Conceptualising Neuroscience-Based Leadership Behaviour

by

Ingra Du Buisson-Narsai

Canterbury Christ Church University

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Acknowledgements

"Where something becomes extremely difficult and unbearable, there we also stand always already quite near its transformation".

Rainer Maria Rilke

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Thesis summary

This thesis primarily focuses on conceptualising Neuroscience Based Leadership (NSBL) by providing a working definition of NSBL, describing the foundational concepts and core behaviours of neuroscience-based leadership (NSBL), and presenting a conceptual framework that integrates interdisciplinary perspectives on leadership behaviour.

This was achieved by:

1. Reviewing existing relevant scientific literature and highlighting current knowledge gaps in the conceptualisations of NSBL using Leadership Behaviour, Social Cognitive Neuroscience (SCN), and Neuropsychotherapy (NP)
2. Conducting a small-scale research project using semi-structured, in-depth interviews with three neuroscientists who have employed neuroscience-based diagnostics in leadership development within a corporate context. This study's key findings reveal key conceptual themes with the following theoretical propositions that underpin NSBL key behaviours: social safety is a primary operating principle; conscious thinking and nonconscious processes drive behaviour; nature-nurture dynamics influence behaviour; experienced-based neuroplasticity drives change; and overlapping large-scale brain networks enable information processing in the brain.
3. Designing and implementing a qualitative Delphi study involving 33 experienced professionals in NSBL to explore how NSBL is defined, conceptualise NSBL as a different domain of leadership behaviour, and provide descriptors of NSBL key behaviours
4. Adopting a case study approach involving an organisational psychologist experienced in Neuropsychotherapy and drawing on his views and experiences to produce a single-case study of NSBL within the context of organisational psychology and applied organisational neuroscience (AONS).
5. Undertaking a reflective and critical review of the four pieces of research and proposing a theoretical framework of NSBL, specifically within formal organisations, to inform, support, foster and develop future NSBL-based behaviour.

The contribution of this study is broad in that it offers a working definition of neuroscience-based leadership and an interdisciplinary conceptual framework to guide practitioners and further research. This conceptual framework integrates theoretical propositions regarding leadership behaviour from Leadership Behaviour theory, Social Cognitive and Affective Neuroscience, and Neuropsychotherapy.

The theoretical framework of NSBL addresses gaps in the literature by differentiating four domains of NSBL: stress resilience-focused core behaviours, affect and emotional-focused core behaviours, relationship-focused core behaviours, and task-focused core behaviours. It also provides neuroscientific concepts that underpin behaviour.

The contribution to practice is that this study advances the understanding of how formal organisations can apply a neuroscientific lens to inform the design of leadership development interventions. This integrative, interdisciplinary theoretical framework can be used for leadership coaching at an individual level.

At the group level, it can facilitate team building. It can provide a neuroscientific language for mental experience at an organisational level, thereby enhancing the explanatory power of concepts in leadership and organisational behaviour.

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Acronyms and abbreviations

AI	Appreciative Inquiry
AONS	Applied organisational neuroscience
BARS	Behavioural anchors rating scales
CCCU	Canterbury Christ Church University
CEN	Central executive network
DMN	Default mode network
EEG	Electroencephalography
fMRI	Functional magnetic resonance imaging or functional MRI
HPCSA	Health Professions Council of South Africa
IMoLB	Integrative Model of Leadership Behaviour
IOP	Industrial and organisational psychology
MPFC	Medial prefrontal cortex
NP	Neuropsychotherapy
NSBL	Neuroscience-based leadership
OB	Organisational behaviour
OCN	Organisational cognitive neuroscience
OD	Organisational development
ONS	Organisational neuroscience
PDF	Portable Document Format; Professional Development Foundation
PET	Positron emission tomography
PFC	Prefrontal cortex
qEEG	Quantitative electroencephalography
SCN	Social-cognitive neuroscience

Chapter One: Introduction and Orientation to the Research

"We must recollect that all of our provisional ideas in psychology will presumably one day be based on an organic substructure" – Sigmund Freud.

1. Introduction

The purpose of Chapter One is to provide the reader with an "at a glance" view of the entire thesis. The background and motivation for the research, leading to the research problem, are presented. Next, the research aims, paradigm and disciplinary context are provided. A conceptual framework of the study is presented, followed by the research design. Finally, a chapter division is offered.

2. Background: The Challenge of Neuroscience-based Leadership

This thesis documents a five-year research journey exploring the conceptualising of neuroscience-based leadership (NSBL) behaviour. To the best of my knowledge, this is one of the first studies to report on the conceptualisation of NSBL behaviour in formal organisations.

Formal organisations are complex human systems that are not emotionless or inanimate objects, and leadership behaviour is one of the most crucial building blocks for creating a sustainable organisation that can adapt to challenges and engage people (Neal & Rhyne, 2022). Effective leadership behaviour in formal organisations is essential as we emerge from the COVID-19 world, driven partly by hybrid working arrangements, access to workflow technologies and concerns about mental health in the workplace (Neal & Rhyne, 2022). Meta-analytic evidence exists for the link between leader characteristics and leader behaviour (DeRue, Nahrgang, Wellman, & Humphrey, 2011), showing that leadership behaviour tends to explain more of the variance in leadership effectiveness than leadership traits.

Apart from complexity, contemporary organisations are also appropriately referred to as "anxiety machines" (Daskal, 2017, p. 65 as cited in Flotman, 2020), eliciting what is known as "primitive anxieties" (Petriglieri, 2020, p. 3). One of the few areas of agreement between leadership practitioners is that leaders who are assigned and entrusted with the organisation's primary task are under unprecedented strain, which causes anxiety (Flotman, 2020). Vince (2019, p. 953) argues that fear is the unconscious emotional and physiological response to threats in leaders' internal and external environment, which is often unsettling and can lead to toxic behaviour in the work environment if not effectively contained. Multiple lenses and theories are used to study leadership behaviour (Day and Antonakis, 2013).

According to modern neuroscience, the brain and behaviour are inextricably linked through the nervous system's plasticity. The brain is the structure of mental function, and psychological phenomena originate in this complex organ. Psychological and sociocultural phenomena (such as leadership behaviour) are exemplified in the brain by memories and learning, which involve structural changes in the neurons and neural circuits (Ward, 2016).

The connection between the brain and behaviour has been studied using brain lesions, imaging, post-mortem studies, psychological and psychiatric research and neurological disorders. These studies have helped consolidate evidence for the close relationship between neural and mental functions (Lezak, Howieson, Bigler, & Tranel, 2012). Unlike traditional behavioural research, neuroimaging and neurosensory studies allow researchers to infer some of a subject's mental processes simply by looking at their brain activity rather than interrupting the subject and asking about their feelings to determine their mental state (Society for Neuroscience, 2018).

To this extent, the emerging fields of social-cognitive and affective neuroscience (Ochsner & Lieberman, 2001), organisational neuroscience (Becker et al., 2011; Murray & Antonakis, 2015), organisational cognitive neuroscience (Lee et al., 2012) and Neuropsychotherapy (Grawe, 2007; Rossouw, 2014) aim to apply neuroscientific methods and research insights to examining and understanding human behaviour. Most of these approaches focus on the applied settings of organisations: the individual, the group, and organisational or even inter-organisational levels.

Organisational Neuroscience is a developing field that studies behaviour in formal organisations. It is a promising and multidisciplinary field that explores the application of the neural basis of human behaviour, specifically leadership behaviour, in workplace settings (Balthazard, Waldman, Thatcher, & Hannah, 2012; Boyatzis, Good, & Massa, 2012).

Neuroscience is also being leveraged in climate change research and interventions to play a proactive role in societal living conditions encapsulated in the new field of Environmental Neuroscience (Doel et al., 2023). This study presented a non-exhaustive selection of cognitive and affective processes and the related brain regions that play a role in climate change. Thus, evidence is accumulating for the value of neuroscience research towards enhancing human health and wellbeing in the workplace and beyond.

However, is it essential for an individual to understand the neural basis of leadership and management phenomena to be an effective leader? Di Domenico and Ryan (2017) confirmed the importance of using neuroscience methods in studying human behavioural constructs (such as the construct of leadership):

- “First, to state the obvious, experience and behaviour are mediated by the brain, and a complete account of intrinsic motivation therefore requires an understanding of the neural systems that support it.”

- "Second, neuroscience affords the examination of internal processes not accessible by self-reports of experience or behavioural observations. A Neuroscience of intrinsic motivation promises new insights that introspective and behavioural methods alone cannot afford."
- "Finally, neuroscience methods can be used to investigate motivational processes at a higher level of resolution than experiential and behavioural methods. Neuroscience methods, therefore, have the potential to refine conceptual accounts of intrinsic motivation by articulating the granular processes that comprise it" (Di Domenico & Ryan, 2017, p. 2).

Despite the evident impact of this consolidation of evidence, much concern has been raised about the scientific merit of neuroscientific studies, for example, the inability to precisely localise brain correlates of mental phenomena, small sample sizes, and lack of replication research (Lindebaum & Zundel, 2013). These criticisms concerning the use of neuroscientific methods imply that unless questions over the generalisability of existing neuroscientific study results and the inability to localise phenomena in the brain can be addressed, opportunities for theory development in organisational settings cannot be accurately explored. Thus, the challenge is incorporating reliable empirical data to produce theoretical frameworks with scientific merit.

It is also worth noting that neuroscience does not propose to reduce all behavioural phenomena to neurotransmission or synapses, receptors, and circuits. Psychological and sociocultural events and phenomena continue to influence human behaviour, including behaviour in the workplace (Nowack & Radecki, 2018). To responsibly incorporate neuroscientific research into psychological phenomena, Bott et al. (2016) propose using Engels' (1981) biopsychosocial model of health. The biopsychosocial (BPS) model of health attributes complex phenomena or events to multiple causes. The BPS model represents an integrative approach to the mutual influence of biological, psychological (thoughts, emotions, and behaviours) and social factors that all play a significant role in human functioning (Engel, 1981, cited in Bott et al., 2016).

This research study aligns with the meta-biopsychosocial (BPS) philosophy and model of behaviour (Bott et al., 2016). In alignment with the BPS model, prominent scholars in the field of organisational neuroscience also showed that, to accomplish work-related tasks in organisations, the brain relies on and closely interfaces with the body, interpersonal and social dynamics, and cognitive and emotional processes that are distributed across persons and artefacts (Healy and Hodgkinson; 2014).

Refining the neuroscience perspective and the specific neuroscience concepts underlying leadership behaviour can enable leaders to be more effective in the workplace. General application questions typically include: What influence does the workplace have on the brain? What influence does the brain have on the workplace? The answer seems logical: the workplace clearly has a significant impact on brain wellbeing. It can stimulate the brain or cause disruptions, leading to avoidance patterns and poor performance. Although this seems logical, the organisational environment has not been a significant research focus from a neuroscientific perspective. It is rife with distorted interpretations of neuroscience research findings (Day and Antonakis, 2012; 2013).

The distortion of neuroscience research findings has significant ramifications when it is seen as an "authoritative argument or the guru effect (interpreting as profound a concept that the individual fails to understand) in non-scientific disciplines" (Sperber et al., 2010, cited in Bott et al., 2016, p. 322). These distortions of research findings can do more harm than good to clients and pose a critical ethical risk. Psychology practitioners should adhere to ethical standards, act within the boundaries of their professional scope of practice, gain more knowledge, and obtain supervision when working in this emerging area of organisational neuroscience to protect clients from harm (Bott et al., 2016).

The challenge is to move beyond speculation and deliver an ethical, coherent, evidence-based research contribution. Such a contribution should also enhance the practice of current neuroscience research to the concrete challenges business leaders face in dealing with complex, ambiguous, rapidly changing, multidimensional problems encountered in contemporary business environments.

Figure 1

The BPS model: Tiered systems suggest different levels of analysis, adapted from (Myers, 2008).

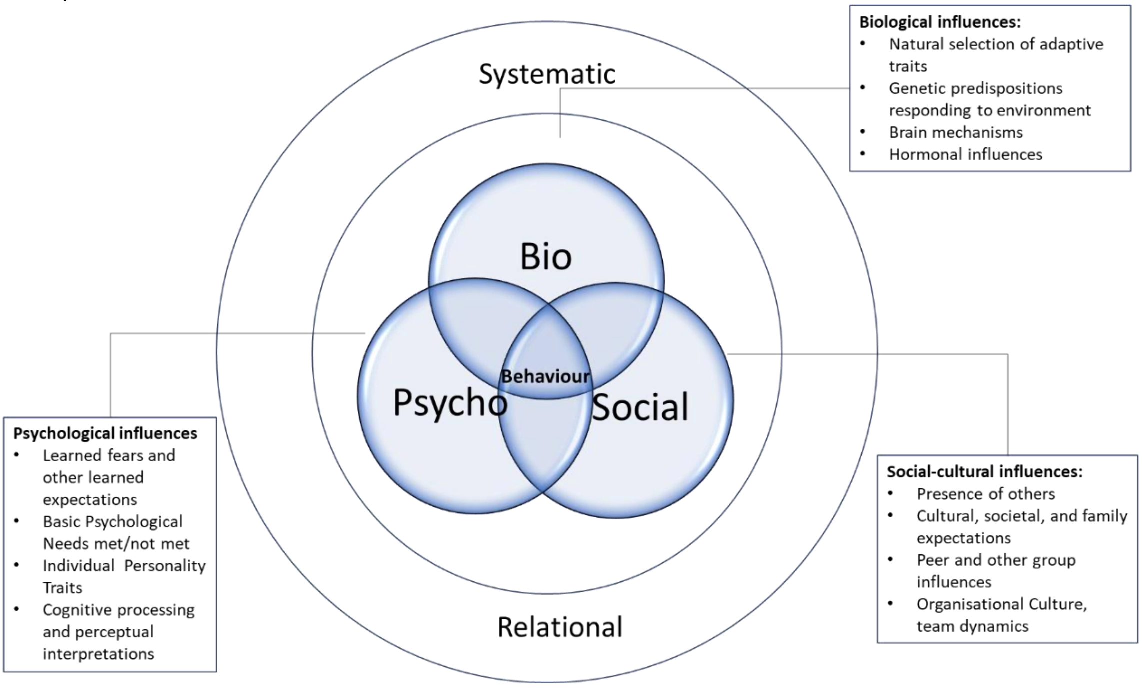


Figure 1 shows human behaviour is part of an extensive social system and smaller neural, anatomical and molecular systems.

3. Rationale for the Research

Given the intense interest in neuroscience in the workplace, responsible practice is required by organisational scholars (Bott, Radke, & Kiely, 2016). According to these authors, ethical and responsible practice challenges originate from errors in making causal connections between the brain and organisational behaviour phenomena, small research samples involved in neuroscience studies, lack of replication studies, and lack of convincing applications to organisational psychology (Kotchoubey et al., 2016).

To ensure that reductionist explanations of psychological phenomena are avoided, and that ethical and responsible practice is enhanced, Bott et al. (2016) call for continuous reflection on credible models and standards of practice. This research heeded the call. Therefore, the rationale for this study is to fill the gap in the leadership behaviour literature by conceptualising NSBL via the expert opinions of experienced professionals.

Organisational psychology as a profession values the importance of a holistic understanding of human abilities, potential, and behaviour (Spector, 2021). Exploring the neurobiological foundations of behaviour could contribute to a holistic understanding of leadership behaviour.

Both empirical organisational neuroscience studies (using neuroscience methods such as functional magnetic resonance imaging) and applied neuroscience studies (using translational approaches by interpreting neuroscience research findings) have benefits in the work context (Boyatzis et al., 2012; Geldenhuys, 2022; Waldman et al., 2011). Empirical and applied neuroscience studies pave the way for organisational scholars and practitioners to advance existing leadership and organisational behaviour theories, thereby increasing the explanatory power of psychological concepts (by clarifying the neuroscientific principles underpinning behaviour).

4. Role of the Researcher

The researcher is an organisational psychologist who consults with formal organisations in South Africa and performs her role within the scope of practice for health professionals in South Africa. This included the roles of doing evidence-based research, using valid and reliable instruments, and conducting ethical research. In addition, the researcher was committed to the highest ethical standards, as prescribed by Canterbury Christ Church University.

5. The Research Problem

Organisational psychology is concerned with human behaviour in the workplace. Therefore, the behaviour of leaders is directly relevant to this field, as it increases the resilience and adaptability of individuals, teams, and the organisation (Spector, 2021).

Despite presenting NSBL as a leadership construct, the theorists in this new field have not yet convincingly anchored the construct in the leadership body of knowledge by incorporating relevant evidence or a comparative overview (Lindebaum & Zundel, 2013; Neal & Rhyne, 2022; Nowack & Radecki, 2018; Spector, 2021).

This was evident in the literature reviewed, which suggested that building a theoretical alliance between complex leader behaviour and even more complex neurobiological activity is undoubtedly challenging. Several authors have discussed this (Balthazard, Waldman, Thatcher, & Hannah, 2012; Boyatzis, Good, & Massa, 2012; Waldman, Balthazard, & Peterson, 2011; Waldman & Balthazard, 2015).

Therefore, it is clear that an interpretive conceptual framework or preliminary NSBL model is needed. The envisaged outcome is an interpretive conceptual model that integrates concepts from leadership behaviour and relevant neuroscientific theories into one model relevant to leadership behaviour at the individual level of leadership functioning. In other words, what do leaders do or don’t do when they understand brain functioning.

6. Research Aims and Questions

The general aim of this exploratory qualitative study was to expand the existing knowledge base on NSBL by examining the applied theoretical models, foundational concepts and core behavioural descriptions of NSBL from the perspective of experienced professionals.

