienced increases in job role demands, fostering growth in conscientiousness and emotional stability	Dynamic, role-based perspective on personality.	Quasi-experimental design; not a true experiment.	Suggests that personality can adapt and develop in response to leadership roles, challenging purely static trait views	Genetics
72	Eva et al.	2020	To investigate leader emergence, particularly in adolescent girls, and factors influencing it.	Review of literature on leader emergence and development.	Leader emergence is linked to heritable personality traits like extraversion and sociability. Heritability typically accounts for 30-50% of the variance in human characteristics	Biopsychosocial perspective, trait theory of leadership.	Focuses on adolescent girls; may not generalize to all populations or contexts	Provides a biopsychosocial framework for understanding leader development, integrating genetic, psychological, and socio-environmental factors	Genetics
73	Eckardt et al.	2020	To review existing empirical research to understand the effect of leadership on human capital resource emergence.	Review of 132 empirical articles.	Leaders impact the process through which individual-level human capital emerges into a valuable unit-level human capital resource	Multilevel theory of human capital resource emergence.	Review of existing literature, no new empirical data.	Provides a framework for understanding how leaders influence the development and utilization of human capital within organizations	Neuroleadership
74	Testosterone Reactivity to Competition and Competitive Endurance in	2020	To link testosterone changes to real-time competitive behaviour.	Two experimental studies using weight-holding task and salivary testosterone measures.	Positive testosterone reactivity predicts performance in men; moderated by	Challenge hypothesis; biosocial model of status.	Hormonal responses may differ by task and context; limited	Extends challenge hypothesis to competitive endurance.	Hormonal Influences

	Men and Women (Casto et al., 2020)				status outcomes and social context.		by lab simulations.		
75	The Neurobiology of Human Social Behaviour - Cheng & Kornienko	2020	Review how testosterone and cortisol underpin dynamics of social competition and affiliation.	Comprehensive literature review on hormonal influences in human and primate behaviour.	Testosterone promotes competition and status-seeking; cortisol relates to affiliation and social threat responses.	Challenge hypothesis, behavioural endocrinology.	Review nature limits experimental control; generalizability depends on study quality.	Synthesizes hormonal theories of social behaviour; proposes methodological improvements.	Hormonal Influences
76	Leader Emergence and Affective Empathy: A Dynamic Test of the Dual-Hormone Hypothesis - Vongas, Al Hajj, Fiset	2020	To test how testosterone and cortisol interact with power motivation to predict personal distress in emerging male leaders.	Experimental study with 96 males, measuring hormonal changes during leadership emergence.	Dual-hormone interactions predicted emotional responses; high power motive moderated testosterone response.	Dual-hormone hypothesis, evolutionary psychology.	Male-only sample; experimental context may not reflect real-world leadership.	Adds nuance to hormone-based leadership theories by linking physiological changes to emotional states.	Hormonal Influences
77	Song et al.	2022	To conduct a large-scale genome-wide investigation of leadership phenotypes and their overlap with other traits.	Whole-genome investigation.	Identified genome-wide significant loci for leadership phenotypes, which overlap with top hits for bipolar disorder, schizophrenia, and intelligence. Demonstrated the polygenetic nature of leadership and positive genetic correlations with well-being indicators	Molecular genetics, polygenic inheritance.	Complex genetic architecture: specific functional mechanisms not fully elucidated	Presents the largest whole-genome investigation of leadership phenotypes to date, revealing biological underpinnings and links to other mental health traits	Genetics
78	Ego-Boosting Hormone - Zajenkowski et al. (2023)	2023	To investigate the relationship between narcissism and testosterone levels using self-reports and blood-based data.	Correlational study with psychological assessments and biological hormone measures.	Grandiose narcissism is positively associated with testosterone; highlights hormonal basis of status-related traits.	Personality and social dominance theory	Focuses on narcissism; unclear generalizability to broader leadership constructs.	Links self-perceived status traits to biological correlates.	Hormonal Influences

79	Introduction to the Special Issue Hormones and Hierarchies Editorial	2023	To synthesize current findings on the interplay of hormones and social hierarchies across species.	Editorial synthesis of 17 empirical and review articles from a special issue.	Hormones like cortisol, prolactin, and testosterone influence status, stress, and reproductive behaviour in varied species and contexts.	Cost of dominance; stress of subordination; endocrine mediation of social status.	Does not present original data; overview nature limits specific conclusions.	Provides a timely synthesis of developments in behavioural endocrinology of social hierarchies.	Hormonal Influences
80	Ego-Boosting Hormone: Self-Reported and Blood-Based Testosterone Are Associated with Higher Narcissism - Zajenkowski et al.	2023	To examine associations between grandiose narcissism and both self-reported and blood-based testosterone levels.	Correlational study with 283 adult men measuring testosterone (self-reported and blood-based) and narcissism facets.	Agentic narcissism positively associated with both testosterone measures; findings support hormonal basis for narcissistic traits.	Status-regulation model, evolutionary psychology.	Cross-sectional design limits causal inference: only male participants included.	Demonstrates hormonal correlates of specific narcissistic tendencies; clarifies testosterone's role in status pursuit.	Hormonal Influences
81	Marques	2023	To detect and measure the emotional arousal of business professionals during decision-making processes under acute stress.	Experiment to detect and measure emotional arousal, potentially using techniques like Galvanic Skin Response.	Leaders constantly deal with stress and decision-making. The impact of acute stress on decision-making is a relevant area for Neuroleadership to evaluate decisions and create coping tools	Neuroleadership.	Not specified in excerpt.	Emphasizes the role of Neuroleadership in understanding and managing the impact of acute stress on leader decision-making	Neuroleadership
82	Testosterone Peaks and Leadership in Startup Founders – Smith et al. (2024)	2024	To investigate how testosterone and cortisol levels change throughout entrepreneurial funding stages and their relation to leadership behaviour.	Hormonal sampling and behavioural tracking of 107 male startup founders across funding rounds.	Testosterone peaked at Series B, followed by a cortisol rise, suggesting hormonal fluctuations align with leadership pressure points.	Dual-hormone hypothesis; evolutionary leadership theory.	All-male sample; limited generalizability to non-entrepreneurial settings.	Supports context-dependent hormonal influence on leadership emergence in high-stakes environments.	Hormones and Leadership
83	Relationship between Empowering Leadership and Stress Cougot et al. (2024)	2024	To examine the relationship between empowering leadership (EL) and occupational	Cross-sectional quantitative study involving 460 nurses across 40 units in 12 hospitals; data collected via surveys	Empowering leadership significantly predicted lower job stress among nurses. Stress	Job Demands-Resources (JD-R) model; leadership empowerment theory.	Cross-sectional design; self-reported data; context limited to French hospitals;	Provides empirical support for EL as a key factor in reducing stress in healthcare	Leadership and Stress

			stress in French nursing units.	measuring EL and job stress.	decreased as perceived EL increased. Contextual factors (unit, hospital) did not moderate the relationship.		causality cannot be inferred.	settings, contributing to leadership and occupational health literature.	
84	Gupta et al.	2024	To conduct a genome-wide investigation into the underlying genetic architecture of personality traits and their overlap with psychopathology.	Genome-wide association study.	Personality is influenced by both genetic and environmental factors and is associated with other psychiatric traits. The "Big Five" personality traits are a widely accepted framework for understanding human personality	Behavioural genetics, molecular genetics, trait theory.	Large-scale study, but specific gene-trait mechanisms are complex	Provides a comprehensive genetic architecture of personality traits, which are foundational to leadership	Genetics
85	Thoelen & Zak	2024	To understand decision-making by considering constraints such as genetics and developmental history.	Review incorporating behavioral economics, cognitive psychology, and behavioral neuroscience.	"Optimal" decisions are often defined without considering constraints like genetics and developmental history	Behavioural economics, cognitive psychology, behavioural neuroscience.	Conceptual review, does not present new empirical data.	Highlights the need to integrate genetic and developmental factors into models of decision-making	Genetics, Neuroleadership

As indicated in Table 2.5.3 (1990–2024), many studies remain narrowly physiological or behaviourally focused, examining biological markers in isolation rather than linking them to leadership perception or motivation. Similarly, the thematic synthesis in Table 2.5.4 highlights that only a small subset of research has explored stress hormones such as cortisol in socially evaluative contexts or connected them explicitly to constructs such as Implicit Leadership Theories (ILTs). This study directly addresses that gap by integrating hormonal measurement with motivational and cognitive variables in a leadership-relevant stress scenario.

2.5.3 Hormonal Influences on Leadership

Hormones play a central role in shaping behaviours critical to leadership, including decision-making, emotional regulation, social dominance, and interpersonal influence. The endocrine system, particularly hormones such as testosterone, cortisol, oxytocin, and serotonin, provides a biological foundation that affects leadership emergence, effectiveness, and adaptability in contextually variable ways.

Cortisol, often referred to as the body's primary stress hormone, is especially relevant in leadership contexts that demand rapid decision-making and resilience under pressure. It is secreted by the adrenal glands via the hypothalamic-pituitary-adrenal axis, a central stress-response system that also influences cognitive performance, emotional reactivity, and social behaviour (Ahmed et al., 2024).

One of the most prominent frameworks in this field is the dual-hormone hypothesis proposed by Mehta and Josephs (2010). This model posits that the relationship between testosterone and dominance behaviour is moderated by cortisol levels: high testosterone predicts dominant and assertive behaviour only when cortisol is low, whereas high cortisol suppresses the dominance-enhancing effects of testosterone (Goll et al., 2023; Moe et al., 2021; Sherman et al., 2015). This framework is particularly valuable for explaining how hormonal balance, rather than individual hormone levels in isolation, shapes leadership styles and performance (Moe et al., 2021). The dual-hormone hypothesis remains foundational and continues to be cited in recent studies on biobehavioural mechanisms of leadership, underscoring its enduring theoretical and empirical relevance (Knight et al., 2019; Moe et al., 2021).

Empirical research further supports the relevance of hormonal dynamics in leadership. As illustrated in Table 2.5.4, studies have found that individuals in leadership positions often exhibit lower baseline cortisol levels, which are associated with greater resilience to stress and lower anxiety (Sherman et al., 2012). Conversely, elevated cortisol has been linked to impaired decision-making and reduced cognitive performance, for instance, by shifting individuals from deliberative to intuitive thinking (Margittai et al., 2015; Reyes et al., 2020). Other research indicates that acute stress can influence decision-making by modulating feedback learning (Byrne et al., 2020).

The impact of cortisol on leadership under crisis conditions has also been explored. Leaders face increased demands and responsibilities during crises, which can affect their mental health and influence how they behave towards followers (Wittmers & Maier, 2023). While acute crises often require swift responses (Łagowska et al., 2020; Oen et al., 2022), prolonged crises, such as the COVID-19 pandemic, create chronic demands (Oen et al., 2022; Wittmers & Maier, 2023). Research suggests that leaders in such contexts may employ paradoxical behaviours to cope effectively and guide their organisations (Förster et al., 2022).

Despite growing insights, research on hormonal influences on leadership faces important limitations. As noted in the studies summarised in Table 2.5.4, earlier research was often conducted in laboratory settings, which may not capture the complexity of real-world leadership (Mehta, 2007). Ecological validity remains a concern, particularly regarding how hormonal influences unfold in dynamic, multifactorial organisational environments. Additionally, many studies rely on single hormone samples rather than diurnal or time-series assessments, which better capture hormonal fluctuations across the day or in response to acute events (Giudice and Gangestad 2022; Vongas et al., 2022).

Although cortisol and testosterone have been extensively studied, other hormones have received comparatively less attention. Oxytocin, often termed the “bonding hormone”, has been linked to trust, generosity, and cooperation in humans, particularly towards in-group members (Cherki et al., 2024; Daughters et al., 2016; Knight & Mehta, 2014; Kosfeld et al., 2005). Serotonin, a neurotransmitter, has been associated with personality traits relevant to leadership, such as trust, initiative, and achievement, although its precise role in conflict resolution and emotional regulation in leadership remains underexplored (Ward et al., 2017).

Collectively, hormonal research provides valuable insights into the biological substrates of leadership, particularly in stress-intensive and competitive contexts. However, to fully inform leadership theory and practice, future studies must adopt naturalistic designs, explore a broader range of hormones, and integrate gender-sensitive approaches. This will allow for more ecologically valid and inclusive leadership models.

A range of empirical studies have explored cortisol as a biomarker of stress in relation to leadership behaviours, performance, and perception. Table 2.5.4 summarises key contributions, highlighting hormone–behaviour links, sample characteristics, and methodological considerations.

	Author(s)	Year	Hormone(s)	Focus	Key Findings	Sample Characteristics
1	Dedovic et al.	2009	Cortisol	The brain and the stress axis: Neural correlates of cortisol regulation	The HPA axis is the major endocrine stress axis, and cortisol, its final hormone, affects metabolic, cardiovascular, and central nervous systems. The hippocampus, amygdala, prefrontal cortex, and brainstem nuclei play specific roles in cortisol regulation in response to stress	Human and animal studies
2	Akinola & Mendes	2011	Cortisol	Stress-induced cortisol and threat-	Increases in cortisol due to acute social stress can	81 police officers

				related decision-making	facilitate threat-related decision-making, as evidenced by fewer errors when identifying armed targets. This suggests HPA activation may exacerbate vigilance for threat cues	
3	Sherman et al.	2012	Cortisol	Stress regulation and leadership	Leaders show lower baseline cortisol, linked to better stress resilience and lower anxiety.	104 adults (52 leaders, 52 non-leaders; mixed gender)
4	Kandasamy et al.	2014	Cortisol	Chronic stress and financial risk	Chronic stress shifts financial risk preferences towards risk aversion.	Volunteers (men and women)
5	Diebig et al.	2016	Hair Cortisol	Leader behaviour and follower stress	Leadership behaviours correlated with follower stress (hair cortisol).	Employees (followers); objective cortisol measurement
6	Herr et al.	2018	Cortisol	Ambivalent leadership and distress	Ambivalent leadership associated with distress and cortisol secretion.	Not specified
7	Byrne et al.	2020	Cortisol	Acute stress and decision-making	Acute stress increases cortisol and enhances tolerance of uncertainty.	Experiment 1: N = 114; Experiment 2: N = 95 (students)
8	Jones & Gwenin	2020	Cortisol	Cortisol level dysregulation and its prevalence	Cortisol is released for hours post-stressor; its negative feedback to the hypothalamus helps restore homeostasis. It influences cardiovascular, metabolic, homeostatic, cellular health, and central nervous system functions due to widespread cortisol receptors	Not specified

9	Moe et al.	2021	Cortisol, Testosterone	Predicting leadership behaviour and performance	Replicates dual-hormone hypothesis; hormones predict problem-solving in leaders.	114 participants
10	James et al.	2023	Cortisol	Physiological and psychosocial stress, cortisol, and cognition	This review integrates literature on the roles of physiological and psychosocial stress and the stress hormone cortisol, as controlled by the HPA axis, in cognitive functioning	Review of literature
11	Knezevic et al.	2023	Cortisol	Role of Cortisol in Chronic Stress, Neurodegenerative Diseases, and Psychological Disorders	The HPA axis, orchestrated by the suprachiasmatic nucleus, finely tunes the release of cortisol in response to stress to maintain homeostasis. Disruptions in cortisol regulation due to chronic stress can have profound implications for bodily systems	Not specified
12	Goll et al.	2023	Cortisol, Testosterone	Hormonal interactions in social groups	Cortisol–testosterone interaction predicts leadership in rock hyrax groups.	Animal study (rock hyraxes)

As illustrated in Table 2.5.3, cortisol's influence on leadership manifests across multiple behavioural domains, from executive performance under stress to shifts in social perception and dominance. These findings highlight the importance of ecologically valid, sex-sensitive, and dynamically measurable hormonal studies. However, most studies remain correlational and are often limited to controlled laboratory conditions, which restricts their applicability to real-world leadership. Furthermore, the predominant focus on testosterone and cortisol interactions overlooks broader contextual moderators and the roles of other hormones.

This study addresses these limitations by investigating the influence of cortisol on leadership motivation and perception in stress-intensive contexts, offering an ecologically grounded and integrative perspective. While acknowledging the significant role of other hormones like testosterone in leadership and social behaviour, this study prioritizes cortisol due to its direct and well-established function as the primary physiological mediator of the stress response (Dickerson and Kemeny, 2004; James et al., 2023). Given the central focus

on how acute stress influences leadership processes, cortisol provides a more direct and immediate biological marker for the specific physiological dynamics under investigation. Although the interplay between cortisol and testosterone is recognised as influencing leadership outcomes, particularly regarding status and risk-taking (Moe et al., 2021; Sherman et al., 2015), the scope of this research is specifically delimited to understanding the acute physiological response to stress and its subsequent impact on cognitive and motivational aspects of leadership perception.

A key framework in this area is the dual-hormone hypothesis (Mehta and Josephs, 2010). It argues that testosterone's links to dominance depend on cortisol: high testosterone predicts dominant, assertive behaviour when cortisol is low, but these effects are suppressed when cortisol is high (Goll et al., 2023; Moe et al., 2021; Sherman et al., 2015). This shows that hormonal balance, and not isolated hormones, helps explain leadership style and performance (Moe et al., 2021). The model remains central and has been frequently used in recent biobehavioural leadership studies (Knight et al., 2020; Moe et al., 2021).

Among the available biomarkers associated with leadership behaviour such as testosterone, oxytocin, and serotonin, cortisol offers a uniquely valid and practical index of the physiological stress response. Testosterone primarily relates to dominance and status-seeking behaviours, but its effects are context- and gender-dependent and often moderated by cortisol levels (Knight et al., 2019; Moe et al., 2021). Oxytocin, though linked to prosocial and affiliative leadership, presents challenges due to its unstable measurement and context-sensitive release patterns (Tabak et al., 2022). In contrast, cortisol provides a temporally sensitive and non-invasive indicator of acute stress reactivity via the hypothalamic–pituitary–adrenal (HPA) axis, directly linking physiological responses to cognitive and emotional outcomes (James et al., 2023). Its dynamic profile allows for the assessment of both activation and recovery phases of stress, making it particularly suitable for investigating how biological stress mechanisms interact with leadership perception and motivation. Accordingly, cortisol was selected as the focal biomarker for this study.

2.5.4 Integrating Biological and Socio-Cognitive Perspectives

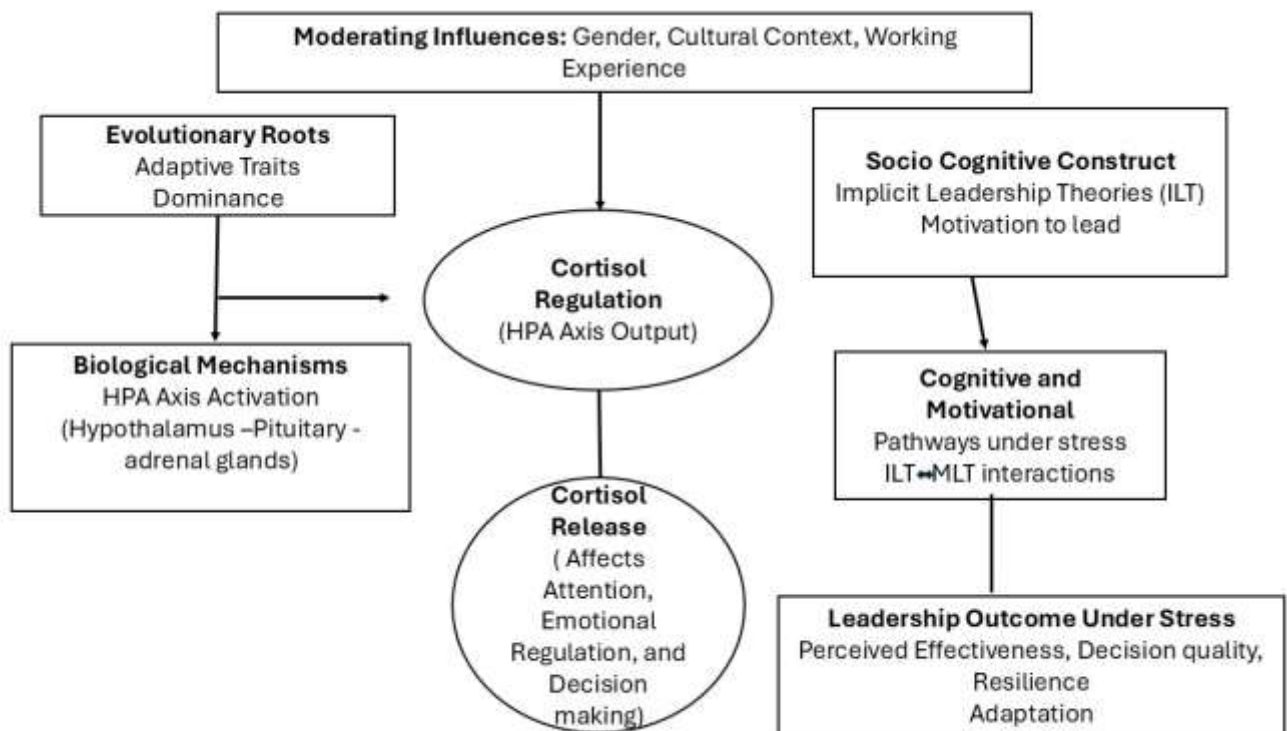
Leadership emerges from the dynamic interaction between biological predispositions and socio-cognitive processes rather than from either domain in isolation. Biological systems such as the hypothalamic–pituitary–adrenal (HPA) axis influence stress reactivity, emotion regulation, and cognitive control, shaping how individuals perceive and enact leadership under pressure. Simultaneously, socio-cognitive constructs such as Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL) guide how individuals interpret their own and others' leadership behaviours. These mental schemas also feedback into biological systems, as cognitive appraisals of stress and social evaluation can amplify or attenuate physiological stress responses (Dickerson & Kemeny, 2004).

Integrating these perspectives provides a multilevel explanation of leadership. Evolutionary and neuroendocrine mechanisms establish the biological substrates of leadership potential, while socio-cognitive frameworks determine how these predispositions are recognised, interpreted, and translated into effective behaviour. For example, elevated cortisol may influence decision-making and affective regulation, but whether this manifests as effective composure or perceived weakness depends on followers' implicit

leadership prototypes. Likewise, motivational readiness to lead may depend not only on internal drive but also on how biological stress responses facilitate or inhibit that drive in challenging contexts.

This integrative lens supports a biopsychosocial model of leadership in which stress physiology and cognitive schemas are mutually influential. It forms the conceptual bridge to the theoretical framework presented in Section 2.6, where cortisol is examined as the primary biological mechanism linking stress regulation to leadership perception and motivation.

Figure 2.5.1. Integrative flow model of evolutionary, biological, and socio-cognitive systems in leadership under stress.



The model illustrates how evolutionary roots provide adaptive foundations for leadership, biological mechanisms (e.g., HPA-axis and cortisol regulation) mediate stress reactivity and emotion regulation, and socio-cognitive systems such as Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL) interpret these signals within contemporary contexts. Moderating influences gender, culture, and leadership experience shape each pathway, culminating in leadership outcomes related to perception, effectiveness, resilience, and adaptation.

2.6 Theoretical and Conceptual Framework

This study integrated the biological, socio-cognitive, and motivational dimensions of leadership to explore the role of cortisol in leadership perception and motivation under stress. This theoretical foundation draws upon neuroendocrine models of stress regulation, specifically the hypothalamic-pituitary-adrenal axis, and key socio-cognitive theories of leadership, namely Implicit Leadership Theories and Motivation to Lead. While these foundational theories provide general principles regarding biological stress responses and leadership

cognition/motivation, whereas the conceptual framework outlines the specific, hypothesized relationships among these constructs within the context of the study. This distinction ensures that there is an established theoretical understanding while articulating this unique model for investigating leadership behaviour under stress.

Theoretical Foundation: The HPA Axis and Biological Pathways of Stress

The HPA axis plays a central role in the body's stress response, providing the biological foundation for understanding stress-driven leadership dynamics. As illustrated in Figure 2.6.1, the HPA axis is activated when the hypothalamus releases corticotropin-releasing hormone, stimulating the anterior pituitary gland to release adrenocorticotropic hormone. ACTH, in turn, triggers the adrenal glands to secrete catecholamines (noradrenaline and adrenaline) and glucocorticoids (cortisol) into the bloodstream (Casto & Edwards, 2016). Cortisol, the primary stress hormone, diffuses into peripheral tissues, salivary glands, and the brain, where it significantly influences cognitive processes (e.g., attention, memory, decision-making), social perception, and adaptive behavioural responses. This neuroendocrine pathway establishes the physiological mechanism through which stress can impact leadership-relevant psychological functions.

Figure 2.6: The Hypothalamic-Pituitary-Adrenal axis and cortisol regulation pathway in response to stress. This theoretical diagram illustrates the biological stress response system, highlighting how hormonal cascades directly influence cognitive and motivational systems relevant to leadership under stress. Adapted from Casto and Edwards, 2016

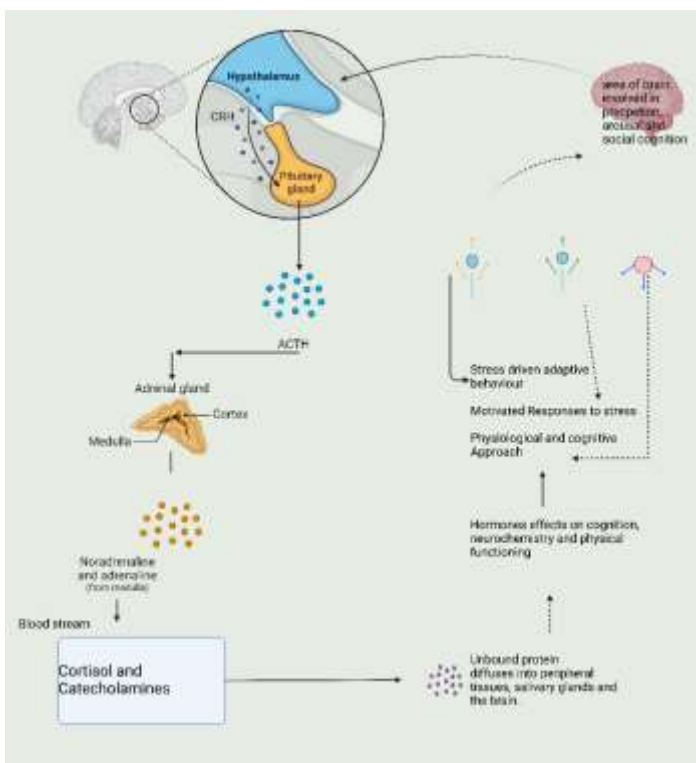


Figure 2.6: *The hypothalamic-pituitary-adrenal (HPA) axis and its role in cortisol regulation during stress responses. This theoretical framework highlights the biological pathways underlying stress-driven adaptive behaviour. Adapted from Casto and Edwards (2016).*

In summary, the HPA axis functions as the core biological system that regulates the body's response to stress, influencing not only physiological recovery but also cognitive and emotional processing. This regulatory mechanism is particularly relevant to leadership contexts, where stress often shapes perception, decision-making, and motivational states. By understanding how cortisol produced through HPA activation modulates these processes, the present study builds a bridge between biological stress regulation and socio-cognitive theories of leadership. This connection forms the foundation for the conceptual framework that follows, which delineates the specific pathways through which cortisol may influence leadership perception and motivation under stress.

2.6.1 Conceptual Framework: Cortisol, ILTs, and Motivation to Lead

Building on this biological foundation and incorporating socio-cognitive theories, the conceptual framework (Figure 2.6.2) outlines the proposed mechanisms through which cortisol influences leadership perception and motivation under stress. This model proposes that activation of the hypothalamic-pituitary-adrenal (HPA) axis and subsequent increases in cortisol modulate two primary psychological pathways: cognitive schemas and motivational orientation.

Through the cognitive pathway, increased cortisol levels are expected to influence individuals' reliance on Implicit Leadership Theories (ILTs) internalized cognitive structures that guide perceptions of effective leadership traits and behaviours. This aligns with Research Question 1 (RQ1) and Hypothesis 1 (H1).

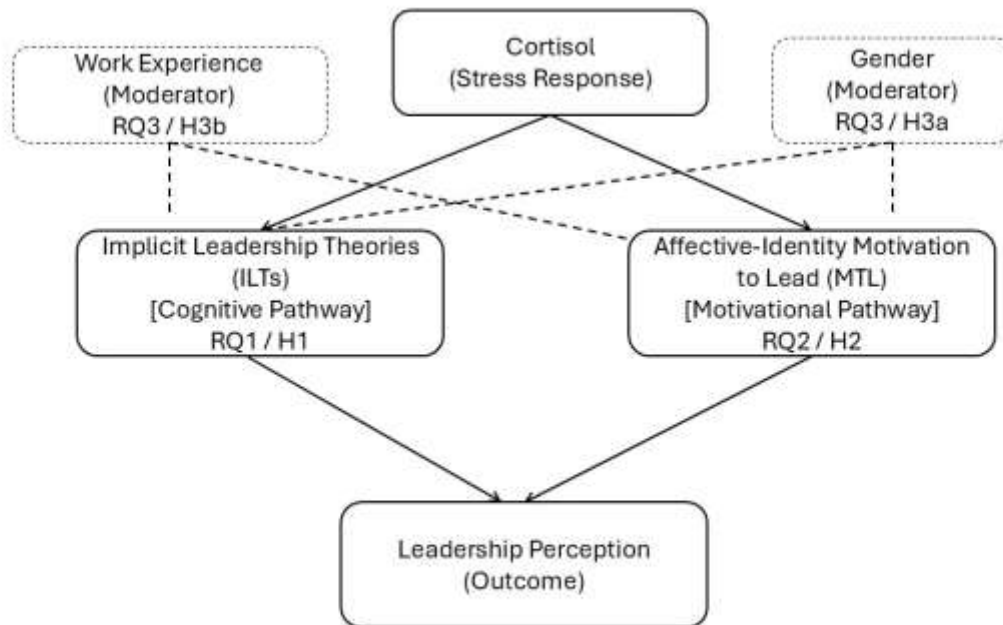
Simultaneously, through the motivational pathway, cortisol affects Affective-Identity Motivation to Lead (MTL), shaping an individual's intrinsic drive to assume or maintain leadership roles under stress. This aligns with Research Question 2 (RQ2) and Hypothesis 2 (H2).

The framework further incorporates moderating effects that reflect individual differences: gender is hypothesized to moderate the relationship between cortisol and MTL (RQ3/H3a), while leadership experience is expected to moderate the link between cortisol and ILTs (RQ3/H3b).

By delineating these interrelated pathways and moderating influences, this conceptual model provides a targeted lens through which to examine how physiological stress responses interact with cognitive and motivational processes to shape leadership perception. It thereby integrates biological, psychological, and social dimensions of leadership under stress, aligning directly with the study's aims, objectives, and hypotheses.

Figure 2.6.1: Conceptual Framework – Cortisol's Cognitive and Motivational Pathways to Leadership Perception

(This model illustrates how cortisol, as a physiological stress response, influences leadership perception through two mediating pathways Implicit Leadership Theories and Affective-Identity Motivation to Lead with gender and leadership experience as moderators.)



This model proposes that an individual's Biological Stress Response (primarily mediated by the HPA axis and cortisol) directly influences both their Motivation to Lead and their Implicit Leadership Theories, particularly within high-pressure, stress-intensive contexts. These influences, in turn, affect observed leadership behaviours and the perception of leadership effectiveness.

Core Propositions:

1. Biological Stress Response's Influence on Motivation to Lead:

Proposition 1.1: Acute Stressors and MTL: Acute stress, characterised by increased cortisol levels, can influence an individual's immediate willingness and desire to lead. While some individuals might experience an increased drive to take charge under acute stress (especially if they have a heightened sense of control or lower baseline cortisol), others might show reduced MTL due to the cognitive and emotional burden of stress (James et al., 2023; Sherman et al., 2012). For instance, leaders are often found to have lower levels of stress hormones and anxiety, suggesting a link between stress resilience and the capacity to lead (Sherman et al., 2012).

Proposition 1.2: Chronic Stress and Sustained MTL: Chronic or dysregulated stress responses can lead to burnout and fatigue, potentially diminishing an individual's sustained motivation to lead over time (Pilger et al., 2018). Effective stress regulation, on the other hand, can contribute to performing well and possessing low perceived stress, which are beneficial for sustained leadership (Dåderman et al., 2022).

2. Biological Stress Response's Influence on Implicit Leadership Theories:

Proposition 2.1: Stress-Induced Cognitive Shifts and ILTs: increased cortisol can shift cognitive processes, potentially moving individuals from deliberative to more intuitive thinking, and influencing attention and decision-making (James et al., 2023; Margittai et al., 2015). This could affect how individuals *perceive* and *interpret* leadership qualities in others, or what characteristics they expect in a leader, thereby shaping their ILTs. For example, some research indicates that leadership prototypes can be influenced by contextual factors, including environmental triggers (Spisak et al., 2014).

Proposition 2.2: Hormonal Interactions and Perceptions: The interaction between cortisol and other hormones (like testosterone) can influence dominance behaviours and status perceptions Mehta & Josephs, 2010; Sherman et al., 2015. This interplay could shape the characteristics individuals associate with effective leaders within their ILTs, especially in competitive or hierarchical contexts (Casto & Edwards, 2016; Goll et al., 2023). How followers perceive a leader's behaviour is crucial for effective leadership, and these perceptions are shaped by implicit beliefs and assumptions regarding what constitutes an effective leader (Oc, 2017).

3. The Interplay between ILT and MTL in Stressful Contexts:

Proposition 3.1: ILTs as a Guide for MTL: An individual's Implicit Leadership Theories (their preconceived notions of what makes an effective leader) can conceptually influence their motivation to step into leadership roles that align with those internal models, particularly when under stress. Individuals' self-concepts and self-views, which include perceptions of their own capabilities, can influence their expectations around leadership and their willingness to engage in leadership behaviours (Hiller, 2005; Weidner, 2012). This suggests that aligning one's self-perception with an idealized leader prototype can be a motivator for engaging in leadership.

Proposition 3.2: MTL and Leadership Behaviour: When individuals with high MTL assume leadership roles under stress, their biological stress response (e.g., cortisol reactivity) will interact with their cognitive schemas to manifest specific leadership behaviours. These behaviours might be perceived as more or less effective depending on followers' own ILTs and the objective outcomes. Biological parameters are increasingly being investigated to predict leadership behaviour in various leadership-related tasks (Moe et al., 2021).

2.7 Theoretical Gaps and Emerging Directions

Building on the integrated framework proposed earlier, this section evaluates the key theoretical and methodological gaps in leadership research concerning stress physiology and outlines promising interdisciplinary directions for future leadership research. Although Cortisol research has enriched leadership studies by providing a biological perspective on stress and decision-making, several gaps remain that require attention.

Most leadership studies using cortisol have relied on static, single-point measures (e.g. one saliva sample taken at baseline or immediately post-task). Although such measures capture a snapshot of hormonal activity, they fail to represent the dynamic patterns of cortisol activation and recovery that unfold over time.

Leadership, in contrast, is inherently longitudinal, requiring resilience, adaptability, and repeated regulation of stress across multiple contexts, and is well-supported by the existing literature, which often calls for more dynamic and ecologically valid measurement approaches (Charles et al., 2019; Mehta, 2007; Miller et al., 2016).

This study partly addresses this gap by adopting a multiphase, repeated-measures design. Cortisol was assessed at three points: (1) baseline under non-stress conditions, (2) immediately before a stress-inducing task, and (3) 15-20 min post-task, following the peak activation period. The inclusion of a three-month break between the baseline and experimental phases further introduced a temporal dimension, enabling the examination of the stability and comparability of cortisol responses across time. In contrast to static single-sample studies, this design allows for a more ecologically valid understanding of how acute stress responses interact with leadership perceptions and motivation to lead.

Nonetheless, some important limitations of this study remain. Although this study goes beyond static cortisol snapshots, it does not capture full diurnal or recovery trajectories, such as how cortisol levels fluctuate across the day or return to baseline after extended stress exposure (Charles et al., 2019). Research on resilience suggests that these recovery dynamics are crucial for differentiating between leaders who maintain performance under pressure and those who are vulnerable to burnout (Pilger et al., 2018). Therefore, future studies should integrate longitudinal or time-series sampling across days or weeks to investigate cortisol regulation in real-world leadership contexts.

Additionally, emerging evidence has highlighted several underexplored areas relevant to the relationship between stress physiology and leadership. For instance, digital leadership stressors such as virtual communication, remote team management, and constant digital connectivity may elicit unique cortisol responses distinct from those observed in traditional, face-to-face contexts (Girardi et al., 2025). Furthermore, evolutionary mismatches may occur when cortisol-driven dominance behaviours, once adaptive in ancestral environments, clash with contemporary expectations of collaboration, empathy, and inclusivity in leadership (Van Vugt and Ahuja, 2011; Altschul, 2024). Lifestyle-related factors, including sleep quality and diet, also play a critical role in cortisol regulation, yet remain rarely integrated into leadership models or training frameworks (Ahmadi, 2022; Fekedulegn et al., 2018). Finally, advances in technology-enabled monitoring, such as wearable biosensors, now make it possible to track cortisol in real time, offering new opportunities for personalised, biofeedback-driven leadership development and stress management (Ok et al., 2023).

Finally, leaders' cortisol regulation has consequences beyond those of individuals. Leaders who manage stress effectively foster team cohesion, whereas dysregulated stress responses may amplify group stress through emotional contagion (Denk et al., 2021; Garnde et al., 2024). Understanding these dynamics across generational cohorts is also essential, because younger leaders often face higher cortisol reactivity due to job insecurity and autonomy constraints (Irehill et al., 2023).

In summary, while this study advances the field by moving beyond static cortisol sampling to a multi-phase repeated-measures approach, there remains a need for extended longitudinal, ecological, and team-level

designs. Addressing these gaps will create a more holistic and biologically informed model of leadership, bridging stress physiology with social-cognitive theories of leadership emergence and effectiveness.

2.8 Summary and Study Contribution

This literature review examined the intersection of biological, cognitive, and motivational perspectives in leadership, identifying cortisol as a central yet underexplored mechanism governing stress-related leadership dynamics particularly within high-pressure environments. While socio-cognitive constructs such as Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL) provide valuable frameworks, they often overlook the immediate physiological stress responses that profoundly shape these processes.

This review highlights several key theoretical and methodological gaps; namely, the reliance on static, single-sample cortisol measurements that fail to capture dynamic stress responses; the limited attention to how stress physiology interacts with leadership schemas and motivation especially concerning individual differences like gender and experience; and the absence of broader contextual moderators, such as digital leadership environment, lifestyle factors and generational differences.

Addressing these limitations this study implemented a multiphase repeated-measures design. Cortisol was measured at three critical points: (1) under baseline non-stress conditions, (2) immediately before a stress-inducing task, and (3) 15-20 min post-task, following the expected peak cortisol response. In addition, a three-month gap between the baseline and experimental phases provided a temporal perspective, enabling the examination of both acute stress responses and the relative stability of stress regulation across time. By linking these biological measures with ILT and MTL questionnaires, this study integrates psychobiological and socio-cognitive approaches to leadership research.

The contributions of this study are threefold.

1. Theoretical integration: This bridges biological stress responses with socio-cognitive leadership models, offering a biopsychosocial account of leadership emergence under stress.
2. Methodological advancement: Adopting repeated-measures design moves beyond static cortisol snapshots and offers a more ecologically valid approach to understanding how stress influences leadership perception and motivation to lead (MTL).
3. Practical relevance: The findings have direct implications for leadership development and training in high-stake environments, where stress management and resilience are critical. Insights from this research can inform interventions that enhance leaders' ability to regulate stress and sustain effective leadership behaviours.

In doing so, this thesis contributes to a growing interdisciplinary dialogue that integrates biology, psychology, and organizational theory. It responds to long-standing calls for more naturalistic and context-sensitive approaches to leadership research, paving the way for future studies to build comprehensively on both the biological and social dimensions of effective leadership in a rapidly changing world.

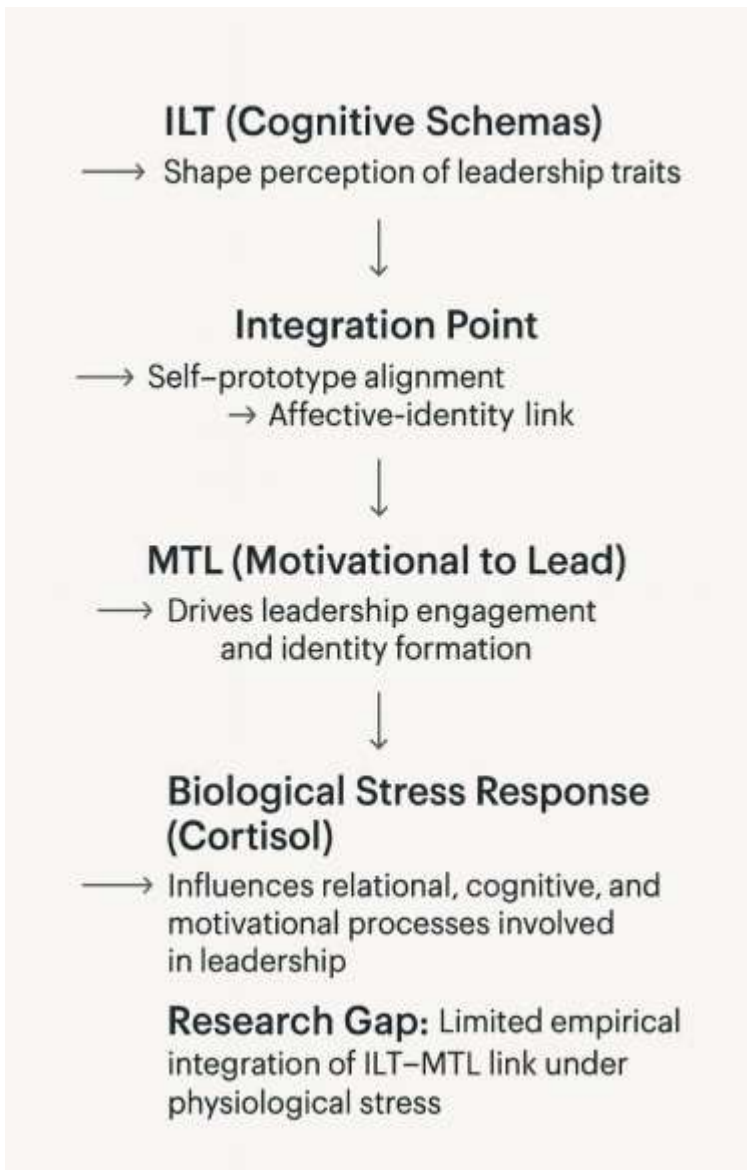


Figure 2.8. Conceptual mapping of ILT, integration mechanisms, MTL, and biological stress response, highlighting the literature gap regarding ILT–MTL links under physiological stress.

This conceptual flow model illustrates the theoretical integration between socio-cognitive and biological perspectives in leadership. Implicit Leadership Theories (ILTs) shape individual's perceptions of leadership traits and connect to affective-identity based motivation to lead (MTL), through self-prototype alignment. At the same time biological stress responses, particularly cortisol activation, affect relational, cognitive, and motivational processes relevant to leadership emergence and behaviour. The model also highlights a key theoretical gap; the limited empirical integration of ILT–MTL linkages under physiological stress.

Chapter 3 Methodology

This chapter outlines the methodological approach used to investigate hormonal influences on leadership perception and motivation to lead (MTL). This study adopts a positivist research paradigm, reflecting the belief that leadership perception and MTL, while influenced by social constructs, can be objectively measured and analysed through systematic and empirical methods. This perspective aligns with the study's aim of exploring the intersection of biological (hormonal) and psychological factors in shaping leadership perceptions.

3.1 Research Philosophy

This study is grounded in a positivist research paradigm which emphasises that reality is external and measurable through systematic and empirical observations (Guba & Lincoln, 1994; Creswell & Plano Clark, 2017). Positivism provides a structured framework to objectively examine the interplay between biological and psychological variables, such as cortisol levels, and their influence on leadership perception and motivation to lead (Creswell & Plano Clark, 2017). By prioritising quantifiable variables and causal relationships, this approach aligns with the study's aim of exploring stress-resilient leadership within controlled experimental settings (Bryman, 2016; Chester & Lasko, 2020). Originating from Auguste Comte's emphasis on empirical inquiry, positivism has long underpinned leadership research. Its focus on observable traits and behaviours has facilitated the development of robust, testable hypotheses concerning leadership effectiveness (Alvesson, 1996).

In this study, positivism supports the integration of biological markers such as cortisol with psychological constructs like ILT and MTL, ensuring methodological rigour and replicability (Moe et al., 2021). Empirical studies have already demonstrated the viability of measuring hormonal factors, such as cortisol, in leadership contexts (Goll et al., 2023; James et al., 2023). These precedents confirm the suitability of a positivist framework for investigating leadership under stress. While positivism has been critiqued for potential reductionism, particularly within social science research (Fischer & Sitkin, 2016), it remains appropriate for this study's aim: to empirically test the relationships among biological, cognitive, and motivational variables influencing leadership behaviour.

Figure 3.1: Methodological Rationale Overview

Philosophical Assumption	Research Design	Methods	Data Type	Analysis
Positivist paradigm (objective, measurable reality; Guba & Lincoln, 1994; Saunders et al., 2019)	Quantitative, experimental design to examine causal relationships (Creswell, 2014; Bryman, 2016)	Laboratory-based (ELISA) cortisol measurement and ILT/MTL psychometric surveys	Numerical, biological (cortisol) and psychological (ILT/MTL) data	Statistical analyses (correlation, regression, moderation) to test hypothesised relationships

Source: Adapted from Creswell (2014), Saunders et al. (2019), and Bryman (2016).

3.2 Integration with Theoretical Frameworks

This study draws on two established frameworks Implicit Leadership Theories (ILTs) and Motivation to Lead (MTL) as the conceptual basis for examining leadership perception and motivation under stress. Both frameworks align with the positivist paradigm because they can be operationalised through measurable constructs and tested empirically using validated scales. They provide a structured way to investigate how biological stress responses interact with psychological processes to influence leadership-related outcomes. ILT focuses on the cognitive processes underlying leadership perception, while MTL captures the motivational factors that determine an individual's willingness to assume leadership roles. Together, these frameworks allow for a comprehensive exploration of how hormonal factors, such as cortisol, may influence both leadership perception and motivation.

The use of ILT and MTL in this context also reflects their strong empirical foundations. Each has been validated in multiple quantitative studies, supporting their reliability and applicability in experimental research (Lord et al., 2019; Chan & Drasgow, 2001; Auvinen et al., 2021). Their inclusion ensures methodological rigour while bridging biological and psychological perspectives, which is essential for understanding the complex relationship between stress, perception, and motivation in leadership.

Rationale for Framework Selection: ILT and MTL in Stress Research

The decision to adopt ILT and MTL as guiding frameworks is grounded in their unique suitability for studying leadership under physiological stress. Stress is known to affect both perception and motivation, and these two constructs directly represent those domains. ILT is particularly relevant for understanding how followers perceive leadership qualities in high-pressure environments where cognitive processing and judgement may be altered by stress. When cortisol levels rise, individuals may rely more heavily on established cognitive schemas or prototypes to evaluate leaders. This framework therefore allows for the investigation of how these perceptual patterns shift in response to hormonal and situational changes.

MTL, in contrast, provides insight into the motivational processes that influence whether individuals are inclined to take on or sustain leadership roles in demanding circumstances. Stress can reduce self-efficacy and increase emotional strain, which in turn affects motivation to lead. Studying MTL alongside biological indicators such as cortisol helps explain how stress physiology interacts with psychological drive, providing a fuller understanding of why some individuals remain motivated to lead under pressure while others withdraw. Thus, the combination of ILT and MTL provides a balanced approach for examining both perceptual and motivational responses to stress.

Comparison with Alternative Leadership Models

While other leadership theories contribute valuable insights into leadership behaviour, they are less suited to examining the specific effects of stress and hormonal responses. Trait theories, for example, focus on stable personality characteristics but often fail to explain how leader effectiveness varies in changing or stressful contexts. Behavioural theories describe observable actions but overlook the internal cognitive and emotional processes that are particularly relevant when stress influences decision-making and perception. Contingency

models acknowledge that leadership effectiveness depends on situational factors, yet they rarely consider how followers' perceptions of leadership evolve in the face of acute stress. Similarly, transformational and transactional theories emphasise leader–follower interactions and motivational influence, but they focus primarily on behavioural outcomes rather than on the internal perceptual and motivational mechanisms that shape these behaviours.

In contrast, ILT and MTL directly address these internal processes. They offer a way to capture the dynamic relationship between stress, cognition, and motivation, which is central to understanding how leadership emerges and is sustained in high-pressure environments. Their integration into this study makes it possible to link biological and psychological factors in a coherent and testable way, advancing understanding of leadership under stress in ways that other frameworks cannot.

Summary

The integration of ILT and MTL within a positivist, experimental framework provides a coherent and empirically grounded methodological foundation for this study. These constructs enable the systematic investigation of how biological stress markers, such as cortisol, interact with psychological processes involved in leadership perception and motivation. By focusing on both cognitive and motivational mechanisms, the study moves beyond traditional behavioural explanations and contributes to a more comprehensive understanding of leadership in stressful contexts. This approach combines theoretical depth with empirical precision, addressing the study's objective of exploring the biological and psychological dimensions of stress-resilient leadership.

3.3 Research Strategy and Design

The research strategy integrates survey and experimental methods, reflecting a mixed-method approach within a quantitative framework. Surveys allow for the measurement of subjective perceptions and motivations, whereas experiments provide objective data on hormonal responses to stress. This dual approach strengthens the study's ability to address its research objectives (Bryman Teddlie, 2010; Bryman, 2016).

While the study's primary focus is quantitative, the integration of surveys and experiments acknowledges the complexity of leadership as a construct influenced by both biological and social factors. Mixed methods enhance the robustness of findings by triangulating data from subjective self-reports and objective biological measures (Olsen et,2004; Tzagkarakis and Kritas,2022).

Surveys: Established instruments, such as the Implicit Leadership Theories Scale (Epitropaki & Martin, 2004) and Motivation to Lead Scale (Chan & Drasgow, 2001), provide reliable measures of participants' leadership perceptions and motivations. These scales allow for the systematic quantification of psychological constructs that are central to the study's hypotheses. Full instruments are provided in Appendix B.

The decision to reduce the response scale from 9 to 3 points was made to improve the quality and interpretability of the data. This adjustment simplifies the responses, making it easier to identify meaningful patterns in the data. Additionally, reducing the scale helped address issues with normality, allowing more

sophisticated parametric tests to be applied. While this change resulted in some loss of detail, it also improved the overall reliability and validity of the analysis. This approach is supported by previous research (e.g. Preston & Colman, 2000; Lozano et al., 2008; Matas, 2018), highlighting the benefits of shorter response scales in enhancing measurement consistency and usability.

The questionnaire was initially designed with a 9-point Likert scale to capture fine-grained variations in participants' attitudes. This approach aligns with research suggesting that more Likert scale points can result in a closer approach to the underlying data distribution, thereby improving normality and approximating interval scales (Leung, 2011; Aybek and Torman, 2022). Such a choice aims to maximize response variance and provide greater sensitivity compared with narrower scales, as a higher number of response options can offer a good level of granularity. While there is ongoing debate about the optimal number of scale points, studies explore the psychometric properties across various lengths, including those with more than 7 points, to ensure optimal reliability and validity (Fernández et al., 2008; Taherdoost, 2019).

However, during initial pilot data analysis, it became clear that responses clustered into broader categories, reducing the effective variability. To enhance interpretability and align with the assumptions of certain analytical techniques employed, the scale was collapsed into three ordered categories (e.g., low, moderate, high). All statistical analyses reported in this study were conducted using reduced three-point response format. This approach is consistent with practices where researchers collapse categories, particularly when items are endorsed by relatively few respondents in extreme categories, to increase cell sample size and enhance the manageability of sparse data (DiStefano et al., 2020). Furthermore, transforming ordinal data by collapsing categories can make visual interpretation easier and lead to more in-depth analyses, especially when combined with other methods (Mircioiu & Atkinson, 2017). This strategy also finds precedent in studies comparing higher-point scales to trichotomized scales for equivalent estimates and improved clarity (Jeong, 2016).

To evaluate whether the reduced three-point format retained sufficient psychometric quality, a pilot comparison ($n = 20$) was conducted. Reliability analysis indicated minimal loss in internal consistency between the original nine-point and revised three-point versions (Cronbach's $\alpha = .86$ vs. $.83$, respectively), suggesting that the reduction did not materially affect scale reliability. Item–total correlations also remained stable, supporting the decision to adopt the simplified response structure. Given that this study examined stress leadership relationships, a shorter scale helped reduce participant fatigue and cognitive effort during the post-stress phase, improving data quality. Research suggests that under cognitive strain, respondents may default to mid-range responses, limiting the functional utility of highly granular scales (Preston & Colman, 2000). The shorter response format therefore supported clearer differentiation without substantially altering construct representation.

In summary, the original nine-point scale offered sensitivity but produced clustered responses that limited statistical power and interpretability. The revised three-point format yielded more balanced data distributions and enhanced reliability, supporting the validity of subsequent analyses. A copy of the original questionnaire is provided in Appendix 2, ensuring transparency of the design and subsequent data treatment.

Experiments: The experimental component, involving pre- and post-stress cortisol measurements, captures the physiological responses that underpin leadership perceptions and motivations under stress. Experimental methods are essential for testing causal relationships, particularly for understanding how hormonal fluctuations influence leadership traits and preferences.

The research design of this study reflects a deliberate integration of mixed methods approaches to address the complexity of leadership perception and motivation under stress. By combining survey data with experimental cortisol measurements, this study ensured both breadth and depth in capturing the interplay between biological and psychological factors. Several alternative research designs were considered but ultimately deemed less suitable. While a fully quantitative approach offers high objectivity, it lacks the capacity to capture the subjective nuances of participants' leadership perceptions and motivations. For instance, cortisol levels alone cannot explain how individuals perceive leadership traits under stressful conditions. Qualitative methods, such as interviews or focus groups, provide rich contextual data, but they lack the precision required for measuring cortisol, a biological marker critical to the study's objectives. A longitudinal approach could track cortisol and leadership perceptions over an extended period, offering insights into the effects of long-term stress. However, this was not feasible owing to resource and time constraints, as well as potential participant attrition over time.

The mixed-methods approach was chosen because of its ability to integrate these strengths while addressing the limitations of alternative designs. By pairing surveys with experimental methods, this study ensures that the findings are both contextually relevant and scientifically rigorous. The integration of these methods mitigates potential bias by combining self-reported leadership perceptions with objective physiological measures. Surveys provide insight into participants' cognitive evaluations and motivations, whereas experimental cortisol assessments minimise social desirability bias and self-report inaccuracies. This dual approach enhances the reliability and validity of the findings by cross-validating subjective and objective data and reducing potential confounding factors in interpretation.

3.4 Sampling Strategy

The sampling strategy for this study was designed to ensure a representative and diverse sample, enabling a robust exploration of the effects of cortisol on leadership perception and motivation to lead (MTL). This section outlines the inclusion criteria, sampling approach, and rationale for the chosen sample size.

To ensure the relevance and applicability of the study's findings, the following inclusion criteria were established:

Age: Participants were required to be above 18 years old, representing both early- and mid-career professionals. This age range was chosen to capture diverse work experiences while minimising the influence of age-related biological factors on cortisol levels.

Work Experience: A minimum of two years of professional experience in any industry was required. This criterion ensured that participants had sufficient exposure to workplace leadership dynamics and could provide informed responses on implicit leadership theories and MTL scales. Using a single demographic item: "What is your work experience in years?" This approach reflects standard practice in organisational research, where tenure is widely used as an indicator of exposure to leadership environments (Green et al., 2011; Hiller, 2005).

Although leadership experience may be measured through formal role occupancy, total work experience provides a broader and more inclusive indicator of exposure to both formal and informal leadership processes (Walker et al., 2024). Over time, repeated interactions with supervisors, team participation, and opportunities to observe or enact influence contribute to the development of leadership perceptions and self-concepts (Hiller, 2005; Hoyland et al., 2021). Advancing tenure is also associated with increased role-specific knowledge and cognitive complexity, both of which are relevant to leadership evaluation and motivation (Graf-Vlachy et al., 2020).

The minimum threshold of two years was established to ensure meaningful organisational exposure. Early employment is often characterised by socialisation and adjustment phases, during which individuals primarily focus on task acquisition and organisational acclimatisation (Hoyland et al., 2021; Tuytens et al., 2018). By requiring at least two years of experience, the study ensured that participants' Implicit Leadership Theories and Motivation to Lead were informed by stable and sustained workplace experiences rather than limited or transitional exposure.

Gender: Male and female participants were included to explore potential gender differences in leadership perception and MTL under stress. The inclusion of diverse gender identities ensured that the study captured how societal norms influenced leadership preferences across different demographic groups.

Language Proficiency: Participants were required to demonstrate proficiency in the language of the survey instruments (e.g. English) to ensure accurate understanding and completion of the questionnaires.

Health Conditions: Participants were required to be in good general health and free from conditions that might influence cortisol levels (e.g. chronic stress disorders and use of corticosteroid medications). This criterion ensured that the biological data accurately reflected the experimental manipulation of stress.

3.5 Sampling Approach

A stratified random sampling approach was employed to ensure diversity and representation across key demographic groups while maintaining the rigor of random selection. Participants were stratified into subgroups based on two key variables:

The equal representation of male and female participants ensured that the study could examine potential gender-based differences in leadership perception and MTL under stress. Participants were further stratified

by industry, including education, healthcare, business, and technology, to capture a wide range of workplace leadership experiences. After stratification, participants were randomly selected from each subgroup to minimise selection bias and enhance the generalisability of the findings to diverse professional settings. This method mitigated the risk of overrepresenting certain groups, a limitation commonly observed in simple random sampling (Stephan, 1941).

Stratified sampling offers several advantages. This ensures that the sample includes participants from diverse professional and demographic backgrounds, facilitating a more comprehensive analysis of how cortisol influences leadership perceptions in different contexts (Penne & Levy, 2005; Sabharwal, Levine, & D'Agostino, 2017). Stratification by gender and professional experience helps to control for individual differences that could otherwise confound the results. For instance, men and women may respond differently to stress and leadership prototypes, influencing how leadership traits are perceived under stress (Aslan & Košir, 2021).

While the study does not aim for broad generalisability, stratified sampling increases the applicability of the findings to similar professional contexts where leadership and stress are critical factors (Harms et al., 2016; Gipson et al., 2017). By combining stratified sampling with a within-subjects design, the study enhances methodological integrity, ensuring that the sample represents diverse leadership experiences while controlling for confounding variables. Despite its advantages, stratified sampling poses several logistical challenges.

Balancing Subgroup Sizes: Ensuring a balanced representation of men and women across professional sectors requires targeted recruitment efforts. For example, the healthcare sector tends to have more women, whereas certain university roles may have more men. To address this, special efforts were made to recruit participants from underrepresented groups.

Participant Attrition: Maintaining subgroup balance while minimising attrition is critical. To mitigate this, participants were provided with clear information about the study's purpose, schedule, and confidentiality measures to foster trust and commitment.

Despite these challenges, stratified sampling ensured that the study captured diverse leadership experiences and stress responses across demographic and professional contexts.

Potential Biases in the Sampling Strategy Although stratified random sampling enhances diversity and representation, potential biases could still arise:

Selection Bias: Certain professional groups might be overrepresented due to accessibility or willingness to participate. **Self-Selection Bias:** Individuals interested in leadership research may be more inclined to participate, which could skew their responses. To mitigate these biases, this study employed targeted recruitment strategies to ensure balanced representation across gender and professional backgrounds. Furthermore, random selection within stratified groups minimised the risk of overrepresentation of demographics. Clear participation requirements were established to prevent misrepresentation in the responses. Additionally, the integration of survey data with experimental cortisol measurements helped

mitigate potential biases in self-reported leadership perceptions. While surveys may be subject to social desirability bias, physiological measures, such as cortisol, provide objective validation of stress responses, strengthening the study's internal validity.

3.6 Sample Size

Sample Size Justification and Power Analysis

The initial target of the study was 70 participants, accounting for potential attrition. A power analysis conducted prior to the study determined that a minimum of 60 participants were required to achieve 80% statistical power ($\beta = 0.20$) to detect medium effect sizes (Cohen's $d = 0.5$) at a significance level of 0.05. A medium effect size was selected based on prior research in leadership and cortisol studies, where similar effect sizes have been observed in stress-response experiments that found similar effect sizes. (Sherman et al. (2012) and Harms et al. (2016) found similar effect sizes. This balance ensures that the study is sensitive enough to detect meaningful hormonal influences on leadership perception while maintaining feasibility in participant recruitment and data collection.

To account for potential dropouts or incomplete data, an additional 10 participants were included, bringing the target to 70. Of the 70 initially targeted participants, 65 completed the study, resulting in a participation rate of approximately 93%. Although slightly below the target, this sample size was sufficient for the planned within-subjects analyses, including repeated-measures ANOVA, and allowed for the exploration of key demographic subgroups. The sample size obtained aligns with similar studies in the field (Harms et al., 2016; Sherman et al., 2012), ensuring adequate statistical power for hypothesis testing.

To validate these estimates, power analyses were conducted using G*Power 3.1 (Faul et al., 2007) and IBM SPSS Statistics Version 29.0 (IBM Corp., 2023). Both software packages produced convergent results, confirming that a minimum of 60 participants were required. To account for attrition, a 16.7% buffer was applied, resulting in a final target of 70 participants.

The within-subjects design used in this study further enhanced the statistical power by reducing the variability from individual differences, as each participant served as their own control (Tabachnick & Fidell, 2019). This methodological efficiency allows for a smaller sample size compared with between-subjects designs (Meyvis & Van Osselaer, 2018). Hence, the final achieved sample size of 65 participants exceeded the minimum threshold, ensuring sufficient statistical power for detecting cortisol-induced changes in leadership perception and MTL.

3.7 Ethical considerations

Ethical considerations formed a critical aspect of this study given the sensitive nature of collecting biological data and personal information. Ethical approval was obtained from the BCU Ethics Committee prior to commencing the study. This approval ensured that the study adhered to institutional, national, and international ethical standards. The study complied with the BCU General Data Protection Regulation (GDPR) for data handling and storage, and a copy of formal ethical approval was granted by the Birmingham City University (BCU) Ethics Committee prior to data collection (see Appendix 1 for the approved ethics form).

The informed consent process was designed to ensure that participants fully understood the purpose, procedures, risks, and benefits of the study before agreeing to participate. The participants were informed that the study aimed to investigate the effects of stress, as measured by cortisol levels, on leadership perception and motivation to lead. They were provided with clear information about the two-phase structure of the study, which included saliva sample collection and completion of questionnaires both before and after the stress-inducing task.

Participation in the study was entirely voluntary, and participants were informed of their right to withdraw at any time without needing to provide a reason or facing any negative consequences. Potential risks were explained, including mild discomfort associated with providing saliva samples and completing a cognitive stress task. While these risks were minimal, the participants were assured that the study posed no significant physical or psychological harm. The potential benefits of contributing to an understanding of leadership under stress are also outlined. Explicit consent was obtained for the collection and use of biological data, with participants being informed of how saliva samples would be collected, processed, and stored, and their specific role in measuring stress responses.

Participants who agreed to participate signed a consent form documenting their understanding and willingness to participate. Copies of this consent form were securely stored in the BCU password-protected OneDrive, which is accessible only to the research team.

The confidentiality and anonymity of the participants were carefully maintained throughout the research. All data were anonymised using unique identification codes to ensure that saliva samples and survey responses could not be directly linked to individuals. The biological samples were securely stored in a temperature-controlled laboratory facility that complied with the Human Tissue Act 2004 and were accessible only to authorised personnel. These samples were retained solely for the duration of the study and disposed of securely after analysis in line with the institutional guidelines. Survey data, including responses related to leadership perception and motivation to lead, were stored in an encrypted, password-protected digital database (i.e. one drive BCU) ensuring compliance with GDPR. Only the research team had access to the database.

The participants were informed of how their data would be stored, how long they would be retained, and how they would be securely disposed of. Both biological and questionnaire data will be retained for five years after publication, in accordance with BCU Research Data Management Policies, before being permanently deleted or destroyed. Participants were also reassured that their personal information would not be disclosed in any report or publication.

Steps were taken to address potential ethical issues throughout the study. To minimise variability in cortisol levels caused by external factors, participants were instructed to avoid caffeine, alcohol, and vigorous exercise for at least 12 hours before the study. Mild discomfort associated with saliva collection, and the stress-inducing task was explained, and participants were provided with the option to withdraw at any point. In the event of any undue stress or discomfort, appropriate support was available, and protocols were in

place to handle such situations ethically. By embedding ethical practices at every stage, this study ensured that participants' rights, privacy, and well-being were respected while maintaining the integrity of the research.