Another goal is to conceptualise neuroscience-based leadership from the perspective of applied organisational neuroscience (AONS) and to create a preliminary interdisciplinary theoretical framework for NSBL. This research aims to expand theory and practice in this area.

The assumption is that creating a well-defined, comprehensive portrait of NSBL behaviour will add to the validity and legitimacy of this new leadership domain.

6.1 Specific Aims

- Describing the current theoretical frameworks that inform the study of NSBL.
- Describing the foundational neuroscientific concepts and principles that underpin this new leadership domain.
- Describing the core behaviours leaders display that follow a neuroscientific approach.
- Articulating how Neuropsychotherapy is assimilated into or fits into the domain of NSBL.
- Conceptualising a neuroscience-based leadership interpretive framework.
- The final aim is to formulate recommendations from the research to contribute to the understanding of NSBL.

These aims informed the determination of research questions.

6.2 The Central Research Question

A comprehensive understanding of the definition, concepts and core behaviours associated with NSBL is lacking. Without this conceptual basis for understanding NSBL, implementing neuroscience-based leadership development interventions would prove problematic.

Thus, the central research question is: "How do experienced professionals conceptualise NSBL and describe core NSBL behaviour?"

6.3 Sub-questions that guided the Thesis Chapters

The secondary intention is to explore the complex factors surrounding the NSBL phenomenon and present the different perspectives or meanings of the participants.

The following four specific research questions were set for this study:

1. How is NSBL delineated and defined?
2. What are the core theories that inform NSBL?
3. What are foundational neuroscientific concepts that underpin leadership behaviour?
4. What keywords or phrases describe the behaviours that differentiate NSBL from other approaches to leadership?

7. The Research Paradigm

7.1 *Critical realism*

A paradigm is a set of beliefs shared by communities that regulate inquiry within a discipline, providing lenses, frames, and processes through which investigation is accomplished (Weaver & Olson, 2006). According to (Mouton and Marais, 1992), a paradigm is a device that keeps the philosophical content of the research together.

The philosophical aim of this thesis is to eventually build a conceptual framework of the neuroscientific foundations of leadership behaviour through a richer theory of NSBL. This need to build a richer, more robust theory meant to understand the behavioural micro-foundations of leadership requires the linking of diverse fields of study. The critical realism paradigm developed by Bhaskar (2008) was adopted for this research. It proposes familiar explanatory mechanisms across the sciences as a meta-theory and philosophy. This research paradigm enables the connecting and unifying of concepts from diverse fields like neuroscience and leadership behaviour – found at different levels of explanation (Rutzou, 2016). Bhaskar pointed out that the body and mind are causally related but also separate (2011). Healey & Hodgkinson (2014, p. 771) state that "critical realism provides an ideal means to bridge social neuroscience and organisational science".

This theory-building approach of using common explanatory mechanisms across the sciences is also argued through consilience, which involves using independent measurement methods, meaning that the methods have few shared characteristics (Wilson, 1998). According to Becker et al. (2011, p. 936), Consilience enables building richer and more robust theories, especially in organisational neuroscience. Some scholars argue that psychology is not entirely distinct from studying properties relating to the interaction of neurons and synapses."

The concept that all the different areas of research study one real, existing universe is an apparent explanation of why scientific knowledge determined in one field of inquiry has often helped understand other fields (Wilson, 1998). It is postulated that this consilience of lenses can also help debunk potential myths in neuroscience and organisational psychology (and in this research defining NSBL).

Given how comparatively little research appears to have been carried out on NSBL behaviour, critical realism is suitable for this study as it stresses the importance of ontological reflexivity, in which assumptions about the social world are noted and questioned. To enable this reflexivity, the researcher also applied continuous critical reflection on her practice using Kolb and Kolb's model of learning theory and reflection (Kolb & Kolb, 2009)– this resulted in the refinement of the research questions in this study. The learning journal was used throughout the study period to help reflect on the project activity, data collection and findings from the data analysis. This was done pragmatically to remain flexible yet critical in resolving the research problem (Klenke, 2008).

Critical realists believe refining and improving knowledge about the real world over time is possible. The NSBL conceptual model captured in Chapter 6 is, therefore, open for critical review and reflection, and the wish is that practitioners and researchers refine and adapt the model as required.

7.2 Theoretical perspectives

7.2.1 Organisational psychology

Industrial and organisational psychology (IOP) is an applied, evidenced-based branch of psychology concerned with measuring and enhancing human behaviour and performance in the workplace. IOP is both a science and a practice focusing on real-world methods to help organisations get the most out of their people (Spector, 2021). Therefore, the behaviour of leaders is directly relevant to this field at the individual, team, and organisational levels (Spector, 2021).

7.2.2 Leadership behaviour

Leadership behaviour is a sub-discipline of leadership theory studied mainly within Organisational Psychology (Spector, 2021). Leadership theory contains various content-based models upon which leader qualities or behaviours are considered. Examples include transformational, leader-member exchange, servant, complex/adaptive, ethical, and authentic conceptualisations of leadership (Avolio, Walumbwa, & Weber, 2009). Leadership behaviour is guided by the question, "What do leaders do?" (Day & Antonakis,2012; 2013). The focus of this study is to answer the question: What do neuroscience-based leaders (NSBL) do? A behavioural approach to neuroscience-based leadership theory is thus required.

Critical academic studies have set out the essence of leadership behaviour (Behrendt, Matz, & Göritz, 2017; Hogan & Kaiser, 2005; Yukl, 2012). However, these contemporary theory-based conceptualisations of leadership behaviour have been criticised for their weak theoretical foundations (Van Knippenberg & Sitkin, 2013). According to Day and Antonakis (2012), there is a need for better integration of all the theories on leadership, including the neuro-biological level of analysis.

7.2.3 Neuroscience

Applied neuroscience is an all-encompassing term that describes how research findings in neuroscience are used in other fields to expand perspectives of the neurobiological architecture that underpins human behaviour (Ashkanasy, Becker, & Waldman, 2014; Becker, Cropanzano, & Sanfey, 2011). Applied neuroscience draws knowledge from many areas of science, from psychology to molecular biology.

In addition, this broad field extends to the emerging domain of applied organisational neuroscience, which, according to Becker et al. (2011, p. 933), is "an emerging area of scholarly dialogue that explores the implications of brain science for workplace behaviour."

Organisational neuroscience is not neuropsychology, which, according to the APA Dictionary (n.d.), is "the branch of science that studies the physiological processes of the nervous system and relates them to behaviour and cognition, in terms both of their normal function and of the dysfunctional processes associated with brain damage". Instead, applied organisational neuroscience provides another level of analysis, which is not reductionistic; it can both advance and connect organisational psychology theories (Becker et al., 2011).

The fields of neuroscience that have the most relevance to NSBL in the organisational context are social-cognitive neuroscience (Lieberman, 2007; Ochsner & Lieberman, 2001), affective neuroscience (Feldman Barrett, 2017), Neuropsychotherapy (Grawe, 2007; Rossouw, 2014), and organisational cognitive neuroscience (Lee, Senior, & Butler, 2012). Defining and conceptually integrating these perspectives can offer distinctive insights into how neuroscientific theory may inform leadership behaviour. This is described below:

Affective neuroscience: The nature of emotions

This is a complex field and, at present, riven by paradigmatic division – the classical theory of emotions vs the theory of constructed emotions (Gendron & Feldman Barrett, 2009; Lindquist & Feldman Barrett, 2012; Feldman Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019).

Affective neuroscience, as a classical theory of emotions, suggests seven primary emotional systems: seeking, lust, care, play on the side of positive emotions, and fear, anger/rage, and panic/sadness on the negative side (Montag & Panksepp, 2017; Panksepp, 2004).

The theory of constructed emotions (a more recent theory of affect and emotion) opposes previous accounts of primary emotions. The theory of constructed emotions follows a recent line of argumentation: "The brain uses its past experience to engage in predictive modelling of the environment". According to this perspective, emotions are constructed by the brain when it uses its model of the environment to make sense of incoming information (Markett, Wudarczyk, Biswal, Jawinski, & Montag, 2018, p. 3). The classical view is that environmental stimuli and neural systems mediate types of emotions (Feldman Barrett, 2006; Feldman Barrett, 2015; Panksepp, 2007).

The literature is unclear whether the theory of constructed emotions explanation can be merged with the classical theories on emotions (Feldman Barrett, 2017)

Social-cognitive neuroscience: Person perception and the self

Social neuroscience aims to explain, using neural mechanisms, how individuals' thoughts, feelings and behaviours are influenced by the actual, imagined, or implied presence of others (Adolphs, 2009; Lieberman, 2010; Ward, 2016). There is also great overlap between the processes of social-cognitive neuroscience and the scope of the neuroleadership framework developed by Ringleb and Rock (2008). The application of this framework in formal organisations has been explored in academic research (Coetzer, 2019; Waldman et al., 2011).

Cognitive neuroscience: Attention, memory, decision-making

Organisational Cognitive Neuroscience (OCN) is defined as "applying neuroscientific methods to analyse and understand human behaviour within the applied setting of organisations, which may be at the individual, group, organisational, inter-organisational, and societal levels. OCN draws together all the fields of business and management in order to integrate an understanding of human behaviour in organisations and to more fully understand social behaviour" (Lee, Butler, & Senior, 2008, cited in Butler, 2014, p. 1).

Neuropsychotherapy: Understanding basic psychological needs.

Neuropsychotherapy is used to study leadership behaviour within the new domain of organisational neuroscience (Geldenhuys, 2020; Ghadiri et al., 2013; Rossouw, 2014). Neuropsychotherapy explores the underlying neural mechanisms and principles that influence human behaviour and provides guidelines to enable optimal functioning (Rossouw, 2014). Neuropsychotherapy originates from Seymour Epstein (1994) and Klaus Grawe (2007), who defined four basic psychological needs present among all humans. The enduring non-fulfilment of these needs or their infringements negatively impacts mental health and wellbeing.

8. A conceptual framework: Contextual and Conceptual Orientation

A conceptual framework contributes to the theoretical coherence of NSBL in an interdisciplinary way. This builds a shared understanding of concepts and context. This research adopted the conceptual framework guidance set out by Van der Waldt (2020).

The five steps that were taken to construct the NSBL conceptual framework include:

Step 1: *Choose the topic*. The topic of this study is neuroscience-based leadership behaviour in formal organisations. "Leadership behaviour" falls within the domain of work of organisational psychology. Organisational Neuroscience is an emerging research domain within organisational psychology that integrates organisational behaviour with neuroscience research. Organisational Neuroscience is mainly studied from a Social Cognitive Neuroscience and Neuropsychotherapy perspective.

Step 2: *Choose the title*. The title of the research is "Conceptualising Neuroscience-based Leadership Behaviour." The focus is on how a neuroscience lens can refine the behavioural description by incorporating the neuroscientific principle or mechanisms involved. The variables are "neuroscience", "leadership", and "behaviour".

Step 3: *Isolate the key concepts and constructs in the title*. The specific variables described in the literature include broad definitions of NSBL, leadership behaviour theories and constructs, social cognitive and affective neuroscience, and Neuropsychotherapy theories. Various aspects will be researched in the different chapters to determine how these are potentially related.

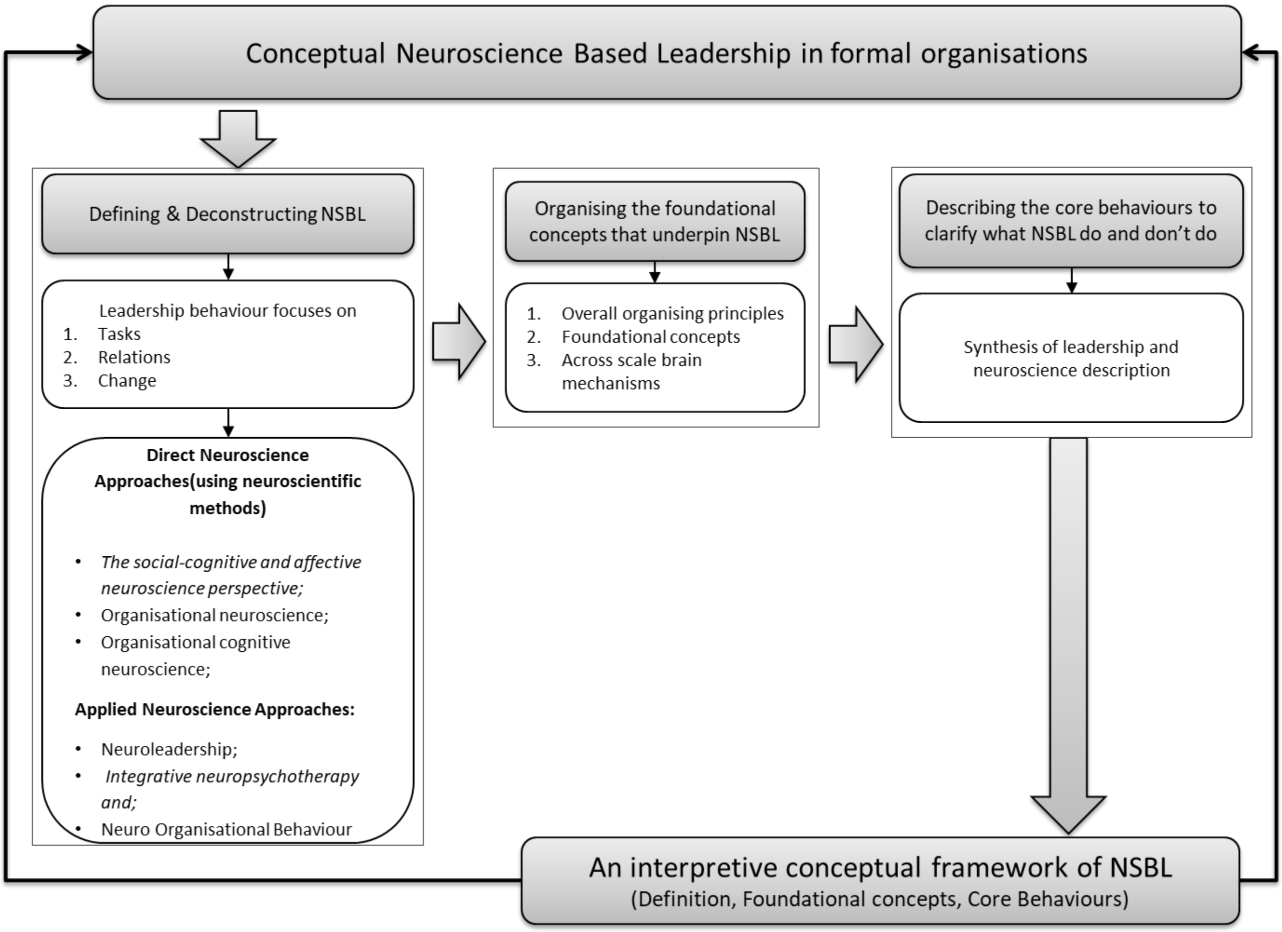
Step 4: *Do a literature review and identify related concepts and variables*. The literature review in Chapter Two was used as a "mental map" to direct and focus the study by consulting peer-reviewed articles on leadership behaviour, conceptual studies on organisational neuroscience and neuroscience in leadership, empirical neuroscience method studies, and peer-reviewed textbooks and established scientific journals.

Literature was reviewed and updated throughout the four pieces of work, and the conceptual framework was reconstructed throughout the research journey.

Step 5: *Produce the conceptual framework*. The study's problem statement provides a reference for constructing the conceptual framework and is set out in Figure 2. Each chapter contains a conceptual framework constructed using the guidelines set out by Van der Waldt (2020).

Figure 2

A conceptual framework of NSBL with key themes



9. Research Design

The research design should logically follow the research problem and include the guidelines to address the problem. In this instance, the research problem and aims were best answered by using qualitative tools, the compatibility of which is supported by (Mouton & Babbie, 2001).

9.1 Research approach

Given the emerging nature of the NSBL topic, an exploratory qualitative research design was used based on a critical realist paradigm (Bhaskar, 2008; Caelli, Ray, & Mill, 2003; O'Neil & Koekemoer, 2016). An exploratory qualitative design is a basic qualitative approach that allows participants to describe the content of a particular experience or real-world problem by offering opinions, beliefs, feelings, and perspectives (Percy, Kostere & Kostere, 2015). This exploratory research included literature reviews, in-depth interviews, a Delphi-study and a single case analysis. The researcher used QRS NVivo 11 to look for patterns from which the themes emerged.

In addition, a translational research approach was required to translate and link neuroscience research results with leadership theory and practice (Loewenstein, Rick, & Cohen, 2008). Healy and Hodgkinson (2014) illustrated that translational research is acceptable for using basic neuroscientific insights to enrich organisational behaviour while utilising social scientific research methods that are more familiar to organisational researchers. It also seems possible to adopt the translational research methods by making use of mixed, multi-level methods to transfer discoveries from root sciences to new applications in a way that fits the demands of the domain of application (Loewenstein et al., 2008; Sharp, Monterosso, & Montague, 2012 as cited in Healey & Hodgkinson, 2014).

This research study used insights from neuroscience research by including theoretical frameworks of applied neuroscience like the Social Cognitive Neuroscience Framework (Ochsner and Lieberman, 2001) and the Neuropsychotherpay model (Grawe, 2007; Rossouw, 2014) to translate neuroscientific insights to the domain of leadership behaviour.