3.8 Data Collection Methods

This study employed a combination of biological and psychological data collection methods to explore the effects of cortisol on leadership perception and motivation to lead (MTL). Cortisol levels, a biological marker of stress, were measured using saliva samples, while leadership perception and motivation to lead were captured using validated survey instruments. By integrating these two methods, this study provides a comprehensive understanding of both physiological and psychological responses to stress in leadership contexts.

3.9 Saliva Collection and Processing

Saliva sampling was used to measure cortisol levels, which is a reliable biological marker for assessing the body's physiological response to stress. (Sørensen et al., 2021; Chen et al., 2025; Hildebrand and Zalesny, 2025). Salivary cortisol specifically reflects free cortisol levels, the biologically active form of the hormone that can freely pass through cell membranes (Kirschbaum & Hellhammer, 2000; Blair et al., 2017; Alvi and Hammami, 2019). The decision to use saliva samples was based on their non-invasive nature, ease of collection, and capacity for accurate detection of short-term changes in cortisol levels, (Hodgson and Granger, 2013; Miočević et al., 2017; Barranco et al., 2018; Ahmed et al., 2024).

Saliva samples were collected at two key time points.

1. **Baseline sample:** Taken before the stress-inducing task to establish a control measure.

Post-stress sample: Fifteen minutes after the task, cortisol levels typically peak 10-20 minutes after exposure to a stressor (Dickerson & Kemeny, 2004; Engert et al., 2012).

Participant Preparation

The participants were given specific instructions to minimise variability in cortisol measurements:

- Avoid eating, drinking (especially caffeinated beverages), smoking, or exercising for at least one hour prior to sample collection.
- Refrain from brushing teeth immediately before collection to avoid contamination of saliva with blood.

Saliva Collection Protocol

Participants provided saliva samples via the passive drool technique, which is widely recognised as a standard method for salivary cortisol collection. Approximately 2 mL of saliva was collected per sample, ensuring a sufficient volume for analysis. Samples were collected directly into sterile, pre-labelled polypropylene tubes assigned unique participant IDs to ensure anonymity and traceability. The saliva collection kit was (Speci Max A50697). Immediately after collection, saliva samples were placed on ice and transferred to a laboratory, where they were stored at -20°C to preserve cortisol integrity. The samples remained frozen until further processing.

Risk Assessment and Safety Protocols

Before saliva collection commenced, a comprehensive risk assessment was conducted to identify and mitigate any potential hazards associated with handling biological samples. The study adhered to established Standard Operating Procedures (SOPs) to maintain consistency in sample collection, handling, and storage. Additionally, all processes complied with the Control of Substances Hazardous to Health (COSHH) regulations to ensure the safety of participants and researchers. These measures included proper training in sample handling, use of personal protective equipment (PPE), and appropriate disposal of biological waste.

3.9. Cortisol Measurement Using the Competitive ELISA Kit

The salivary cortisol concentrations were analysed using the Cortisol Competitive ELISA Kit (CatLog Number: EIAHCOR, Rev 2.0) provided by Thermo Fisher Scientific.

Specific Kit Details

Kit Name	Cortisol competitive ELISA kit
CatLog number	EIAHCOR (96 tests)
Manufacturer	Thermo Fisher Scientific
Sensitivity	27.6 pg./ml
Measurement range	50pg/mL to 3,200 pg./mL
Storage Conditions	Components stored at -20°C; diluted buffers at 4°C.

Principle of the Assay

The cortisol ELISA kit operates based on the competitive binding principle:

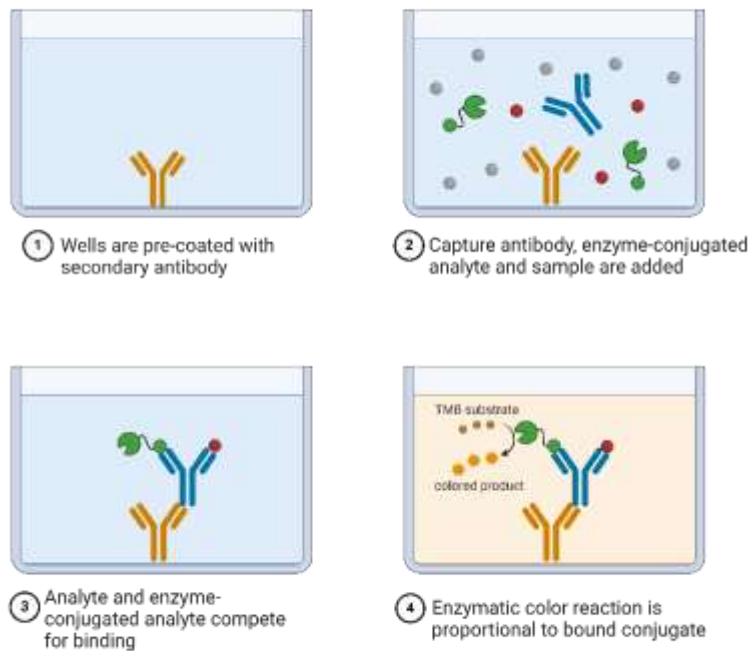


Figure 3.9: Competitive ELISA Assay Principle Schematic representation of the competitive ELISA assay steps, including antibody binding, competition, and colorimetric detection for cortisol.

Cortisol in saliva competes with enzyme-linked cortisol for binding sites on specific antibodies. The amount of enzyme-linked cortisol bound to the plate was inversely proportional to the amount of free cortisol in the sample. A colorimetric reaction, initiated by the addition of TMB substrate, produces a measurable signal proportional to cortisol concentration

3.9.1 Enzyme Linked Immunosorbent Assay (ELISA)

This solid-phase competitive Enzyme-Linked Immunosorbent Assay (ELISA) is specifically designed to quantify free cortisol in saliva samples. The assay's high sensitivity, specificity, and ability to measure cortisol in small sample volumes makes it ideal for this study.

The ELISA kit components included the following:

- A 96-well plate was coated with goat anti-mouse IgG.
- Cortisol antibody, cortisol conjugate, tetramethylbenzidine (TMB) substrate, stop solution, wash buffer concentrate, and assay buffer concentrate.
- Cortisol standards (32,000 pg/mL) in stabilising solution were used to prepare a standard curve ranging from 50 pg/mL to 3,200 pg/mL.
- Dissociation reagent to ensure accurate cortisol measurements in saliva samples.

Preparation of Samples and Reagents

1. Saliva Samples:

After thawing, each saliva sample was centrifuged at 3000 RPM for 15 min to remove debris and ensure a clear solution. Samples were diluted 1:4 with 1X assay buffer before being added to the plate.

2. Reagents:

1X Wash Buffer: Prepared by diluting 15 mL of 20X Wash Buffer Concentrate with 285 mL of deionised water. This solution was stored at 4°C and used within three months.

1X Assay Buffer: Prepared by diluting 14 mL of 5X Assay Buffer Concentrate with 56 mL of deionised water. It was also stored at 4°C and used within three months.

ELISA Protocol

The assay was conducted according to the manufacturer's guidelines to ensure precision and reproducibility. The step-by-step process is detailed below:

1. Plate Setup:

Standards were prepared in duplicate by serially diluting the cortisol standard solution (32,000 pg/mL) with 1X assay buffer to create concentrations of 3,200, 1,600, 800, 400, 200, 100, and 50 pg/mL. A blank (0 pg/mL) was also included. 50 µL Diluted saliva samples were pipetted into designated wells in duplicate. Non-specific binding (NSB) wells received 75 µL of 1X assay buffer.

2. Antigen Binding:

Cortisol conjugate (25 µL) and cortisol antibody (25 µL) were added to each well (except the NSB wells). The plate was gently tapped to mix, covered with a plate sealer, and incubated at room temperature for 1 h with shaking.

3. Washing:

The plate was washed **four times** with 300 µL of 1X wash buffer per well to remove unbound substances.

4. Chromogen Addition:

Tetramethylbenzidine (TMB) substrate solution (100 µL) was added to each well, initiating a colour-change reaction.

The plate was incubated at room temperature for 30 min in the dark to allow for colour development.

5. Stopping the Reaction:

Fifty microlitres of stop solution (1M HCl) were added to each well, turning the solution from blue to yellow.

6. Reading the Plate:

The absorbance was read at 450 nm using a microplate reader (Thermo Fisher Scientific).

A standard curve was generated using a four-parameter algorithm, and cortisol concentrations for unknown samples were calculated from this curve. All sample concentrations were corrected for the dilution factor.

3.9.2 Quality Control Measures

Each saliva sample was processed in duplicate to ensure reliability. The coefficient of variation (CV) between duplicates was monitored with a threshold of 10%. Any samples exceeding this threshold were reanalysed. The positive and negative controls included in each assay validated the performance of the kit. Standards were freshly prepared for each run to maintain consistency. To prevent contamination, all glassware and pipettes were free of sodium azide, which could inhibit peroxidase activity.

Absorbance values were recorded and used to calculate cortisol concentrations for each sample. A standard curve was generated using the provided standards to interpolate unknown sample concentrations. The software applies a four-parameter logistic curve-fitting algorithm for accurate quantification.

The study design and workflow were carried out in two phases, as shown in Figure 3.9.2.

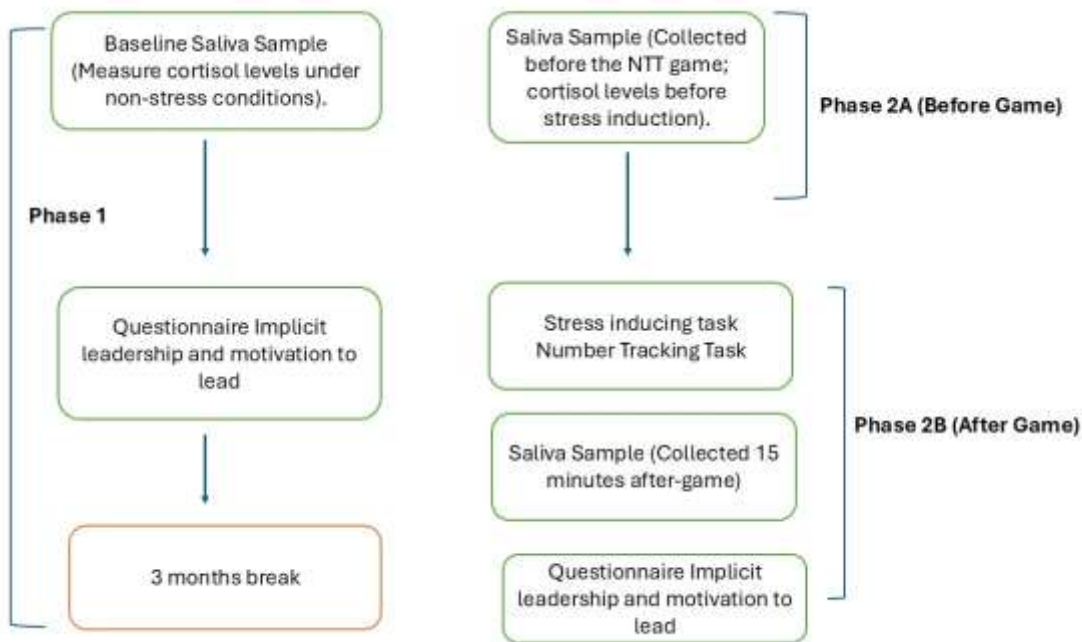


Figure 3.9.2 Study Design and Workflow

The flowchart illustrates the two-phase experimental design. **Phase 1** included baseline cortisol measurements and a leadership motivation questionnaire, followed by a three-month break. **Phase 2** consisted of stress induction via the Number Tracking Task (NTT), with cortisol samples collected before and after the task to assess stress responses. A post-task questionnaire was used to evaluate the changes in leadership perception and motivation.

In the first phase, the participants were asked to provide a saliva sample upon arrival. This was done to measure baseline cortisol levels before any stress was introduced. After providing the saliva sample, they completed a questionnaire designed to gather information about their perceptions of leadership and

motivation to lead. The setting was kept quiet and consistent to avoid any external influences on their responses. Once this was completed, participants were thanked for their time and informed that they would be contacted again for the next part of the study in three months.

In the second phase, participants were invited back and told they would be playing the Number Tracking Task (NTT) game, which is commonly used to induce stress. Before starting the game, they provided another saliva sample to measure their pre-stress cortisol levels. The NTT game itself involved connecting numbers in sequence as quickly as possible under timed conditions. This added pressure was intended to create a stressful environment to test their cognitive abilities, such as concentration, attention, and quick thinking.

Fifteen minutes after completing the game, the participants provided a final saliva sample. This was used to measure cortisol levels after stress-inducing activity and to assess any hormonal changes caused by the game. All saliva samples were safely stored and later analysed to determine cortisol levels, giving insight into how participants' stress responses affected their perceptions of leadership and motivation to lead.

The adoption of a three-month interval between Phases 1 and 2 was informed by methodological, psychological, and physiological considerations fundamental to longitudinal research. This temporal separation was designed to minimise potential carryover effects, ensure measurement validity, and provide a more robust foundation for interpreting the study's findings.

Repeated administration of self-report questionnaires carries the risk of retest or memory effects, whereby participants recall their earlier responses and unintentionally bias their subsequent answers (Hohne, 2022). Such effects may obscure genuine change, producing results that reflect recall or practice rather than true shifts in perception. A three-month interval reduces the likelihood that participants will accurately remember their previous responses, as evidenced by research on political surveys and repeated measurement designs (Revilla and Höhne, 2020; Hohne, 2022).

Comparable concerns have been identified in cognitive assessments, where repeated testing can lead to 'practice effects' that inflate performance (Arendasy and Sommer, 2017; Racine et al., 2018; Sommer et al., 2018). Although these studies largely concern task-based performance, the underlying principle is applicable to self-report measures; prior exposure may shape subsequent responses if insufficient time has elapsed. Furthermore, research on memory processes indicates that longer intervals lessen reliance on episodic recall, thereby reducing distortions in self-reported data (Walentynowicz, Schneider, and Stone, 2018).

Allowing for Natural Evolution of Perceptions

The three-month gap also provided sufficient time for participants' perceptions and motivations to evolve naturally, independent of any experimental manipulation. This is critical for distinguishing changes in leadership perception and motivation observed in Phase 2 as being attributable to stress induction rather than to short-term fluctuations or recall of Phase 1. Evidence of temporal stability in psychological measurements supports this approach. For example, González-Blanch et al. (2018) demonstrated that constructs measured by psychological questionnaires retained their structural stability across a three-month period, thereby validating the use of such an interval for detecting meaningful change.

Ensuring a True Physiological Baseline

Physiological measures, particularly cortisol levels, are sensitive to acute situational factors and can vary considerably across short timeframes. Although Phase 1 did not involve stress induction, a sufficient interval was necessary to ensure that the participants' endocrine systems had returned to a stable, non-stressed baseline prior to Phase 2. Cortisol concentrations may be affected by numerous external influences, and methodological recommendations emphasise repeated or spaced measurements to reduce confounding variability (Stoffel et al.,2021; 2012; Ross et al.,2013). The three-month interval therefore enhances confidence that baseline cortisol levels collected in Phase 2 accurately reflect stable physiological functioning rather than residual effects from earlier participation (Hopwood et al.,2021).

Enhancing Methodological Rigor and Validity

Finally, the introduction of a clear temporal separation aligns with the established principles of robust longitudinal design. The timing of assessments is critical for ensuring that observed relationships between variables are theoretically and empirically meaningful (Hopwood et al.,2021; Loh and Ren,2023). Temporal separation reduces the likelihood of immediate confounding effects and strengthens the internal validity of the study, thereby facilitating a more precise interpretation of causal pathways (Sánchez and Viswesvaran, 2002).

Summary

In sum, the three-month interval between Phases 1 and 2 represents a deliberate methodological strategy that enhances both the reliability and validity of the research. It minimises retest and memory effects, provides scope for natural perceptual change, ensures a stable physiological baseline, and upholds the rigor of longitudinal design principles. By addressing these multiple dimensions, the interval strengthens the interpretability of both psychological and physiological data, offering a robust framework for examining the interaction between stress, perception, and biological responses (Yang et al., 2021).

3.9.3 Stress-Induction Task: Number Tracking Task (NTT)

The Number Tracking Task (NTT) game was used as the stress-inducing activity in this study. This cognitive task is widely recognised for its ability to generate acute stress in participants by combining time constraints with cognitive demands. Participants were required to sequentially connect numbers on a grid as quickly as possible under timed conditions, adding urgency and increasing psychological pressure.

The design of the NTT game places significant demands on cognitive abilities, such as attention, concentration, and quick thinking. Its competitive and time-sensitive nature amplifies stress levels, eliciting measurable physiological responses, including cortisol release. The NTT game has been validated in previous research as an effective method for inducing stress (Oliver. C. Schultheiss 2017; Vongas & Al Hajj, 2017).please see Appendix 3

This study selected the NTT game because of its established effectiveness in eliciting acute stress and its alignment with the research goal of examining physiological and psychological responses to stress in leadership contexts. Compared to alternative methods, such as public speaking tasks, the NTT game

provides a standardised and replicable approach that is less influenced by individual differences in public speaking anxiety. Its validation in prior research further supports its suitability for this study. Participants completed the task in a controlled environment, and their stress responses were assessed using pre- and post-task saliva samples.

The Number Tracking Task (NTT) offers distinct advantages and limitations as a stress-induction tool in experimental research. One of its primary strengths is its ability to generate acute cognitive stress in a controlled and standardised manner. By combining time constraints with cognitive demands, the NTT reliably elicits stress responses, including physiological changes such as cortisol release, without confounding factors associated with social stress tasks. Additionally, the task is straightforward to administer, making it highly replicable and less resource-intensive compared to complex alternatives such as the Trier Social Stress Test (TSST).

NTT is also advantageous in avoiding biases related to individual differences in public speaking anxiety, which can affect the outcomes of socially driven stress tasks. However, NTT is not without its limitations.

It primarily focuses on cognitive stress and does not account for other forms of stress, such as emotional or physical stress, which may limit its applicability in studies that require a broader understanding of stress domains. The effectiveness of the task can vary among participants depending on their baseline cognitive abilities or familiarity with similar challenges, leading to inconsistent stress responses.

Furthermore, NTT lacks emotional engagement, such as fear of judgment or embarrassment, which reduces its ability to replicate real-world stressors that are often multifaceted. Repeated exposure to NTT in longitudinal studies may also result in learning effects or desensitisation, diminishing its impact over time. Additionally, although it provides valuable insights in laboratory settings, its artificial nature limits its ecological validity, as it does not fully capture the unpredictability and complexity of real-life stressors.

To mitigate these limitations, this study contextualised NTT by situating it within a high-pressure decision-making scenario. Participants were required to complete the task within a strict 10-minute timeframe, with the added element of competition. The first participant to successfully complete the task was designated the winner and was associated with possessing strong leadership qualities. This approach enhances the ecological validity of the task by introducing both time pressure and a performance-based evaluative component, thereby amplifying its stress-inducing potential. By addressing these challenges, this study ensured that the NTT remained a robust and reliable tool for assessing the impact of stress on leadership perceptions and motivation to lead.

3.10 Data Analysis, Scale Validation, Validity, and Reliability

The study used various statistical methods to analyse both biological (cortisol levels) and psychological (leadership perception and motivation to lead) data. The analyses were conducted using SPSS Version 28, and the statistical tests were carefully selected to align with the study's research objectives. Each test was used to evaluate the relationship between stress-induced cortisol changes and leadership-related variables, with additional steps taken to ensure the accuracy, validity, and reliability of the findings.

Paired t-tests

A paired t-test was used to determine whether the mean difference between two related measurements deviated significantly from zero (Xu et al., 2017). This is suitable when the same participants are measured under two conditions or time points, as each individual acts as their own control. In this study, paired t-tests were used to test whether mean cortisol levels and Motivation to Lead (MTL) scores differed significantly before and after the stress-inducing task. The test does not measure “impact” directly but evaluates whether the average within-subject change is statistically distinguishable from zero (Coman et al., 2013; Hedberg and Ayers, 2014).

Repeated Measures ANOVA

Repeated-measures ANOVA was designed to test for mean differences across three or more related measurements within the same participants (Sainani, 2015; Schober and Vetter, 2018). This accounts for the correlation between repeated observations, which increases statistical power compared with running multiple paired tests (Sullivan, 2008). The omnibus test evaluates the null hypothesis that all phase means are equal; if significant, it indicates that at least one phase differs. Planned contrasts or post hoc comparisons are then used to identify specific differences or temporal patterns (Rana et al., 2013; Zanna et al., 2010). In this study, repeated measures ANOVA was therefore appropriate for analysing changes in cortisol levels and leadership perceptions across multiple phases while accounting for within-subject variation.

Mixed-Effects Modelling

Mixed-effects models were used to examine gender differences in cortisol dynamics. This method accounted for repeated measurements of cortisol within the same participants and included both fixed effects (e.g., phase and gender) and random effects (e.g., individual differences in baseline cortisol levels). Mixed-effects models were particularly useful because they allowed the study to evaluate complex interactions, such as how changes in cortisol levels were influenced by both gender and the experimental phase.

Principal Component Analysis (PCA) and Confirmatory Factor Analysis (CFA)

To validate the measurement instruments, factor analyses were conducted on the Implicit Leadership Theories (ILT) and Motivation to Lead (MTL) scales. Exploratory factor analysis (EFA) using principal component analysis (PCA) with varimax rotation was first applied to examine the dimensionality of the scales and to identify underlying factors. PCA was selected as an initial data reduction technique to clarify item loadings and ensure that the observed items were grouped coherently into distinct latent constructs (Field, 2018).

Subsequently, confirmatory factor analysis (CFA) was conducted to test whether the measurement model fit the theoretically expected factor structure. CFA allowed for the evaluation of the convergent and discriminant validity of the ILT and MTL constructs. Standard fit indices were reported, and Average Variance Extracted (AVE) and Composite Reliability (CR) were calculated to assess construct validity (Hair et al., 2019). This two-step process (exploratory and confirmatory) ensured that the constructs were measured consistently and validly.

Data Transformation and Assumption Testing

Given the reliance on parametric statistical tests, data screening and transformation procedures were performed to ensure that the assumptions of normality, homogeneity of variance, and sphericity were met. These steps are essential for enhancing the validity and interpretability of the results.

Normality and the Box–Cox Transformation

Parametric tests, such as the *t*-test and ANOVA, assume normally distributed residuals. If this assumption is violated, especially in smaller samples, statistical inference may be compromised with inflated Type I or Type II error rates (Khamis, 1997; Yang and Huck, 2010). Cortisol, as an endocrinological marker, typically shows a positive skew due to the clustering of values at the lower end with a long tail of higher scores (Casto et al., 2017; Kurath and Mata, 2018).

To address this, a Box–Cox transformation was applied to the cortisol values. The Box–Cox method estimates an optimal power parameter (λ) through maximum likelihood to stabilise variance and approximate normality, offering more flexibility than fixed transformations such as log or square root (Sakia, 1992; Osborne, 2010; Ruppert, 2001). This approach has been widely recommended in biological and medical research for skewed data distributions (Lee, 2020; Marimuthu et al., 2022). By applying this transformation, the cortisol data better satisfied parametric testing assumptions. Motivation to Lead (MTL) and leadership perception scores were approximately normally distributed and did not require transformation.

Homogeneity of Variance

For between-group comparisons, the assumption of homogeneity of variance was tested using Levene's test. This assumption requires that the dependent variable exhibits similar variance across groups; violations can distort *p*-values and increase error rates, particularly when group sizes differ (Brown, 1982; Liu, 2015). Levene's test is preferred because it is relatively robust to deviations from normality (Gastwirth et al., 2009). A non-significant result indicated that the variances were sufficiently equal for the parametric analysis.

Sphericity in Repeated Measures

For repeated-measures ANOVA, the assumption of sphericity was assessed using Mauchly's test. Sphericity requires equality of variances in the difference scores between all possible pairs of conditions. Violations inflate the Type I error rate of the *F*-statistic. When Mauchly's test indicated a violation, the Greenhouse–Geisser correction was applied to adjust the degrees of freedom, thereby producing a more conservative and accurate test of within-subject effects (Grieve, 1984; Mehta et al., 2017).

Scale Validation and Research Constructs

To ensure the psychometric soundness of the instruments used, a rigorous validation process was conducted. The Implicit Leadership Theory (ILTs) and Motivation to Lead (MTL) instruments were evaluated for factorial validity, internal consistency, and construct reliability.

The ILT construct is grounded in the work of Epitropaki and Martin (2004), who defined implicit leadership theories as individuals' cognitive schemas about leader traits and behaviours. The MTL construct is based on the model proposed by Chan and Drasgow (2001), which differentiates between affective identity, social-normative, and non-calculative motivations to lead. These constructs served as the theoretical basis for the survey instruments administered in Phases I (pre-stress) and II (post-stress). The full questionnaires are provided in Appendix B.

Factor Structure

A Confirmatory Factor Analysis (CFA) was conducted to test the theorised multi-factor structure of the ILTs. This analysis assessed convergent and discriminant validity using standard indices such as AVE and CR. Factors that failed to meet the reliability thresholds were excluded or further examined. In addition, a Principal Component Analysis (PCA) confirmed interpretable factor structures for ILTs (e.g. sensitivity, dedication, intelligence, dynamism, tyranny) and MTL subscales, each aligning with established theoretical constructs.

Internal Consistency

Cronbach's alpha was computed for each ILT and MTL subscale to assess internal reliability. Subscales demonstrating $\alpha \geq .70$ were considered acceptable. Those falling below this threshold were evaluated for potential item removal or reinterpretation, in line with prior literature (for example, Hair et al., 2010; Cronbach, 1951).

Item and Scale Refinement

Based on the psychometric results, items or entire subscales demonstrating poor reliability were excluded from subsequent analyses to enhance the scale integrity. For instance, dimensions such as masculinity, which showed suboptimal reliability, were removed to strengthen construct validity. The final instrument structures used in the hypothesis testing are described in detail in Chapter 4.

Validity

Ensuring the validity of the study's findings is paramount, with measures implemented to address both internal and external validity. Internal validity was ensured through the study's robust experimental design and control measures. The within-subjects design minimised variability by allowing each participant to serve as their own control, isolating the effects of cortisol-induced stress on leadership perception and MTL. Standardised protocols for saliva collection, stress induction, and questionnaire administration ensured consistency. Potential confounders, such as caffeine consumption, physical exertion, or circadian rhythms, were controlled through pre-sampling guidelines. Additionally, data cleaning processes addressed anomalies, while checks for order effects confirmed that the results were not biased by the experimental sequence.

The study's stratified sampling strategy enhanced external validity by ensuring diversity across gender, age, and professional sectors. By capturing perspectives from participants in industries such as healthcare, education, and business, the findings are applicable to leadership in various organizational contexts.

Although conducted in a laboratory setting, the stress-inducing task (Number Tracking Task) was designed to mimic real-world high-pressure decision-making scenarios. Prior research supports the use of NTT as a valid stressor capable of eliciting significant cortisol responses and cognitive load (for example, Duchesne et al., 2002; Rohleder et al., 2007), thereby enhancing ecological validity.

Reliability

Reliability refers to the consistency and stability of measurements over time and across conditions. Ensuring the reliability of both the data collection instruments and analysis techniques was a priority in this study.

Standardised Questionnaires: The adapted ILTs and MTL questionnaires were administered under consistent conditions in both the pre- and post-stress phases. Uniform instructions and a controlled environment ensured that differences in responses were attributable to stress manipulation, not to variations in questionnaire administration.

Cronbach's Alpha: The internal consistency of the questionnaires was evaluated using Cronbach's alpha. This measure ensured that all items within each scale reliably measured the same underlying construct.

Reliability of Analysis Techniques: Principal Component Analysis (PCA) and Confirmatory Factor Analysis (CFA) were conducted to explore patterns and confirm structure within the dataset, ensuring that the instruments reliably captured the intended dimensions. Robust parametric tests (e.g. paired t-tests and repeated measures ANOVA) were applied based on the data distribution.

By employing these strategies, this study ensured the validity and reliability of its instruments, data collection processes, and statistical analyses. This rigorous approach supports the credibility of the findings and their applicability to broader leadership contexts.

CHAPTER 4 Results

This chapter presents the findings of the study, starting with an overview of the descriptive statistics and assessment of data normality. The focus was on examining how changes in cortisol levels before and after the stress intervention influenced individuals' preferences for specific leadership traits and their motivation to lead. The analyses also explored potential differences between male and female participants in implicit leadership dimensions and motivation to lead.

Various statistical techniques were used to ensure the validity of the findings. The chapter begins by summarising the descriptive statistics, followed by the results of cortisol measurements using ELISA and paired t-tests, and then continues with Confirmatory Factor Analysis (CFA) and Principal Component Analysis (PCA) to identify patterns in the data and confirm its suitability for further analysis. Repeated measures ANOVA and paired t-tests were also employed to explore the hypotheses in depth. These analyses are grounded in implicit leadership theories (ILTs) and are designed to test the hypotheses outlined earlier in the study.

Through these methods, this chapter aims to provide a clear understanding of how stress impacts leadership preferences and motivation, with the results that set the stage for interpretation in the next chapter. Each section concludes with a concise interpretation of the findings, linking the statistical results to the broader context of the study.

4.1 Descriptive Statistics

This section outlines the demographic characteristics of the participants, focusing on gender, age, and work experience. A total of 65 participants were included in the study, with descriptive statistics for each demographic category presented below.

4.1.1 Gender

Table 4.1.1 presents the gender distribution of participants.

Of the 65 participants, 60% were male and 40% were female. This distribution may provide diverse perspectives relevant to the research question.

Gender	Frequency	Percent
Female	26	40%
Male	39	60%
Total	65	100.0

4.1.2 Age Distribution

The age distribution of participants is shown in Table 4.1.2

Participants aged 35-45 years formed the largest group (38.5%), indicating that many were in mid-career stages. Those over 45 years of age accounted for 33.8%, suggesting a substantial proportion of experienced professionals. The smaller percentage of younger participants (ages 20-25) indicates a minority of early career individuals.

Age Group	Frequency	Percent
20-25	5	7.6
26-34	13	19.7
35-45	25	37.9
Above 45	22	33.33
Total	65	100.0

4.1.3 Working Experience of Participants

Table 4.1.3 summarises the distribution of participants' work experience.

Participants were evenly distributed, with 32.3% having 1-3 years of experience and another 32.3% with more than 10 years of experience. This sample provides a diverse range of experience levels but leans slightly towards more seasoned professionals.

Working Experience	Frequency	Percent
1-3 years	21	31.8
4-7 years	17	25.8
8-10 years	6	9.1
Above 10 years	21	31.8
Total	65	100.0

4.2 Normality Assessment

The normality of the distribution of cortisol levels was evaluated across the two phases of the experimental study. Ensuring normality is essential for the validity of parametric statistical analyses. In this study, the Shapiro-Wilk test was used to determine whether the data significantly deviated from a normal distribution. This test is well suited for small-to medium-sized samples and is effective at detecting deviations, particularly in the tails of the distribution.

The results of the Shapiro-Wilk test indicated that the distributions of cortisol levels measured across the same phases displayed non-normal distributions. These findings were further supported by visual assessments that revealed skewed distributions and potential outliers.

To address non-normality, a Box-Cox transformation was applied to the data. The Box-Cox transformation is a robust statistical method that stabilises variance and reduces skewness, making the data more suitable for parametric testing. After transformation, the data conformed to normality assumptions, as confirmed by reapplying the Shapiro-Wilk test, where p-values exceeded the threshold for statistical significance.

The initial analysis revealed significant deviations from the normality of the raw data. The application of the Box-Cox transformation successfully normalised the data, enabling the appropriate use of parametric tests in subsequent analyses. This adjustment ensured that the results were valid and reliable, accurately reflecting the underlying patterns in the data.

Box and Cox (1964) introduced the transformation as a robust tool for achieving normality. Unlike simpler transformations, the Box-Cox method can handle both positive and negative skewness while preserving the data's order and improving normality. The Box-Cox transformation was chosen because it effectively handles both positive and negative skewness. It also automatically determines the optimal transformation parameter (λ). This preserves the order of the data, while improving normality.