Demonstrating rigour through a process of thematic analysis

The researcher used theoretical thematic analysis (Percy et al., 2015) to analyse the data. Theoretical thematic analysis is driven by theory, and the pre-determined themes are usually located in the research question. Thus, the research question will have identified concepts from theories related to the topic under investigation. The data collected was analysed individually, and patterns that emerged from the data were organised under the appropriate pre-existing themes, keeping in mind that new patterns and themes could emerge from the data during the data analysis process (Percy et al., 2015).

9.2 Ethical Conduct

According to Kerlinger and Lee (2000), the ethics of human science research relate to what is correct and what is incorrect in the conduct of the study. More specifically, this includes issues like voluntary participation, informed consent, confidentiality, anonymity, data storage, and dissemination of results and feedback. These issues were incorporated into the research across all three projects.

Participation in the research was voluntary, and participants were truthfully and carefully informed about the nature of the study. To demonstrate the researcher's duty of care and commitment to ethical considerations, a PhD fact sheet was provided to all prospective participants, and research consent forms were reviewed and signed by each of them. The researcher signed and submitted all necessary documents as required by the Ethics Committee of Canterbury Christ Church University (CCCU).

9.3 Strategies employed to ensure quality and rigour of research.

Lincoln and Guba's (1986) criteria for qualitative studies were applied to ensure that credible interpretations of the findings were produced. These criteria included reporting on credibility, transferability, dependability, and confirmability and are discussed in the various research chapters.

9.4 Operationalising the conceptual framework: Stages of the research journey.

This thesis offers six chapters: this current chapter (Chapter One), four unique evidenced-based research chapters (Chapters Two to Five), and a closing reflective chapter (Chapter Six). Each chapter contains an introductory abstract, its own reference list and appendices. By design, this research portfolio provides an integrated study of NSBL behaviour, merging practice, research, and implications for future research and professional practice.

The four major pieces of research and the reflective chapter are delineated in the following sections. See also Appendix A, which sets out the portfolio of work, the research questions, and the research design. The stages of the research, as captured in the chapters, are set out in Figure 3.

9.4.1 Chapter Two

Chapter Two contains an integrative review of the literature and provides a theoretical basis or platform to build an understanding of the definitions, frameworks, models and theories involved in the field of NSBL. This chapter gave a starting point and scoping exercise to facilitate an understanding of the research problem.

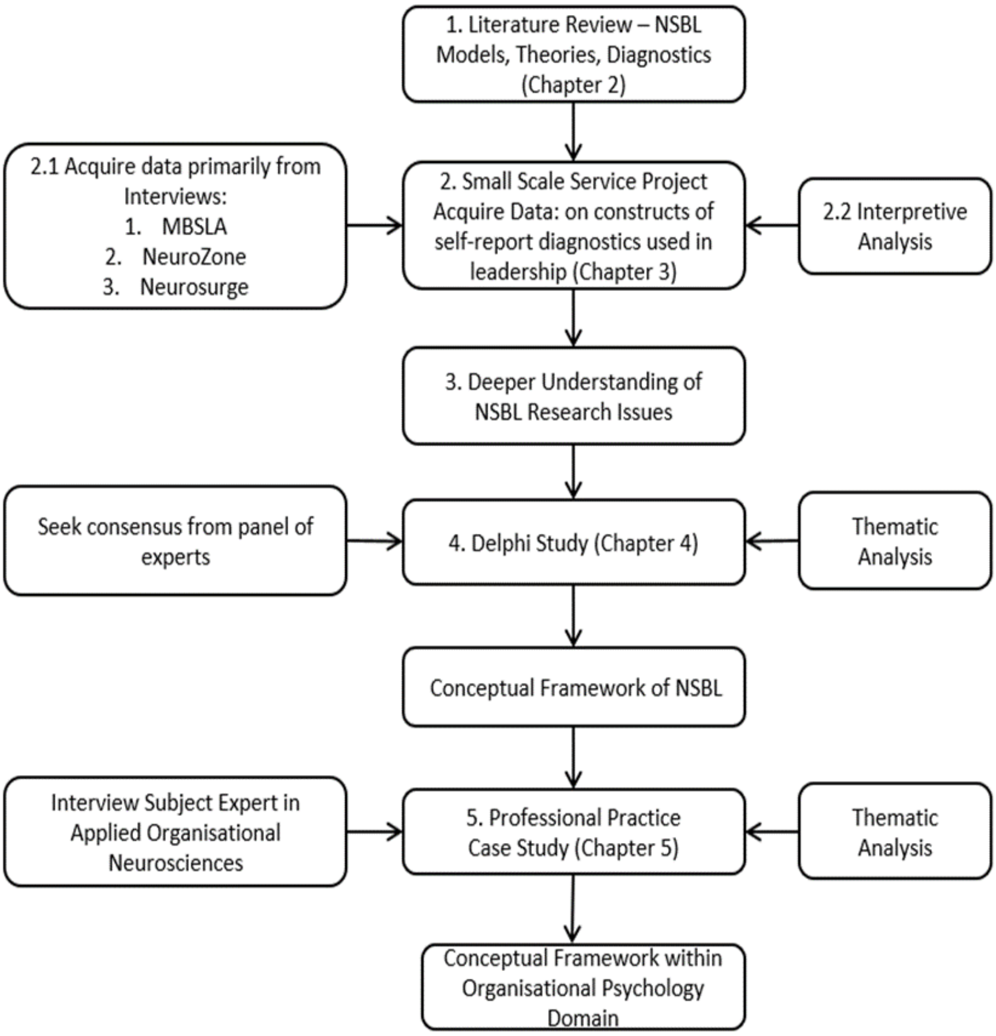
9.4.2 Chapter Three

Chapter Three details a small-scale research project that focuses on neuroscience-based self-report diagnostics used in leadership development in organisations. It was evident from this project that there are limited neuroscience-based self-report diagnostics used in formal organisations at management and leadership levels.

Semi-structured, in-depth interviews were conducted with neuroscientists who have employed neuroscience-based diagnostics in leadership development within a corporate context. The research questions focused on the conceptual underpinnings of a neuroscience-based approach, the constructs measured in the diagnostics, and how they relate to neuroscience-based leadership behaviour. A qualitative interpretative analysis was used to examine the research data.

Figure 3

Stages of the research by chapter



The study revealed the following neuroscientific conceptual underpinnings relevant to leadership behaviour: social safety is a primary operating principle; conscious thinking and nonconscious processes both drive behaviour; neurotransmitters nature-nurture dynamics influence behaviour; experienced-based neuroplasticity drives change; overlapping networks that enable information processing in the brain and the brain-body as interconnected system. This study was used to facilitate the formulation of an initial consolidation of foundational concepts of NSBL.

9.4.3 Chapter Four

Chapter Four covers the large-scale research project of a qualitative Delphi study. The Delphi study focused on determining a convergence (or divergence) of opinion regarding the definition, foundational concepts, and core behavioural descriptors of NSBL from the perspectives of experienced professionals working with NSBL.

Qualitative interpretative analysis was used in this chapter within a critical-realist paradigm. This large-scale project offered the opportunity to conceptualise, design and implement a research methodology to create new knowledge. The aim was to explore how NSBL is defined, conceptualise NSBL as a new domain of leadership behaviour, and provide core behavioural descriptors of NSBL.

9.4.4 Chapter Five

In Chapter Five, the last piece of formal research adopts a single-case study approach. A case study method's contribution to theory building is particularly useful in areas where existing theoretical and conceptual frameworks are inadequate (Mouton & Marais, 1992), as is the case with NSBL behaviour.

This piece of research examined the view of a best respected and established researcher in organisational psychology. The participant's experience in researching and practising applied organisational neuroscience is used to produce this research demonstrating how NP theory can be assimilated into leadership behaviour, thereby contributing to conceptualising NSBL.

The few available organisational neuroscience research studies use neuroscientific methods to study organisational phenomena. However, applying neuroscientific findings within organisational settings without formally conducting neuroscientific methods has not been emphasised. This study was vital to fully understand aspects of NSBL within the domain of NP and how to apply theory adaptation to enhance the body of knowledge of applied organisational neuroscience.

9.4.5 Chapter Six

Lastly, Chapter Six offers a consolidated coverage that reviews all four pieces of work. It is also a critical reflective account that looks back on the learnings from all four pieces of work, describing and uncovering the insights gained. An interpretive conceptual framework of NSBL, specifically within formal organisations, is proposed to inform future practice and research. Here, the importance of the research findings is demonstrated from a practical viewpoint for those supporting the use of a neuroscientific lens in improving leadership behaviour. This chapter also anticipates how the proposed NSBL framework can inform future practice and research.

10. Definition of Terms

Table 1

Definition of terms

Term	Definition
Applied Organisational Neuroscience (AONS)	AONS is an emergent field with the chief aim to integrate and apply neuroscientific research results to the study of organisational phenomena and to enable optimal human functioning (Becker, Cropanzano, & Sanfey, 2011; Ashkanasy, Becker, & Waldman, 2014; Geldenhuys, 2020).
Core Behaviours	Core behaviours are internally coordinated responses (actions or inactions) of entire living organisms (individuals or groups) to internal and/or external stimuli, excluding responses that are more easily understood as developmental changes (Levitis et al., 2009; p. 103 cited in Banks et al. 2021). In the context of this study, and as identified by subject experts, a leader's most important emerging behaviour is to facilitate the achievement of relationship-oriented and task-oriented goals driven by basic psychological needs.
Conceptual framework	A mental and visual map of the research which combines reputable theoretical and empirical work found in the literature with the research question, methods and findings of the current study (Ravitch & Riggan, 2016; van der Waldt, 2020).
Leadership behaviour	The observable actions taken by a leader to influence and enable individual and group efforts to achieve shared objectives. Leadership does not have to be tied to a position of authority. It can be shown by anyone who supports, guides, and connects co-workers and changes co-workers' opinions or approaches on work efforts (Yukl, 2012).
Neuropsychotherapy (NP)	Neuropsychotherapy focuses on the fulfilment of employees' emotional needs at work. The four basic human needs – self-esteem, control and orientation, attachment, and pleasure-seeking – are represented in the human brain in different large-scale networks (Rossouw, 2014; Ghadiri, Habermacher, & Peters, 2013).
Neuroscience	The study of the form and function of the brain and its link to behaviour. It is mainly categorised as a multidisciplinary science in close liaison with other fields (Society for Neuroscience, 2018).
Neuroscience-based leadership (NSBL)	Broadly put, NSBL explores the neural basis of leadership and management practices, aiming to successfully bring about the interface between the tools of various neuroscience fields like social-cognitive and affective neuroscience and topics, constructs and theories from organisational and leadership sciences (Waldman, Balthazard, & Peterson, 2011).
Organisational neuroscience (ONS)	An emerging research domain within organisational psychology that integrates organisational behaviour with neuroscience research.
Social-cognitive neuroscience	Social-cognitive neuroscience is an emerging interdisciplinary field of research studying the processes in the human brain that allow people to understand others, understand themselves, and navigate the social world effectively (Ochsner & Lieberman, 2001, p. 717).
Synthesis	The blending of others' experimental, observational, and theoretical work to progress science (Gardner & Moran, 2006).

11. Limitations

In this exploratory qualitative study, the points below are acknowledged as the most pertinent limitations:

- As an exploratory qualitative design, the project does not provide statistical analysis or measure a causal relationship.
- The sample sizes were small to gain in-depth perspectives, specifically in the expert interviews conducted in Chapter Three and Chapter Five.
- Exploratory Qualitative research is open to the researcher's bias, where the researcher is not considered to interpret the data impartially but rather provides a personal interpretation.
- The reliability of participants' recall of specific NSBL experiences with leaders is a further limiting factor.

These limitations align with some of the most prominent criticisms against neuroscience as a lens for understanding human behaviour in organisational settings. The most noteworthy is that NSBL studies are premature in methodology, many imprecise theoretical statements are used in the field, ethical concerns exist in using neuroscience as a theoretical lens, and neuroscience studies are too conceptual and of limited practical use in formal organisations.

This research is an exploratory attempt towards conceptualising this new field of NSBL. The contribution of this study is broad in that it offers a working definition of neuroscience-based leadership and an interdisciplinary conceptual framework on NSBL behaviour to guide practitioners and further research.

Taken together, this study argues for increased training and education on the neuroscientific approach, specifically in using neuroscience as an interpretive lens or designing leadership development interventions. Specifically, providing education on the neuroscientific principles and language in "use" to enhance the explanatory power of concepts in leadership and organisational behaviour.

12. Chapter Summary

This chapter presented the background and rationale for this academic research portfolio into NSBL behaviour.

The research problem refers to the conceptualisation of neuroscience-based Leadership behaviour within the context of formal organisations. The envisaged outcome is an interpretive conceptual framework that integrates concepts from leadership behaviour and relevant neuroscientific theories into one model relevant to leadership behaviour.

The conceptual model for the research was provided, including factors that will aid in conceptualising NSBL, including definitions, underpinning theories and concepts and core behaviour explanations.

Related research questions and aims were stated, and a methodology for answering the problems and aims was outlined. This included discussing how the research paradigm directed a suitable design to guide the study and reference the methods used to gather and interpret results. This study used qualitative in-depth interviews and a Delphi study to obtain evidence-based descriptions through thematic analysis to provide new insights into conceptualising NSBL behaviour. The chapter concluded with a thesis layout and discussed a chapter demarcation.

Each chapter will be introduced with an abstract section that includes the background, approach, research methods, conclusion, and keywords.

In Chapter Two, the literature is reviewed to answer the overarching research questions.

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Appendices

Appendix A: An overview of the thesis portfolio

	Chapter Two: Critical review of literature	Chapter Three: Small-scale research project	Chapter Four: Applied Research Project	Chapter Five: Report of professional practice	Chapter Six: Reflective account
Aim	The aim of this literature review is to delineate neuroscience-based leadership, provide a comparative synopsis of different theories, and present a synthesis of the construct of neuroscience-based leadership grounded in the current body of knowledge	1.To review the relevant neuroscience-based diagnostics or psychometrics used in leadership development, the constructs of these measures, and the neuroscientific foundational concepts that underpin these diagnostics.	1.To articulate a working definition of neuro-science-based leadership. 2.To identify and describe neuroscience concepts that are used in the application of neuroscience-based leadership behaviour development. 3.To identify and refine core neuroscience-based leadership behaviours as portrayed beyond existing literature but as viewed by experienced professionals in the field of organisational neuroscience, with specific reference to leadership in formal organisations. 4. Theoretical framework to visually illustrate how concepts and core behaviours interconnect.	This research seeks to: 1.illuminate how applied organisational neuroscience is defined and to 2.propose an initial, interpretive framework of NSBL using NP theory.	Provide an overarching synthesis and commentary of the learning journey that culminates in a theoretical framework to visually illustrate how concepts and core behaviours interconnect.

	Chapter Two: Critical review of literature	Chapter Three: Small-scale research project	Chapter Four: Applied Research Project	Chapter Five: Report of professional practice	Chapter Six: Reflective account
Research questions	How is NSBL conceptualised in the literature – as captured in evidenced-based research?	1.What core neuroscientific concepts underpin constructs measured in self-report brain diagnostics used in leadership development? 2.What is the relevance of applying a neuroscience-based approach (neuroscience self-report diagnostic constructs and underpinning core concepts) for leadership behaviour in formal organisations?	1.What is a working definition of neuroscience-based leadership? 2.What are key neuroscience concepts that underpin neuroscience-based leadership behaviour? 3.What keywords or phrases describe the behaviours that differentiate neuroscience-based leadership from other approaches to leadership?	1.How is AONS defined? 2.How can NP theory inform the conceptualisation of NSBL and offer an interpretive framework of NSBL behaviour? 3. How can NP theory inform leadership behaviour in formal organisations?	N/A
Unit of analysis		Interview subject experts.	Consensus-seeking on behavioural anchors.	Open-ended interview (single-case study).	
Number of participants	N/A	3	33	1	N/A
Method and analysis	Integrative literature review to produce a conceptual mental map and key themes from the literature.	A Qualitative Interpretive Study Theoretical thematic analysis.	A Delphi study with thematic analysis.	A Qualitative Descriptive Case Study Theoretical thematic analysis.	N/A
Data collection	Research articles, books, and other published texts.	In-depth, semi-structured interviews.	Delphi study (three rounds of consensus-seeking).	In-depth, semi-structured interview.	N/A

Chapter Two: Literature Review

Title: Conceptualising neuroscience-based leadership behaviour

"He who loves practice without theory is like the sailor who boards ship without a rudder and compass and never knows where he may cast" Leonardo da Vinci.

Abstract

Background: This study aims to articulate the phenomenon of neuroscience-based Leadership (NSBL) behaviour. As technology evolves, neuroscience increasingly provides explanatory findings grounded in replicable experimental evidence of how the brain works, thereby contributing to an early understanding of the underlying neuro-mechanisms of human behaviour. The literature review was guided by questions relating to delineating the field of NSBL, articulating underpinning neuroscientific concepts, and critical themes in neuroscience-based leadership behaviour.

Approach: An integrative literature review approach was followed with preliminary conceptualisation as a key focus, as NSBL is a newly emerging topic.

Data sources: Three criteria were identified for inclusion of sources in the literature review: (1) all relevant papers published in the last ten years in peer-reviewed journals; (2) books grounded in theoretical research by academics that were mentioned in the peer-reviewed publications; and (3) dissertations in the field of brain-based leadership. Electronic searches were conducted on APA PsycNet, SAGE Journal, JSTOR databases and Google Scholar between July 2017 and January 2022. Search terms were entered and combined to identify the relevant literature.