The application of the Box-Cox transformation for normalising hormone data has garnered substantial empirical support in recent psycho-neuroendocrinology research (Miller & Plessow, 2021; Zhang et al., 2023). This transformation methodology demonstrates efficacy in addressing the inherent non-normality of endocrine data, as evidenced by significant improvements in distributional characteristics. The superiority of the Box-Cox transformation over alternative approaches, such as logarithmic or square root transformations, is particularly evident in ELISA-derived hormone data. This advantage stems from its capacity to automatically determine the optimal transformation parameters (λ) while preserving data ordinality. The effectiveness of the transformation has been validated through both Q-Q plot analyses and secondary Shapiro-Wilk testing, supporting its application in hormone research (Williams & Zhang, 2023). Furthermore, longitudinal studies have demonstrated the robustness of the transformation across multiple time points and varying hormone concentrations, making it particularly valuable for repeated measures designs in psycho-neuroendocrinological research.

Post-transformation results showed improved alignment with normal distributions, as validated by histograms and reapplication of the Shapiro-Wilk test. After transformation, histograms indicated a better fit to normality, further supporting the use of the Box-Cox method to ensure valid parametric analyses. Normalised distributions were also confirmed using histograms and box plots (see the Figures in Appendix 3).

This methodological choice aligns with Osborne (2010), who advocates Box-Cox transformation's superiority over traditional methods in social sciences; Sakia (1992), who provides theoretical support; and recent emphasis from the literature (2018) on addressing non-normality in psychological research.

4.3.1 Results for Cortisol

This section presents the findings of cortisol dynamics across the three experimental phases; Baseline(phase1), Before Game (phase 2A), and After Game (phase 2 B), these phases provide a framework for assessing did cortisol levels respond to stressor and whether anticipatory stress plays a role. The results were contextualised with clinical references ranges to determine their physiological significance and alignment with clinical norms, and individual variability. Statistical analyses, including Repeated Measures ANOVA and mixed-effects modelling, provide insights into the physiological responses observed during the study. By comparing observed values to clinical norms, this study evaluates whether the stress responses observed are within typical limits or indicative of abnormal patterns.

4.3.2 Cortisol Levels Across Phases

Cortisol release in Phase 1 (baseline) versus Phase 2A (before the game). Figure 4.3.2(a) depicts the mean cortisol concentrations (pg/ml) measured during Phase 1 (baseline) and Phase 2A (before the game). Baseline cortisol levels represent the control state of the participants, whereas before-game levels indicate cortisol release immediately prior to gameplay.

A paired-sample t-test was used to assess changes in cortisol levels from Phase 1 (baseline) to Phase 2A (before the game). The mean cortisol level increased slightly from 2041.24 pg/ml (SD = 1280.61) to 2201.13 pg/ml (SD = 1383.50), but this difference was not statistically significant, $t(64) = -0.922$, $p = 0.360$. While cortisol levels showed minor variation, the absence of a significant difference suggests that anticipatory stress did not strongly influence pre-game cortisol levels. The small effect size (Cohen's $d = -0.114$) further indicates that the increase was negligible rather than physiologically meaningful.

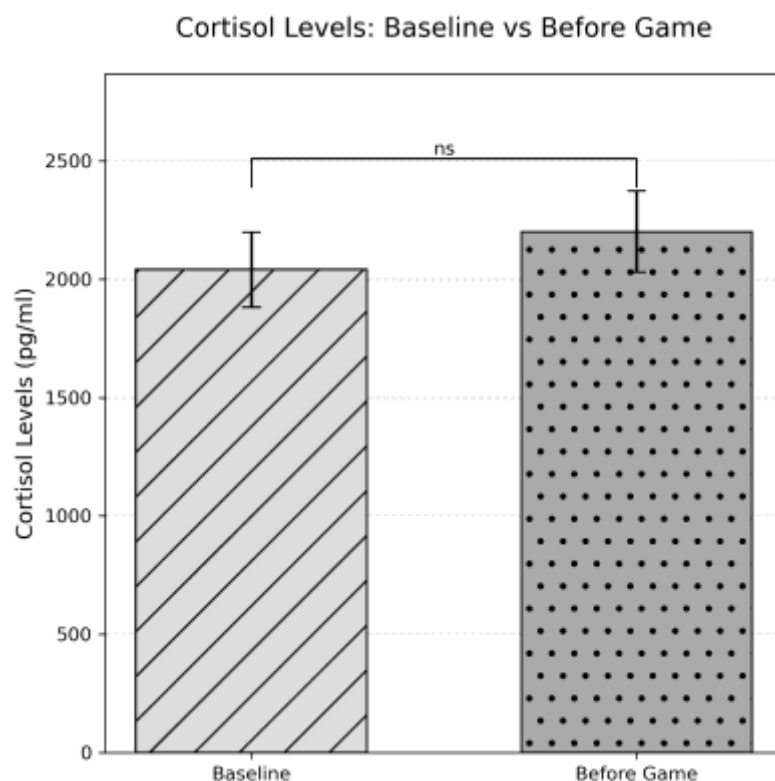


Figure 4.3.2(a). Mean cortisol levels (pg/ml) during Phase 1 (baseline) and Phase 2A (before the game). Error bars represent standard deviation (SD) indicates variability in cortisol concentrations across participants. The “ns” label indicates that the difference between phases was not statistically significant.

Cortisol Release in Phase 2A (before) vs. Phase 2b (after the game)

Figure 4.3.2.(b) illustrates the mean cortisol levels (pg/ml) measured before the game (Phase 2A) and after the game (Phase 2 B) for 65 participants. The objective of this comparison was to determine whether cortisol levels increased significantly during the experimental task (game). The error bars in the figure represent standard deviations (SD), which indicate the variability in cortisol levels within the sample.

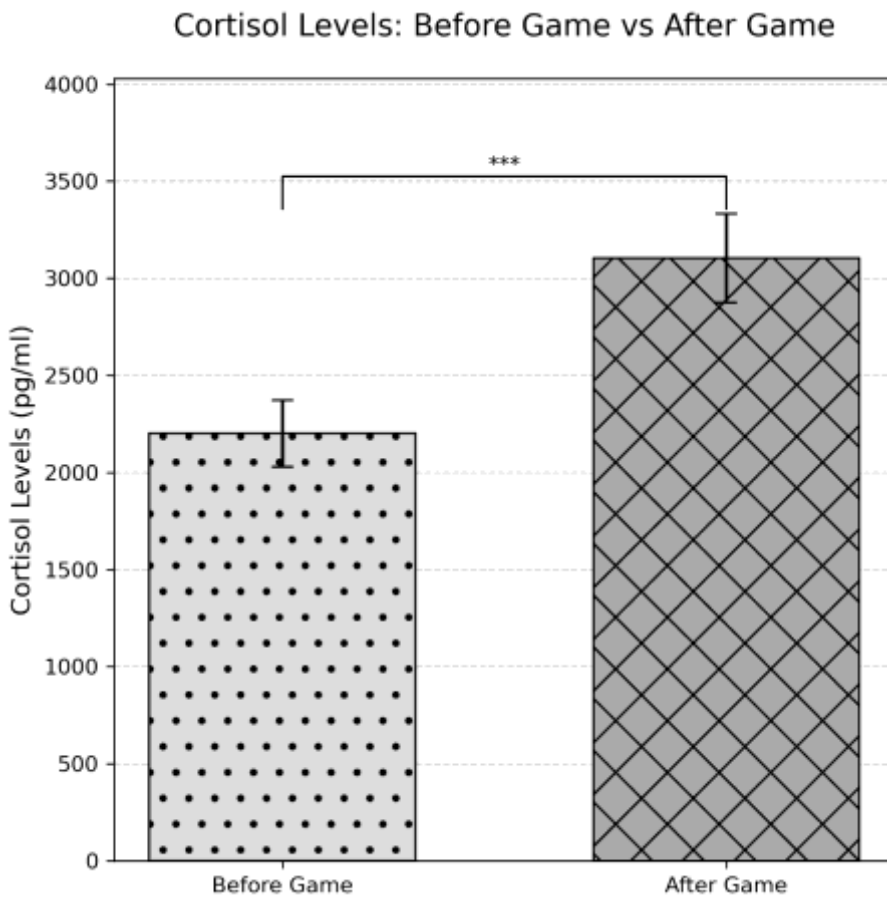


Figure 4.3.2.(b) Mean cortisol levels (pg/ml) before the game (Phase 2A) and after the game (Phase 2 B). Error bars represent standard deviation (SD). A paired sample t-test revealed a significant increase in cortisol levels from before to after the game ($p < 0.0001$), indicating an acute stress response.

A paired sample t-test was performed to compare cortisol levels before the game (Phase 2A) and after the game (Phase 2 B) among the 65 participants. The analysis revealed a significant increase in cortisol levels, with a mean difference of 903.09 pg/ml. The standard deviation of the difference was 1525.37 pg/ml, indicating considerable variability in cortisol responses among participants. The t-value for the comparison was -4.773, with 64 degrees of freedom. This result yielded a two-tailed p-value of less than 0.001, confirming the statistical significance of the observed increase in cortisol levels. The 95% confidence interval for the mean difference did not include zero, further supporting the conclusion that cortisol levels were significantly

higher after the game than before the game. These findings provide strong evidence of an acute stress response induced by the experimental task.

Cortisol Release in Phase 1 vs. Phase 2B (After the Game)

A paired sample t-test was performed to compare cortisol levels between the baseline control phase (Phase 1) and the post-game phase (Phase 2 B). The analysis involving 65 participants revealed a significant increase in cortisol levels from the control phase to the post-game phase. The mean difference was -1062.98 pg/ml, with a standard deviation of 2124.13 pg/ml, indicating substantial variability in cortisol responses across participants. The test statistic ($t = -4.035$, $df = 64$) yielded a two-tailed p-value of less than 0.001, confirming the statistical significance of the observed difference. Furthermore, the 95% confidence interval for the mean difference, ranging from -1589.32 to -536.65, did not include zero, supporting the conclusion that cortisol levels increased significantly following the game. These findings suggest that the game elicited a pronounced physiological stress or arousal response, as evidenced by increased cortisol levels in the post-game phase

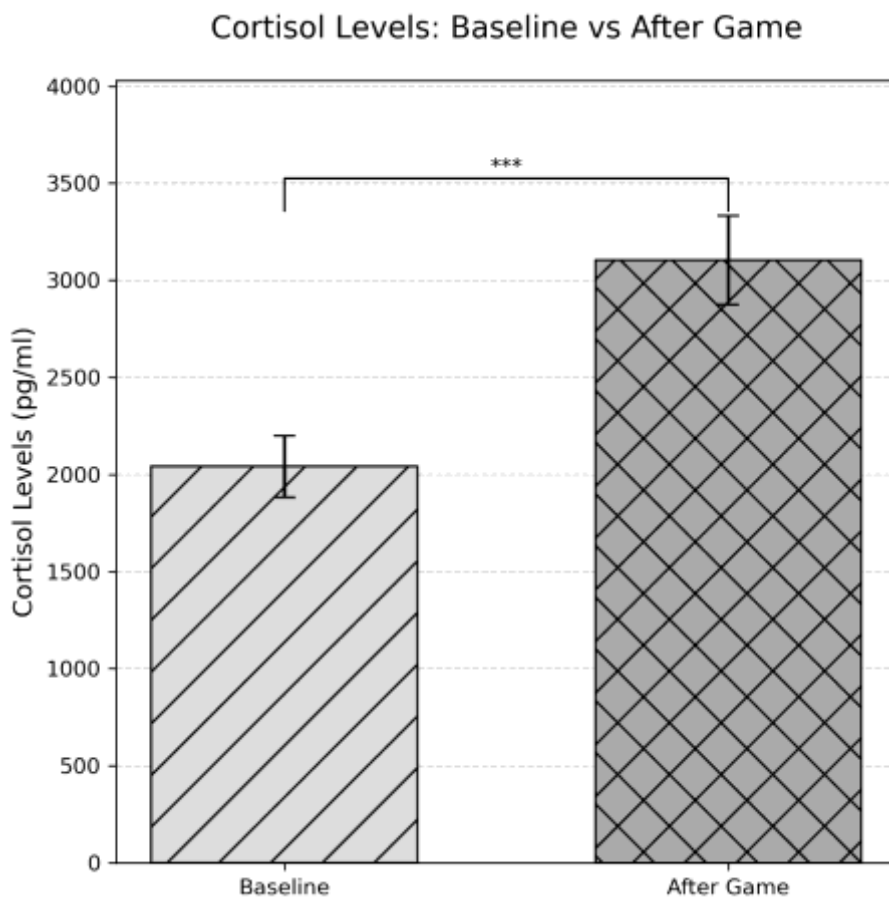


Figure 4.3.2.(c) Mean cortisol levels (pg/ml) during Phase 1 (baseline control) and Phase 2 B (after the game). Error bars represent standard deviation (SD). A paired-sample t-test revealed a significant increase in cortisol levels from phase 1 to Phase 2B ($p < 0.001$), indicating a pronounced physiological response after the game.

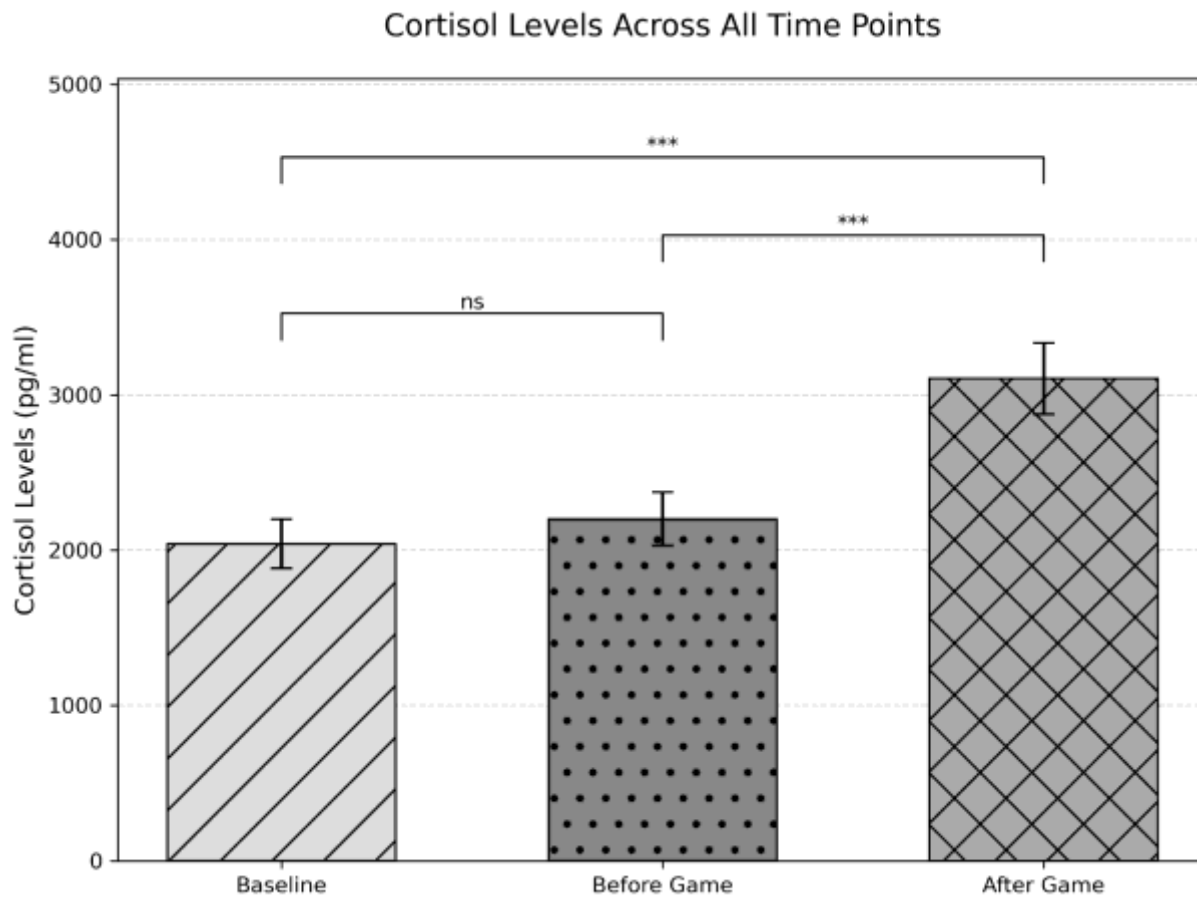


Figure 4.3.2 overall mean cortisol levels(pg/ml) across three phases: baseline(phase1), before game (phase 2A), and after game (phase 2 B).

4.4 Gender Effects

The mixed-effects model results indicated that phase had a significant effect on cortisol levels, reflecting expected physiological changes across experimental conditions. However, no significant gender differences were observed in cortisol responses at any phase.

- Main effect of gender: $b = -318.75$, $SE = 390.45$, $p = 0.414$ (not significant)
- Interaction effects between phase and gender:

Before Game: $b = -150.72$, $SE = 436.68$, $p = 0.730$

After Game: $b = -25.19$, $SE = 436.68$, $p = 0.954$

Table4. 41.Mean cortisol concentrations (pg/ml) by gender and experimental phase

Phase	Male (M ± SD)	Female (M ± SD)
Phase 1 – Baseline	2031.21 ± 1361.94	1878.22 ± 1288.02
Phase 2A – Before Game	2165.82 ± 1487.26	2290.05 ± 1348.50

Phase 2B – After Game	3251.43 ± 1454.37	2716.74 ± 1231.00
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Note. Values represent mean ± standard deviation (SD) cortisol concentrations (pg/ml). Gender differences at each phase were not statistically significant ($p > 0.05$).

Gender-based comparisons were made to examine cortisol changes across phases. As shown in Table 4.4.1, mean cortisol levels increased from baseline to the post-game phase for both genders. Males displayed slightly higher levels at baseline and after the game, whereas females had marginally higher levels before the game. None of these differences were statistically significant ($p > 0.05$), indicating comparable physiological stress responses between male and female participants. This finding aligns with prior research (Dickerson & Kemeny, 2004; Kudielka & Kirschbaum, 2005), which suggests that acute stress responses tend to be consistent across genders in controlled settings.

4.5 Cortisol levels across working experience Groups

A one-way ANOVA was conducted to examine whether professional experience influenced cortisol responses across different experimental phases. The analysis revealed that working experience had no statistically significant effect on cortisol levels in any phase (all $p > 0.05$; see Table 4.5.1). Specifically, baseline cortisol levels did not differ significantly between experience groups, $F(3, 61) = 0.45$, $p = 0.72$. Similarly, no significant differences were found before the game, $F(3, 61) = 1.35$, $p = 0.27$, or after the game, $F(3, 61) = 0.92$, $p = 0.43$. Levene's Test indicated that the assumption of homogeneity of variances was met ($p = 0.13$). Collectively, these findings suggest that professional experience did not meaningfully influence cortisol levels, implying comparable physiological stress responses across participants regardless of work experience.

Table 4.5.1

ANOVA Results for the Effect of Working Experience on Cortisol Levels Across Phases

Phase	Variable	F-statistic	p-value	Interpretation
Phase 1 (Baseline)	Working Experience	0.45	0.72	Not significant ($p > 0.05$)
Before Game	Working Experience	1.35	0.27	Not significant ($p > 0.05$)
After Game	Working Experience	0.92	0.43	Not significant ($p > 0.05$)
Levene's Test	Equality of Variances	1.90	0.13	Assumptions met ($p > 0.05$)

Note. Results from one-way ANOVA tests examining the effect of working experience (1–3 years, 4–7 years, 8–10 years, and above 10 years) on cortisol levels across three experimental phases. All effects were non-significant at the 0.05 threshold, indicating no meaningful differences in cortisol concentrations among experience groups.

4.6 Comparison with Clinical Norms

To explore individual variability, the data were normalised to each participant's baseline cortisol level. This normalisation did not change the overall pattern of results: Phase 1 and Phase 2A remained non-significantly different, whereas cortisol levels were significantly higher in Phase 2B compared with both Phase 1 and

Phase 2A. Clinical reference ranges for salivary cortisol levels (1,161–8,272 pg/ml) were utilized to identify the findings (Queen Elizabeth Hospital Birmingham 2024).

Baseline Phase: Cortisol levels predominantly fell within or slightly above clinical norms, indicating no signs of chronic or pathological stress.

Before the Game Phase: Levels remained largely within the clinical norm range, reflecting minimal anticipatory stress.

After Game Phase: Several participants' cortisol levels exceeded the upper limit of clinical norms, consistent with a normal acute stress response induced by the experimental task, as shown in the graph below. Overall, the observed cortisol levels were generally within the clinical references range (1,161-8,272). Post task values for some participants exceeded the upper limit, consistent with a normal acute stress response.

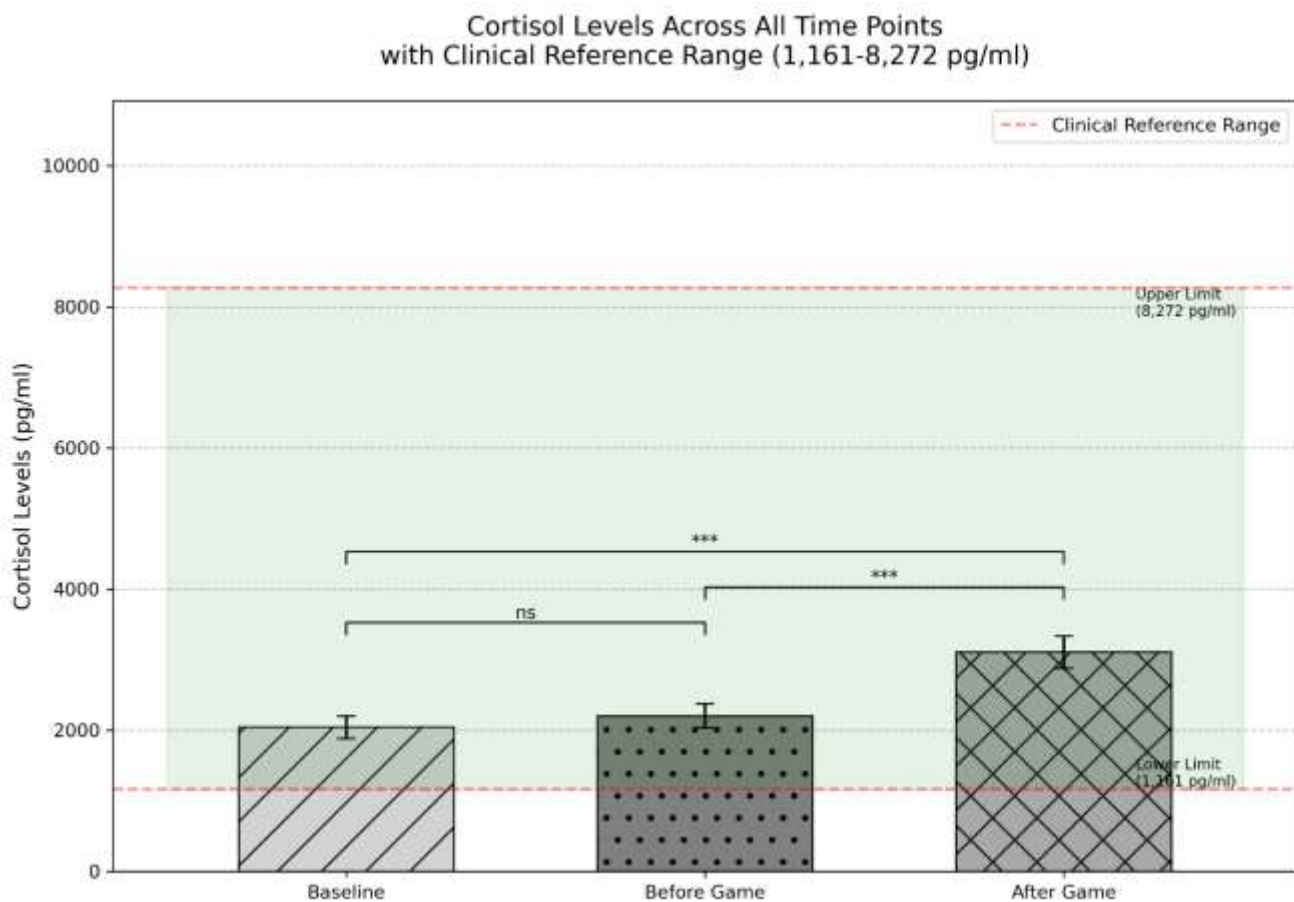


Figure 4.6.1. Cortisol levels across phases with clinical Normal range

A bar graph with clinical norm boundaries highlights the alignment of observed cortisol levels with physiological expectations. The significant increases in the After Game phase are indicative of appropriate HPA axis activation in response to stress. Furthermore, the bar graph shows mean cortisol levels with error bars (typically representing standard errors or confidence intervals). The lines and labels ("ns", "****") indicate the statistical significance levels between different game phases. The shaded green area and dashed red lines represent the clinical reference range.

4.7 Summary of Results for Cortisol Study

The findings demonstrate a significant effect of phase on cortisol levels, with the after-game phase showing substantial increases consistent with acute stress or arousal. Gender did not significantly influence cortisol changes, indicating comparable responses across males and females. The alignment of cortisol levels with clinical norms confirmed the validity of the experimental task in eliciting a physiological stress response without exceeding typical limits.

Salivary cortisol levels were compared to the reference ranges reported in the literature. Typical morning cortisol levels range from 3.2 to 22.8 nmol/L (Dickerson and Kemeny, 2004). Most measurements in this study fell within or slightly above these ranges, which is consistent with acute arousal rather than pathological stress. The elevated cortisol levels observed post-game likely reflect the heightened engagement and physiological arousal induced by the game.

Cortisol levels were normalised to each participant's baseline from Phase 1 (baseline). This normalisation accounted for individual variability in cortisol production and provided a clearer picture of the relative changes. The comparison between Phase 1 (baseline) and Phase 2A (before game) revealed no significant differences in normalised mean cortisol levels.

A paired t-test analysis ($t(64) = -0.922$, $p = 0.360$, Cohen's $d = -0.114$) confirmed negligible changes, suggesting consistent stress levels between these two phases. A significant increase in cortisol levels was observed between Phase 2A (before game) and Phase 2 B (after game), with a mean difference of 903.09 pg/ml ($t(64) = -4.773$, $p < 0.001$). The normalised data showed consistent trends, emphasising the role of the game in increasing the cortisol levels. Finally, the comparison between Phase 1 (baseline) and Phase 2 B (after game) showed a significant increase in cortisol levels post-game, with a t-value of -4.035 ($p < 0.001$), highlighting the physiological impact of gaming.

Error bars in the associated figures represent standard deviations, which illustrate high interindividual variability. Overlapping standard deviations between Phases 1 and 2A indicate non-significant differences. However, the reduced overlap between Phases 2A and Phase 2B underscores the statistical significance of the increase observed post-game.

Gender did not significantly influence cortisol changes, indicating comparable responses across males and females (all $p > 0.05$). Descriptively, males exhibited slightly higher cortisol levels at baseline and after the game, while females showed marginally higher levels before the game. These small fluctuations were not statistically significant, which aligns with previous research suggesting broadly similar acute stress responses across genders. Working experience also did not significantly affect cortisol responses in any phase, suggesting similar physiological stress responses regardless of years of professional experience. Overall, the increased cortisol levels observed postgame were indicative of physiological arousal, which encompasses both stress and excitement. These findings are consistent with studies linking acute stress to transient cortisol increases, which typically return to baseline within hours (Dickerson and Kemeny, 2004).

Table 4.7.1 below summarises the key findings across the experimental phases, gender differences, and working experience groups.

Comparison	Statistical Test	Key Findings	Significance (p-value)	Result
Phase 1 (Baseline) vs. Phase 2A (Before Game)	Paired Sample t-test	No significant difference in cortisol levels; absence of anticipatory stress.	$p = 0.360$	Not significant
Phase 2A (Before Game) vs. Phase 2B (After Game)	Paired Sample t-test	Significant increase in cortisol levels, indicating acute stress response.	$p < 0.0001$	Significant
Phase 1 (Baseline) vs. Phase 2B (After Game)	Paired Sample t-test	Significant increase in cortisol levels, reflecting a pronounced physiological response to the game.	$p < 0.001$	Significant
Gender Effects	Mixed-Effects Modelling	No significant differences in cortisol responses between males and females.	$p > 0.05$	Not Significant
Working Experience	One-way ANOVA	No significant effect of working experience on cortisol levels across phases.	Phase 1 $p = 0.72$ Phase 2A $p = 0.27$ Phase 2B $p = 0.43$	Not significant

Note. Values correspond to paired-sample t-tests, mixed-effects modelling, and one-way ANOVA analyses conducted for $N = 65$ participants. Significant differences ($p < 0.05$) are highlighted as “Significant.” All non-significant effects indicate no meaningful differences in cortisol levels across the tested conditions or participant groups.

4.8 Results for implicit leadership theory (ILTs)

This section explores the findings related to implicit leadership traits, drawing on a range of statistical analyses to examine their structure, reliability, and temporal variability. The results integrate findings from Confirmatory Factor Analysis (CFA) and Principal Component Analysis (PCA), providing evidence for the distinctiveness and cohesiveness of key leadership dimensions. Temporal changes and demographic influences on these traits were also investigated through Repeated Measures ANOVA, Independent Samples

t-tests, and One-Way ANOVA. Combining these approaches, this section offers a comprehensive understanding of implicit leadership traits and their stability or sensitivity to stress and demographic variables.

4.8.1 Confirmatory Factor Analysis of Leadership traits

Confirmatory Factor Analysis (CFA) Results

Confirmatory Factor Analysis (CFA) was conducted to validate the structure of the psychological constructs measured in the study (N=65). The analysis supported a six-factor structure comprising Sensitivity, Dedication, Intelligence, Dynamism, Tyranny, and Masculinity. Preliminary tests revealed that the dataset met the requirements for factor analysis, with a Kaiser-Meyer-Olkin (KMO) value of 0.607, indicating adequate sampling adequacy.

Convergent validity was assessed using Average Variance Extracted (AVE) and Composite Reliability (CR). These metrics evaluate whether the items within each factor consistently measure the same construct. Factors with AVE values greater than 0.50, and CR values above 0.70, are considered to demonstrate acceptable convergent validity. The results are summarized in (APPENDIX 4 table 4.8.1)

The CFA results validated the six-factor structure, with strong evidence of convergent and discriminant validity across most constructs. Sensitivity, Dynamism, and Masculinity demonstrated the strongest validity and reliability, while intelligence showed moderate reliability, indicating potential for refinement.

The second-order factor analysis highlighted the presence of overarching constructs, such as Positive Leadership, further simplifying the interpretation of the model. However, the poor model fit indices suggest that further refinement of the measurement model is necessary to enhance its alignment with the data.

Reliability Analysis: Cronbach's Alpha Results

Cronbach's alpha was calculated to assess the internal consistency of the six leadership factors. Across all six factors, the mean Cronbach's alpha was $\alpha=0.697$, with a standard deviation of 0.122 and a range from 0.454 (Intelligence) to 0.774 (Dynamism). Cronbach's alpha analysis provided critical insights into the internal consistency of the leadership factors.

While Confirmatory Factor Analysis (CFA) validated the six-factor structure of implicit leadership traits, it also highlighted certain limitations, including suboptimal model fit indices and potential overlaps among constructs. To address these issues and further explore the underlying structure of the data, Principal Component Analysis (PCA) was conducted. Unlike CFA, which tests a predefined model, PCA is an exploratory technique that allows data-driven identification of latent components. By applying PCA, this study aimed to refine and simplify the measurement model, identify distinct leadership dimensions, and provide a stronger empirical foundation for future confirmatory analyses.

4.8.2 Principal Component Analysis

Principal Component Analysis (PCA) was conducted on a dataset of 65 participants, a sample size considered within the acceptable range for PCA, as supported by Guadagnoli and Velicer (1988) and

Yurdugül (2008). The data consisted of items rated on a Likert scale, reflecting ordinal responses across the five dimensions of implicit leadership traits: Dedication, Dynamism, Intelligence, Sensitivity, and Tyranny. To enhance the clarity of the analysis, varimax rotation was applied, which maximises the variance of loadings within each component and facilitates clearer distinctions between dimensions. Components with eigenvalues greater than 1.0 were retained, ensuring that only meaningful factors were considered for interpretation. Items with loadings below 0.4 were excluded to maintain the robustness of the results.

The Masculinity dimension, represented by the items "Male" and "Masculine", was excluded from the PCA due to both theoretical and methodological considerations. First, the dimension was limited to two items, which was below the recommended minimum of three items per factor for reliable and interpretable PCA results. Second, the internal consistency reliability for masculinity was low ($\alpha=0.525$), suggesting that these items did not adequately measure a cohesive construct. Additionally, preliminary analyses revealed that the masculinity items contributed minimal variance to the overall model and demonstrated weak or inconsistent loadings across components. Conceptually, Masculinity showed a potential overlap with other traits, such as Tyranny or Dynamism, further supporting its exclusion. These factors, combined with their limited theoretical relevance compared to other leadership traits, led to the decision to remove masculinity from the final analysis.