Review methods: Multiple databases were searched. Titles and abstracts were then reviewed in line with the research title. Exclusion and inclusion criteria were applied. Data quality was assessed, and thematic analysis was used in alignment with the overarching research questions.

Conclusion: The literature reviewed suggests that neuroscience-based leadership is an emerging field and is in the theory-building stage, accompanied by polarised scholarly opinions. Currently, practitioners in applied organisational neuroscience are mainly working in the absence of reliable theoretical underpinnings, which may detract from the validity and credibility of this new field. Limitations of this review include the lack of peer-reviewed publications on neuroscience-based leadership, which is a restrictive factor for an evidence-based approach. This lack of evidence relates to the emergent nature of the field and the complexity of assembling a review in an interdisciplinary field.

Key words: neuroscience-based Leadership (NSBL), leadership behaviour, neuroscience.

1. Introduction

The focus of the literature review was to investigate and articulate NSBL, provide a comparative synopsis of different theories, and present a synthesis of the construct of NSBL grounded in the current domain of study.

2. The Literature Search

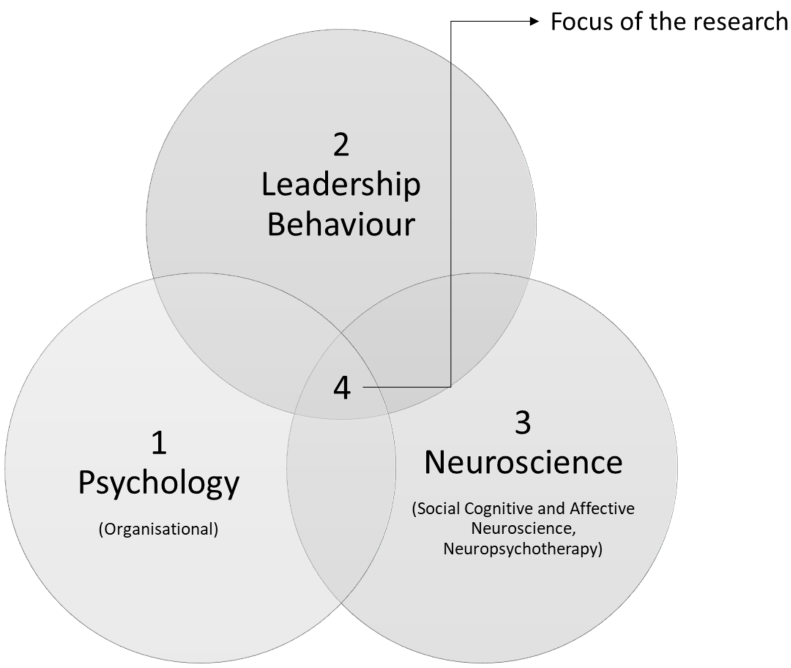
2.1 Plan and method

This study aimed to evaluate and synthesise the literature to allow new frameworks and perspectives on NSBL to emerge. Therefore, an integrative literature review approach was adopted (Snyder, 2019). An integrative literature review can be done for emerging topics where the objective is to generate initial conceptualisations and theoretical models(Torraco, 2005, as cited in Snyder, 2019). This type of review often demands a "more creative collection of data, as the purpose is usually not to cover all articles ever published on the topic but rather to combine perspectives and insights from different fields or research traditions" (Snyder, 2019, p. 336)

The literature was reviewed to find relevant studies on how neuroscience-based leadership behaviour is articulated. This integrative literature review was limited to the "intersection" of the three research areas, namely Leadership Behaviour, Organisational Psychology and Neuroscience, to delineate the area of investigation or the research focus shown in Figure 1 below.

Figure 1

The focus of the research: NSBL behaviour



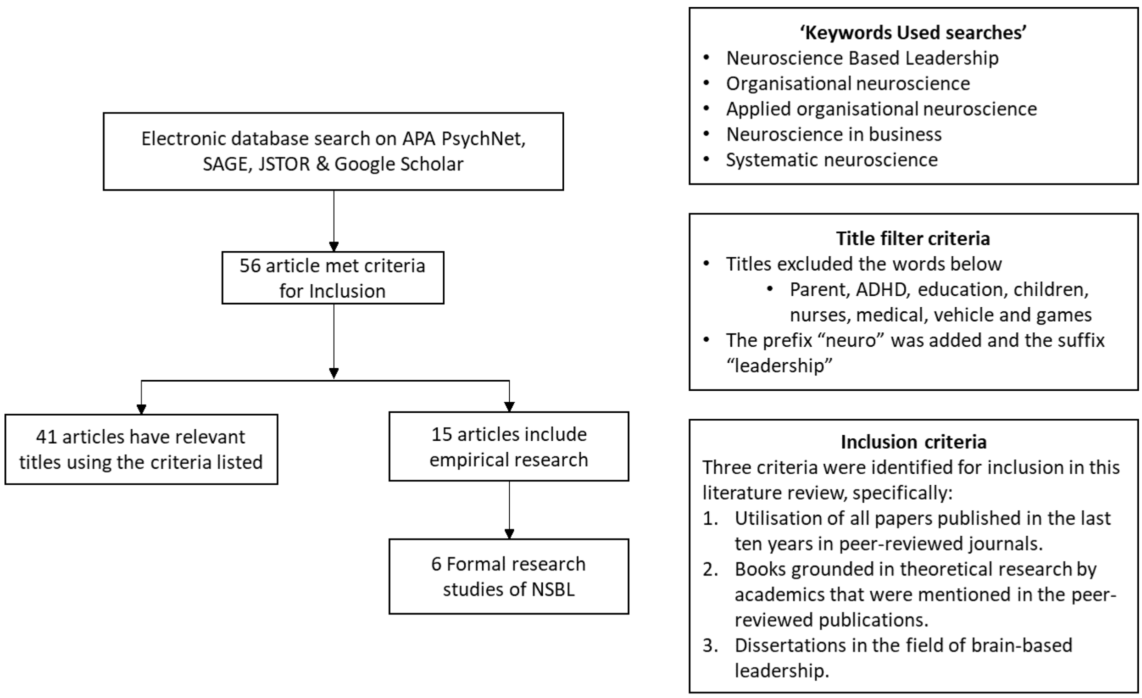
The literature review is intended to be an evidence-based contribution to NSBL; therefore, the measures for inclusion in the literature review are significant. Three criteria were identified for the inclusion of sources in this literature review: (1) all relevant papers published in the last ten years in peer-reviewed journals; (2) books grounded in theoretical research and that were mentioned in the peer-reviewed articles; (3) dissertations in the field of brain-based leadership.

It is envisioned that this study will contribute toward a theoretical, scientifically valid, and application-based understanding of the construct of neuroscience-based leadership. A flowchart of the literature search process is included in Figure 2.

Search string development commenced with identifying keywords, concepts, and statements focal to the phenomenon of NSBL. Electronic searches were conducted on APA PsycNet, SAGE Journal, JSTOR databases and Google Scholar between July 2017 and January 2018. Search terms were entered and combined to identify the relevant literature. The search terms included "neuroscience-based leadership" OR "key behaviours" OR "leadership behavioural markers" OR "neuroscience" OR "leadership" OR "neuroleadership." Each of these terms was searched individually and then combined with the others to create different permutations and reveal more potential resources.

Figure 2

The literature searches.



Journal titles were screened at the start, and abstracts were read to determine relevance. Reference lists of relevant articles were then examined to expand the literature review. Initially, searches were narrowed to peer-reviewed, empirical journal articles, and then dissertations and books were included. Articles written in English and published within the previous ten years (2008–2018) were included. Studies were excluded if they did not focus on organisational settings.

Fifty-six sources met the benchmark criteria for inclusion; 41 papers focused on delineating the field of organisational neuroscience or NSBL; 14 papers included empirical research related to the field of NSBL. These studies are reviewed in this thesis. This was the saturation point, as no further relevant articles came to light. Additional peer-reviewed articles were found in the reference lists of these articles.

Neuroscience studies use the term "marker" instead of "anchor" or "core behaviour". A search was conducted using the terms "neuro-structural markers", "neurochemical markers", "neurodevelopmental indicators", and "neural correlates". A search was also done to review literature that could assist in defining the term "behavioural anchor/key behaviours" as it is researched in neuroscience.

Firstly, a search on "neurochemical markers excluding nursing-doctors-medicine" on Google Scholar yielded 20 results. However, none of them met the selection criteria. Secondly, I searched "neurodevelopmental indicators" on Google Scholar, JSTOR and SAGE, which gave 64 results, none of which met the selection criteria. Thirdly, a search was conducted on "neuro-structural markers" and yielded six results, none of which were relevant. Lastly, a search on "neural correlates" resulted in two articles. The reference lists of these articles were then used to delve into the literature further, which yielded valuable results.

Neuroscience self-report diagnostics are also used in leadership development in formal organisations to assess brain capacities and supporting behaviours. Electronic searches were conducted on the CCCU Library portal between July 2023 and August 2023. Search terms were entered and combined to identify the relevant literature. The search terms included "neuroscience-based self-report diagnostics" OR "neuroscience-based self-report instruments.

Each of these terms was searched individually and then combined with the others to create different permutations and reveal more potential resources. Journal titles were screened initially, and abstracts were read to determine relevance. Hundred and three sources met the benchmark criteria for inclusion. The search was narrowed down to "neurosciences, biological psychiatry and Neuropsychiatry" as sort criteria.

The search yielded 63 papers with empirical research on the neuroscience of self-report psychometrics. Out of these, only one article had relevance to the field of NSBL, namely, "The Relationship between Emotional Intelligence and Cool and Hot Cognitive Processes: A Systematic Review" by (Gutiérrez-Cobo, Cabello, & Fernández-Berrocal, 2016). The reference list of the relevant article was used to expand the literature review.

Additionally, psychometric test providers were contacted using a snowball approach to gain information on the self-report brain diagnostics used in formal organisations.

2.2 Article Details

Articles were selected based on their strength of evidence for informing a neuroscience-based approach to leadership behaviour. Articles weighted as high-quality were used first to construct the major argument and in the synthesis of the literature. Criteria for high-quality articles were an evidenced-based article, peer-reviewed and relevant to leadership behaviour, organisational neuroscience, or neuroscience in leadership.

The peer-reviewed articles were clustered into five categories: empirical and theoretical review articles relating to leadership behaviour, empirical articles relating to Neuroscientific studies in leadership, theoretical review articles on organisational neuroscience, theory adaptation articles relating to applied organisational neuroscience and articles on neuroscience-based self-report diagnostics. Table 1 below provides an overview of the final number of key articles included in this review of NSBL. Also, see **Appendix A** for a summary tabulation of these peer-reviewed articles.

Table 1

The number of Peer-reviewed articles

	Focus of Articles	**Number**
1.	Peer-reviewed empirical and theoretical review articles relating to leadership behaviour	7
2.	Peer-reviewed empirical articles relating to Neuroscientific studies in leadership.	14
3.	Theoretical review articles relating to organisational neuroscience or neuroscience-informed leadership conceptualisations	15
4.	Peer-reviewed theory adaptation articles relating to applied organisational neuroscience.	4
5.	Articles relating to neuroscience-based self-report brain diagnostics	5
	Total number of articles:	45

As a result of the specialised and multifaceted field of neuroscience, books authored by academics were included as references. This is aligned with the purpose of an integrative literature review, which is not to cover all articles ever published on the topic of research but rather to combine views from different sources, fields, or research traditions (Snyder, 2019).

In the leadership domain, Bass and Bass (2009, p. 1167) suggested that "those in academia often disdain mainstream books that have not been peer-reviewed". They argued that these popular books are nevertheless read by organisational practitioners and thus influence behaviour and contribute to the body of knowledge. The academic books were scrutinised with diligence regarding their relevance for inclusion in this formal research. In addition, published PhD dissertations were reviewed to take stock of efforts towards conceptualising neuroscience-based leadership. (See Appendix B for the literature search on PhD dissertations and see Appendix C for additional resources (PhD dissertations and relevant academic books on organisational neuroscience and leadership behaviour.

3. Findings and key themes in the literature

This section outlines the main themes that arose from the integrative literature review. (Snyder, 2019). To ensure that the research is not based on flawed assumptions, the researcher followed the guidelines in Snyder (2019) on how to conduct an integrative review. This entailed reading and re-reading the empirical and theoretical review articles, books and dissertations, as these texts could only be compared once a good understanding of the content was grasped.

Inductive and deductive qualitative thematic analysis was applied, guided by the procedures set out by Boyatzis 1998 (as cited in Klenke, 2008) as well as Snyder (2019). Klenke (2008) proposed that a theme is a pattern found in the information that, at a minimum, describes and organises the possible observations or, at a maximum, interprets aspects of the phenomenon. The thematic analysis involved pinning down, probing and recording patterns in the data (or "themes") that emerged when reading and re-reading the articles and other published texts.

Five main themes emerged from the article reviews following this thematic analysis process. It was evident that the aims of the articles were to (1) Review Leadership Behaviour theory, (2) Delineate the field of organisational neuroscience and neuroscience-based leadership, (3) Explore theoretical domains relevant to NSBL, (4) Conceptualising NSBL behaviour: What do NSBL "do" and "don't do" (5) Self-report brain diagnostics used in NSBL: foundational concepts and constructs measured.

3.1 Leadership Behaviour Theory

3.1.1 Article Findings

The articles selected included seven relevant articles that were peer-reviewed. Four empirical studies and three theoretical review articles relating to leadership behaviour are set out in Table 1 and detailed in Appendix A. These articles provided evidence of models of leadership behaviour from the literature. These models were selected as they provide a scientific foundation or domain theory of leadership behaviour.

3.1.2 Discussion

The importance of clarifying leadership behaviour was confirmed in a meta-study on leadership constructs by Dinh et al. (2014). This study entailed an extensive qualitative review of leadership theory research published in the top ten leadership journals between 2000 and 2012. Of importance to the current literature review is that Dinh et al. (2014) also included biological approaches in categorising leadership theories. This thematic line of research included articles that used genetic, biological or neurological data.

Although Dinh et al. (2014) caution against falsely assuming that neurological data can explain all behaviour, they nevertheless encourage the importance of recognising "the complexity of human interaction in a social context and the value that leveraging the advances in cognitive neuroscience can bring to the study of leadership" (Dinh et al., 2014, p. 42). Based on peer-reviewed publications, these authors found that biological approaches to leadership formed part of "other nascent approaches including Emotions and leadership, Toxic leadership, E-leadership, and Entrepreneurial Leadership" (Dinh et al.,2014, p. 40).

Most of the behavioural taxonomies described by Dinh et al. (2014) and used in these leadership theories have limitations associated with questionnaire and interview studies. As they succinctly put it, "We know much less about how leaders make organisations effective than how leaders are perceived." (Dinh et al., 2014, p. 37). This deficiency in research data on how leaders establish effective organisations stems from "focusing on leaders and their qualities, rather than on how they change processes in other individuals, in groups, or in organisations" (Dinh et al., 2014, p. 37). While somewhat dated, the concern raised by these authors regarding “how leaders change processes" can serve to enrich contemporary research into leadership behaviour.

In an empirical study on "Effective Leadership Behaviour", one of the foremost academics on leadership theory, Gary Yukl (2012), described the essence of leadership behaviour as "influencing and facilitating individual and collective efforts to accomplish shared objectives" (Yukl, 2012, p. 242). These two distinct leadership behavioural roles, the task leader and the socio-emotional leader, have been extensively documented in the leadership literature by Yukl (2012) and Dinh (2014).

Yukl (2012) showed that leadership behaviour can be clustered into a hierarchical taxonomy with four meta-categories and 15 component behaviours representing effective leadership behaviour. Yukl also initially suggested organising leadership theory not only on the type of theory (like behavioural theory or trait theory) but also on the level of analysis and proposed four categories: intraindividual, dyadic, group, and organisational processes.

Another workable evidence-based taxonomy of leadership behaviour was provided by Yukl and Michel (2014). These authors integrated findings from five decades of leadership behaviour research into a parsimonious and meaningful conceptual framework with three meta-categories (task, relations, and change behaviour). This taxonomy has more peer-reviewed scientific support than alternative models (Dinh et al., 2014; Yukl, 2012).

In studying organisational behaviour (Osborn, Hunt, Uhl-Bien, & Schermerhorn, 2010) also recorded leadership behaviour as focusing on the task, relationships and change. However, questions were raised about its suitability in complex adaptive environments. An empirical meta-analysis by Behrendt, Matz, and Goritz (2017) indicated an integrated model of leadership behaviour (IMoLB). The (IMoLB) model is parsimonious and is built on well-proven psychological propositions and theories. These authors added to Yukl's classification (2012). They proposed three task-focused behavioural sets, "enhancing understanding, strengthening motivation and facilitating implementation," and three relation-oriented behavioural sets, "fostering coordination, promoting cooperation and activating resources" (Behrendt et al., 2017, p. 229).

Task-oriented behaviours focus on achieving shared objectives, and relation-focused behaviours support this process by enhancing the team's and its members' coordinated engagement. See Figure 3. The IMoLB model advances leadership behaviour theory development by (1) amalgamating current classification systems and taxonomies, (2) refining behavioural constructs and descriptors of leadership behaviour, (3) stipulating the precise correlations between those constructs and (4) prompting novel propositions and hypothesis.

Another meta-model on leadership competencies and related behaviour is the domain model of Leadership (Hogan & Kaiser, 2005, p. 173), which identifies four broad domains: "(a) intrapersonal focus (regulating one's emotions and easily accommodating to authority), (b) interpersonal focus (building and maintaining relationships), (c) business focus (planning, budgeting, coordinating, and monitoring business activities), and (d) leadership focus (building and motivating diverse high-performance teams)".

According to Hogan & Kaiser (2005), there is no one best style of leadership. Instead, a leader's effectiveness is based on the situation. The domain model is broad insofar as most leadership models can be arranged in terms of these four domains. It provides a taxonomy of competencies and suitable measures of the critical elements in these domains. The domain model is also developmental: "Intrapersonal skills develop first, possibly in the pre-teen years; interpersonal skills develop next, probably during the teenage years; business skills develop when a person enters the workforce; leadership skills develop last." (Hogan & Kaiser, 2005, p. 173).

Thirdly, the domain model offers a "hierarchy of cumulative trainability", with intrapersonal skills being hard to train and leadership skills being the simplest to train (Hogan & Kaiser, 2005). There is meta-analytic evidence for the domain model (Bono &

Judge, 2004; Ones, Viswesvaran & Schmidt, 1993). This model is still used extensively in organisational psychology (Berry, 2021; Hogan Assessments, 2020). These meta-categories resemble what Fiske et al. (2007) found reliably to be the universal dimensions of social cognition, i.e., Warmth and Intellectual competence (Fiske, Cuddy, & Glick, 2007).

Contemporary research on leadership behaviour in formal organisations shows that organisations are pursuing hyper-adaptability and contingency amidst increasing global complexities (Contreras, Baykal, & Abid, 2020; Uhl-Bien & Arena, 2017). According to Spisak, Nicholson, & van Vugt (2011, p. 2), leadership behaviour is an adaptation to manage challenges associated with “exploration vs exploitation and competition vs cooperation”. According to these authors, dealing with distinct adaptability -relevant coordination problems over time, has selected for contingent leadership prototypes to aid in the swift endorsement of appropriate context-specific leaders.

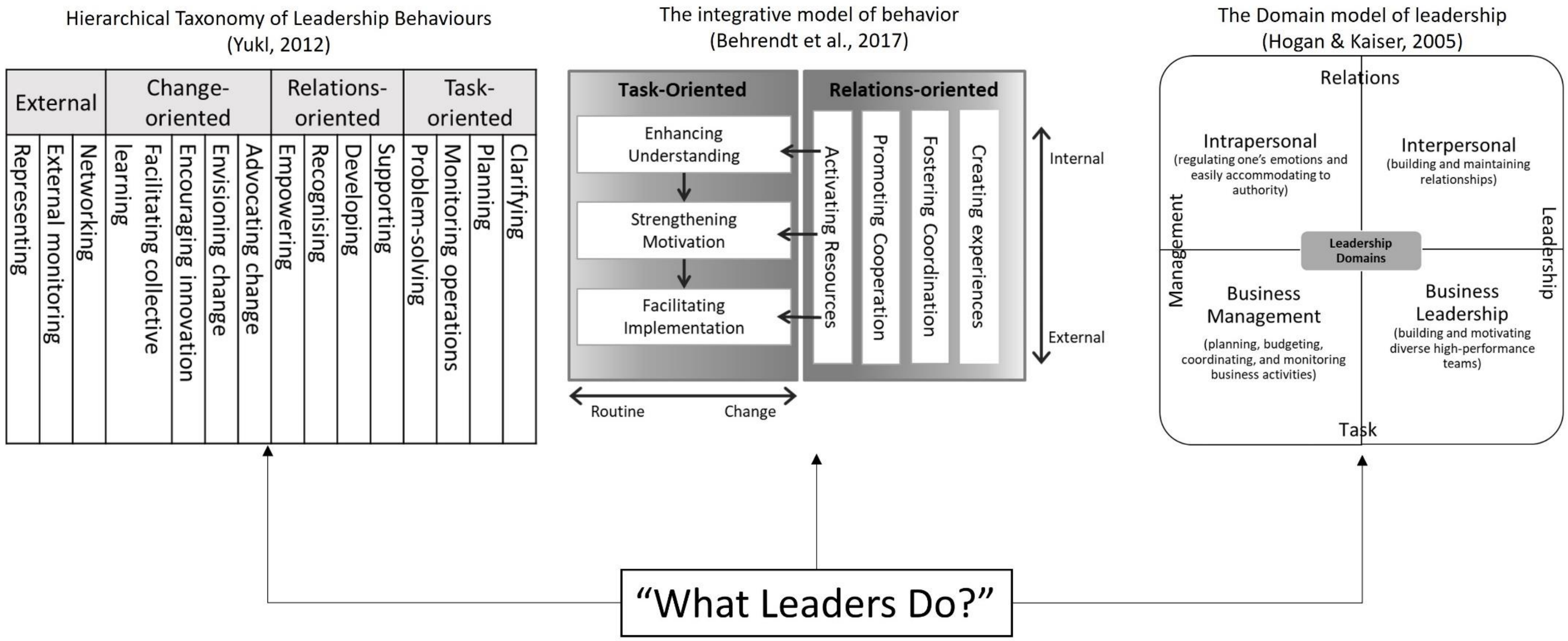
Recent studies on the role of leadership and its distinct behaviours to improve organisational functioning in virtual and remote working environments draw on the concept of contingent leadership effectiveness (Contreras et al., 2020; Torre and Sarti, 2020). According to Torre and Sarti (2020, p. 5), "A relationship-oriented leader and a task-oriented leader can offer an interesting perspective of analysis". These authors suggested that the task/relationship model (Fiedler, 1964) be adapted to virtual leadership and be described as a "tasks-technology orientation, while the socio-relational orientation maintains its relevance aimed at promoting mutual trust" (Torre and Sarti, 2020, p. 5).

Contingency approaches to leadership recognise that we cannot describe exactly what leaders do because it will always vary depending on the situation, and as Veldsman & Johnson (2016) suggest, there is much to be gained for the field of leadership development by following a contingent approach. Overall, many studies support the task vs relations-oriented model and are synthesised in Figure 3 - The Theoretical Models of Leadership Behaviour.

To conclude, the definition of leadership behaviour is wide-ranging and constantly debated in the literature (Bass & Bass, 2009). De Haan (2016, p. 506) believes that as a construct, leadership is "deficient in precision, accuracy, conciseness, and obscure." P1 It also appears that leadership behaviour research is fraught with conceptual difficulties as it is studied from a variety of content approaches and can benefit from further clarification of the variety of approaches rather than the uniformity. To conceptualise NSBL it would seem best to start at the individual level, focusing on the leader independent of followers and the organisational context.

Figure 3

A synthesis of contemporary theoretical models on Leadership Behaviour (Adapted from (Behrendt et al., 2017; Day & Antonakis, 2013; Hogan & Kaiser, 2005; Yukl (2012)



Although the models mentioned above include the literature on leadership behaviour as a domain, they are insufficient from a neuroscience perspective. To comprehensively describe neuroscience-based leadership, the literature on the apparent connection between theoretical neuroscientific processes and leadership phenomena was reviewed to move this emerging field beyond the anecdotal to an evidenced-based body of knowledge.

The following section reviews the literature on peer-reviewed neuroscientific studies in leadership behaviour.

3.2 Neuroscience theories relevant to leadership behaviour

3.2.1 Article Findings

In total, fifteen articles focused on neuroscientific theories and conceptualisations relating to organisational and leadership behaviour. This included peer-reviewed publications on NSBL and a pivotal set of relevant articles: a review of the field by Lee, Senior, and Butler (2012); a synopsis of the field of social-cognitive neuroscience and Leadership by Waldman, Balthazard, and Peterson (2011b); a discussion and review of organisational neuroscience by Becker, Cropanzano, and Sanfey (2011); a review of neuroscience and organisational behaviour by Ashkanasy, Becker, and Waldman (2014); and scrutiny of the field of organisational neuroscience in leadership research by Lindebaum and Zundel (2013). See Appendix A for a detailed breakdown of all 15 articles.

3.2.2 Discussion

The emerging interdisciplinary field of NSBL aims to define the neural basis of leadership and management phenomena. The challenge with applying neuroscience or brain data to leadership behaviour is that oversimplifying the proclaimed neural basis of leadership behaviour can render the study of anything "neuro" a short-lived movement (Lindebaum & Zundel, 2013). The pitfalls of brain-based approaches are that it is seen by some as a reductionist approach; research findings are often preliminary; a lack of replication studies exists; and research samples are typically too small to generalise findings (Ashkanasy et al., 2014; Lindebaum & Zundel, 2013).

The effective engagement with the field of neuroscience by organisational scholars is advocated by Van Ommen and Van Deventer (2016, p. 573): "We find ourselves amid a proliferation of neuro-centred disciplines, establishing what some call a neuroculture." These authors warn against neo-liberal (i.e., new and faddish) approaches to studying human behaviour, as these approaches lack scientific rigour and replication studies and are driven by populist anecdotal interpretations and broad generalisations.

This thesis aims to mitigate the critique of neuroscience being a faddish approach to leadership behaviour by providing evidence-based exploratory research. The intention is not to argue for a neuroscientific revolution in leadership behaviour studies but to build on current evidence that offers a research agenda to revisit traditional disciplines like psychology and leadership in examining socially complex phenomena like leadership behaviour.

A closer look at this research agenda encompasses a range of approaches, highlighting that neuroscience can adequately inform leadership research and practice. For example, a comprehensive study by Ochsner and Kosslyn (2013, p. 2) referred to "multiple levels of analysis" in which the "combination of both behavioural and brain data allows researchers to converge on theoretical explanations that are robust and malleable and are not tied to a single explicit experimental methodology".

A more transitional view of organisational neuroscience is advocated by Healey and Hodgkinson (2014). They suggest using critical realism as a philosophical stance to research NSBL phenomena to advance organisational neuroscience. Critical realism's view of human behaviour is that it is "embedded in a complex ecology of causal forces. It is seen as realism without reductionism" (Healey & Hodgkinson, 2014, p. 771). In addition, these authors also propose using the term "socially situated cognition (SSC)" as an umbrella term to encapsulate the principles of situatedness, grounding and embodiment" (Healey and Hodgkinson; 2014, p. 786). This socially situated cognition enables the study of NSBL from related theories like Social Cognitive Neuroscience and Neuropsychotherapy. These theoretical approaches are reviewed next.

The *NeuroLeadership Journal*, a publication of the NeuroLeadership Institute first issued in 2008, was also searched for studies about behavioural anchors of NSBL. For example, a NASA case study successfully mapped leadership competencies to the neuroscience frameworks of Ringleb and Rock (2008).

The aim of the research is to conceptualise NSBL. In this quest, the objective is also to successfully bring about the interface between the tools of various neuroscience fields like social-cognitive neuroscience, affective neuroscience, cognitive neuroscience, integrative neuroscience, interpersonal neurobiology and other domains within neuroscience, and themes and theories from leadership science.

The articles reviewed showed two main approaches to leverage neuroscience in organisational and leadership behaviour. (1) Direct neuroscience approaches (using neuroscience methods): social-cognitive neuroscience, organisational neuroscience, and organisational cognitive neuroscience, and (2) Applied neuroscience approaches (using translational approaches): integrative Neuropsychotherapy, Neuroleadership, and neuro-organisational behaviour. This is discussed next.

Relevant theoretical approaches to neuroscience-based leadership

This section reviews the literature on current theoretical approaches and frameworks relating to neuroscience-based leadership. These include:

- Direct neuroscience approaches (using neuroscience methods):
  - the social-cognitive neuroscience;
  - organisational neuroscience; and
  - organisational cognitive neuroscience.
- Applied neuroscience approaches (using translational approaches):
  - neuroleadership;
  - integrative neuropsychotherapy; and
  - neuro-organisational behaviour.

3.2.2.1 Direct Neuroscience Approaches (using Neuroscientific Methods)

Social-Cognitive Neuroscience (SCN)

As a research field, social-cognitive neuroscience studies social phenomena and processes using cognitive neuroscience research tools such as neuroimaging and neuropsychology (Lieberman, 2007). The neuroscientific methods used to study social phenomena include functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and transcranial magnetic stimulation, to name a few (Psychology.iresearchnet.com, 2018).

Lieberman (2007) suggested four broad research areas within social-cognitive neuroscience: understanding others, understanding oneself, regulating oneself, and the processes that occur at the interface of self and others. According to SCN, two core-processing distinctions can be neuro-cognitively identified across all four areas. Firstly, the distinction between automatic versus controlled processes can be disconnected in the neural regions contributing to social cognition.

Secondly, the differentiation between internally focused processes that focus on one's or another's mental interior and externally focused processes that focus on one's or another's visible features and actions is a new distinction in this research field.

Lieberman accentuates that SCN is an equal contributor to understanding the social mind:

> "Social cognitive neuroscience uses the tools of neuroscience to study the mental mechanisms that create, frame, regulate, and respond to our experience of the social world. On its worst days, social cognitive neuroscience is phrenological, cataloguing countless brain regions involved in the vast array of social processes. On its best days, social cognitive neuroscience

> enhances our understanding of the social mind as well as any other method" (Lieberman, 2010, p. 143).

Ochsner and Lieberman (2001) argued that the area of social-cognitive neuroscience might have the most pertinence to the study of leadership phenomena as leadership is fundamentally a social process. This study incorporated SCN as a core theory to elucidate NSBL behaviour, as leadership is fundamentally a social process.

Organisational Neuroscience (ONS)

Organisational neuroscience is a "deliberate and judicious approach to spanning the divide between neuroscience and organisational science and represents a paradigm or interpretive framework that sheds new light on existing problems" (Becker and Cropanzano, 2010, p. 1055).

The primary focus is on the brain's physical foundations and their connection. According to these authors, the three mature areas of neuroscience that have relevance to leadership in formal organisations are:

1. Combating procrastination – goal selection and maintenance.
2. Mirror neurons and group sub-climates – modelling others.
3. How attitude structures resist organisational change – change plasticity.

Organisational Cognitive Neuroscience (OCN)

Organisational cognitive neuroscience (OCN) is the cognitive neuroscientific study of organisational behaviour. OCN is defined as applying neuroscientific methods to analyse and understand human behaviour within applied settings of organisations (at the individual, group, organisational or inter-organisational level). It uses fMRI and electroencephalogram (EEG) technology.

OCN focuses on social processes within the workplace. According to Butler and Senior (2007), leadership cannot be studied only from a social-cognitive neuroscientific stance; it must be studied in an OCN environment.

Despite the interest in organisational neuroscience, formal organisations are far from using neuroimaging techniques to gauge leadership behaviour, as Gazzaniga (2006) indicated:

> "I have to tell you that neuroscience is not the panacea it may appear to be. You won't be able to use brain scanning to help you tell whether your leading R&D scientist has had a genuine eureka moment. Nor will you be able to use a scanner to choose the right CEO to turn your struggling company around. Not next year. Not the year after. Not in our lifetimes" (Gazzaniga, 2006, p. 66).

3.2.2.2 Applied Neuroscience approaches (the application of neuroscience research in the workplace)

Defining Applied Organisational Neuroscience (AONS)

No definition could be tracked for applied organisational neuroscience in the literature. However, the literature review identified several broad definitions of organisational neuroscience.

The most cited definition of organisational neuroscience states that organisational neuroscience is "An approach to spanning the divide between neuroscience and organisational science and represents a paradigm or interpretive framework that sheds new light on existing problems" (Becker, Cropanzano, & Sanfey, 2011, p. 937).

Another definition comes from the field of neuro-organisational behaviour. Neuro-OB also advocates three levels of analysis: (1) neural, (2) cognitive and (3) behavioural. Organisational neuroscience is defined as "the field that integrates the use of neuroscientific methods and techniques to the study of organisational phenomena" (Beugré, 2010).

Passarelli (2015) argues that organisational neuroscience is complementary to organisational behaviour. It offers a multi-level social neuroscience approach relevant to social phenomena in organisational contexts. Even though it is a comparatively new approach in management research, organisational neuroscience is rooted in "social neuroscience", which focuses on integrating social psychology and neuroscience.

Healy and Hodgkinson (2014) did not add a definition of organisational neuroscience. Still, they proposed "socially situated cognition" as a term to capture situatedness and embodiment principles. The authors give a significant role to neurobiology as a primary contributing factor to goal-directed human activity. It forms part of an open organisational system with other social, environmental, and technological sources.

Ward, Volk and Becker (2015, p. 19) reasoned that ON includes three common elements: "(1) the brain level of analysis, (2) the organisational level of analysis and (3) the interactions between brains and organisational phenomena." These authors caution against simplistic endeavours to "pinpoint a narrow location in the brain as a source of cognitive processes."

A shared definition of applied organisational neuroscience (AONS) does not exist and is evolving rather than definitive. Based on the above review, an initial description of AONS is defined as:

> *Applying neuroscientific research results and foundational neuroscientific principles within an organisational context that can be used at individual, team, and organisational levels to understand and enhance human functioning.*

This working definition implies that AONS can enable organisational scholars (including leader-managers) to look at the neurophysiological foundations on which psychological construct draws, in combination with additional social and environmental factors, as suggested by Healy and Hodgkinson (2014).

To conclude, AONS is an emerging field of scholarly discourse that expresses the linkages and effects of brain science on workplace behaviour (Beugré, 2010; Healey and Hodgkinson, 2014; Passarelli, 2016).

Next, applied neuroscience approaches to leadership behaviour are discussed based on the literature reviewed.

Neuroleadership

This emerging interdisciplinary field studies: "the neural basis of leadership and management practices, effectively bringing about the interface between the tools of social-cognitive and affective neuroscience, cognitive neuroscience, integrative neuroscience, neurobiology and other domains within neuroscience, and questions theories from the leadership and management social sciences" (Ringleb & Rock, 2008, p. 1). The key proponents of the neuroleadership field, Ringleb, Rock, and Ancona (2012), adopted the *Be-Know-Do* model of the Leader-to-Leader Institute (2004).