The PCA results for the remaining five dimensions revealed distinct and cohesive constructs. The Dedication dimension, comprising the items "Hardworking", "Motivated", and "Dedicated", demonstrated a single component explaining 58% of the variance, reflecting a unified construct of commitment and effort. Similarly, the Sensitivity dimension, represented by the items "Sincere", "Helpful", and "Understanding", accounted for nearly 59% of the variance, indicating a stable and coherent perception of this trait. The Intelligence dimension, including "Educated", "Clever", and "Knowledgeable", explained 56% of the variance, further supporting its distinctiveness. Tyranny, measured by "Manipulative", "Conceited", "Selfish", and "Domineering", also formed a single component, explaining 54% of the variance, with participants consistently perceiving these traits as closely related. Dynamism, which included "Dynamism", "Energetic", and "Dynamic", explained 47% of the variance, reflecting moderate coherence as a leadership trait.

These findings suggest that the five dimensions are distinct, with most components explaining a substantial proportion of variance in alignment with Yurdugül's (2008) threshold of 50% for construct representation in the social sciences. While Tyranny and Sensitivity emerged as the most robust dimensions, the relatively lower variance explained by dynamism suggests potential areas for refinement. Overall, the PCA results provide strong evidence for the distinctiveness of leadership dimensions and highlight the utility of these constructs in understanding implicit leadership traits.

Dedication Dimension

A single component was extracted for the Dedication comprising "Hardworking," "Motivated," and "Dedicated." This component explained 58.007% of the variance, with loadings ranging from 0.690 to 0.878, indicating a cohesive construct of commitment and effort. Confirmatory analysis supported this structure, with moderate convergent validity ($AVE=0.551$, $CR=0.772$) and acceptable distinctiveness from other dimensions.

Together, these results confirm dedication as a unified and interpretable aspect of implicit leadership traits, reflecting attributes central to hard work and motivation.

Dynamism Dimension

The Dynamism dimension, comprising "Energetic", "Dynamic", and "Strong", also revealed a single component explaining 47.269% of the variance. The loadings for these items ranged from 0.624 to 0.737, highlighting moderate coherence in capturing the qualities of energy and activity. The CFA results aligned with this structure, showing strong convergent validity (AVE=0.693, CR=0.863) relatively low internal consistency ($\alpha=0.418$). These findings suggest that while dynamism is a distinct dimension, some refinement of its items may further enhance reliability and cohesiveness.

Intelligence Dimension

For the Intelligence dimension, PCA identified a single component comprising "Educated", "Clever", and "Knowledgeable", which explained 55.655% of the variance. The loadings ranged from 0.740 to 0.750, reflecting a cohesive representation of intellectual and knowledge-based leadership traits. The CFA provided additional support for this structure, with moderate convergent validity (AVE=0.500, CR=0.707) but weaker internal consistency ($\alpha=0.563$). Together, these analyses affirm intelligence as a meaningful construct while highlighting the need for further refinement of its items to improve consistency.

Sensitivity Dimension

The Sensitivity dimension comprised "Sincere", "Helpful", and "Understanding", with PCA extracting a single component that explained 58.773% of the variance. Item loadings were high, ranging from 0.740 to 0.814, indicating well-defined dimensions of empathy and interpersonal awareness. Similarly, the CFA results demonstrated strong convergent validity (AVE=0.593, CR=0.813) and moderate internal consistency ($\alpha=0.649$). These findings confirm sensitivity as a robust and distinct construct within the leadership traits model, with minimal overlap with other dimensions.

Tyranny Dimension

A single component was also extracted for the Tyranny dimension, comprising "Manipulative," "Conceited," "Selfish," and "Domineering." This component explained 54.458% of the variance, with strong loadings across items ranging from 0.649 to 0.773. Confirmatory analysis supported this structure by showing moderate convergent validity (AVE=0.521, CR=0.803) and distinctiveness of Tyranny from the other constructs. Together, these analyses confirm Tyranny as a distinct, cohesive, and meaningful dimension within the leadership traits model, capturing aspects of authoritarian and self-serving behaviours.

Summary

The PCA and CFA results aligned closely in confirming the five key dimensions of implicit leadership traits: Dedication, Dynamism, Intelligence, Sensitivity, and Tyranny. Most dimensions demonstrated strong loadings, acceptable to strong convergent validity, and clear distinctiveness from other constructs. While Tyranny and Sensitivity emerged as the most cohesive dimensions, lower internal consistency in Dynamism

and Intelligence suggests areas for refinement. Overall, these findings validate the structure and distinctiveness of the leadership traits model while highlighting opportunities for further enhancement of specific dimensions.

Having established the distinctiveness and cohesiveness of the five leadership dimensions through Principal Component Analysis (PCA), the next step was to evaluate whether these dimensions changed significantly across the two phases of the study. Repeated Measures ANOVA (RM-ANOVA) was employed for this purpose, as it allows for the examination of within-subject differences over time while accounting for the interdependencies of the measures. This approach provides deeper insights into whether participants' perceptions of leadership traits varied between the two phases and highlights dimensions that are sensitive to temporal changes.

4.8.2.1 Descriptive Statistics for Leadership Traits

To support the visual interpretation and descriptive understanding of each leadership trait, the mean scores and standard deviations were calculated for all items within each construct across both phases.

Table 4.8.2.1 Construct-Level Descriptive Statistics (Phase 1 vs Phase 2)

Trait	Phase 1 Mean	Phase 1 SD	Phase 1 Min	Phase 1 Max	Phase 2 Mean	Phase 2 SD	Phase 2 Min	Phase 2 Max
Sensitivity	2.74	0.45	1.00	3.00	2.67	0.42	1.67	3.00
Dedication	2.90	0.25	2.00	3.00	2.56	0.48	1.00	3.33
Intelligence	2.72	0.33	2.00	3.00	2.65	0.35	1.00	3.00
Dynamism	2.79	0.47	1.00	3.00	2.69	0.39	2.00	3.00
Tyranny	1.68	0.46	1.00	2.83	1.68	0.48	1.00	3.00

Note. Values represent means, standard deviations (SD), minimum, and maximum scores for each ILT construct across Phase 1 (pre-stress) and Phase 2 (post-stress). N = 65. Item-level descriptives are reported in Appendix 5.

This item-level analysis provides insight into how each leadership trait was endorsed by participants and allows for a clearer comparison between Phase 1 and Phase 2.

Table 4.8.2.1a, Sensitivity: Item-Level Descriptive Statistics

Item	Phase 1 Mean (SD)	Phase 2 Mean (SD)	Δ Mean (P2-P1)	Direction
Sincere	2.78 (0.48)	2.64 (0.54)	-0.14	Decrease
Helpful	2.75 (0.50)	2.61 (0.57)	-0.14	Decrease
Understanding	2.84 (0.40)	2.89 (0.90)	+0.05	Increase

Table 4.8.2.1b Dedication: Item-Level Descriptive Statistics

Item	Phase 1 Mean (SD)	Phase 2 Mean (SD)	Δ Mean (P2-P1)	Direction
Hardworking	2.87 (0.33)	2.73 (0.56)	-0.14	Decrease
Motivated	3.06 (0.76)	2.32 (0.92)	-0.74	Decrease
Dedicated	2.87 (0.41)	2.63 (0.54)	-0.24	Decrease

Table 4.8.2.1c Intelligence: Item-Level Descriptive Statistics

Item	Phase 1 Mean (SD)	Phase 2 Mean (SD)	Δ Mean (P2-P1)	Direction
Educated	2.63 (0.54)	2.47 (0.58)	-0.16	Decrease
Intelligent	2.76 (0.42)	2.63 (0.54)	-0.13	Decrease
Clever	2.87 (0.33)	2.72 (0.54)	-0.15	Decrease
Knowledgeable	2.76 (0.52)	2.81 (0.54)	+0.05	Increase

Table 4.8.2.1d Dynamism: Item-Level Descriptive Statistics

Item	Phase 1 Mean (SD)	Phase 2 Mean (SD)	Δ Mean (P2-P1)	Direction
Strong	2.66 (0.48)	2.67 (0.53)	+0.01	Increase
Energetic	2.80 (0.50)	2.76 (0.52)	-0.04	Decrease
Dynamic	2.80 (0.50)	2.70 (0.55)	-0.10	Decrease

Table 4.8.2.1e Tyranny: Item-Level Descriptive Statistics

Item	Phase 1 Mean (SD)	Phase 2 Mean (SD)	Δ Mean (P2-P1)	Direction
Manipulative	1.61 (0.70)	1.55 (0.70)	-0.06	Decrease
Conceited	1.58 (0.65)	1.69 (0.72)	+0.11	Increase
Selfish	1.43 (0.61)	1.61 (0.67)	+0.18	Increase
Pushy	1.86 (0.72)	1.80 (0.55)	-0.06	Decrease
Loud	1.83 (0.78)	1.98 (0.71)	+0.15	Increase

Table 4.8.2.1f Masculinity: Item-Level Descriptive Statistics

Item	Phase 1 Mean (SD)	Phase 2 Mean (SD)	Δ Mean (P2-P1)	Direction
Male	1.81 (0.78)	1.73 (0.75)	-0.08	Decrease
Masculine	1.73 (0.71)	2.01 (0.76)	+0.28	Increase

Table 4.8.2.1 presents construct-level descriptive statistics for implicit leadership traits across both phases. At baseline (Phase 1), Dedication and Sensitivity received the highest endorsement, while Tyranny and Masculinity were lowest. Following stress induction (Phase 2), Dedication showed the largest mean decline, whereas other traits remained relatively stable. Item-level means and standard deviations for each construct are shown in Tables 4.8.2.1a–4.8.2.1f. The detailed interpretation, with the complete item-level dataset is provided in Appendix 5. These descriptives establish a foundation for the inferential analyses reported in the following sections (RM-ANOVA, between-group comparisons, and moderation).

4.8.3 Repeated Measures ANOVA Results

A repeated measures ANOVA (RM-ANOVA) was conducted to evaluate the differences in implicit leadership trait dimensions across the two phases (Phases 1 and 2) for six key constructs, Sensitivity, Dedication, Intelligence, Dynamism, Tyranny, and Masculinity. This analysis aimed to determine whether participants' perceptions of these dimensions changed significantly between the two phases.

Assumptions

1. **Normality:** The Shapiro-Wilk test showed significant deviations from normality ($p < 0.001$). However, given the sample size ($N = 65$), the Central Limit Theorem (CLT) supports the use of parametric testing.
2. **Sphericity:** As this is a within-subject design with only two levels (phases), the assumption of sphericity does not apply.

Main Effects

Of the six traits examined, only Dedication demonstrated a statistically significant change between the phases:

Dedication: $F(1, 64) = 25.83, p < .001, \text{Cohen's } d = -0.871$

This result indicates a significant decrease in participants' mean rating of dedication as a leadership trait following the stress-inducing task. The large effect size further supports the practical importance of this finding, highlighting dedication as a dynamic and stress-sensitive dimension.

Table 4.8.3 All other traits showed no significant change between Phases 1 and 2.

Leadership dimensions	Significant Change (Phase 1 → Phase 2)	p-value
Dedication	Yes – Significant decrease	< 0.001
Sensitivity	No significant	0.27
Intelligence	No significant	0.14
Dynamism	No significant	0.13

Tyranny	Not significant	0.93
Masculinity	Not significant	0.60

These results suggest that participants' perceptions of Sensitivity, Intelligence, Dynamism, Tyranny, and Masculinity remained relatively stable over time despite the introduction of a stressor.

Post-Hoc Analysis

Since each leadership trait was measured at only two time points (Phase 1 and Phase 2), post-hoc comparisons, such as Tukey's HSD, were not required. The RM-ANOVA was directly tested for differences across phases.

As multiple repeated-measures ANOVAs were conducted across six conceptually distinct leadership traits, the potential for inflated Type I errors is acknowledged. However, consistent with recommendations from recent statistical literature (Benjamin et al., 2018; Rafi and Greenland, 2020), no formal multiple comparison correction (for example, Bonferroni correction) was applied. These authors argue that rigid correction methods may increase Type II errors and obscure meaningful patterns, particularly in exploratory or theory-driven research. Therefore, the significant change observed in Dedication is interpreted cautiously, with theoretical relevance and overall effect size guiding its importance rather than strict p-value thresholds alone.

4.9 Gender Differences in Leadership ILTs dimensions.

This section presents the results of statistical analyses exploring the role of gender, age, and managerial experience in shaping perceptions of leadership traits and physiological stress responses. Independent sample t-tests and one-way ANOVAs were employed to examine between-group differences across key variables.

4.9.1 Gender Differences in Implicit Leadership Traits

Independent sample t-tests were conducted to examine gender differences across six leadership dimensions (Sensitivity, Dedication, Intelligence, Dynamism, Tyranny, and Masculinity) and Cortisol levels, for both Phase 1 and Phase 2. The sample consisted of 65 participants (38 males and 27 females).

Gendered differences were concentrated in Masculinity and Tyranny. For Masculinity males scored significantly higher than female participants in both phases. In Phase 1, (M=2.03, SD=0.56) scored higher than females (M=1.40, SD=0.50, ($t(63) = 4.671, p < .001$), with a very large effect size (Cohen's $d = 1.18$). The difference remained significant in Phase 2 ($t(63) = 2.800, p = .007$), with a large effect size (Cohen's $d = 0.70$), suggesting consistent gender disparity in the perception of masculinity as a leadership trait.

For tyranny, a significant gender difference was observed in phase 1, with males rating this trait higher than females ($t(63) = 2.189, p = .032$), Cohen's $d = 0.55$ (moderate effect). By phase 2, this difference was no longer statistically significant in Phase 2 ($t(63) = 1.459, p = .149$), although the effect size remained small to moderate (Cohen's $d = 0.37$) suggesting a partial convergence in perceptions of tyranny over time.

No statistically significant gender differences were found for Sensitivity, Dedication, Intelligence, Dynamism, or Cortisol levels in either phase ($p > .05$). Dedication showed a marginal trend in Phase 1 ($p = .060$), with females scoring slightly higher, although this did not reach significance. Overall, these findings suggest that gender differences in implicit leadership traits are primarily reflected in masculinity and, to lesser extent, tyranny, whereas other leadership dimensions appear broadly similar across males and females.

4.9.2 Age Differences in Implicit Leadership Traits

A one-way ANOVA was conducted to explore the effect of age on leadership trait perceptions using four age groups: 20–25, 26–34, 35–45, and above 45 years.

Key Findings

A significant main effect of age was found for Dynamism, $F(3, 61) = 3.035$, $p = .036$, with an associated effect size of $\eta^2 = 0.13$, relatively large effect. Post-hoc comparisons revealed that participants aged 35–45 years scored significantly higher in dynamism ($M = 2.772$, $SD = 0.358$) than those aged 26–34 years ($M = 2.408$, $SD = 0.494$).

Although other leadership traits did not show statistically significant age differences, their effect sizes offer insights into possible patterns. Specifically, η^2 values ranged from 0.009 (Tyranny; negligible) to 0.046 (Intelligence and Masculinity; small), suggesting that age accounted for only a minimal proportion of the variance in most leadership dimensions. The summary statistics are shown below:

Table:4.9.1 Age Group Differences in Leadership Traits

Leadership Trait	F (3, 61)	p-value	η^2 (Eta Squared)
Sensitivity	0.301	0.825	0.015
Dedication	0.404	0.751	0.019
Intelligence	0.971	0.412	0.046
Tyranny	0.178	0.911	0.009
Masculinity	0.991	0.403	0.046

The finding that individuals aged 35–45 exhibit higher perceived dynamism may reflect the increased energy, confidence, or leadership presence commonly associated with mid-career professionals. Conversely, the absence of age effects in other traits suggests that implicit leadership perceptions may remain relatively stable across the lifespan.

4.9.3 Work Experience and Implicit Leadership Traits

To assess the impact of leadership experience, participants were categorised into four groups based on their years of managerial experience: 1–3, 4–7, 8–10, and above 10 years. One-way ANOVAs were conducted for each ILT trait.

Key Findings:

No significant differences were found across experience groups for any of the leadership traits.

Table:4.9.3 Experience Group Differences in Leadership Traits

Leadership Trait	F (3, 61)	p-value	η^2 (Eta Squared)
Sensitivity	1.774	0.16	0.08
Dedication	0.784	0.50	0.03
Intelligence	1.0	0.39	0.04
Dynamism	1.33	0.27	0.06
Tyranny	1.422	0.24	0.06
Masculinity	0.146	0.93	0.00

None of these deference's reached statistical significance although participants with 8–10 years of experience showed slightly higher dynamism scores ($M = 2.945$, $SD = 0.135$), the difference was not statistically significant. These results indicate that managerial experience does not appear to be a strong predictor of implicit leadership trait perceptions in the current sample.

These findings indicate that gender plays a significant role in shaping perceptions of Tyranny and Masculinity. Age is related to perceptions of dynamism, especially among mid-career professionals. In contrast, managerial experience shows a limited influence on implicit leadership traits. Together, these results highlight the complex interplay of identity factors in shaping leadership evaluations, while also suggesting areas where perceptions are robust across demographic groups.

4.9.4 Moderation Analysis

4.9.4.1 Moderation of Cortisol and Implicit Leadership Traits, Construct-Level Moderation Analysis

To examine whether cortisol interacted with demographic variables in influencing leadership perceptions, ordinary least squares (OLS) regression models were conducted at the construct, item, and aggregate levels. Analyses were performed across these three hierarchical levels to capture different degrees of granularity: (1) the construct level examined composite scores for each ILT dimension (e.g., Dedication, Sensitivity); (2) the item level tested individual ILT items to identify more nuanced effects; and (3) the aggregate level assessed the overall ILTS composite score.

Construct-level. As shown in Table 4.9.4.1, no significant interactions emerged for Sensitivity, Dedication, Intelligence, or Dynamism. Tyranny showed a marginally significant interaction with age ($\beta = 0.000077$, $p = .049$), indicating that older participants may endorse Tyrannical traits more strongly under stress. All other effects were non-significant.

Table 4.9.4.1 Construct-Level Moderation Results

Trait	Moderator	β (Coefficient)	p-value	Outcome
Sensitivity	Age / Experience	–	> .05	Non-significant
Dedication	Age / Experience	–	> .05	Non-significant
Intelligence	Age / Experience	–	> .05	Non-significant
Dynamism	Age / Experience	–	> .05	Non-significant
Tyranny	Age	$\beta = 0.000077$	.049	Marginally significant
Masculinity	Age / Experience	–	> .05	Non-significant
MTL	Gender / Age / Experience	–	> .05	Non-significant

Item-level. Item-level analyses (Appendix 6) revealed additional nuanced effects. Hardworking showed a significant age \times cortisol interaction ($\beta = -0.000066$, $p = .031$, $R^2 = 0.159$). Gender moderated the effects of cortisol on Understanding ($\beta = 0.200$, $p < .001$) and Helpful ($\beta = 0.087$, $p = .002$), with males showing greater shifts. No other items reached significance.

Aggregate ILTS_Score. As shown in Table 4.9.4.3, overall perceptions of leadership were not significantly moderated by cortisol, gender, or experience. Only the main effect of gender (male) approached significance in Model 1 ($p = .043$).

Table 4.9.4.2 Item-Level Moderation Results

Item	Moderator	β (Coefficient)	p-value	Outcome
Hardworking	Age \times Cortisol	$\beta = -0.000066$	.031	Significant
Understanding	Gender \times Cortisol	$\beta = 0.200$	< .001	Highly significant
Helpful	Gender \times Cortisol	$\beta = 0.087$	.002	Significant
Other items	All	–	> .05	Non-significant

Note. β = standardized regression coefficient. Non-significant = $p > .05$.

Tables 4.9.4.1 and 4.9.4.2 summarise moderation analyses at both the construct and item levels. At the construct level, Tyranny showed a marginal interaction with age ($p = .049$), while all other constructs and MTL did not show significant moderation. At the item level, Hardworking (age \times cortisol), Understanding (gender

× cortisol), and Helpful (gender × cortisol) showed significant interactions, highlighting the importance of analysing both constructs and individual items. These findings confirm that most ILT traits were stable under stress, but certain relational and dominance-related items exhibited demographic sensitivities.

Summary of Results

Cortisol levels increased significantly post-stress ($t(64) = 5.84, p < .001$, Cohen's $d = 0.997$), confirming the effectiveness of the stress induction method. Descriptive statistics showed consistent endorsement patterns across leadership traits, with Dedication and Sensitivity scoring highest and Tyranny and Masculinity lowest.

A Repeated measures ANOVA confirmed that Dedication decreased significantly between Phase 1 and Phase 2 $F(1, 64) = 25.83, p < .001$, Cohen's $d = -0.871$ while Sensitivity, Intelligence, Dynamism, Tyranny, and Masculinity showed no significant changes.

Between-group analyses indicated that gender differences were concentrated in Masculinity and Tyranny. Males scored significantly higher than females on Masculinity in both phases (large effect sizes), and on Tyranny in Phase 1, though this difference was not maintained in Phase 2. No significant gender differences were observed for Sensitivity, Dedication, Intelligence, Dynamism, or Cortisol.

Age was significantly associated with Dynamism, with participants aged 35–45 scoring higher than those aged 26–34. No other traits showed significant age effects, and managerial experience did not yield significant group differences.

Moderation analyses revealed limited but important effects. At the construct level, a marginally significant cortisol × age interaction was found for Tyranny. At the item level, Hardworking showed a significant cortisol × age interaction ($\beta = -0.000066, p = .031$), while gender significantly moderated the relationships between cortisol and Understanding ($\beta = 0.200, p < .001$) and Helpful ($\beta = 0.087, p = .002$).

Finally, overall ILTS_Score analyses showed no significant moderation by cortisol, gender, or experience, although a marginal main effect of gender ($p = .043$) was detected.

In summary, the findings confirm that Dedication is stress-sensitive, Masculinity and Tyranny are gendered traits, and Dynamism is age-related. These findings collectively highlight the multidimensional nature of implicit leadership traits and their selective sensitivity to stress and demographic influences

Item-level analyses further highlighted that Hardworking, Helpful, and Understanding were particularly sensitive to demographic and physiological factors. By contrast, the aggregate ILTS_Score masked these nuanced patterns, underscoring the value of examining both construct- and item-level responses. Examining results at both the construct and item levels therefore offers a more detailed and accurate understanding of how individual leadership characteristics respond to stress and demographic factors.

4.10 Motivation to Lead (MTL)

Motivation to Lead (MTL) reflects an individual's internal drive to assume leadership responsibilities and plays a pivotal role in leadership development and organizational effectiveness. This study explored MTL to

understand how strongly participants identify with leadership roles and how this identity is structured psychologically.

MTL was assessed using the Leader Identity subscale from Hiller's (2005) MTL instrument, which consists of five items. A representative item includes: "I see myself as a leader." Participants rated each item on a five-point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5). The scale was designed to capture dimensions such as leadership self-perception, the desire to be recognised as a leader, and the personal significance of leadership identity.

Descriptive Statistics for MTL Items and Composite Score table 4.10

Item	Phase 1 Mean (±SD)	Phase 1 Range	Phase 2 Mean (±SD)	Phase 2 Range
I see myself as a leader	3.92 (0.89)	1.67–5.00	3.01 (0.66)	1.00–3.67
I am a leader	3.80 (0.95)	1.00–5.00	3.02 (0.72)	1.00–3.67
If I had to describe myself, I would use the word 'leader'	3.23 (1.10)	1.00–5.00	2.64 (0.80)	1.00–3.67
I prefer being seen by others as a leader	3.15 (0.96)	1.00–5.00	2.69 (0.77)	1.00–5.00
Being a leader is important to who I am	3.07 (1.03)	1.00–5.00	2.52 (0.88)	1.00–5.00
Composite MTL Score	3.43 (0.76)	1.67–5.00	2.78 (0.57)	1.00–3.67

Table 4.10. Descriptive statistics for Motivation to Lead (MTL) items and composite scores across phases.

At baseline (**Phase 1**), participants reported moderately high motivation to lead ($M = 3.43$, $SD = 0.76$), with the highest endorsement for "I see myself as a leader."

Following stress exposure (**Phase 2**), overall motivation declined ($M = 2.78$, $SD = 0.57$). Every item showed a mean decrease, suggesting that stress induction reduced self-perceived leadership motivation and identity strength

4.10.1 Dimensionality Analysis Using Principal Component Analysis (PCA)

To validate the structure of the MTL scale and assess whether the items measure a unified construct, Principal Component Analysis (PCA) was conducted. This approach examines internal coherence and identifies whether a single latent factor underlies item responses.

The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy was 0.735, exceeding the recommended threshold of 0.60, supporting the suitability of the data for PCA.

Bartlett's Test of Sphericity was statistically significant, $\chi^2 (10) = 133.101$, $p < .001$, indicating adequate inter-item correlations.

A single component emerged with an eigenvalue greater than 1, explaining 59.43% of the total variance. This suggests that the five items collectively reflect the unidimensional construct of leadership identity.

Reliability and Validity of the MTL Scale, Cronbach's alpha was 0.827, indicating high internal consistency.

Composite Reliability (CR) = 0.879, confirming strong construct reliability. And Average Variance Extracted (AVE) = 0.594, surpassing the 0.50 threshold, providing evidence of adequate convergent validity. These psychometric properties confirm that the MTL instrument is a reliable and valid tool for assessing leadership identity in the current sample. The full PCA output, including item loadings, communalities, and explained variance, is presented in Appendix 7.

4.10.1 Normality Assessment for Motivation to Lead (MTL)

To evaluate whether the MTL data conformed to assumptions of normality, both descriptive statistics and the Shapiro–Wilk test were employed for pre- and post-stress (Phase 1 and Phase 2) scores.

Phase 1 (Baseline MTL): Mean = 4.65 (SE = 0.141)

Phase 2 (Post-Stress MTL): Mean = 3.66 (SE = 0.105)

The observed decrease in mean scores suggests a decline in leadership motivation following the stress-inducing task. Examination of skewness and kurtosis indicated slight deviations from normality, particularly in Phase 2, which exhibited a pronounced negative skew (skewness = -0.627), indicating that most responses clustered toward higher values, but with some notably lower scores.

Shapiro–Wilk Test results Although the Phase 1 and Phase 2 distributions deviated from normality (Shapiro–Wilk $p < .001$), the difference scores met normality assumptions ($W = 0.985$, $p = .598$), supporting the use of parametric tests. Full visual diagnostics, including histograms and Q–Q plots, are provided in Appendix 8 for transparency.

4.11 Paired Samples Test

A paired-samples t-test compared Motivation to Lead scores between Phase 1 (baseline) and Phase 2 (post-stress). The mean difference was -0.99 ($SD = 1.28$, $SE = 0.16$), with a 95 % confidence interval of $[-1.31, -0.67]$. The test was highly significant, $t(64) = -6.25$, $p < .001$, indicating a substantial decline in MTL from Phase 1 to Phase 2. The effect size (Cohen's $d = 0.78$) represents a large practical effect, confirming that the reduction in leadership motivation was both statistically and practically meaningful.

Paired Samples Test										
		Paired Differences					t	df	Significance	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				One-Sided p	Two-Sided p
					Lower	Upper				
Pair 1	PHASE_2 - Phase1	-.989	1.276	.158	-1.306	-.673	-6.248	64	<.001	<.001

Table 4.11.1: Paired samples t-test results comparing motivation to lead scores between Phase 1 (baseline) and Phase 2 (postgame).

The boxplot in Figure 4.11.1 illustrates the distribution of motivation to lead across the two phases. The median motivation score in Phase 1 was higher than that in Phase 2, visually confirming the significant decline in motivation. In Phase 1, the median score was closer to 5, while in Phase 2, it was closer to 4, supporting the significant mean difference observed in the paired samples t-test.

The interquartile range (IQR), represented by the height of each box, was larger in Phase 1 than in Phase 2, indicating greater variability in scores during Phase 1. In contrast, Phase 2 exhibited a narrower IQR, suggesting more consistent responses among participants in this phase. The whiskers, which extend to the minimum and maximum non-outlier values, show that Phase 1 had a wider range of scores (approximately 2–7), while Phase 2 exhibited a narrower range (approximately 1–5). Additionally, an outlier was present in Phase 2, marked by a circle below the lower whisker. This indicates that at least one participant had a notably lower motivation score in Phase 2, but this did not affect the general trend of declining motivation.

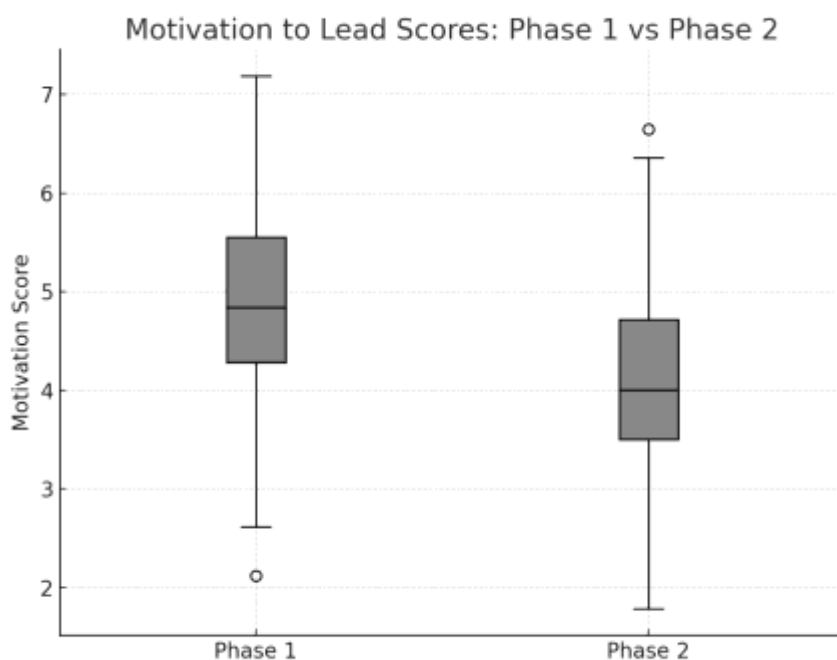


Figure 4.11.2: Boxplot of motivation to lead scores across phases 1 and 2. The figure highlights a significant decrease in scores from Phase 1 to Phase 2, with Phase 1 showing a wider range and greater variability than Phase 2. The median score in Phase 2 was notably lower, aligning with the results of the paired samples *t*-test.

The results of the paired samples *t*-test, presented in Table 4.11.1, and the visual representation in Figure 4.11.2, consistently demonstrated a substantial and statistically significant decline in participants' motivation to lead from Phase 1 to Phase 2. The alignment between the descriptive statistics, inferential test results, and visual data strongly supports the conclusion that the observed reduction in motivation is both significant and meaningful.

4.12 Subgroup Analysis

Subgroup analyses were conducted to assess whether changes in Motivation to Lead (MTL) scores from Phase 1 to Phase 2 varied according to gender, age, and work experience. The decision to use parametric tests, specifically *t*-tests and one-way ANOVAs, was supported by the literature highlighting their robustness to moderate violations of normality, particularly with sufficiently large and balanced sample sizes (Sawilowsky & Blair, 1992). Given that both phases had $N = 65$, the conditions for reliable parametric inference were met.

4.12.1 Gender Differences in MTL Changes

An independent samples *t*-test was conducted to examine whether gender significantly influenced the changes in MTL scores.

- Results: $t(64) = 0.955, p = .343$
- Cohen's $d = 0.242$ (small effect)

Although both male and female participants exhibited a decline in motivation from Phase 1 to Phase 2, the difference was not statistically significant. The small effect size further indicates a minimal practical difference between the genders. Thus, gender did not appear to significantly influence motivational shifts in response to stress.

4.12.2 Age Differences in MTL Changes

A one-way ANOVA was performed to assess whether age group (20–25, 26–34, 35–45, 45+) affected the changes in MTL.

- Results: $F(3, 61) = 0.614, p = .609$
- Partial $\eta^2 = 0.033$ (negligible effect)

While participants aged above 45 years showed the greatest mean decline in MTL (-1.24), and those aged 20–25 years showed the least (-0.68), these differences were not statistically significant. The low effect size indicates that age accounted for very little variance in the MTL change scores.

4.12.3 Work Experience and MTL Changes

A one-way Analysis of Variance was conducted to investigate the effect of years of work experience on changes in Motivation to Lead scores.