The research aim of this endeavour is to improve leadership effectiveness within organisations by directly considering the physiology of the mind and the brain. The four domains researched in this field include:

- *Decision-making and problem-solving*: This domain encompasses the limits of conscious decision-making and problem-solving, how insight inhibits thinking about the problem, and the neural basis of peak decision-making. The impact of the threat-and-reward state on business decision processes is also explored.

- *Regulating emotions*: This domain focuses on types of emotions; for example, negative emotions are more potent and longer-lasting than positive emotions. Negative emotions reduce cognition, perception, creativity, and collaboration. The impact of affect-labelling and reappraisal on cognitive performance is covered in this domain.

- *Collaboration*: This domain focuses on the social orientation of the brain and the way that social pains and pleasures overlap with brain regions for physical pains and pleasures. The domain also covers the motivational factors of status, certainty, autonomy, relatedness and fairness and their relevance to increasing employee engagement.

- *Facilitating change*: This domain encompasses the neurobiological architecture of emergent change, learning, innovation, habit formation, attention density, and how attention changes the brain (Ringleb & Rock, 2008).

One possible criticism of this approach is that it may be reductionist, as it relies too much on the virtues of individual neuroanatomical components to illuminate leadership and organisational behaviour rather than on sociological or psychological observation and explanation (Lindebaum & Zundel, 2013). Although hierarchical reductionism is flawed, the neuroleadership approach has provided insights into the neuroscientific mechanisms generating behaviour in the workplace.

Neuropsychotherapy (NP)

NSBL, from a neuropsychotherapy approach, focuses on fulfilling employees' emotional needs at work (Rossouw, 2014; Ghadiri et al., 2013). The four basic human needs – self-esteem, control and orientation, attachment, and pleasure – are represented in the human brain in different large-scale networks. These basic human needs must be balanced (and treated equally) for optimum mental functioning, positively impacting the individual and the organisation.

The foundational principles of neuropsychotherapy are anchored in the ground-breaking research on the *Aplysia californica* sea slug by molecular neuroscientist Eric Kandel, which won a Nobel Prize. He transformed the model of contemporary neuroscience from an electrochemical paradigm to decode neural activation to that of the brain as a neural network with unknown potential to be altered (neuroplasticity) at a molecular and cellular level.

Kandel's (1998) pivotal publication, "A New Intellectual Framework for Psychiatry", captured his significant scientific revolution in molecular neuroscience. This engendered changes from the bygone functional approaches to the new dynamic view of the brain. Kandel's work pioneered a new proposition – the link between the brain and the environment, genes as communication agents, the interconnectivity between nature and nurture**,** the link between the brain and the environment the effect of enriched social environments on brain development, and even the role of talking therapies to facilitate changes to the brain (Kandel, 1998, 2006; Rossouw, 2013).

A crucial application to Leadership is Kandel's (1998) proposition that psychotherapy produces long-term alterations to behaviour, effected through changes in genetic expression that modify synaptic firing and connections and eventually structurally change the anatomical network patterns among the brain's nerve cells.

The neuropsychotherapy approach to leadership behaviour embraces the view that leaders can create enriched environments through their conversational tones, listening and attunement to others

(Rossouw, 2014; Ghadiri et al., 2013). Conversely, continuous harsh language and harsh conversational tones can create a compromised environment.

When the organisational environment (culture) is compromised, the neural system of each individual within the organisation becomes compromised as it arranges itself to survive and inhibits neural proliferation, which enables positive change and adaptation to the environment (Kandel, 1998).

Neuro-Organisational Behaviour (neuro-OB)

An attempt at linking the brain to behaviour is that of neuro-organisational behaviour (neuro-OB) (Beugré, 2010), which refers to the study of the impact of the brain on behaviours that occur in organisations. According to Beugré (2010), neuro-OB should include three levels of analysis: (1) neural, (2) cognitive, and (3) behavioural. For example, in studying the phenomenon of organisational change: (1) the neural level will present the activation of a specific brain area like the basal ganglia that are associated with procedural knowledge and habits; (2) the mental processes could involve cognition, such as memories of previous change initiatives, as well as emotional arousal like anger, fear or resentment; and (3) the behavioural level concerns the behaviour displayed by organisational members such as resistance to change.

According to the proponents of neuro-OB, it differs from social-cognitive neuroscience in that SCN merges the tools of cognitive neuroscience with questions and theories from social sciences. SCN includes the empirical study of neural mechanisms underlying social-cognitive processes.

As Beugré (2010) suggested, Neuro-OB applies social-cognitive neuroscience research findings to the workplace; for instance, fairness and trust are studied in the workplace setting. One possible criticism of neuro-OB is that its explanatory success might be doubtful in a highly complex field.

Table 2 includes a comparative summary of the theoretical approaches found in the literature. These approaches are unique, but they also offer convergent configurations that together target the necessity of a neurobiological, psychological and socially anchored view of organisational and leadership behaviour.

Table 2

A comparative summary of theoretical approaches to NSBL (compiled by the researcher)

	SCN – Social Cognitive Neuroscience (Lieberman, 2007; Ochsner & Lieberman, 2001)	**ON – Organisational Neuroscience** (Becker & Cropanzano, 2010	**Neuroleadership** (Ringleb & Rock, 2008	**NP - Neuropsychotherapy** (Ghadiri, Habermacher, & Peters, 2013; Grawe, 2007; Rossouw, 2014a)
1.	Understanding self: - Self-recognition - Self-knowledge - Self-reflection - Self-control (regulation)	Combatting procrastination goal selection	Decision-making insight	The need for attachment – belonging
2.	Intentional Self-Regulation - Impulse control - Reappraising emotional events	Mirror neurons group subcultures Emotional contagion	Regulating emotions	The need for orientation and control
3.	Unintentional Self-Regulation: Putting feelings into words (affect labelling)	Attitude structures change: implicit vs explicit	Collaborating with others	The need for self-esteem and its protection and development
4.	Understanding others - Imitation - Mentalising - Empathy	**OCNS – Organizational Cognitive Neuroscience** (Lee, Senior, & Butler, 2012). The focus is on social processes in organisations	Facilitating change	The need for pleasure and avoidance of pain.
5.	Understanding groups - Attitudes & prejudice - Social connection/ rejection - Social & Moral Reasoning - Fairness & trust in reactions			

3.3 Defining Neuroscience-based Leadership (NSBL)

3.3.1 Article Findings

There were three articles relating to defining a neuroscientific approach to leadership behaviour (Lee et al., 2012; Ringleb and Rock, 2008; Waldman & Balthazard, 2015). Textbooks also provided investigations into NSBL (Ghadiri et al., 2013; Gordon, 2016; Swart, Chisholm, & Brown, 2015)

3.3.2 Discussion

The terms "neuroscience of leadership" or "brain-based leadership" are often used to describe leaders who exemplify how their brain functions and who develop specific competencies to manage the zone of optimal personal, team and organisational performance (Swart, Chisholm, & Brown, 2015).

A specific definition of NSBL is that by Ringleb and Rock (2008). These authors coined the term neuroleadership to explore the neural basis of leadership and management practices, aiming to successfully interface the tools of various neuroscience fields like social-cognitive and affective neuroscience, and topics, constructs and theories from organisational and leadership sciences. Neuroleadership is also seen as a sub-field of leadership that can be defined as the study of the biological micro-foundations of that relationship. The critical dimensions include "problem-solving and decision-making, regulation of emotions, collaboration with others, and facilitating change" (Ringleb & Rock, 2008).

Waldman & Balthazard (2015) did not give a definition of NSBL, but they do argue for a socially situated approach to NSBL; for instance, "While neurological variables associated with individual leaders can affect organisational behaviour, it is equally important to understand how the context can affect neurological qualities of individuals" (Waldman & Balthazard, 2015, p. 208).

According to Gordon (2016), who adopted an integrative neuroscience-based approach, the term "brain-based leader" provides insight into another person's brain behaviour dynamics (including emotion, feeling, thinking, and self-regulation). In addition, a brain-based leader is someone who exemplifies the knowledge of the organising principle of the human brain to 'minimise danger, maximise reward' and actively cultivates the neurobiological proficiencies that underlie effective decision-making and work relationships, collaboration with others, and self-regulation to ensure positive change and human performance optimisation (Gordon, 2016 p. 88)

Spain and Harms (2014) provided a socio-genomic perspective on leadership, which assumes that genes and the environment modify gene expression. This leads to a conception of genetic and environmental effects in leadership that is fundamentally dynamic, gives an understanding of the biological substrates of leadership, and provides a meta-theoretic framework of biological models showing that there is a fundamental interplay between genes and the environment throughout the life course (Spain, Harms, & Jackson, 2013).

A neuropsychotherapy-based description of NSBL is provided by Ghadiri et al. (2013, p. 139) as "Leadership through using the knowledge of the brain and specifically the neuroscientifically founded four basic needs." In addition, there is evidence that humans can deliver optimum performance, change adaptability and wellbeing when these unique psychological needs are met (Garnett et al., 2022).

Common elements across these definitions include knowledge of brain function, the biological micro-foundations and mechanisms of leadership constructs and behaviours, and achieving results through focusing on the individual, teams, and organisational-level processes like change management. In light of the above-reported definitions of NSBL, it is conceivable that there is an appreciation for both evolutionary and neuroscientific theories not to discount other approaches to leadership but to initiate debate and move the field forward.

Synthesis by the researcher of the above definitions of NSBL

From the above-reported descriptions of NSBL, the researcher has created a definition of NSBL as:

> *Neuroscience-based leadership is anchored in a scientifically grounded working knowledge of the brain, understanding human psychological needs in the workplace, and applying neuroscientific concepts to achieve optimum performance goals and wellbeing at the individual, team and organisational levels*.

To conclude, the nature of neuroscience-based leadership is multifaceted – content-rich but challenging to articulate. The numerous aspects of the construct contain gaps that give room for developing a new and evolving construct. This combined working definition will be re-evaluated in this research study based on the contributions from the Delphi panel survey participants.

3.4 Articulating Core Behaviours of Neuroscience-Based Leaders

3.4.1 Article Findings

Fourteen articles related to empirical neuroscience studies on leadership or organisational behaviour. Four articles used theory adaptation to elucidate the relevance of neuroscience to organisational and leadership behaviour phenomena.

3.4.2 Discussion

The empirical studies N=14 used the direct measurement of brain processes as possible underpinnings of leadership constructs. These empirical neuroscientific studies help to understand specific issues relevant to leadership as well as provide theoretical insights into the basis of leader cognition, social engagement, emotions, and behaviours that might not be readily tapped by existing constructs or methods. The following constructs were researched, confirming a link between psychological constructs and brain mechanisms.

Bagozzi et al. (2013) studied perspective taking and medial PFC activation; Balthazard et al. (2012), differentiated transformational and non-transformational leaders on the basis of neurological imaging; Boyatzis et al. (2012), studied the neural substrates activated in memories of experiences with resonant and dissonant leaders; Dulebohn et al. (2009); studied the biological bases of unfairness; Dulebohn et al. (2016), gave evidence from fMRI about gender differences in fairness evaluations; Feldman Barrett & Satpute (2013); Hannah et al. (2013), showed the psychological and neurological bases of leader self-complexity and effects on adaptive decision-making; Higgins, Peterson, Pihl, and Lee (2007), researched, prefrontal cognitive ability and manager performance informed by neural underpinnings; Mason et al. (2009) studied the neural mechanisms of social influence; Molenberghs et al. (2017) studied the neuroscience of inspirational leadership; Peterson et al. (2008) showed how neurofeedback can be used to train the brain and develop psychological capacities in business leaders.

These empirical neuroscientific studies all share the common denominator of dealing with individual leaders and constructs associated with intrinsic brain mechanisms. These studies are once-off studies with no replication studies available; therefore, some can see them as reductionist. However, it does pave the way for additional possibilities for Neuroscience applications to Leadership research.

The role of neuroscience in explaining leadership behaviour was deliberated in the final edition of The Bass Handbook of Leadership by Bass and Bass (2009), with a conclusion that in the future, scientific methods such as brain imaging will increasingly be used to elucidate leadership thinking and behaviour. According to Bass and Bass (2009), brain scanning, and neuroscience have effectively been applied to various business contexts like economics, marketing, and business ethics.

Most current theory-based connections between patterns of brain activity and leader behaviour initially attempted to dismantle the leadership behaviour being studied and then endeavoured to link that behaviour to specific brain regions and neural processes (Beugré, 2010; Boyatzis et al., 2014).

According to Waldman et al. (2011b), the current research body of knowledge on NSBL is scant. Therefore, theory and evidence must be identified in the neuroscience literature to form interpretations regarding potentially relevant neurological activity for NSBL behaviour. Novel research propositions could then be developed to link neurological activity to particular leadership behaviours, encompassing "both theory forming and theory honing because it will help scrutinise theories about which cognitive processes facilitate various social behaviours" (Butler & Senior, 2007, p. 5 as cited in Waldman et al., 2011b).

Finally, there has been little assessment of the empirical NSBL literature in terms of its quality or methodological rigour. To conclude, using inter-disciplinary (e.g.) layers of theory to describe NSBL is a plausible albeit exploratory way to investigate the link between neuroscience and leadership behaviour (Lee and Chamberlain, (2007).

3.4.2.1 Using a valid level of description to link Neuroscience to Psychological Constructs

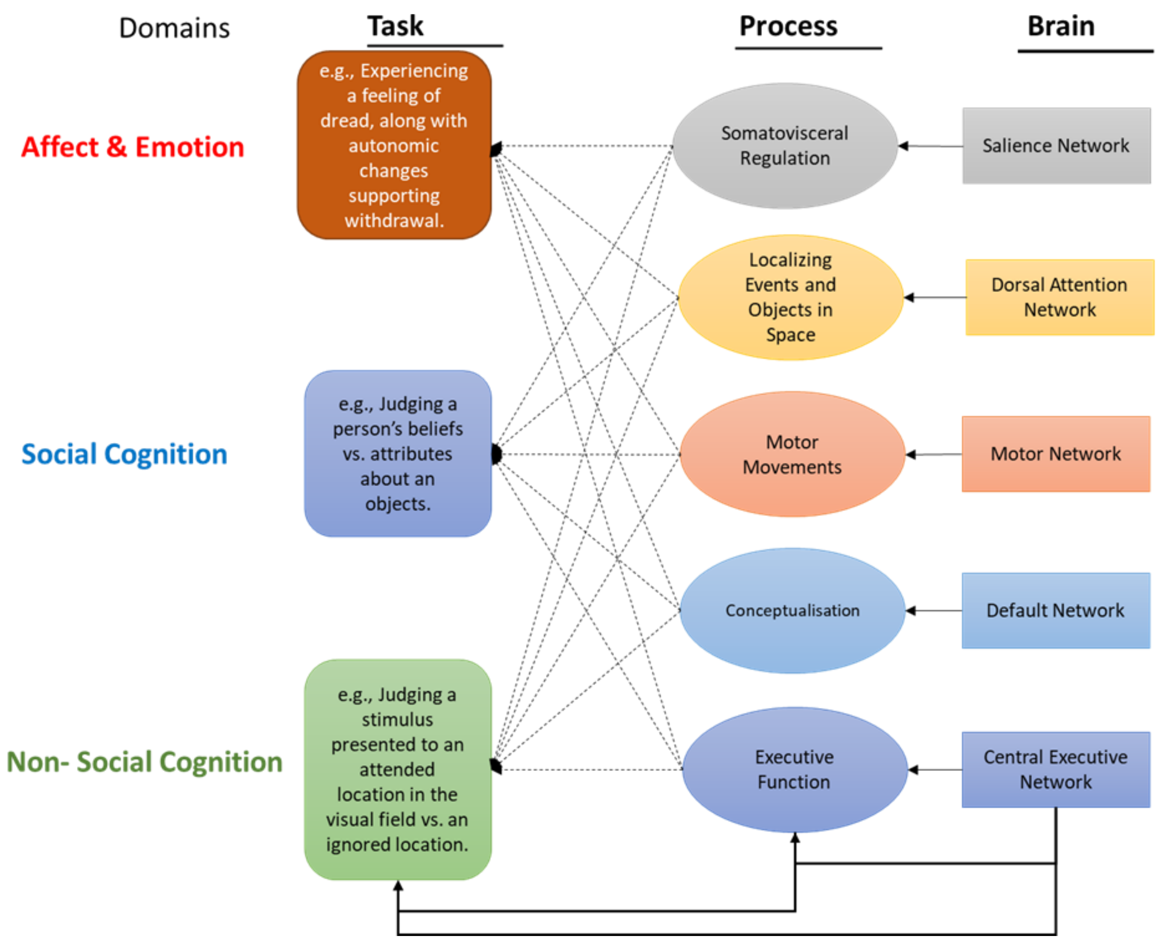
Meta-neuroscientific studies show that core processes and mechanisms are involved in the various domains of neuroscience, i.e., affective, cognitive, social and health (Feldman Barrett & Satpute, 2013). The brain does not initiate emotional, social and cognitive phenomena in the operation or mechanisms of separate brain regions (Bressler & Menon, 2010). Instead, the brain is intrinsically organised into domain-general, distributed functional networks, and a range of affective, social, and cognitive phenomena arise from the interaction of these networks (Feldman Barrett & Satpute, 2013).

Describing the psychological functions of domain-general networks produces an alternative functional architecture of the human brain that provides a valid level of description linked to other scales and levels of describing the brain. Several meta-analysis studies support this view (Denny, Kober, Wager, & Ochsner, 2012; Fan, Duncan, De Greck, & Northoff, 2011).

This is set out in Figure 4 – Domain-general brain networks.

Figure 4

Domain-general intrinsic brain networks interact to produce a wide variety of tasks (adapted from Feldman Barrett & Satpute, 2013)



The model provides a comprehensive depiction of both neuroscientific processes and psychological constructs. This research focuses on neuroscience-based leadership in formal organisations, which includes all three domains listed in Figure 4.

The fields of social-cognitive and affective neuroscience (Feldman Barrett, 2017; Lieberman, 2007) and neuropsychotherapy (Ghadiri et al., 2013; Grawe, 2007; Rossouw, 2014) as a sub-field of applied neuroscience have relevance to NSBL. These fields all deal with leadership topics, such as goal-setting, change, emotions, empathy, and motivation.

Integrating these perspectives can offer unique insights into articulating NSBL behavioural descriptors. Becker et al. (2011) argued that combining concepts at different levels of explanation provides a content-rich conciliation and more rigorous theories. According to Jack et al. (2019), it is important to take a broader view of the brain and cognition when identifying potentially relevant processes for effective leadership behaviour.

The following section introduces key behaviours, using these relevant neuroscientific theories to conceptualise NSBL.

3.4.2.2 The core behaviours of NSBL: A narrative of observed practice

The preceding discussion has attempted to briefly outline the convergence of neuroscience research and leadership behaviour research and the prominence of two theoretical approaches to neuroscience-based leadership behaviour: Social Cognitive Neuroscience (SCN)) and Neuropsychotherapy (NP). In the ensuing discussion, examples of core NSBL behaviours will be presented as a synthesis of the literature reviewed.

The leadership and organisational behaviour field aims to develop and test theories of behavioural phenomena (Andersson et al., 2013; Ashkanasy, 2013; Liu et al., 2019). According to Banks et al. (2021), the study of behaviours is inadequate in leadership and general organisational behaviour research, which is problematic. This is because the absence of human behaviour in leadership research is a theoretical problem in conceptualising concepts in leadership theories.

Behaviour(s) can be characterised as internally coordinated responses (actions or inactions) of entire living organisms (individuals or groups) to internal and/or external stimuli, excluding responses that are more easily understood as developmental changes (Levitis et al., 2009, p. 103 cited in Banks et al. 2021). Instead of core behaviours, behavioural anchors were initially defined by Smith and Kendall (1963) as a type of descriptor that served to highlight narrative behavioural markers at scale points for use in measuring observed practice in workplace settings. Others stipulated that key behaviours should be context-specific, transparent, and reliable for effective assessment and to reflect the operational environment (Bersin, 2015; Martin-Raugh, Tannenbaum, Tocci, & Reese, 2016; Yule, Flin, Paterson-Brown, & Maran, 2006).

Banks et al., 2021 primarily propose formally separating perceptions, evaluations, and behaviours in leadership theories to properly guide subsequent methodological decisions. They made specific recommendations for defining leadership behaviours as set out in Table 3.

Leadership behavioural theory entails several models that explain leadership in terms of the actions leaders take to influence others rather than their motivations, traits, or past experiences (Van den Bos et al., 2009). Leadership is viewed as a behavioural response that can be learned.

Table 3

Theoretical recommendations to research leader behaviour (source: Banks et al. 2021)

Recommendation	Description
1. Broaden the conceptualisation of behaviour.	Consider a broader range of conceptualisations of leader behaviours to facilitate theoretical advancements.
2. Avoid theoretical conflation	Explicitly define and specify concepts of perceptions, evaluations, behaviour, and other related concepts (e.g., intentions, values)
3. Re-evaluate existing theories	Re-evaluate existing theories to ensure the concepts that they are composed of are properly specified.
4. Conceptualise contamination/deficiency in concepts.	Develop a theory that accounts for both potential contamination and deficiency. Contamination and deficiency in measuring perceptions and evaluations are not always noise but could be theoretically relevant.
5. Theorise inaction	Theorise the effects of both action and inaction in behaviours to fully understand the nature of leader (follower) behaviour.

Consequently, it can be said that behaviours should be unambiguous and represent examples of behaviours that demonstrate adeptness. In contrast to behavioural descriptors used in Organisational Behaviour, Neuroimaging-based technologies have primarily led the neuroscience field of behavioural markers.

Neuroimaging-based neural correlations have become the foremost instrument for the depiction of a brain-based image of the person, the main quest being to identify the neurological (including chemical and anatomical) origins or roots and contextual explanations of a specific phenomenon like depression (Vidal & Ortega, 2012) or bullying (Hazler, Carney, & Granger, 2006) and, in this review, leadership.

A concern with this approach is that claims for neuroscience are often made by deliberating psychological results rather than neuroscientific results, which Vidal and Ortega (2011, p. 356) label a "widely used strategy among neurocultural actors". It is a challenge to prove that neuroscience can deconstruct complex leadership processes into elementary components that can be examined in neural terms. Thus, it is over-ambitious to identify the neurobiological markers or correlates of leadership at this stage. However, it does hold promise for elucidating neuroscientific-informed descriptions of leadership behaviour.

A synthesis of overlapping components in the literature was adopted to articulate the NSBL core behaviours. This aligns with the case made for the significance of "synthesising the experimental, observational, and theoretical work of others" to progress science (Gardner and Moran, 2006, p. 229). Considering that this study aims to conceptualise NSBL behaviour, synthesising the core behaviours proposed by the two critical theoretical theories deployed in leadership studies in formal organisations, i.e., SCN and NP, is necessary.

3.4.2.3 Social Cognitive Neuroscience (SCN) as interpretive lens into NSBL behaviours

As an interdisciplinary field of research, SCN combines knowledge of social science disciplines (in particular psychology) and neuroscience (Lieberman, 2007). According to Ochsner & Lieberman (2001), SCN brings together questions related to the social (motivational and social factors relevant to behaviour and experience), cognitive (information processing mechanisms), and neural level (brain mechanisms)

As leadership is essentially a social-relational process, the social-cognitive approach offers much promise in defining the neuroscientific underpinnings of leadership. Social-Cognitive Affective Neuroscience complements leadership behaviour in that it entails a multi-level approach involving factors internal to the individual (individual differences, internal mental processes) and external to the individual, including environmental factors and organisational contexts (Jack, Rochford, Friedman, Passarelli, & Boyatzis, 2019).

To further develop insight into these links between leadership behaviour and the explanatory power of the neurosciences, a suggestive framework is used, as set out in Table 4. As shown, there is a similarity between the general levels of analysis emerging from leadership behaviour models (Behrendt et al., 2017; Hogan & Kaiser, 2005; Yukl, 2012) and the types of processes being studied in social-cognitive neuroscience (Becker, Cropanzano, & Sanfey, 2011; Beugré, 2018; Lieberman, 2007; Voegtlin, Walthert, & Robertson, 2019)

The research areas of social cognitive neuroscience that can be linked to the domain of leadership behaviour involve research relating to understanding oneself, others, and the relationship between the self and others, like group processes (Lieberman, 2007).

Table 4

A suggestive framework that links the components of leadership behaviour with the components of social-cognitive neuroscience

Leadership Behaviour Dimension	Social-Cognitive Neuroscience Theoretical Framework
Intrapersonal **(Self-Oriented)**	**1. Self-awareness & understanding** The ability to recognise and understand oneself plus the ability to do self-reflection. **Constructs:** • Bonding and belonging, social realism • Separation and rejection • Mindful attention awareness • Somatosensory awareness: Interoception, exteroception
Intrapersonal **(Self-Oriented)**	**2. Self-regulation** The ability to generate and differentiate affect and emotions. **Constructs:** • Universal emotions vs constructed emotions • Emotional-regulation strategies • Unintentional self-regulation/dysregulation.
Interpersonal (Dyads) **(Relations-Oriented)**	**3. Understanding others** Having a theory of mind and reasoning about the mental states of others. Understanding how people's minds respond to situations. **Constructs:** • Reading faces and bodies • Mirror neurons and imitation of others. • Mentalising and understanding the intentions of others. • Empathy and perspective-taking
Interpersonal (Groups) **(Change-Oriented)** **AND** **(Task and Change Oriented)**	**4. Interaction between self, others, and task** **Constructs:** • In-group vs outgroup (understanding connection and rejection) • Fairness and Trust • Prejudice and unconscious bias • Cooperation • Goal pursuit and Social decision-making

At the intra-personal level, SCN focuses on research on understanding the self. This includes processes relating to self-reflection, which is about actively engaging with one's own experiences (past or current) and feelings to reflect on circumstances that cause pleasurable or painful feelings. Neuroscience research also measures autobiographical reflections of past and present experiences, aiding self-understanding (Lieberman, 2007). Learning how to move towards or away from similar situations in the future is also studied in SCN (Lieberman, 2007).

The second focus is on self-regulation processes involved in decision-making and achieving individual and social goals as it facilitates the control and reappraisal of emotional events (Lieberman, 2007) self-regulation processes involved in decision-making and achieving individual and social goals as it facilitates the control and reappraisal of emotional events. Studies have shown that the brain can override impulses intentionally and helps us to regulate our behaviour in certain situations (Lieberman, 2007).

At the interpersonal level (dyads), the focus is on understanding others, which includes research on imitating (copying others), understanding the minds of others (mentalising), and the neural underpinnings of empathy (Ochsner & Lieberman, 2001). Understanding others could help leaders become more effective.

At the interpersonal level (groups), SCN focuses on understanding the interaction between the self and others, including social neuroscience research into social decision-making, which includes constructs like trust, cooperation, and fairness. Understanding these processes can help leaders build solid social relations, cultivate group cohesion and responsibly influence others.

This suggestive framework (Table 4) can inform research and practice. Understanding these processes can help leaders build solid social relations, cultivate group cohesion and responsibly influence others.

Critique against SCN

Lieberman (2007) cautions that it is a mistake to consider biological predispositions deterministic; their impact is probabilistic and context-dependent. Furthermore, Social cognitive neuroscience focuses on brain mapping using neuroimaging research. So, it is not a cure-all but a neuroscience method that may shed new light and prompt new behavioural research programs.

Another approach used to understand leadership behaviour and the human experience at work is Neuropsychotherapy (Ghadiri et al., 2013; Rossouw, 2014).

3.4.2.4 NPT as an interpretive lens into NSBL behaviours

Neuropsychotherapy Defined

Neuropsychotherapy is used to study leadership behaviour within the new domain of organisational neuroscience (Geldenhuys, 2020; Ghadiri et al., 2013; Rossouw, 2014). Neuropsychotherapy explores the underlying neural mechanisms and principles that influence human behaviour and provides guidelines for optimal functioning (Rossouw, 2014). Neuropsychotherapy originates from Seymour Epstein (1994) and Klaus Grawe (2007), who defined four basic psychological needs present among all humans. The enduring non-fulfilment of these needs or infringements negatively impacts mental health and wellbeing.

A basic needs model of optimal psychological functioning

Many different approaches and interpretations represent our psychological needs. Grawe (2007) defined four basic needs among all humans, where the violation or enduring non-fulfilment leads to impairments in mental health and wellbeing. These are the need for attachment/belonging, orientation and control, self-esteem and its protection and development, and the need for pleasure and avoidance of pain. Understanding and activating these basic needs in the work environment helps us to peer into the "psychological black box" of leadership complexity. These basic needs and the striving to fulfil them are supported by neuroscientific theory (Draguns, 2007; Ghadiri et al., 2013).

A more recent "Integrated model of the base elements of the theory of Neuropsychotherapy" is captured by Rossouw (2014, p. 57) and set out in Figure 5. It begins at the bottom by acknowledging an individual's unique gene pool. Exposure to early environmental factors leads to early expression (epigenetics) of an individual's need for safety in the form of attachment to a primary caregiver.

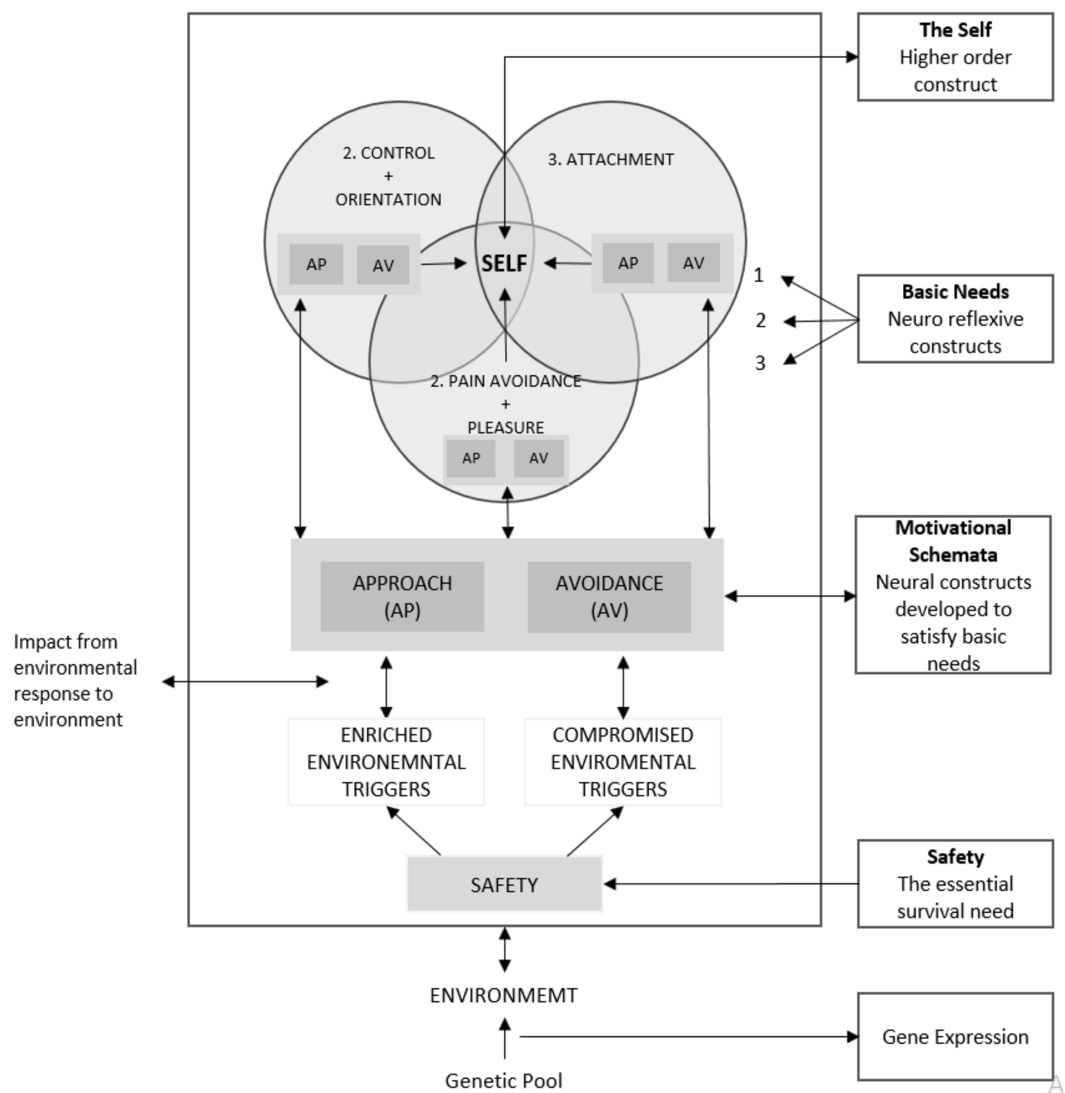
The model recognises the influence of environmental triggers (either enriched or compromised) on how an individual responds (Rossouw, 2014). At the next level of the model, motivational schemas are introduced, referring to the specific neural mechanisms and patterns that lead to approach behaviour or avoidance behaviour in a particular situation to meet the basic psychological needs, which are presented at the next level of the model (Rossouw, 2014).

The concept of *self* is positioned as a higher-order construct in the model or "neural meta-structure that influences approach/avoid volition" (Rossouw, 2014, p. 32). Self-esteem is not reducible to a reflex. It is viewed as a higher-order need that is influenced by the fulfilment of other needs (Henson & Rossouw, 2013). Therefore, self-esteem development depends on a person's capacity for self-reflection and conscious self-awareness (Geldenhuys, 2022). Whereas self-esteem enhancement is motivated by approach schemata, self-esteem protection is motivated by avoidance schemata, differentiating, for instance, between asking for support and withdrawing from others to avoid a sense of shame (Grawe, 2007).

The relevance of this model to NSBL is that, according to neuropsychotherapy (NP) theory, behaviour is largely deemed a system by-product of needs satisfaction prioritisation (Epstein, 2003; Rossouw, 2014). Hence, understanding and developing observable leadership behaviour requires understanding the psychological needs that drive behaviour in the workplace.

Figure 5

The four basic needs that influence human behaviour (Rossouw, 2014)



NSBL, from a Neuropsychotherapy approach, focuses on fulfilling employees' psychological needs within concrete organisational settings (Rossouw, 2014; Ghadiri et al., 2013). According to the Neuropsychotherapy (NP) model of psychological functioning in the workplace (Henson & Rossouw, 2013, p. 29):

"Understanding brain development from a neural perspective can inform team and in-group climate insights. Understanding the principles of basic human needs allows leaders to realise that effective leadership revolves around trusting others (consider the attachment needs), helping workers to feel valued, heard and listened to (consider the basic human need for control), and providing genuine positive feedback when it is due (consider the need for pleasure maximisation)".