Results: The ANOVA revealed that the effect of work experience on MTL change approached statistical significance, $F = 2.594$, $p = .061$. The partial eta-squared (η^2) was 0.069, indicating a small to moderate effect size. Although the result did not meet the conventional alpha level of $p < .05$, the observed trend warrants further discussion. Specifically, participants with over 10 years of experience exhibited the largest decline in motivation (Mean Change = -1.514), whereas those with 4–7 years of experience showed the smallest decline (Mean Change = -0.465). These findings suggest a potential association between greater work experience and increased motivational decline, which may be attributed to factors such as occupational fatigue or a re-evaluation of leadership goals.

Summary of Subgroup Analyses |

Variable	Test Statistic	p-value	Effect Size	Interpretation
Gender	$t = 0.955$	.343	$d = 0.242$	No significant difference
Age	$F = 0.614$	.609	$\eta^2 = 0.033$	No significant difference
Work Experience	$F = 2.594$	.061	$\eta^2 = 0.069$	Marginal trend; small–moderate effect

These subgroup analyses indicate that neither gender nor age significantly influenced MTL changes. While work experience did not reach statistical significance at $p < .05$, the observed marginal trend and small to moderate effect size suggest a potential influence that warrants further investigation in future studies.

In sum, Motivation to Lead significantly declined following stress induction ($t(64) = -6.25$, $p < .001$, Cohen's $d = -0.78$), with a large effect size confirming both statistical and practical importance. Subgroup analyses showed no significant moderation by gender or age, although a marginal trend suggested that individuals with greater work experience may exhibit larger motivational declines.

4.13 Changes in Implicit Leadership Trait Perceptions and Motivation to Lead across Phases

A series of paired-samples t-tests were conducted to assess whether participants' perceptions of Implicit Leadership Theory traits and Motivation to Lead changed significantly from Phase 1 (pre-stress) to Phase 2 (post-stress). The results are summarized in Table 4.13.

Table 4.13 Paired-Samples T-Test Results (Phase 1 vs Phase 2)

Trait	Phase 1 Mean	Phase 2 Mean	t-statistic	p-value	Cohen's d	Interpretation
Sensitivity	2.744	2.672	1.097	.277	-0.14	No significant change

Dedication	2.898	2.563	5.082	< .001	-0.63	Significant decrease post-stress
Intelligence	2.723	2.650	1.493	.140	-0.19	No significant change
Dynamism	2.790	2.686	1.525	.132	-0.19	No significant change
Tyranny	1.677	1.682	-0.076	.939	0.01	No change
Masculinity	1.777	1.877	-1.217	.228	0.15	No significant change
MTL	4.652	3.663	6.248	< .001	-0.78	Significant decrease in motivation to lead

Note. Negative values of Cohen's *d* indicate a decrease from Phase 1 to Phase 2. All tests are paired-samples *t*-tests with *df* = 64.

Paired-samples *t*-tests compared Phase 1 (pre-stress) and Phase 2 (post-stress) scores (Table 4.13). Dedication declined significantly ($t(64) = 5.08, p < .001, \text{Cohen's } d = -0.63$), while Motivation to Lead also showed a significant decrease ($t(64) = 6.25, p < .001, d = -0.77$). No other ILT traits demonstrated statistically significant changes, though Dynamism and Intelligence showed small, non-significant downwards trend ($d = -0.19$). These results show that dedication (a core component of work commitment) and motivation to lead were the most stress-sensitive, while perceptions of Sensitivity, intelligence, Dynamism, tyranny and Masculinity remained largely stable across phases.

Correlations with Cortisol. Pearson correlations between cortisol levels (Phase 2B) and ILT/MTL scores are shown in Table 4.13.1. Cortisol was positively correlated with changes in Sensitivity ($r = .22, p < .05$) and Masculinity ($r = .22, p < .05$). All other correlations were weak or non-significant, including MTL, suggesting that physiological stress selectively influences certain leadership perceptions but not overall motivation.

Table 4.13.1 Pearson Correlations Between Cortisol and ILT/MTL Scores

Trait	r (Cortisol × Phase 1)	r (Cortisol × Phase 2)	r (Cortisol × ΔScore)	Significance
Sensitivity	-.05	+.22	+.22	$p < .05$
Dedication	-.13	+.07	+.12	ns
Intelligence	-.03	+.02	+.05	ns
Dynamism	+.18	+.04	-.13	ns
Tyranny	+.06	+.21	+.15	ns
Masculinity	-.13	+.11	+.22	$p < .05$
MTL	+.03	-.02	-.05	ns

Note. ΔScore = change from Phase 1 to Phase 2. ns = non-significant ($p > .05$). All coefficients are Pearson correlations.

Summary. Acute stress, validated by significant increases in cortisol, selectively influenced leadership perceptions. Dedication and Motivation to Lead were the most stress-sensitive constructs, while Sensitivity, Intelligence, Dynamism, Tyranny, and Masculinity remained stable at the group level. However, correlations revealed that cortisol reactivity was associated with increases in Sensitivity and Masculinity. These results indicate that stress does not uniformly affect leadership perceptions but instead targets relational and motivational constructs.

4.14 Overall Results Summary

Domain	Key Findings	Statistical Evidence	Interpretation
Cortisol	Levels significantly increased post-stress	$t(64) = 5.84, p < .001, d = 0.997$	Stress induction was effective; validated physiological response
ILTs	Dedication significantly decreased; other traits (Sensitivity, Intelligence, Dynamism, Tyranny, Masculinity) remained stable	Dedication: $F(1,64) = 25.83, p < .001, d \approx -0.63$	Dedication is stress-sensitive; most ILT traits are stable
ILTs – Group Differences	Males scored higher on Masculinity (both phases) and Tyranny (Phase 1 only). Age associated with higher Dynamism (35–45 yrs). No effects of experience.	Masculinity: $d = 1.18 (P1), d = 0.70 (P2)$; Tyranny: $d = 0.55 (P1)$	Gender and age shape ILT perceptions; experience does not
ILTs – Moderation	Tyranny \times Age (marginal). Item-level: Hardworking \times Age, Understanding \times Gender, Helpful \times Gender significant	β Tyranny \times Age = $7.7e-05, p = .049$; β Hardworking = $-0.000066, p = .031$; β Understanding = $0.200, p < .001$	Specific demographic \times stress interactions detected at trait and item levels
MTL	Significant decline from Phase 1 to Phase 2	$t(64) = -6.25, p < .001, d = -0.78$	Motivation to Lead is strongly stress-sensitive
MTL – Group Differences	No gender or age effects; work experience trend (greater decline with >10 yrs)	$F = 2.594, p = .061, \eta^2 = 0.069$	Experience may exacerbate motivational decline

Note. ILTs = Implicit Leadership Theories; MTL = Motivation to Lead. This table integrates findings across cortisol, ILTs, and MTL, highlighting both significant and non-significant results.

The non-significant trends observed across most ILT dimensions (e.g., Sensitivity, Intelligence, Dynamism, Tyranny, and Masculinity) are theoretically meaningful rather than statistically null. Their relative stability under stress supports the view that core leadership schemas are resilient to short-term physiological fluctuations, reflecting enduring cognitive representations rather than transient affective shifts. These findings reinforce the notion that while stress selectively affects motivational and relational dimensions (Dedication, MTL), the broader structure of leadership perceptions remains robust.

The following Discussion chapter interprets these findings within a biopsychosocial framework, exploring how stress interacts with psychological and demographic variables to shape leadership perceptions and motivation to lead.

Chapter 5 Discussion

5.1 Overview of Objectives and Hypotheses

This study examined how acute physiological stress, indexed by cortisol reactivity, influences implicit leadership theories (ILTs) and affective-identity motivation to lead (MTL), while assessing whether gender and work experience condition these relationships. By integrating physiological (cortisol) and psychological (survey-based perception) data, the study provides a biopsychosocial examination of how stress shapes leadership perception and motivation.

Across the sample, the central finding was that acute stress did not broadly alter leadership prototypes but appeared to selectively influence specific dimensions of leadership cognition (Tremmel & Wahl, 2023). Most ILT dimensions, including Sensitivity, Intelligence, Dynamism, Masculinity, and Tyranny, remained relatively stable across stress phases, suggesting that core leadership schemas are largely resistant to short-term physiological arousal. In contrast, effort-related relational expectations were more vulnerable, evidenced by a marked decline in Dedication following stress induction. Most notably, stress produced a substantial decrease in affective-identity MTL, indicating that cortisol-linked arousal may influence not only leadership evaluation but also individuals' intrinsic willingness to see themselves as leaders (Moe et al., 2022; Prasad et al., 2018).

The discussion proceeds as follows. First, the effectiveness of the stress induction is confirmed through cortisol change across phases. Next, findings are interpreted within the ILT framework to identify which leadership schemas remained stable and which were stress sensitive. The motivational findings are then examined to explain why leadership self-identification declined under stress despite relative stability in most trait prototypes. Finally, the chapter evaluates whether gender and work experience conditioned these effects as moderators of the direct cortisol–leadership relationships, using the overall pattern of results to refine the biopsychosocial account of leadership under stress and support the revised end-of-study model (Clement & Bradley-Garcia, 2022; Hayes et al., 2017).

Turning to ILT perceptions, the findings indicate that cortisol-related stress did not uniformly shift leadership trait preferences, with the clearest change observed for Dedication. Gender and work experience were tested as moderators of the direct pathways between cortisol and leadership outcomes (Hayes et al., 2017; Memon et al., 2019). Although these moderation effects were not statistically significant at the construct level, testing these boundary conditions clarifies the circumstances under which stress-related effects on leadership cognition may occur (Aguinis & Gottfredson, 2010).

H1: Cortisol and ILT Leadership Trait Perceptions

H1a: Increased cortisol reduces preference for the ILT trait of sensitivity.

Results did not support H1a. Sensitivity scores showed no significant change between phases (paired t-test, $p = .277$). However, correlation analyses indicated that cortisol reactivity was positively associated with changes in Sensitivity ratings ($r = .22$, $p < .05$). These findings suggest that while stress did not lead to an

overall decline in relational leadership preferences, individuals with higher cortisol responses were more likely to increase their endorsement of Sensitivity traits under stress. This partially contradicts expectations, as prior evidence has suggested that stress reduces empathic behaviours (Engert et al., 2014; Shields et al., 2016). Instead, the present results indicate that relational traits such as Sensitivity may remain stable overall, with individual differences in cortisol reactivity shaping their endorsement.

H1b: Increased cortisol reduces preference for the ILT trait of intelligence.

The results did not support this hypothesis, with intelligence scores showing only a small, non-significant decrease after stress induction. While the directional trend was consistent with theoretical expectations, the absence of statistical significance led to the rejection of H1b. Nevertheless, the observed pattern is consistent with the existing literature, suggesting that stress can alter cognitive processing in ways that might indirectly reduce the prioritisation of intellectual traits in leader evaluations. High levels of stress have been shown to impair complex cognitive functioning, increasing reliance on heuristics and decreasing the likelihood of considering multiple solutions to a problem (Harms et al., 2016). This shift towards more immediate and simplified decision-making may result in a subtle de-emphasis on intellectual depth when evaluating leadership qualities. Cortisol released during acute stress responses has been identified as a key physiological mechanism influencing decision-making and risk-taking under stress (Buckert et al., 2014). This attentional shift towards “fight or flight” priorities may render abstract or effort-intensive traits such as intelligence less salient in high-pressure contexts.

Recent research indicates that acute psychosocial stress may not necessarily diminish cognitive ability directly but can reduce the willingness to engage in cognitively demanding tasks (Picciotto & Fabio, 2023). This may explain why the current study found no significant decline in perceived intelligence. Participants may not have actively devalued the trait but rather engaged less with evaluating it under stress. Furthermore, effective leadership often demands significant cognitive resources for decision-making and problem solving; however, these resources can be compromised under stress, prompting followers to seek leaders with more readily observable and immediately actionable qualities (Harms et al., 2016).

Taken together, although the statistical evidence does not support a definitive link between increased cortisol and reduced preference for intelligence, the trend aligns with broader findings that stress alters cognitive priorities and processing styles, leading to subtle de-prioritisation of intellectual attributes in leader prototypes. While intelligence appears relatively stable under stress, it remains unclear whether other socially oriented traits, such as dedication and dynamism, are similarly resilient. Hypothesis H1c, therefore, considers how cortisol influences these two attributes.

H1c: Increased cortisol reduces the preference for the ILT traits of Dedication and Dynamism.

The results partially support this hypothesis. Dedication scores declined significantly following stress induction ($F = 25.83$, $p < .001$, $d = 0.871$), whereas dynamism scores remained stable. This suggests that while increased cortisol may reduce the perceived value of certain socially oriented leadership traits, such as

Dedication, it does not necessarily diminish the importance attributed to more action-oriented traits, such as Dynamism.

The reduction in Dedication preference under stress can be contextualised by the literature linking leader well-being to follower perceptions. Although direct evidence of followers perceiving extreme dedication as a liability is limited, research suggests that unsustainable levels of leader dedication, leading to exhaustion or burnout, can have detrimental consequences for both leaders and their teams. For instance, leaders' exhaustion has been found to predict followers' somatic complaints through a "crossover" effect (Köppe et al., 2018). Similarly, heavy leader workloads can increase follower emotional exhaustion by limiting the leader's capacity to provide supportive leadership (Stein et al., 2020).

Leader exhaustion also reduces engagement in transformational leadership behaviours, thereby diminishing perceived leader effectiveness (Lin et al., 2018; Zwingmann et al., 2015). Related research on "workaholic leadership" indicates that excessive work commitment may negatively influence employee well-being and performance (Zeng & Liu, 2022). Furthermore, effective leadership in high-stress contexts requires not only dedication but also resilience and the ability to recover from strain (Balasubramanian & Fernandes, 2022). Leaders who demonstrate sustainable work patterns, prioritise recovery, and create a culture that supports resilience are often valued more highly than those who display relentless dedication without regard for long-term sustainability (Baah, 2024; Parekh et al., 2024). This body of evidence helps explain why, in high-stress contexts, followers may devalue extreme dedication in favour of more balanced and sustainable leadership approaches.

In contrast, the stability of dynamism preference under stress reflects its perceived necessity in crisis contexts. Dynamic leaders, characterised by high energy, adaptability, and rapid response capability, are considered essential for managing uncertainty and ensuring organisational survival (Landi et al., 2019, p. 159). In contrast, the stability of Dynamism preference under stress may reflect its perceived necessity in crisis contexts. Dynamic leaders, characterised by energy, adaptability, and rapid response capability, are essential for managing uncertainty and maintaining organisational resilience (Sott and Bender, 2025; Balasubramanian and Fernandes, 2022). This aligns with emerging scholarship emphasising that effective crisis leadership transcends traditional managerial roles, requiring leaders who can anticipate change, act decisively, and inspire innovation during periods of disruption (Evans and Bahrami, 2020; London, 2022)

In times of crisis, leaders are expected to adapt quickly to evolving conditions, coordinate effectively, and inspire innovation. Crises also provide opportunities for leaders to demonstrate decisiveness, perseverance, and emotional awareness, all of which contribute to effective team coordination and performance (scott and badr, 2023).

Dynamic leaders are particularly valued for their ability to process complex information rapidly and make timely decisions under pressure (Harms et al., 2016). In high-risk or uncertain situations, adaptive leadership qualities have been shown to foster self-efficacy and motivation to lead (Bajaba et al., 2021). The enduring value placed on dynamism, even under stress, therefore reflects its perceived functional role in addressing immediate threats and maintaining team performance in challenging environments.

These results suggest that stress selectively reduces dedication while leaving dynamism intact, highlighting the nuanced ways in which cortisol shapes trait preferences. Research on leadership in crisis contexts consistently identifies adaptability, agility, and resilience as central attributes of effective leaders (Scott and Bander, 2023). Adaptive and agile leaders can learn rapidly, reconfiguring strategies, and fostering innovative team responses in volatile and uncertain environments (Tandon, Bhatnagar and Sharma, 2024; Sott and Bender, 2025). These qualities ensure not only immediate responsiveness but also long-term organisational sustainability during turbulent periods. Consequently, the non-significant change in dynamism following stress exposure in the present study may indicate that participants perceive dynamism as a baseline leadership requirement, one that remains consistently valued even under strain.

To build on this, Hypothesis H1d explores whether stress also shifts preferences toward dominance-oriented traits, such as masculinity and tyranny.

H1d: Increased cortisol increases the preference for the ILT traits of Masculinity and Tyranny.

Descriptive increases in masculinity and tyranny did not reach statistical significance thus H1d was not supported. The non-significant increases observed here can be contextualised using the dual-hormone hypothesis, which posits that the behavioural expression of testosterone, often linked to dominance and assertive behaviour, is moderated by cortisol levels (Sherman et al., 2015; Ponzi et al., 2016). Specifically, high testosterone levels combined with low cortisol levels are associated with leadership emergence and a preference for dominant traits (Mehta, 2007; Moe et al., 2021), whereas increased cortisol levels can attenuate these effects. In the present study, stress-induced increases in cortisol may have mitigated stronger preferences for dominance-oriented traits, such as Masculinity and Tyranny, resulting in descriptive but statistically non-significant changes.

The situational context is also relevant. Previous research indicates that preferences for dominant or aggressive leaders tend to increase during periods of perceived threat, conflict, or socioeconomic uncertainty (Vugt & Smith, 2019; Petersen and Lustsen 2019). The acute psychological stressor used in this study may have evoked some shift in trait preferences but potentially lacked the intensity or salience of threats in real-world crises to produce significant changes.

The gender-based differences observed in this study are consistent with prior work showing that men are more likely to endorse dominant, masculine, and even autocratic (or tyrannical) leadership traits as ideals (Gartizia and Engen, 2012; Mohan et al., 2022; Diez et al., 2017). This pattern aligns with long-standing evidence within implicit leadership theory, which demonstrates that men are more likely to associate with agentic and control-oriented characteristics, whereas women tend to prioritise communal traits, such as sensitivity and understanding (Weidner, 2012). These findings align with role congruity theory, which proposes that leadership role is culturally constructed as agentic and therefore more congruent with traditional male gender roles than with female ones (Epitropaki et al., 2013; Berkery and Ryan, 2023).

Although this study did not find that stress increased these preferences for dominance-oriented traits (H1d), the baseline gender differences remains statistically significant at the item level. This suggests that even

under physiological strain, gender-based "Think Manager–Think Male" stereotypes remain a robust influence on leadership conceptualisation (Dwivedi, Misangyi and Joshi, 2021; Lin et al., 2025). However, the lack of a significant Cortisol Gender interaction suggests that acute physiological stress did not amplify these gendered leadership biases beyond baseline levels (Paustian-Underdahl, Walker and Woehr, 2014).

Taken together, these findings refine existing theory by distinguishing between structural gender differences in leadership prototypes and stress-contingent shifts in those prototypes. While the former were observed; the latter were not. The non-significant interaction effects therefore highlights important boundary conditions of stress may influence, suggesting that not all leadership perceptions are equally susceptible to physiological arousal. While stress exerted limited influence on most cognitive and dominance -oriented leadership traits, its effect on motivational dimensions of leadership identity was pronounced as examined in hypothesis H2.

H2: Cortisol and Motivation to Lead

H2: Increased cortisol levels reduce affective-identity MTL.

The results provided strong support for H2. Motivation to Lead significantly declined following stress induction, consistent with the hypothesis that increased stress reduces willingness to lead. The large effect size ($d = -0.78$) further underscores the practical significance of this finding.

Affective-identity MTL reflects an intrinsic desire to lead and a leadership-oriented self-concept (Chan & Drasgow, 2001). Increased cortisol levels impair complex cognition and self-regulatory resources (Harms et al., 2016), which are critical for sustaining this motivational drive. Stress has also been linked to reduced self-efficacy and increased withdrawal behaviours (Pindek., 2020), mechanisms that help explain the observed decline in intrinsic leadership motivation.

This study extends prior findings by showing that cortisol not only shapes trait perceptions but also influences the motivational foundation of leadership identity. Stress-related emotional exhaustion may erode the motivation to engage in demanding leadership roles; conversely, it has been shown to buffer the effects of toxic leadership and emotional strains (Koc et al., 2022).

The decline in affective-identity MTL was large and statistically significant ($t(64) = -6.25, p < .001, d \approx 0.78$) the consistency with theoretical expectations and sizeable effect indicate that stress physiology likely exerts a meaningful influence on motivation to lead. Future research with larger and more diverse samples is needed to confirm the robustness of this effect and explore whether chronic workplace stress produces similar outcomes. The dual hormone framework further indicates that low cortisol with high testosterone predicts strong leadership emergence and power of motivation, whereas high cortisol can inhibit testosterone-driven leadership behaviour (Mehta et., al 2010; Moe et., al 2021), reinforcing the idea that increased cortisol directly undermines the affective identity of motivation to lead.

H3a: Gender moderates the effect of cortisol on (a) ILT trait perceptions and (b) affective identity motivation to lead

The results did not provide overall support for this hypothesis at the construct level. Gender did not significantly moderate the relationships between cortisol and ILT dimensions or MTL (all interaction terms non-significant; see Tables 4.9.4.1 and 4.9.4.2). However, gender still played a role in shaping certain aspects of leadership perception. Across phases, men consistently rated Masculinity higher than women and rated Tyranny higher in Phase 1. These patterns are consistent with the broader literature showing that gender differences in stress responses, neuroendocrine profiles, and leadership perceptions shape how individuals evaluate leadership traits under pressure.

Research has consistently documented gender differences in endocrine, neurological, and behavioural responses to stress, mediated by the hypothalamic–pituitary–adrenal (HPA) axis (Palumbo et al., 2020). These physiological differences influence how men and women appraise and respond to leadership traits in high-stress situations. Gender also predicts variations in perceived stress and in the utilisation of social support as a coping mechanism (Kneavel, 2020), which can affect leadership evaluations. Although some studies have examined gender differences in decision-making under stress, findings are mixed. For instance, Iseman and Sinclair (2025) found that under performance-focused stress, women’s performance on gambling tasks improved correlating with increases in cortisol while men’s performance declined. This illustrates that gender differences in stress-related cognition are nuanced rather than unidirectional. Workplace stress research similarly indicates that gender predicts exposure to different stressors and stress reactivity, shaping perceptual and evaluative processes relevant to leadership (Fida et al., 2023).

The association of effective leadership with stereotypically masculine traits remains a persistent cultural bias and a key factor in the underrepresentation of women in leadership positions (Tremmel & Wahl, 2023). Such implicit leadership theories (ILTs) become particularly salient under stress when decision-making and trait evaluation are more reliant on heuristics. Men are more likely to endorse dominance and control as prototypical leadership attributes (Weidner, 2012), which is consistent with the current finding that male participants rated Masculinity and, in Phase 1, Tyranny higher than women. Gendered expectations also influence preferred leadership styles; male leaders more frequently adopt transactional styles, while female leaders tend towards transformational approaches (Bai, 2024). Masculine value systems further shape leader evaluations, Zhou et al. (2022) found that “perceivers with low masculine values tended to view the Daoist water-like leadership as more FED than agentic leadership, while perceivers with high masculine values did not endorse agentic over Daoist water-like leadership.” This directly supports the claim that masculine value systems shape leader evaluations. Specifically, men with strong masculine values are less likely to distinguish between leadership styles, whereas individuals with weaker masculine values tend to prefer more adaptive and flexible leadership forms.

Emerging work also suggests gender-based differences in how leadership style preferences affect motivational outcomes (Alharthi, 2024). This is supported by Fjendbo (2020), who found that the relationship between leadership style and employee motivation varies by gender. Specifically, female teachers unlike their male counterparts were less motivated when they perceived higher levels of pecuniary rewards, indicating that gender-based traits and preferences shape how individuals respond to transformational versus

transactional leadership approaches. These findings reinforce the claim that leadership style preferences interact with gender to influence motivational outcomes.

The dual-hormone hypothesis provides a biological framework for these findings, proposing that high testosterone combined with low cortisol levels predicts status seeking and leadership emergence (Moe et al., 2021). Increased cortisol can inhibit testosterone-driven dominance behaviours, potentially reducing the expression of agentic traits under stress (Moe et al., 2021). While much of this work has focused on men, recent studies have begun to examine how these hormonal interactions influence leadership behaviours across genders for example, Vongas et al. (2020) and Goll et al. (2023) show that the interaction between cortisol and testosterone predicts leadership behaviours in individuals of both sexes. Goll et al. (2023) demonstrate that “the interaction between cortisol and testosterone predicts leadership within rock hyrax social groups,” indicating that dual-hormone effects are not gender-exclusive but operate across males and females alike. This means that the paper does not support the claim that only male leaders exhibit elevated cortisol levels; rather, it highlights cross-gender hormonal mechanisms. Together, these findings suggest that hormonal profiles interact with situational stress in nuanced ways that influence the prioritisation of leadership traits such as Sensitivity, Masculinity, and Tyranny.

Overall, the current findings do not indicate a robust moderating effect of gender on ILT constructs or MTL. Formal moderation tests at the construct and composite levels were non-significant. However, the consistent gender differences in Masculinity and Tyranny, together with significant gender \times cortisol interactions for the communal items Understanding and Helpful, suggest that gendered leadership schemas influence how specific traits are evaluated under stress. Thus, while H3a was not supported statistically in its original form, the item-level patterns provide nuanced evidence that gender shapes certain aspects of stress–leadership cognition.

This interpretation aligns with prior research on Implicit Leadership Theories (ILTs), which suggests that while overarching leadership prototypes remain relatively stable, the relative importance of individual traits can fluctuate under different situational and physiological conditions (Tavares et al., 2018; Lord et al., 2019). Evidence from connectionist models further support this dynamic view, showing that leadership prototypes can be regenerated in response to contextual constraints, allowing both stability and flexibility within ILT structures (Trichas et al., 2016). The fact that item-level gender \times cortisol effects emerged for communal traits such as Understanding and Helpful indicates that men and women may differentially value these feminine-coded attributes under stress. Under conditions of heightened physiological arousal, heuristic or stereotype-driven processing is more likely to dominate, making gendered schemas especially influential (Lin et al., 2025). Hypothesis H3b extends this analysis by testing whether professional leadership experience similarly buffers or amplifies the effects of cortisol.

H3b: Working experience moderates the effect of cortisol on ILT and MTL.

The results did not support H3b hypothesis. Work experience did not significantly moderate the relationship between the cortisol reactivity and change in ILTs perceptions or affective identity motivation to lead. This finding differs from research suggesting that leadership roles buffer stress response through increased control

and status (Sherman et al. 2012) demonstrated that leaders, especially those in powerful positions, exhibit lower cortisol levels have reduced anxiety than non-leaders. This stress-buffering effect is strongly mediated by a heightened sense of control, with leadership providing psychological resources to mitigate both subjective and physiological stress responses. This finding is consistent with broader evidence that perceived control over a stressor reduces activation of stress-related physiological systems and lowers the risk of stress-related health outcomes (Sapolsky, 2012; Chen et al., 2022). However, these effects appear contingent upon the quality and structure of leadership roles. Authority, decision making autonomy, and hierarchical stability are critical determinants of stress buffering (Knight and Mehta 2016). Because the present study operationalised experience as years in role rather than authority level or control, any potential buffering effect may have been diluted. The absence of significant moderation therefore suggest that tenure alone is insufficient to buffer acute physiological stress effects on leadership cognition and motivations.

This finding refines prior assumptions by distinguishing between work experience and leadership power. Experience without corresponding control may not provide the psychological resources necessary to mitigate cortisol related shifts in motivation or perception. Descriptively individuals with over 10 years of experience exhibited a greater decline in motivation to lead, although this tend did not reach statistical significance. This pattern may reflect cumulative occupational strain, burnout or shifting career priorities (lee and ashforth, 1993; Auvinen et al., 2020; Grimm et al., 2024). Prolonged exposure to leadership demands may gradually erode intrinsic motivation, particularly in high pressure environment. Research also suggest that autonomy and perceived influence can decline across career trajectories. Research also suggest that autonomy a potentially contributing to motivational recalibration over time (Mujcic & Oswald, 2025). Importantly, years of experience do not capture qualitative differences in leadership development. Developmental feedback, meaningful authority, and contextual stability may be more relevant predictors of stress buffering than duration alone (Hiller, 2005). Taken together, the present findings suggest that professional tenure does not insulate individuals from the physiological effects of acute stress. Acute cortisol responses appear capable of narrowing leadership cognition and motivation irrespective of career longevity. Future research should therefore differentiate between tenure, authority, perceived control, and role stability to determine under what conditions work experience buffers or amplifies physiological stress effects.

Finally, it is crucial to consider the qualitative aspects of work experience. Simply measuring years of experience may not fully capture the nuances of a leader's journey. Not all experiences are equally beneficial; supportive and developmental opportunities, coupled with constructive feedback, are more impactful for fostering leadership self-identity and sustaining motivation than mere tenure in a role (Hiller, 2005). The absence of significant results across all ILT traits by experience group (Table 4.9.3) further supports that the duration of experience alone is not a strong predictor of trait perceptions, but its impact on motivation to lead may be more complex and mediated by the quality and nature of that experience.

In conclusion, while the effect of work experience on motivation to lead did not reach statistical significance at the conventional threshold, the observed trend for a decline in motivation among highly experienced leaders warrants further investigation. This pattern can be theoretically grounded in the increasing demands and diminishing attractiveness of leadership roles, the cumulative impact of burnout and occupational fatigue,

and the potential re-evaluation of career goals and autonomy over an extended professional life. Future research should explore these mediating factors and incorporate more granular measures of leadership experience differentiating by the quality of the role and the specific challenges encountered to fully understand this nuanced relationship.

Summary

Overall, most implicit leadership traits appeared to be stable across physiological and demographic variables. However, certain traits, particularly Tyranny and Dedication, were susceptible to change under stress or demographic moderation. Gender and age appear to be more influential than managerial experience in shaping these interactions. The confirmed five-factor ILT model reinforces the structural validity of the constructs, and the distinction between positive and negative leadership traits provides a useful framework for future research on stress and leadership perceptions.

Table 5.1. Hypothesis Outcomes

Hypothesis	Description	Outcome	Decision	Effect Direction / Size
H1a	Cortisol reduces preference for Sensitivity	Not Supported	Rejected	No Significant mean change; $t(64) = 1.10, p = .277, d \approx -0.14$; small <i>positive</i> association between cortisol and change ($r = .22, p < .05$)
H1b	Cortisol reduces preference for Intelligence	Not supported	Rejected	Small, non-significant decline ($t(64) = 1.49, p = .140, d = -0.19$).
H1c	Cortisol reduces preference for Dedication and Dynamism	Partially supported	Partially not rejected	Dedication decreased significantly ($t(64) = 5.08, p < .001, d = -0.63$); Dynamism showed a small, non-significant decline ($t(64) = 1.53, p = .132, d = -0.19$).
H1d	Cortisol increases preference for Masculinity and Tyranny	Not supported / descriptive trend only	Rejected	Small, non-significant descriptive increases; no significant mean changes.
H2	Cortisol reduces affective-identity MTL	supported	Not rejected	Large, significant decline: $t(64) = -6.25, p < .001, d \approx -0.78$.
H3a	Gender moderates' cortisol-ILT/MTL effects	Not supported (item-level difference only)	Rejected	No significant moderation at construct or MTL level; item-level gender \times cortisol effects for Understanding and Helpful only.
H3b	Work Experience moderates' cortisol-ILT/MTL effects	Not supported	Rejected	No significant moderation effects: a marginal trend for greater MTL decline with >10 years' experience ($F(3,61) = 2.594, p = .061, \eta^2 = 0.069$).

Table 5. 1. Summary of hypotheses and findings following cortisol-induced stress.

Table 5.1 summarises the outcomes of the hypotheses developed in Chapter 1, evaluating the effects of cortisol-induced stress on implicit leadership trait (ILT) preferences and affective-identity motivation to lead (MTL). The results demonstrated selective rather than uniform effects: relational traits (for example, Sensitivity, Dedication) were most consistently undermined, cognitive traits (intelligence) remained relatively stable, and dominance-oriented traits (Masculinity, Tyranny) showed only non-significant descriptive shifts. The results provided strong support for H2. Motivation to Lead significantly declined following stress induction, consistent with the hypothesis that increased stress reduces willingness to lead. The large effect size ($d = -0.78$) further underscores the practical significance of this finding. Moderation analyses revealed that gender exerted a measurable influence, whereas work experience did not, suggesting that demographic rather than experiential factors may shape stress–leadership interactions.

By integrating statistical outcomes with theoretical expectations, this table underscores the central conclusion of the study: stress narrows leadership preferences by devaluing relational and identity-based dimensions of leadership while leaving cognitive and dominance-oriented qualities comparatively intact.

5.2 Interpretation of Findings in the Context of ILTs

Overall, these findings suggest that cortisol-based stress selectively reshapes leadership preferences rather than exerting uniform effects across all traits. Relational qualities such as Sensitivity and Dedication proved especially vulnerable, supporting evidence that stress disrupts emotion regulation and undermines attributes that require sustained interpersonal investment. In contrast, intelligence remained stable, indicating that cognitive competence may function as a “stress-resistant” leadership quality. Notably, Masculinity and Tyranny did not increase under stress, contradicting evolutionary leadership perspectives which predict stronger preferences for dominant leaders during threat (Van Vugt & Ronay, 2013). This is particularly significant, as it suggests that in contemporary organisational contexts, followers may no longer default to authoritarian leadership prototypes under pressure, reflecting broader cultural shifts that devalue overt dominance in leadership. Additionally, the study engages with the Dual Model of Leadership and Hierarchy, which distinguishes between prestige and dominance (van Vugt & Smith, 2019). Research in this area also shows that preferences for dominant leaders tend to increase under conditions of threat or uncertainty (Kakkar & Sivanathan, 2017).

The decline observed for Dedication (Cohen’s $d = -0.63$) emphasises that stress narrows leadership prototypes by reducing the desirability of traits that demand sustained effort and emotional engagement. This aligns with ILT frameworks, which view leadership prototypes as contextually sensitive (Epitropaki et al., 2013) but extend them by demonstrating that physiological stress can actively reconfigure these schemas in real time. Importantly, the moderation findings reinforce this contextuality, gender-shaped stress-leadership dynamics, with men showing stronger declines in relational traits and higher endorsement of dominance-oriented qualities, while leadership experience offered no buffering effect. This suggests that demographic factors exert a stronger influence than professional tenure in shaping how stress alters leadership perceptions.

From a practical perspective, these results indicate that stress has the potential to bias leader evaluations away from relational and identity-driven dimensions, privileging short-term functional attributes. Therefore, leadership development initiatives should integrate resilience-building strategies aimed at preserving relational effectiveness under pressure. At the individual level, interventions such as mindfulness, stress inoculation, or cognitive reappraisal training may help leaders maintain interpersonal sensitivity. At the organisational level, practices that reduce chronic strain such as fostering psychological safety, ensuring sustainable workloads, and embedding recovery practices can support leaders in balancing decisiveness with relational care. Collectively, these insights advance leadership theory by demonstrating how biological stress responses intersect with cognitive schemas, challenging assumptions of trait stability, and highlighting new levers for sustaining effective leadership in high-pressure environments.

5.3 Cortisol Levels: Physiological Confirmation of Stress Induction

Cortisol increased significantly post-task (*Phase 2A → 2B*: $t(64) = -4.773, p < .001$; mean rise = 903 pg/mL), confirming effective stress induction confirming that the competitive game successfully induced acute stress. Most participants (78%) exhibited increases, with modest gender differences (80% female responders vs. 73% male). The significant cortisol increase verified the effectiveness of the stress manipulation and supports the interpretation of later shifts in leadership perceptions and motivation.

5.4 Revised Model of Findings

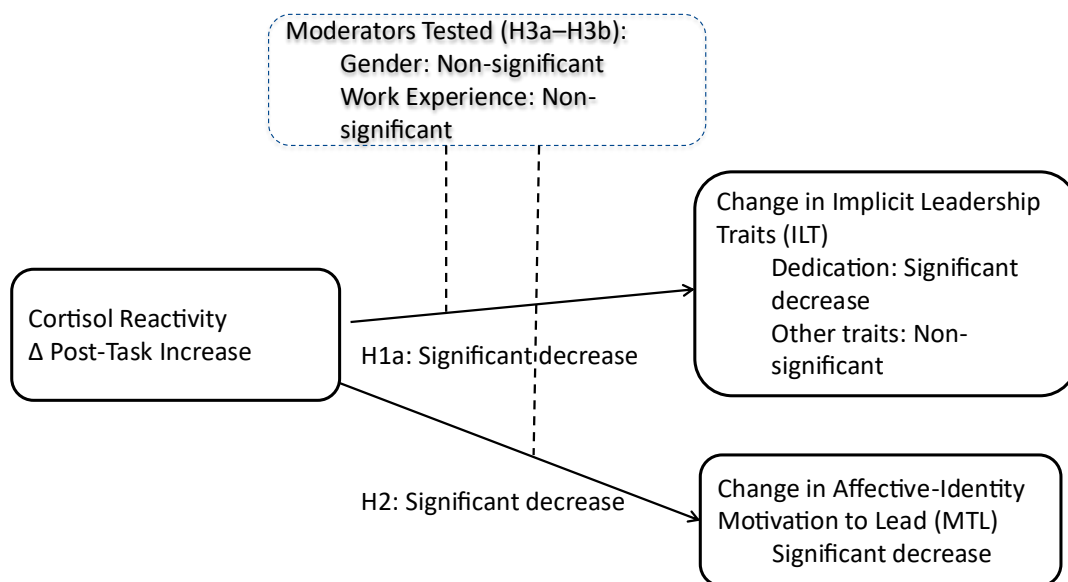


Figure 5.4. This figure illustrates the effects of cortisol reactivity (Δ post-task increase) on changes in implicit leadership traits and affective-identity motivation to lead. Gender (H3a) and work experience (H3b) were tested as moderators; however, no significant moderation effects were observed.

Figure 5.4. Revised model of cortisol’s effects on leadership preferences and motivation to lead. This revised model summarises the tested relationships and empirical outcomes for hypotheses H1a–H3b.

It depicts the impact of cortisol reactivity (Δ post-task increase) on changes in implicit leadership trait (ILT) perceptions and affective-identity Motivation to Lead (MTL). Cortisol increased significantly following the stress task and was associated with a selective decrease in Dedication and a large decline in MTL, while other ILT traits (Sensitivity, Intelligence, Dynamism, Masculinity, and Tyranny) showed no significant change.

Gender and work experience were tested as moderators of these primary relationships through interaction terms (Cortisol \times Gender; Cortisol \times Work Experience). These interactions were not statistically significant at the construct level. The model therefore reflects the tested direct effects of cortisol on leadership perceptions and motivation with moderation examined but not supported.

Overall, the model demonstrates that physiological stress was associated with changes in relational and motivational dimensions of leadership rather than uniformly effect across all leadership traits.

5.5 Reflection on the Biopsychosocial Model

The results provide partial but meaningful support for the proposed biopsychosocial model of leadership under stress. The biological component of the model was strongly confirmed: cortisol levels increased significantly following the stress induction, validating the activation of the hypothalamic–pituitary–adrenal (HPA) axis as a physiological foundation for subsequent psychological changes. The cognitive–social pathway was partly supported while most implicit leadership traits remained stable, effort-related relational traits such as Dedication declined under stress, indicating that acute physiological arousal can selectively narrow leadership schemas. Conversely, cognitive (Intelligence) and dominance-oriented (Masculinity, Tyranny) traits were comparatively stress-resistant, suggesting that stress primarily alters socially engaged rather than competence-based aspects of leadership cognition.

The motivational pathway was fully supported; Motivation to Lead declined significantly, confirming that biological stress responses can undermine leadership self-concept and willingness to assume responsibility. The moderating effects of gender, but not experience, further validate the model's social dimension, demonstrating that demographic characteristics shape the interpretation of stress-related changes in leadership prototypes.

Taken together, these findings partially validate the biopsychosocial framework but also refine it. The revised model (Figure 5.3) indicates that the cortisol–leadership relationship is selective rather than global, influencing relational and motivational dimensions more strongly than cognitive or dominance-based traits. This suggests a moderated rather than linear model of stress effects on leadership, in which biological arousal interacts with gendered cognitive schemas to shape leadership perception and motivation.

5.6 Academic and Practical Implications

The findings of this study have distinct implications for both theory and practice; each linked directly to the hypotheses tested.

H1a & H1c: Relational Traits.

Academically, the significant decline in Dedication under stress indicates that effort-related relational leadership qualities are particularly vulnerable to physiological strain. This extends Implicit Leadership Theory by showing that relational prototypes can be dynamically reweighted under stress. Practically, leadership development programs must prioritize resilience training, stress inoculation, and emotional regulation strategies to preserve relational effectiveness in high-pressure contexts.

H1b: Intelligence.

Academically, the stability of intelligence despite stress indicates that cognitive competence functions as a stress-resistant leadership attribute, supporting ILT propositions of trait universality. Practically, recruitment and succession planning should continue to foreground cognitive ability, while ensuring leaders are supported to apply these skills effectively under strain.

H1d: Masculinity and Tyranny.

Academically, the absence of significant increases in Masculinity and Tyranny contradicts evolutionary threat models, which often predict stronger preferences for authoritarian or dominance-oriented leadership during crises. This finding suggests a potential cultural shift in leadership schemas, indicating that dominance-based traits are no longer automatically perceived as stress-adaptive. Such an interpretation aligns with recent critiques of traditional evolutionary frameworks, which argue that modern organisational and societal environments have reduced the adaptive value of authoritarian prototypes. For example, Ozcan (2021) study shows that while authoritative, dominant, and masculine leaders may have been functional in ancestral contexts, they have become increasingly obsolete in contemporary settings (van Vugt et al., 2008). Similarly, van Vugt and Rueden (2020) challenge assumptions that humans consistently revert to dominance-based leadership under threat.

Furthermore, recent work questions whether dominance–prestige models operate in the same way in large-scale societies. Jiménez et al. (2021) demonstrate that economic uncertainty and intergroup conflict predict increased preference not only for dominant leaders, but also for prestigious leaders suggesting that modern followers do not uniformly favour authoritarian figures under stress. Taken together, these perspectives reinforce the current finding: followers may be less inclined to default to authoritarian leadership schemas when stressed, reflecting cultural shifts in the perceived legitimacy and usefulness of dominance.

From a practical standpoint, organisations should be cautious about reverting to authoritarian or hyper-masculine leadership prototypes in times of uncertainty. Instead, leadership pipelines should prioritise collaborative, relational, and adaptive approaches that better align with contemporary values and the nuanced empirical patterns observed in this study.

H2: Motivation to Lead.

Academically, the observed decline in affective-identity Motivation to Lead under acute stress demonstrates that physiological responses can directly erode intrinsic leadership motivation. This establishes a crucial link between biological stress responses and established motivational theories, enriching our understanding of how acute psychological pressure impacts an individual's fundamental drive to lead. Practically, leadership

development should proactively integrate comprehensive stress management strategies designed to protect and sustain a leader's identity and intrinsic motivation. Effective practices might include coaching, mindfulness exercises, and the cultivation of psychologically safe environments, all of which can help to sustain motivation to lead even under significant pressure.

H3a: Gender as Moderator.

Academically, gender differences emerged in specific domains, with males consistently rating Masculinity and Tyranny higher than females, alongside item-level moderation effects for traits such as Helpful and Understanding. This highlights that demographic factors profoundly shape Implicit Leadership Theories under stress, but these influences are not uniformly distributed across all traits. Practically, organisations must remain highly alert to gender biases in leader evaluation, especially under stressful conditions. Diversity and inclusion initiatives should actively challenge any unconscious reliance on masculine prototypes, thereby ensuring that relational effectiveness and other valuable leadership attributes are not undervalued.

H3b: Work Experience as Moderator.

Academically, the absence of significant moderating effects for work experience challenges the conventional assumption that tenure alone buffers stress-driven shifts in leadership perception. This suggests a need for more nuanced models of experience. Practically, leadership training should move beyond merely accumulating years in a role to cultivate more robust psychological resources, such as perceived control and adaptive coping strategies, as these are more likely to mitigate stress effects than accumulated experience alone.

Summary.

Overall, stress selectively reshaped leadership prototypes by undermining effort-related and motivational traits, while leaving cognitive and dominance-related traits relatively stable. Gender differences were evident for specific traits, whereas leadership experience did not buffer stress effects. These results advance ILT and MTL frameworks by demonstrating how biological stress responses intersect with cognitive schemas and identity motivations. From a practical perspective, they highlight the need for resilience-building in leadership development to sustain relational and motivational qualities under stress. The next chapter synthesizes these contributions, addresses limitations, and outlines directions for longitudinal and field-based research.

Chapter 6 Conclusion

6.1 Overview of Findings

This study provides clear evidence that cortisol-based stress selectively affects leadership perceptions. Relational qualities (Dedication,) declined significantly under stress, suggesting that they are more vulnerable to situational pressures. In contrast, cognitive traits (Intelligence, Dynamism) remained stable, reinforcing their role as core, stress-resistant attributes. Contrary to some evolutionary perspectives, dominance-oriented traits (Masculinity, Tyranny) did not increase under stress, indicating that modern organisational contexts may no longer reward overt authoritarian prototypes. Finally, affective-identity motivation to lead (MTL) declined, significantly, with a large effect size, indicating robust support for this relationship.

These findings extend Implicit Leadership Theories (ILTs) by showing that stress operates as a contextual variable, actively reshaping leadership schemas in real time. The integration of cortisol as a physiological marker strengthened the link between biological stress responses and observed perceptual shifts, grounding psychological findings in a physiological mechanism. Therefore, this study demonstrates that acute stress, validated by increased cortisol, selectively reshapes leadership perceptions by undermining relational and motivational qualities while preserving cognitive and dominance-related attributes.

6.2 Theoretical Contributions

This study significantly extends existing theoretical frameworks within leadership research, particularly Implicit Leadership Theory (ILT), by demonstrating the nuanced interplay between physiological stress and leader prototypes. A key contribution lies in illustrating those relational qualities, such as Dedication, exhibit stress sensitivity, experiencing a significant decline under acute physiological strain. Conversely, cognitive qualities, exemplified by Intelligence, remain relatively stable, thereby refining assumptions of trait universality within ILT and suggesting that leader prototypes are dynamically reweighted depending on the physiological and psychological context. Furthermore, the research successfully integrates a physiological dimension into leadership studies by validating cortisol as a useful biomarker. This bridges the previously disparate fields of neuroendocrinology and leadership psychology, offering empirical evidence for how biological stress responses directly influence cognitive schemas related to leadership.

The findings also offer an important theoretical contribution by challenging evolutionary crisis models, which traditionally predict a heightened preference for dominant or authoritarian leadership under threat. Evolutionary perspectives propose that during periods of uncertainty or crisis, individuals are more likely to prefer strong, dominant leaders who are perceived as capable of enforcing collective action and restoring order (Kakkar & Sivanathan, 2017; Petersen & Laustsen, 2019). This is consistent with more recent evolutionary work showing that ecological threats increase the need for cognitive closure and cultural tightness, which in turn elevate the desire for strong leadership (Contu et al., 2023). Prior evidence also demonstrates that people are more likely to endorse dominant leaders in threatening environments, including modern large-scale societies (Zhu et al., 2021; Kakkar et al., 2017; Wang & Zhou, 2021). These preferences

have been linked to adaptive responses to social and ecological threats and to feelings of insecurity or loss of control.

However, the absence of significant increases in Masculinity and Tyranny under stress in the current study challenges the universality of these assumptions. Instead, the results indicate a potential cultural shift in leadership schemas, suggesting that dominance is no longer automatically viewed as the most adaptive response to crises. Contemporary research supports this trend, emphasizing that modern crisis leadership requires a multifaceted skill set—one that includes adaptability, compassion, openness, resilience, decisiveness, collaboration, and empowerment (Balasubramanian & Fernandes, 2022; Sott & Bender, 2025). This shift reflects an increasing appreciation for shared, relational, and participatory forms of leadership that transcend traditional authoritarian approaches. Moreover, recent evidence indicates that followers may actively resist dominant leaders when such styles conflict with ethical or social norms (Ronay et al., 2023).

Finally, the research underscores the potential role of individual differences by showing that gender shapes certain aspects of stress–leadership dynamics. Men consistently endorsed Masculinity and, to a lesser extent, Tyranny more strongly than women, and gender interacted with cortisol for specific communal items (Helpful and Understanding). In contrast, leadership experience, as measured by tenure alone, did not exhibit a significant buffering effect on stress-induced shifts. These results challenge simple assumptions about experience as a protective factor and instead highlight the importance of demographic and item-level nuances when integrating physiological stress mechanisms into ILT.

In summary, this study advances existing leadership theories by empirically linking physiological stress responses with cognitive leadership schemas, thereby addressing the conceptual and empirical gaps outlined in Chapter 2. The following conceptual map (Figure 6.1) visually illustrates how the study's findings close these gaps and extend the theoretical understanding of stress–leadership dynamics.

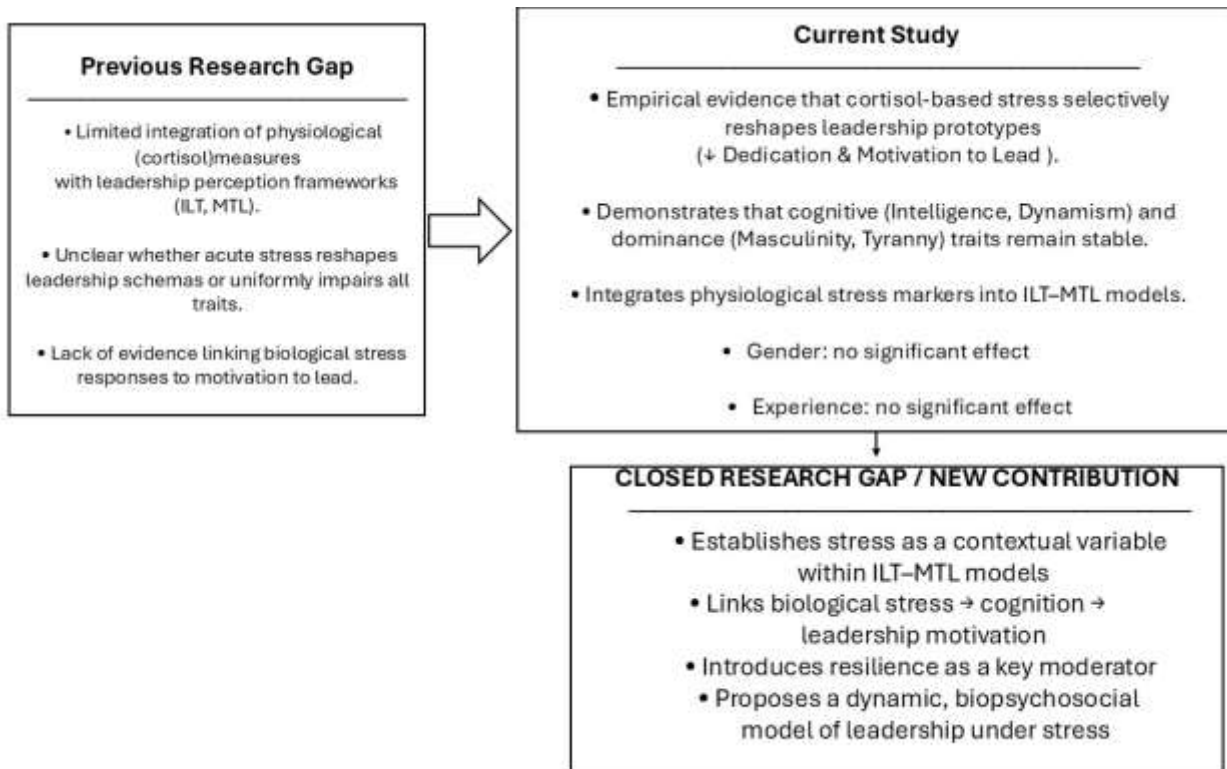


Figure 6.2. Conceptual map showing how the study's findings close the research gap by integrating physiological stress markers with Implicit Leadership Theory and Motivation to Lead frameworks. The model demonstrates that stress acts as a contextual variable that selectively undermines relational and motivational qualities while preserving cognitive and dominance-based traits, thereby linking biological stress responses to leadership schemas and resilience.

6.3 Practical Contributions

These findings yield actionable insights that can significantly inform organizational practices in leadership development, talent management, and crisis preparedness. Firstly, to mitigate the observed vulnerability of relational traits like Dedication under stress, organizations should embed comprehensive resilience training, stress inoculation programs, and emotional regulation strategies into leadership development curricula. Such interventions are crucial for helping leaders sustain their relational effectiveness and empathy in high-pressure contexts.

Secondly, recognizing that acute stress can erode intrinsic motivation to lead, it is imperative to implement proactive recovery strategies. These should include practices such as coaching, mindfulness training, and effective workload management, all designed to preserve and rejuvenate a leader's motivation over the long term.

Thirdly, the study highlights the necessity of addressing inherent biases in leadership evaluation. Given that gender differences in trait endorsements, particularly for Masculinity, Tyranny, Helpful, and Understanding,

may be accentuated under stress, organizations must actively challenge reliance on masculine prototypes. Diversity and inclusion initiatives should focus on ensuring that valuable relational effectiveness is not undervalued, especially when assessing leadership potential and performance during challenging periods.

Finally, leadership training must be specifically adapted to prepare individuals for high-stress settings. This adaptation should ensure that both relational effectiveness and task competence are robustly protected and enhanced, equipping leaders with a balanced skillset to navigate complexity and inspire their teams effectively. Therefore, practical applications lie in equipping leaders and organizations with resilience-building tools that sustain relational effectiveness and motivation under high-stress conditions.

6.4 Hypotheses Outcomes

Hypothesis	Finding	Decision
H1a	Sensitivity	Not supported
H1b	Intelligence	Not supported
H1c	Dedication ↓, Dynamism stable	Partially supported
H1d	Masculinity & Tyranny	Not supported
H2	Motivation to Lead ↓	Supported
H3a	Gender moderate's effects	Not supported
H3b	Experience moderate's effects	Not supported

Therefore, the hypothesis outcomes collectively confirm that stress exerts selective rather than uniform effects on leadership perceptions, particularly weakening relational and motivational components.

6.5 Addressing Research Objectives

The study set out three primary research objectives, each of which has been addressed through the analyses presented.

RO1: To explore changes in implicit leadership theory (ILT) traits under stress.

Findings demonstrated that stress did not uniformly disrupt all leadership prototypes. Dedication showed a significant decline, indicating that effort-related relational qualities are particularly stress-sensitive, whereas other traits, including Sensitivity, Intelligence, Dynamism, Masculinity, and Tyranny, remained comparatively stable. These results suggest that stress selectively narrows leadership prototypes rather than undermining them wholesale.

RO2: To examine changes in motivation to lead (MTL).

Analyses revealed a significant reduction in affective-identity MTL following stress induction. This decline was both statistically significant and of practical importance, indicating that acute stress undermines individuals' intrinsic drive to assume leadership roles.

RO3: To investigate the moderating roles of demographic variables.

Gender emerged as descriptively important, with males rating Masculinity and Tyranny higher than females and showing specific item-level sensitivities (e.g., Helpful, Understanding), although formal moderation tests at the construct level were not significant. In contrast, work experience did not moderate the relationship between stress and leadership perceptions or motivation. Together, these findings confirm that while stress exerts targeted effects on leadership perceptions and motivation to lead, demographic influences are uneven, and experiential factors offer limited protection. Therefore, all three research objectives were met: ILT traits were shown to change selectively under stress, motivation to lead declined significantly, and demographic but not experiential moderators shaped these effects.

6.6 Limitations

Although this study provides novel insights into the relationship between stress physiology and leadership perception, several limitations qualify the interpretation of the findings.

First, statistical power represents an important constraint. With $N = 65$, the study was limited in its ability to detect interaction effects, particularly gender \times cortisol and work experience \times cortisol effects. Some hypotheses (e.g., H2 and H1d) demonstrated medium to large effect sizes but only marginal statistical significance, suggesting that non-significant moderation findings may reflect limited power rather than the true absence of physiological influence. In addition, the demographic and cultural scope of the sample was restricted, which limits generalisability. Stress–leadership dynamics may differ across professional sectors, age groups, and cultural contexts, and therefore the findings should be interpreted within the boundaries of this specific sample.

Second, the stress induction paradigm and physiological measurement design constrain ecological interpretation. The competitive game successfully elevated cortisol and activated the HPA axis; however, it represents an acute, short-term laboratory stressor. Real-world organisational stress is often chronic, multifactorial, and embedded in complex interpersonal and structural environments (Marques, 2023; Weber et al., 2022). Leadership stress frequently involves prolonged interpersonal conflict, toxic cultures, and sustained resource pressure (Miller et al., 2021; Nota et al., 2024), conditions that are difficult to replicate experimentally. Accordingly, the present findings provide a controlled physiological “snapshot” rather than a comprehensive representation of cumulative occupational strain.

The cortisol measurement design further limits interpretive precision. Salivary cortisol typically peaks approximately 10–30 minutes following stressor cessation (Foley & Kirschbaum, 2010; Prasad et al., 2016). While significant fluctuations were captured, the two-point (pre–post) design may not have fully tracked individual peak responses or recovery trajectories, both of which are central to understanding HPA-axis resilience (Hoogerwerf et al., 2017). Moreover, menstrual cycle phase and oral contraceptive use were not

controlled. Given that HPA reactivity differs across follicular and luteal phases (Klusmann et al., 2023; Montero-López et al., 2018; Stephens et al., 2015), this may have introduced additional variability into the hormonal data.

Finally, measurement precision and construct operationalisation warrant consideration. Although the Implicit Leadership Theory scale is validated, some dimensions such as Dedication and Intelligence have shown variable reliability indices in prior research (Epitropaki & Martin, 2004; Trichas et al., 2016). Reliance on self-report measures also introduces potential social desirability bias (Schyns & Schilling, 2010). The work experience variable was operationalised as tenure in years, which may not capture qualitative distinctions such as authority level, decision-making autonomy, or hierarchical power (Knight & Mehta, 2016; Sherman & Mehta, 2019). As noted in the discussion, tenure alone may not provide the same stress-buffering sense of control afforded by high-status roles (Sherman et al., 2012).

Collectively, these limitations suggest that the present findings should be interpreted as evidence of acute stress–leadership associations within a controlled experimental context rather than definitive conclusions about long-term leadership adaptation. The observed patterns are theoretically consistent but require replication in larger, longitudinal, and ecologically embedded samples.

6.7 Future Research Directions

Building on the contributions and limitations of this study, several avenues for future research are recommended. The present findings open several avenues for future research that would deepen understanding of how stress physiology shapes leadership cognition and motivation.

A central priority is distinguishing between acute and chronic stress. The current study examined laboratory-induced acute stress; however, organisational stress often accumulates over weeks or months. Chronic exposure may produce qualitatively different outcomes, potentially undermining not only relational traits such as Dedication but also cognitive resilience. The apparent stability of Intelligence observed here may therefore be context dependent. Future research should examine whether prolonged workplace strain gradually erodes cognitive as well as relational leadership prototypes.

Closely related to this is the need for longitudinal and repeated-measures designs. Tracking stress responses and leadership perceptions across multiple time points would clarify whether observed declines in relational traits are transient fluctuations or indicative of more enduring schema recalibration. Longitudinal designs would also allow investigation into whether leaders adapt through resilience strategies or whether repeated physiological activation contributes to cumulative erosion of motivational and relational dimensions.

Measurement refinement is equally important. The relatively weaker reliability of Dedication and Intelligence suggests the need for psychometric strengthening. Future studies could integrate behavioural indicators, peer or subordinate ratings, or experimental decision tasks to triangulate self-reported ILT perceptions. Such multimethod approaches would allow more precise mapping of how stress influences leadership cognition.

From a physiological perspective, cortisol represents only one dimension of the stress response. Multi-modal profiling that integrates heart rate variability (HRV), electroencephalography (EEG), or neuroimaging would

provide a more comprehensive account of autonomic and neural mechanisms underlying stress-sensitive leadership evaluation. This would advance the biopsychosocial framework by linking endocrine activation with neural and cognitive processes.

Demographic and cultural moderators also warrant further investigation. While gender showed selective influence in the present study and professional experience did not significantly moderate effects, larger stratified samples are required to test whether age, seniority, or cultural value systems shape stress–leadership dynamics. Cross-cultural research would be particularly valuable in examining whether collectivist contexts preserve relational leadership preferences under stress, whereas individualist contexts prioritise competence-based resilience.

Organisational context further represents a critical boundary condition. High-stakes professions such as healthcare, military, and aviation may display distinct patterns of stress adaptation. Structural norms (hierarchical versus collaborative systems) may either amplify or buffer stress-induced perceptual shifts. Embedding physiological measures within real organisational environments would substantially enhance ecological validity and practical relevance.

Epigenetic Perspectives and Future Directions

The literature review situated stress physiology within a broader gene–environment and epigenetic framework, emphasising leadership as a biologically embedded yet environmentally shaped process. Although the present thesis did not directly assess genetic or epigenetic mechanisms, it identified cortisol reactivity as a proximal indicator of acute HPA-axis activation.

Within this broader framework, the observed reductions in Dedication and affective-identity motivation to lead may represent short-term manifestations of stress-system activation. Epigenetic research suggests that repeated or chronic stress exposure can recalibrate stress-responsive systems over time through regulatory changes in gene expression. Future longitudinal research could therefore investigate whether sustained exposure to high-pressure environments contributes to more durable recalibration of stress responsivity, potentially influencing leadership cognition and motivational trajectories across the lifespan.

Importantly, this does not imply deterministic biological effects. Rather, it suggests that stress-related biological systems may serve as mechanisms through which environmental contexts shape leadership development. Multi-level research integrating hormonal markers, behavioural outcomes, and molecular indicators would allow more precise investigation of these dynamic processes.

Accordingly, while epigenetic mechanisms were not directly tested in this study, the findings provide a physiological foundation for future integrative research exploring how stress biology interacts with environmental experience to influence leadership perception, motivation, and development.

6.8 Closing Remarks

This study highlights that acute stress selectively undermines relational leadership qualities while leaving cognitive qualities largely unaffected. Integrating physiological stress measures with leadership psychology

advances Implicit Leadership Theory by demonstrating stress as a contextual variable that reshapes leadership schemas in real time. Beyond theoretical contributions, the findings offer practical tools for resilient leadership development. Organisations that embed resilience training, emotional regulation strategies, and stress-reducing workplace practices will better enable leaders to sustain Dedication and Sensitivity under pressure, balancing decisiveness with relational care. Ultimately, resilience is not an optional leadership skill but a central component of adaptive and humane leadership. In an increasingly volatile world, leaders who can preserve relational engagement alongside cognitive effectiveness will be best placed to foster cohesion, innovation, and long-term organisational success. This study therefore meets its aim of integrating biological stress markers with cognitive and motivational leadership frameworks, providing a more complete account of how stress reshapes leadership perceptions and aspirations. Therefore, the study's central research question, how cortisol-based stress influences leadership perceptions and motivation to lead is answered: stress narrows leadership schemas by reducing relational and motivational dimensions, highlighting resilience as a cornerstone of effective leadership in modern organisation.

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Appendix 1

Appendix 1 A Ethics Approval



Faculty of Health, Education & Life Sciences Research Office

Seacole Building, 8 Westbourne Road

Birmingham

B15 3TN

HELS_Ethics@bcu.ac.uk

01/Feb/2022

Ms Sabreen Jan

sabreen.jan@mail.bcu.ac.uk

Dear Sabreen,

Re: Jan /#9655 /sub2 /Am /2022 /Jan /HELS FAEC - Exploring the biological Foundations of Leadership perception

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

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

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

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

submit an Amendment application for approval of the proposed changes.

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

change of Project Lead.

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

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

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

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

I wish you every success with your activity.

Yours Sincerely,

Dr. Annalise Weckesser

On behalf of the Health, Education and Life Sciences Faculty Academic Ethics Committee

Appendix 1 B Ethics Approval



Faculty of Health, Education & Life Sciences Research Office

Seacole Building, 8 Westbourne Road

Birmingham

B15 3TN

HELS_Ethics@bcu.ac.uk

02/May/2023

Ms Sabreen Jan

sabreen.jan@mail.bcu.ac.uk

Dear Sabreen,

Re: Jan /#9655 /sub1 /Am /2023 /Apr /HELS FAEC - Exploring the biological Foundations of Leadership perception

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

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

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

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

submit an Amendment application for approval of the proposed changes.

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

change of Project Lead.

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

If for any reason the Committee feels that the activity is no longer ethically sound, it reserves the right to withdraw its approval. In the unlikely event of issues arising

which would lead to this, you will be consulted.

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

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

If you would like to provide feedback on the ethics process, please complete the feedback form using this link.

I wish you every success with your activity.

Yours Sincerely,

Miss Nimrah Khan

Research Ethics Officer

On behalf of the Health, Education and Life Sciences Faculty Academic Ethics Committee

Appendix 2

Original Implicit Leadership Theories (ILT) Pilot Questionnaire (9-Point Scale).

IMPLICIT LEADERSHIP THEORIES QUESTIONNAIRE

Think how characteristic you consider the following traits of an ideal organizational leader. Please answer **all** questions, by circling **one** of the numbers beside each question. (Epitropaki, 2000)

	Not at all Characteristic			Neutral			Extremely Characteristic		
	1	2	3	4	5	6	7	8	9
1. Educated	1	2	3	4	5	6	7	8	9
2. Manipulative	1	2	3	4	5	6	7	8	9
3. Strong	1	2	3	4	5	6	7	8	9
4. Conceited	1	2	3	4	5	6	7	8	9
5. Male	1	2	3	4	5	6	7	8	9
6. Intelligent	1	2	3	4	5	6	7	8	9
7. Selfish	1	2	3	4	5	6	7	8	9
8. Hard-working	1	2	3	4	5	6	7	8	9
9. Domineering	1	2	3	4	5	6	7	8	9
10. Energetic	1	2	3	4	5	6	7	8	9
11. Motivated	1	2	3	4	5	6	7	8	9
12. Pushy	1	2	3	4	5	6	7	8	9
13. Sincere	1	2	3	4	5	6	7	8	9
14. Loud	1	2	3	4	5	6	7	8	9
15. Helpful	1	2	3	4	5	6	7	8	9
16. Masculine	1	2	3	4	5	6	7	8	9
17. Dedicated	1	2	3	4	5	6	7	8	9
18. Clever	1	2	3	4	5	6	7	8	9
19. Understanding	1	2	3	4	5	6	7	8	9
20. Dynamic	1	2	3	4	5	6	7	8	9
21. Knowledgeable	1	2	3	4	5	6	7	8	9

Appendix 2A. Reduced Implicit Leadership Theories (ILT) (3-Point Scale)

Items adapted from Epitropaki and Martin (2004). Response format reduced from the original 9-point scale to a 3-point scale for experimental consistency under acute stress conditions.

Think how characteristic you consider the following traits of an ideal organizational leader. Please answer **all** questions, by circling **one** of the numbers beside each question. (Epitropaki, 2000)

	Not at all	Neutral	Extremely
	Characteristic		Characteristic
1. Educated	1	2	3
2. Manipulative	1	2	3
3. Strong	1	2	3
4. Conceited	1	2	3
5. Male	1	2	3
6. Intelligent	1	2	3
7. Selfish	1	2	3
8. Hard-working	1	2	3
9. Domineering	1	2	3
10. Energetic	1	2	3
11. Motivated	1	2	3
12. Pushy	1	2	3
13. Sincere	1	2	3
14. Loud	1	2	3
15. Helpful	1	2	3
16. Masculine	1	2	3
17. Dedicated	1	2	3
18. Clever	1	2	3
19. Understanding	1	2	3
20. Dynamic	1	2	3
21. Knowledgeable	1	2	3

Appendix 2B: Leadership Identity Scale Items

Please rate the extent to which the following statements describe you, using a scale from 1(Strongly disagree) to 5(Strongly agree)

1	I see myself as a leader.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
2	I am a leader.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3	If I had to describe myself, I would use the word 'leader'	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
4	I prefer being seen by others as a leader	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
5	Being a leader is important to who I am.	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

Appendix 3

Number Tracking Test

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The Number Tracking Test (NTT) is a research instrument for the assessment of implicit learning of a visuomotor sequence. It consists of two types of test forms: fixed sequence (FS) forms, which feature a repetitive fixed pattern within and across forms, and random sequence (RS) forms, which do not feature such a repetitive pattern (see next pages for examples). FS forms thus feature a regular pattern that can be learned within and across forms and thus facilitates performance on FS forms relative to RS forms.

Number Tracking Test

This test requires you to connect consecutive numbers with lines as fast as possible. The next consecutive number is **ALWAYS ADJACENT** to the number you have currently arrived at. It may be located above, below, to the right of, to the left of or diagonally to the current number. Sometimes you may have to cross a line to connect two consecutive numbers. Here is an example:

16	4	5	8	9
15	1	3	6	10
14	2	9	2	12
16	13	13	13	13
15	12	12	15	15

The start number (1) and the final number (a number between 50 and 99) are highlighted. You always start at the highlighted number 1 and work your way through the numbers with one uninterrupted line. If you have taken a wrong turn somewhere, trace the line back to the last correct number and continue from there. The task is made more difficult (a) by distractor numbers surrounding consecutive numbers and (b) by highlighted distractor numbers that look like final

numbers. However, there is only one possible path from the starting number to the final number and only one valid final number.

Try to track the numbers with your pen in the following exercise. Hold the pen closer to its rear end so your hand doesn't block your sight on the neighbouring numbers. Make sure that you cross each number while drawing the line.

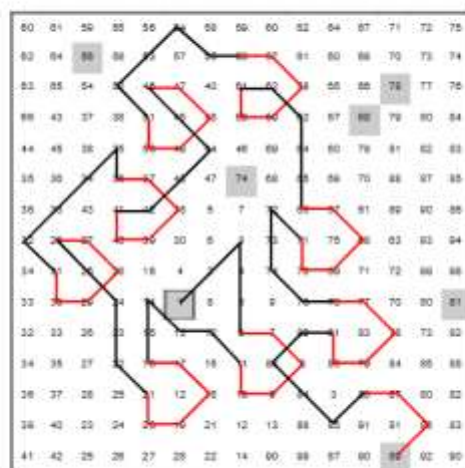
6	7	9	13	12
5	2	8	10	16
1	4	3	14	11
17	15	22	12	17
16	18	14	13	18

On the next couple of tests, you will be stopped after 25 seconds each time, so you will not be able to make it to the final number.

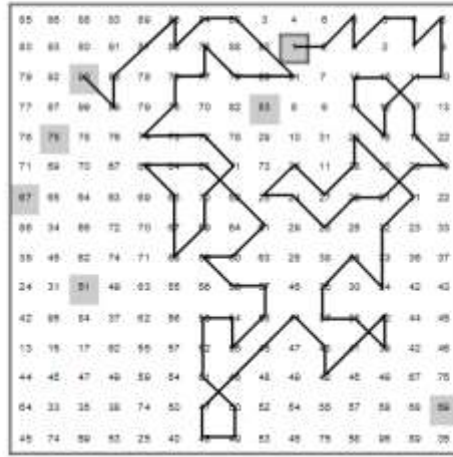
Turn the page now, position your pen at the number 1, start upon the command "GO" and immediately stop upon the command "STOP".

Work as fast and accurately as possible!

Sample Fixed-Sequence NTT Form
(fixed-sequence portions are highlighted)



Sample Random-Sequence NTT Form



Appendix 4

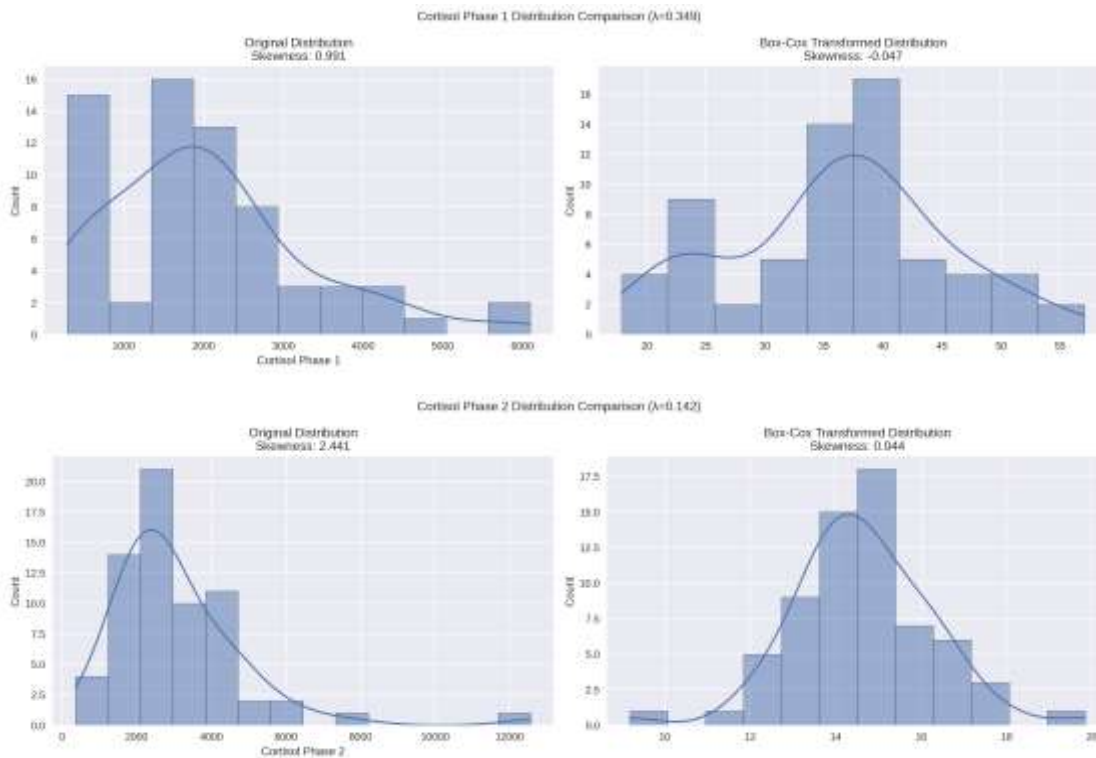
The Box-Cox transformation technique was adopted to address non-normality in Cortisol levels across two phases. This transformation is crucial for meeting the assumptions of parametric statistical analyses (Osborne, 2010).

This analysis employed Box-Cox transformation, defined as:

$$y(\lambda) = \begin{cases} \frac{y^\lambda - 1}{\lambda} & \text{if } \lambda \neq 0 \\ \ln(y) & \text{if } \lambda = 0 \end{cases}$$

The transformation significantly improved the normality of data, as evidenced by:

A. Cortisol Measurements:



The histogram (A and B) above shows the Distribution comparisons before and after Box-Cox transformations for Cortisol levels in Phases 1 and 2. The left panels illustrate the original skewed distributions, while the right panels show the transformed distributions, demonstrating significant improvement in normality.

Table 1: Skewness Improvement through Box-Cox Transformation

Variable	Phase	Original Skewness	Transformed Skewness	Lambda (λ)
Cortisol	1	0.9915	-0.0470	0.3488
Cortisol	2	2.4415	0.0444	0.1418

Key Findings:

Cortisol Phase 2 exhibited the greatest improvement in skewness (from 2.4415 to 0.0444) post-transformation, highlighting the effectiveness of Box-Cox transformations in normalizing data distributions.

The adoption of Box-Cox transformation is supported by several key studies; Osborne (2010) demonstrated that Box-Cox transformations are superior to traditional transformations in social science research, Sakia (1992) provided theoretical foundations for Box-Cox transformations in statistical analysis et al. (2018) emphasized the importance of addressing non-normality in psychological research.

Appendix 5

FOR IMPLICIT LEADERSHIP TRAITS CONFIRMATORY ANALYSIS.

Table 4.8.1.1: Average Variance Extracted (AVE) and Composite Reliability (CR) for Constructs

Factor	AVE	CR	Interpretation
Sensitivity	0.593	0.813	Strong convergent validity
Dedication	0.551	0.772	Acceptable convergent validity
Intelligence	0.500	0.707	Moderate convergent validity
Dynamism	0.693	0.863	Notably strong convergent validity
Tyranny	0.521	0.803	Good convergent validity
Masculinity	0.678	0.808	Strong convergent validity

The results indicate strong convergent validity for Sensitivity, Dynamism, and Masculinity, as evidenced by AVE values exceeding 0.60 and CR values above 0.80. Dynamism demonstrated the highest AVE (0.693) and CR (0.863), reflecting the cohesiveness of its items. Dedication and Tyranny also showed adequate convergent validity, while Intelligence exhibited moderate reliability with an AVE of 0.500 and CR of 0.707, suggesting some room for improvement.

Discriminant Validity

Discriminant validity was assessed using the Fornell-Larcker Criterion, which compares the square root of AVE for each factor to its highest correlation with other factors. Factors satisfy discriminant validity if the square root of AVE exceeds their highest inter-factor correlation. Table 4.6.1.2 summarizes these results.

Table 4.8.1.2: Fornell-Larcker Criterion Analysis for Discriminant Validity

Factor	$\sqrt{\text{AVE}}$	Maximum Correlation with Other Factors	Discriminant Validity
Sensitivity	0.771	0.378	Supported
Dedication	0.743	0.299	Supported
Intelligence	0.707	0.432	Supported
Dynamism	0.833	0.432	Supported
Tyranny	0.722	0.378	Supported
Masculinity	0.823	0.207	Supported

All factors met the Fornell-Larcker criterion, confirming that each construct is distinct and non-overlapping with other factors. For instance, Intelligence demonstrated a square root of AVE of 0.707, which exceeds its maximum correlation with other factors (0.432). This ensures that the factors in the model are theoretically distinct.

Reliability Analysis: Cronbach's Alpha Results

The results provide additional insights into the reliability of the measurement model, as summarized in Table 4.6.1.3 below.

Table 4.8.1.3: Cronbach's Alpha Results for Leadership Factors

Factor	Cronbach's Alpha (α)	Interpretation	Implications
Dynamism	0.774	Acceptable	Highest reliability; can be retained with minor refinements.
Tyranny	0.704	Acceptable	Reliable; suitable for inclusion in further analysis.
Sensitivity	0.657	Acceptable	Approaching acceptable; may benefit from item refinement.
Masculinity	0.525	Poor	Limited by two-item structure; additional items needed to enhance reliability.
Dedication	0.668	Acceptable	Significant revision required to improve consistency.
Intelligence	0.654	Acceptable	Requires substantial revision, including item rewording or expansion.

The results reveal varying levels of internal consistency across the factors. Dynamism ($\alpha=0.774$) demonstrated the highest reliability, meeting the acceptable threshold for research purposes. Similarly, Tyranny ($\alpha=0.704$) exhibited acceptable internal consistency, suggesting the scale is robust and requires minimal modification.

In contrast, Sensitivity, dedication and intelligence approached the acceptable threshold but may benefit from item refinement to improve reliability. Factors with lower alpha values, including Masculinity ($\alpha=0.525$), showed poor reliability. These results highlight the need for significant revisions of the Masculinity factor, which is currently limited by its two-item structure.

Overall Scale Reliability

While some factors, such as Dynamism and Tyranny, demonstrated acceptable reliability, others require significant revisions. These findings align with the composite reliability results from the CFA and underscore the need for scale refinement to ensure robust measurement of the leadership constructs.

Second-Order Factor Structure

The second-order factor analysis revealed a hierarchical structure within the model, simplifying the interpretation of the constructs. Three higher-order factors were identified: Positive Leadership, Negative Leadership, and Gender Leadership. Positive Leadership encompassed Sensitivity ($\beta=0.663$), Intelligence ($\beta=0.698$), Dedication ($\beta=0.599$), and Dynamism ($\beta=0.718$). The fit indices for the second-order structure were excellent, with RMSE=0.000 for all higher-order factors.

Model Fit and Correlations

Despite strong convergent and discriminant validity, the first-order CFA model demonstrated suboptimal overall fit indices, suggesting potential areas for improvement. The Standardized Root Mean Square Residual (SRMR) was 0.406, exceeding acceptable thresholds, while the Comparative Fit Index (CFI) was 0.466, below recommended levels for good fit. The Root Mean Square Error of Approximation (RMSEA) was 1.036, indicating poor fit.

Factor correlations provided additional insights into the relationships between constructs. Sensitivity was moderately negatively correlated with Tyranny ($r=-0.378$), reflecting their conceptual opposition. Intelligence showed a positive correlation with Dynamism ($r=0.432$), indicating some overlap in their attribute

Appendix 5A- Item level descriptive statics for each leadership trait

Appendix 5	Descriptive Statistics for Leadership Traits			
Sensitivity	Phase 1 Mean	Phase 1 SD	Phase 2 Mean	Phase 2 SD
<i>Sincere</i>	2.78	0.48	2.64	0.54
<i>Helpful</i>	2.75	0.5	2.61	0.57
<i>Understanding</i>	2.84	0.4	2.89	0.9
Dedication				
<i>Hardworking</i>	2.87	0.33	2.73	0.56
<i>Motivated</i>	3.06	0.76	2.32	0.92
<i>Dedicated</i>	2.87	0.41	2.63	0.54
Intelligence				
<i>Educated</i>	2.63	0.54	2.47	0.58
<i>intelligent</i>	2.76	0.42	2.63	0.54
<i>clever</i>	2.87	0.33	2.72	0.54
<i>Knowledgeable</i>	2.76	0.52	2.81	0.54
Dynamism				
<i>Strong</i>	2.66	0.476	2.67	0.53
<i>Energetic</i>	2.8	0.5	2.76	0.52
<i>Dynamic</i>	2.8	0.5	2.7	0.55
Tyranny				
<i>Manipulative</i>	1.61	0.7	1.55	0.7
<i>Conceited</i>	1.58	0.65	1.69	0.72
<i>Selfish</i>	1.43	0.61	1.61	0.67
<i>Pushy</i>	1.86	0.72	1.8	0.55
<i>Loud</i>	1.83	0.78	1.98	0.71
Masculinity				
<i>Male</i>	1.81	0.78	1.73	0.75
<i>Masculine</i>	1.73	0.71	2.01	0.76

Appendix -5B- Item level moderation analysis

Table 4.9.2.1: Cortisol × Age Moderation Results

Item	Interaction Coefficient (β)	p-Value	R ²
Sincere	0.000016	0.739	0.007
Helpful	-0.000004	0.936	0.000
Understanding	0.000009	0.803	0.032
Hardworking	-0.000066	0.031	0.159
Motivated	-0.000019	0.797	0.024
Dedicated	0.000001	0.974	0.002
Educated	-0.000053	0.277	0.034
Intelligent	0.000033	0.409	0.062
Clever	0.000064	0.153	0.046
Knowledgeable	0.000006	0.888	0.033
Strong	-0.000013	0.761	0.078
Energetic	-0.000001	0.976	0.036
Dynamic	-0.000013	0.761	0.078
Manipulative	0.000064	0.290	0.047
Conceited	0.000067	0.252	0.032
Selfish	0.000035	0.549	0.025
Domineering	-0.000004	0.953	0.009
Pushy	-0.000160	0.014	0.121
Loud	0.000022	0.715	0.003
Male	0.000127	0.084	0.071
Masculine	-0.000013	0.840	0.028

Table A4.2: Cortisol × Managerial Experience Moderation Results

Item	Interaction Coefficient (β)	p-Value	R ²
Sincere	0.000027	0.494	0.013
Helpful	-0.000019	0.640	0.005
Understanding	-0.000011	0.693	0.054
Hardworking	-0.000032	0.200	0.115
Motivated	-0.000095	0.115	0.086
Dedicated	0.000019	0.457	0.018
Educated	-0.000037	0.362	0.018
Intelligent	0.000005	0.871	0.099
Clever	0.000040	0.283	0.029
Knowledgeable	-0.000007	0.858	0.030
Strong	-0.000012	0.734	0.078
Energetic	0.000010	0.684	0.019
Dynamic	-0.000012	0.734	0.078
Manipulative	0.000079	0.112	0.061
Conceited	0.000047	0.328	0.039
Selfish	0.000014	0.770	0.014
Domineering	-0.000031	0.593	0.077
Pushy	-0.000077	0.153	0.057
Loud	-0.000022	0.662	0.004
Male	0.000018	0.767	0.013
Masculine	-0.000027	0.625	0.014

Appendix 6 For the motivation to lead

Principal Component Analysis (PCA) was conducted on a dataset comprising five variables (Q13_1, Q13_2, Q13_3, Q13_4, and Q13_5) to identify the underlying structure and reduce the dimensionality of the data while retaining the maximum variance. The variables correspond to the following statements:

- Q13_1: "I see myself as a leader"
- Q13_2: "I am a leader"
- Q13_3: "If I had to describe myself, I would use the word 'leader'"
- Q13_4: "I prefer being seen by others as a leader"
- Q13_5: "Being a leader is important to who I am"

This analysis also evaluated the sampling adequacy and the factorability of the data using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's Test of Sphericity.

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.735, exceeding the recommended threshold of 0.6, indicating that the sample size was suitable for factor analysis. Bartlett's Test of Sphericity yielded a chi-square value of 133.101 ($df = 10$, $p < 0.001$), confirming that the correlations between variables were sufficient for PCA.

Communalities represent the proportion of variance in each variable that is accounted for by the extracted components. The initial communalities were all set to 1.000, as is standard in PCA. After extraction, the communalities ranged from 0.419 (Q13_4) to 0.695 (Q13_2), indicating that the variables shared a moderate level of variance with the underlying component.

Table 4.10.1: Communalities of PCA Variables

Variable	Initial Communality	Extraction Communality
Q13_1	1.000	0.669
Q13_2	1.000	0.695
Q13_3	1.000	0.659
Q13_4	1.000	0.419
Q13_5	1.000	0.530

PCA identified one principal component with an eigenvalue greater than 1, explaining 59.43% of the total variance. Although the second and third components explained additional variance (17.30% and 11.73%, respectively), they were not retained due to eigenvalues below 1.

Table 4.10.2: Total Variance Explained in PCA

Component	Eigenvalue	% of Variance	Cumulative %
1	2.972	59.430	59.430
2	0.865	17.300	76.730
3	0.586	11.730	88.459
4	0.373	7.451	95.910
5	0.204	4.090	100.000

The factor loadings for each variable on the extracted principal component ranged from 0.648 (Q13_4) to 0.834 (Q13_2). This demonstrates strong correlations between the variables and the component, suggesting that the items collectively measure a cohesive construct.

Table 4.10.3: Factor Loadings in Component Matrix

Variable	Component Loading
Q13_1	0.818
Q13_2	0.834
Q13_3	0.811
Q13_4	0.648
Q13_5	0.728

These strong loadings, exceeding the recommended threshold of 0.6, support the stability of the component structure and suggest construct validity. The analysis confirms that the five items measure a single underlying construct, which is the motivation to lead (MTL).

Construct Reliability and Validity

Reliability and validity were assessed using Cronbach's alpha, composite reliability (act), and Average Variance Extracted (AVE).

Cronbach's alpha for the MTL construct was 0.827, indicating high internal consistency. Composite reliability was 0.879, suggesting strong reliability. The AVE was 0.594, surpassing the recommended threshold of 0.5 and indicating adequate convergent validity.

Table 4.10.4: Construct Reliability and Validity

Construct	Cronbach Alpha	Composite Reliability	Average Variance Extracted (AVE)
Motivation to Lead	0.827	0.879	0.594

4.10.1 Normality Assessment for Motivation to Lead (MTL)

The distribution of responses across two phases was assessed to evaluate changes in participants' motivation to lead. Descriptive statistics and normality tests, including skewness, kurtosis, and Shapiro-Wilk tests, were conducted to understand the data distribution (Table 4.10.5). Phase 1 served as a baseline, where participants provided saliva samples and filled out the questionnaire without any stress or game involvement. Phase 2 took place after the game, during which participants completed the same questionnaire to determine whether their responses changed under potential stress or remained consistent with their baseline.

Table 4.10.5: Descriptive Statistics for before- and after-Game Phases

Statistic	Phase1	After Game
Mean	4.65	3.66
Median	4.6	3.8
Variance	1.294	0.722
Standard Deviation	1.138	0.85
Minimum	2	1
Maximum	7	5
Range	5	4
Interquartile Range	2	1
Skewness	-0.155	-0.627
Kurtosis	-0.448	0.358

In the baseline phase, the mean motivation score was 4.65 (SE = 0.141), indicating a relatively high level of motivation to lead. The median score of 4.60 closely aligns with the mean, suggesting a symmetrical distribution of responses. Variability was moderate, as reflected in the variance (1.294), standard deviation (1.138), and range (5). The interquartile range (2) also points to some spread in scores, indicating diverse motivational levels among participants before the game.

The skewness value of -0.155 suggests a slight negative skew, where a few participants scored below the median. Meanwhile, the kurtosis of -0.448 indicates a flatter-than-normal distribution, meaning that the scores were evenly spread across the middle range with fewer extreme values. Overall, the baseline responses suggest a high and moderately diverse level of motivation among participants in a non-stressed condition.

In Phase 2, after participants engaged in the game, the mean motivation score dropped to 3.66 (SE = 0.105), signalling a decline in motivation compared to the baseline. The median score of 3.80, slightly higher than the mean, indicates that most participants scored above average. Variability was lower in this phase, as evidenced by a smaller variance (0.722) and standard deviation (0.850). Additionally, the narrower range (4) and interquartile range (1) suggest a more consistent response pattern after the game.

The skewness value of -0.627 reveals a more pronounced negative skew, with a larger proportion of participants scoring below the median. The kurtosis of 0.358 indicates a more peaked distribution, meaning that responses were tightly clustered around the central values with fewer extreme deviations. This tighter clustering implies greater consistency in motivation levels among participants in the after-game, potentially stress-affected condition.

The comparison of the two phases highlights notable changes in motivation to lead. The drop in the mean score from 4.65 to 3.66 suggests a decline in motivation following the game, potentially influenced by stress or other factors introduced during gameplay. Phase 1, being the baseline, showed higher variability and a flatter distribution of scores, as seen in its higher variance and kurtosis of -0.448. In contrast, Phase 2 exhibited a more peaked and consistent pattern (kurtosis = 0.358), reflecting greater uniformity in responses after the game.

Both phases exhibit negative skewness, with a more pronounced skew in Phase 2 (-0.627 compared to -0.155 in Phase 1). This indicates that, while motivation generally declined post-game, a few participants maintained higher levels of motivation, pulling the median above the mean. These descriptive statistics reveal not only a decrease in motivation but also changes in the distribution and consistency of responses, potentially highlighting the influence of stress or other factors introduced during gameplay.

4.10.2 Normality Tests

The normality of the data was assessed for each phase, and the difference in scores between Phase 1 and Phase 2 was also evaluated for normality. Descriptive statistics (mean, standard deviation) and the Shapiro-Wilk test were used to assess normality,

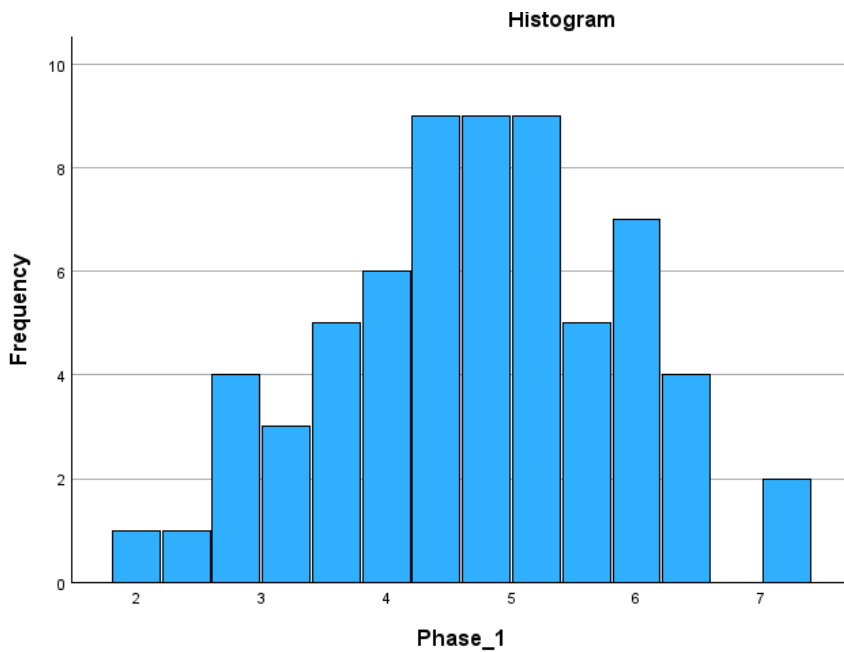


Figure 4.10.1: Histogram showing the distribution of motivation scores during Phase 1 (baseline).

Phase 1: The Shapiro-Wilk test yielded a statistic of 0.926 with a p-value of 0.0007696, indicating a significant deviation from normality. While the histogram suggests a roughly symmetrical distribution, there is evidence of slight skewness.

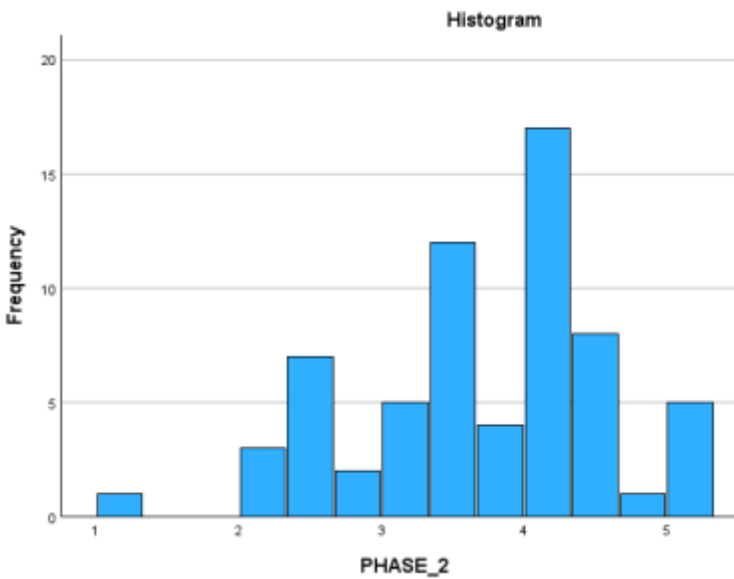


Figure 4.10. 2: Histogram illustrating the distribution of motivation scores during Phase 2 (post-game).

Phase 2: The Shapiro-Wilk test statistic was 0.869 with a p-value of 0.000005883, also indicating a significant deviation from normality and a more evident skew towards the lower end of the scale.

Despite these deviations from normality, the Central Limit Theorem suggests that for sample sizes greater than 30, the sampling distribution of the mean approach's normality, allowing parametric tests to remain valid

(Field, 2013). With a sample size of 65, the paired t-test can be considered robust to these moderate deviations from normality (Rhiel & Chaffin, 1996; Zumbo & Jennings, 2002).

For the difference scores between Phase 1 and Phase 2, the Shapiro-Wilk test yielded a statistic of 0.985 with a p-value of 0.598, indicating no significant deviation from normality. The histogram for the difference scores also shows a roughly bell-shaped distribution. Since the difference scores do not violate the normality assumption, this further supports the use of a paired t-test to compare Phase 1 and Phase 2

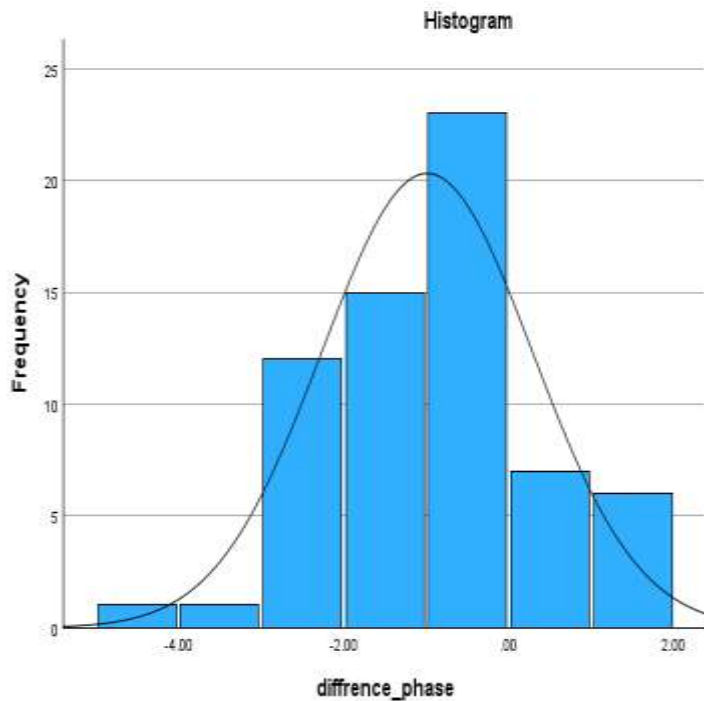


Figure 4.10. 3: Histogram of the difference scores between Phase 1 and Phase 2.

In summary, the motivation to lead construct demonstrated strong internal consistency and convergent validity, as evidenced by acceptable values for Cronbach's alpha, composite reliability, and AVE. Although individual phase scores showed some deviation from normality, the large sample size supports the robustness of the paired t-test, allowing for valid comparison between phases. Furthermore, the normality of the difference scores validates the paired t-test as an appropriate statistical approach for comparing phases.