A synthesis is provided in Table 5.

Table 5

Basic psychological needs and core behaviours that support the meeting of these needs (adapted from Ghadiri et al., 2013, p. 87 and Henson & Rossouw, 2013)

Basic Psychological Needs	Core Behaviours that support basic psychological needs resulting in "approach" motivational schemas
1. Need for Control and orientation.	Give responsibility and provide information on job goals and status. Alignment of life goals with realities of the organisational environment. Sees
2. Need for Attachment.	Cultivating inclusivity and collaborative working patterns by working in groups or teams Eliminate "fear" inducing behaviours through supporting relationships to enhance trust, relatedness and cognitive power.
3. Need for self-enhancement.	Give constructive feedback and ensure employees feel respected at work. Cultivate experiences of success at work Developing competence and skills
4. Need for pleasure maximisation and pain avoidance.	Building rewarding experiences at work (praise, formal recognition, free time) Enhance employees' status at work. Positive praise and individualised rewards

Critique against NP

Grawe (2007) identified the essential neural concepts for a NP theory. Allison & Rossouw (2013) argued that NP might be seen as an overly simplistic representation of human behaviour that may ignore crucial aspects of brain integration (Allison & Rossouw, 2013). The human brain is a complex system, with a hundred billion neurons, trillions of glia, and a million billion connections within the skull alone (Siegel, 2012). Modelling what may happen in this complex system is a complicated balancing act.

Conceivably, in its aim to be explicit about basic needs, this model fails to describe the overlapping nature of neural networks that support the basic needs it represents. Neural networks that represent the need to be attached share pathways with neural networks that represent the need to avoid pain and the need to be oriented in ways that cannot be readily separated. Rather than autonomy, the interdependent nature of these needs evokes a sense of overlap. Further refinement of the NP model is required so that current neuroscientific principles can be used to verify the theory.

Appendix D captures an initial synthesis of possible core behaviours based on leadership behaviour theory's task and relations-oriented dimensions (Yukl, 2012; Behrendt, Matz, & Goritz, 2017).

This synthesis was done based on the empirical literature reviewed and articles on neuroscientific theories relevant to organisational and leadership behaviour like SCN and NP.

3.5 Concepts and Constructs measured in Brain-based Diagnostics.

As part of the integrative literature reviewed, self-report diagnostics were reviewed to shed light on underpinning concepts and constructs that substantiate conceptualising NSBL.

3.5.1 Article Findings

There were 63 articles relating to neuropsychological assessments in clinical settings that were not relevant to workplace behaviour. Five articles were reviewed to answer the research questions.

The integrative literature review highlighted three self-report diagnostics that measure brain capacities relevant to identifying leadership behavioural anchors.

(1) The MyBrainSolutions Leadership Assessment developed by Brain Resource (Gordon, 2008) measures brain capacities across the four primary processing modes set out in the Integrate Model of Gordon (2008). It offers a personalised brain training application that claims to improve brain health and facilitate behaviour change.

(2) The Neurozone Diagnostic of Brain Performance (van der Walt, 2017) offers insight into the brain's constituents for innovative performance. The model consists of real brain structures around a hypothetical axis from basic to most sophisticated. The model and the diagnostics cluster 11 key drivers into four functionalities that determine brain performance.

(3) The online Neurosurge-Diagnostic measures stress profiles and PNE resilience regarding wellness and performance. This diagnostic is based on the Triangles Model (Weinberg, 2016), which sets out three archetypes of personal leadership. The three archetypes are professed to indicate the risk of developing raised pro-inflammatory cytokines that have been implicated in mediating chronic conditions such as type 2 diabetes, cardiac disease, osteoporosis, and dementia.

3.5.2 Discussion

3.5.2.1 Constructs measured in self-report diagnostics.

A frequently used method of studying the brain correlations of behaviour is the use of neuropsychological assessments. Neuropsychological assessments are similar to psychological assessments, using self-report data collection measures and adhering to psychometric principles. They are unique in that they predict brain function. Initially, the main application was for clinical diagnostic solutions.

We now know that neuropsychological assessments have "robust validity in predicting a wide-ranging array of behavioural outcomes including employability and rehabilitation to the workplace after neurological dysfunction, based on measures of executive function and work success" (Lezak, Howieson, Loring, Hannay, & Fischer, 2004, p. 10). Neuropsychological assessments are also valid instruments for use in neuroscientific research. Some of these measures have been normed in terms of healthy populations, such as the Delis- Kaplan Executive Function System (D-KEFS) battery (Delis, Kaplan, & Kramer, 2001).

In answering the research question, the literature review highlighted the three self-report diagnostics listed above that measure brain capacities relevant to leadership behaviour.

See Table 6 for a comparative review of the constructs measured by the three self-report diagnostics.

Table 6

Constructs measured in neuroscience-based self-report diagnostics.

MyBrainSolutions Leadership Assessment	NeuroZone diagnostic	NeuroSurge diagnostic
Feeling capacities: · Stress level. · Anxiety level. · Mood level.	**Foundational drivers**: · Exercise. · Nutrition. · Sleep/wake cycle. · Silencing the mind.	Quantifying degrees of **hostility**.
Emotional capacities: · Emotional awareness. · Non-conscious negativity. · Emotional flexibility.	**Emotional drivers**: · Collective creativity. · Value tagging. · Goal-directedness.	Quantifying the degree of: · **Resilience**. · **Self-esteem**.
Thinking capacities: · Memory. · Focused attention. · Planning.	**Higher-order drivers**: · Learning. · Abstraction. · Executive function.	Quantifying **value contribution.** Quantifying **personal gratification.**
Self-regulation capacities: · Conscious negativity. · Resilience. · Social capacity.		

Table 6 shows that the diagnostics overlap; for example, all diagnostics included resilience constructs, executive function constructs, and constructs relating to mood or affective states.

3.5.2.2 Foundational concepts of self-report diagnostics that are relevant to NSBL.

According to (Podsakoff, MacKenzie, & Podsakoff, 2016), inadequate conceptual definitions remain an issue for organisational, behavioural, and social science scholars. These authors contend that concepts serve as fundamental building blocks of theory, allowing researchers to organise complex phenomena with a common language that, when implemented well, facilitates communication between researchers (Podsakoff et al. (2016).

To develop better conceptual definitions in academic research, Podsakoff et al. (2016) provided guidelines that can be organised into four stages: (a) identify potential attributes of the concept by collecting a representative set of definitions, (b) organise the potential attributes by theme and identify any necessary and sufficient or shared ones, (c) develop a preliminary definition of the concept, and (d) refine the conceptual definition. Before embarking on answering the research question relating to NSBL foundational concepts, it is worth reviewing the depth and breadth of coverage in the academic literature.

Underpinning principles that cut across disciplines

The study of neuroscience is evolving, and neuroscience perspectives in applied fields are increasing. Underpinning principles and concepts that cut across disciplines are published by the Society for Neuroscience. These include concepts like: "Both genes and environment determine nervous system structure and function throughout life",; "Nervous system controls and responds to body functions and directs behaviour," and "The brain is the foundation of the mind" (Society for Neuroscience, 2008).

In 2011, the Royal Society stated, "Educational practice can be transformed by science, just as medical practice was transformed by science about a century ago" (Royal Society, 2011, p. 3). According to the report, this could be done in several ways, for example, by "showing that biological factors play an essential role when it comes to individual differences in learning ability".

Integrative neuroscience as a theoretical framework to articulate foundational concepts.

A comprehensive approach to formulating core concepts and foundational principles is that of integrative neuroscience, which is built on the evidence in the literature of coexisting rules of a dynamic working brain (Gordon, 2000, 2003, 2016). Integrative neuroscience includes a multi-disciplinary approach concerned with how all brain processes are interrelated. This integration results in a diverse yet unified system, dynamic yet coherent, and highlights the following fundamental organising principles:

1. Specialised survival networks help us to avoid danger and minimise pain.
2. All information transfer in the brain consists of electrochemical processes.
3. Incoming information is processed fast via reflexive networks or, if a mismatch occurs, more slowly via reflective networks.
4. Inherited genetic thresholds modulate neural functions.
5. Adaptive needs are met through neural pruning or neural plasticity (long-term potentiation).
6. Multiple interconnected neurons constitute overlapping networks that interact to execute mental functions.
7. The whole brain and body are a highly interconnected system, functionally and anatomically (Gordon, 2000, 2003, 2016).

The value in using an integrative approach to define foundational concepts is the perspective that there is a relatively small number of principles underlying all of the brain's functions. This is important so as to overcome the confluence of multi-disciplinary theories like neuroscience-based leadership.

The integrative approach to define foundational neuroscientific concepts ensures linkages to other theories; for example, the foundational concepts underpinning SCN were reported by Lieberman (2007) and included survival as the primary operating principle of the brain, reflexive (non-conscious) and reflective (conscious) systems, and self-organising brain networks (the DNW and the CEN). Similarly, the foundational concepts underpinning NP include facilitating safety, i.e. physical safety by maintaining therapeutic respect, boundaries and ethical behaviour, and emotional safety through high levels of respect and acceptance. NP aims to ensure solutions-focused therapy with an outcome of psychological healing and recovery (Rossouw, 2014). There are several links to leadership behaviour as to how creating an enriched environment can assist employees in overcoming workplace challenges and enhance performance, work engagement and personal wellbeing. See Appendix D for the foundational concepts of NP theory as summarised by Rossouw (2014).

Foundational Concepts of the self-report brain diagnostics: A comparative synthesis

To provide a perspective about the potential for integrating the underpinning concepts of the three self-report diagnostics, the researcher synthesised the constructs into a discernible outline, albeit cautious that it might be too ambitious. Table 7 captures this comparative synthesis, which was done by comparing the coexisting rules of a dynamic working brain (Gordon, 2000), set out in the first column, to the theoretical foundations defined in the self-report diagnostics technical manuals and white papers in the literature.

Table 7

Foundational Concepts of the self-report brain diagnostics: A comparative synthesis from the literature reviewed.

Researcher's Synthesis of Neural Foundations	MyBrainSolutions description of neural foundations	NeuroSurge description of neural foundations	NeuroZone description of neural foundations
1. Neural patternicity for survival (threat avoidance) overrides reward-seeking.	A continuous brain organising principle is to minimise danger and maximise reward (Gordon et al., 2008).	The brain and immune system communicate bi-directionally, with survival as their primary operating premise (Irwin, 2008).	The brain is functionally structured to be social for survival (Van der Walt, 2017a). It does this through pattern-seeking. The brain has developed and continues to develop with survival as its primary purpose (Van der Walt, 2017b).
2. Mind-states are electro-chemically correlated.	A dynamic continuum of spatially interconnected brain integration across four processes – emotion, feeling, thinking, and self-regulation, with accompanying neural chemistry (Gordon et al., 2008).	Mind-state configurations are associated with electrochemistry and immune system impact (pro-inflammatory or anti-inflammatory): A (resourceful)/ B (aggressive self-interest)/ C (helpless, hopeless) (Weinberg, 2009).	Healthy mood state (Van der Walt, 2017b).

Researcher's Synthesis of Neural Foundations	MyBrainSolutions description of neural foundations	NeuroSurge description of neural foundations	NeuroZone description of neural foundations
3. Nature-nurture dynamics (epigenetics)	Pervasive, non-conscious inherited patterns and biases (Gordon, 2016).	Nature-nurture heritage shapes our subjective reality. Compromised/deprived environments contribute to neural atrophy via hypo-frontality of executive function and immuno-suppression (Arnsten, 2009; Weinberg, 2009).	Value tagging is a subconscious process that motivates us to approach or avoid engagement (Van der Walt, 2017b).
4. Attention deployment is conscious vs less conscious.	Two modes of processing: slow conscious logical cognition and fast non-conscious emotional cognition (Silverstein et al., 2007). Non-conscious brain functions drive most of our behaviours.	Default pattern awareness (Weinberg, 2009).	Problem-solving occurs along a hypothetical "neural axis" from basic and reflexive (predominantly unconscious) to sophisticated but also more unimodal (unconscious and conscious) (Van der Walt, 2017a).
5. Self-directed neuroplasticity.	Targeted brain training provides the framework to change memory systems (Gordon, 2016).	Neuromodulation results in resourceful neurochemical configurations through rewiring nurture circuitry by engaging the environment (Weinberg, 2018).	Neuroplasticity implies the brain forming new memories and building new knowledge (Van der Walt, 2017b).
6. Core processes and overlapping networks.	Integration of emotion, feeling, thinking and self-control processes across different time scales (Gordon, 2016).	Adjustment of archetypes through coaching (neuromodulation).	The foundational, emotional and higher-order drivers (Van der Walt, 2017b).

Researcher's Synthesis of Neural Foundations	**MyBrainSolutions description of neural foundations**	**NeuroSurge description of neural foundations**	**NeuroZone description of neural foundations**
7. The brain as an open system	Epigenetics	Environmental influences	The brain is an open system in which every process is connected (Van der Walt, 2017b).

It is evident that the three self-report diagnostics are similar in underpinning concepts, providing a fingerprint of foundational concepts relevant to brain-based leadership and from which NSBL can be further researched and developed. However, integration attempts are not without problems. Even an integrative approach has limited explanations of mental functions in terms of neuronal mechanisms and thus still has interdisciplinary issues (Kotchoubey et al., 2016). The risk is a modern-day "Tower of Babel" built with a "single purpose, but still doomed by jargon and misunderstandings between the various builders" (Gordon, 2003, p. 28).

4. Contribution and critique of the literature review

The literature reviewed suggested that building a theoretical alliance between complex leader behaviour and even more complex neurological activity is undoubtedly challenging. There is a need for more research into the link between neuroscience and leadership behaviour, which is the purpose of this paper.

4.1 Contribution: Progressing science through translation and synthesis.

This literature review covered research papers, books, dissertations and neuroscience-based diagnostics. The evidence showed that leadership behaviour is multidimensional and has many levels of analysis.

This review included relevant quantitative and qualitative research studies that provided a general view of the NSBL subject but also raised issues of difference, as the various models, theories, and methods hold different assumptions about brain-based behaviour. The empirical studies reviewed prove that the formal research associations between leadership and neuroscience are on the increase but not well-developed, unlike the linkages between psychology and leadership.

According to Gardner and Moran (2006, p. 229), science can progress by "synthesising the experimental, observational, and theoretical work of others". The interpretation and synthesis of the literature reviewed are more aligned with research by Sharp, Monterosso, and Montague (2012), where multi-level approaches are used to interpret insights from direct sciences to different applications like NSBL.

Six themes emerged from the data, articulating leadership behaviour, defining AONS, defining NSBL, foundational Concepts that underpin NSBL, neuroscientific models that (based on the strength of the evidence in the literature) inform the core behaviours that describe what NSBL leaders do and don't do, and core behaviours that describe a neuroscience-based approach to leadership.

Although the literature review highlighted peer-reviewed articles that hold promise for NSBL as a new field, some concerns should be considered.

4.2 Critique of the Literature Review

It is clear from the literature review that little empirical data directly links neuroscience research to leadership behaviour or specific leadership outcomes. It is also clear that there are significant conceptual cavities in the arguments and proposed frameworks underpinning NSBL and in the attempt to link neuroscience and leadership. This is validated by the formal peer-reviewed studies that generally used small samples and, in most cases, produced preliminary findings.

Given the evidence from the literature review, an unanimously agreed definition of neuroscience-based leadership does not exist. Explanations vary from neuroscience in leadership to neuroleadership. The deliberations in the neuroscience-based literature reveal the absence of a theoretical model for NSBL. The review highlighted that no empirical NSBL theory has been firmly established that could explain or predict relationships between brain-based leadership constructs. Thus, correlational and causal relationships between brain activity and leadership behaviour are theoretically unresolved.

Chapter 2 presented with numerous limitations. Firstly, the keywords selected to describe neuroscience-based leadership and core behaviours that underpin NSBL in the database searches might have overlooked important published research. Research was also limited to peer-reviewed scientific journals, books, dissertations and theses that conceptualise a neuroscience-based approach to leadership.

Furthermore, various neuroscientific theories were discussed. Finally, articles were limited to those written in English due to the researcher's competence in these languages, which means that possible relevant articles that may have been published in different languages would have been excluded from the literature review. However, most high-impact journals are published in English.

4.3. Implications for future research

Leadership behaviour is inherently a complex process. When attempting to work in an interdisciplinary way, it is important that the research contribution is simple to understand yet accurate and not overly reductionistic (Healey & Hodgkinson (2014).

Based on the theoretical propositions of the literature reviewed, my hope with my study is to advance our understanding of organisational behaviour and leadership behaviour by providing a neuroscientific lens and level of analysis over and above the typical behavioural level described via organisational psychology theories and models.

The research implication of this review is that it can contribute toward fresh theoretical foundations proposed in the development of an interdisciplinary NSBL conceptual framework. The study's practical significance is that refining core leadership behaviours can enhance understanding of organisational dynamics. For instance, knowing that pressures to meet challenging deadlines activate emotional responses or limbic reactions may assist leaders in taking into account the perspectives of others instead of making rash decisions under pressure.

A way forward in advancing the field of NSBL is to adopt the intermediate, critical realist position proposed by Healey and Hodgkinson (2014). In this approach, the discernment of social neuroscience is one of a number of convergent building blocks. Instead of an empirical theory, social-cognitive neuroscience and various other theoretical proponents of NSBL could serve as a conceptual framework to guide and provide a lens through which to conduct this inquiry.

In the view of Ary, Jacobs, Irvine and Walker (2018), novel approaches should be validated through evidence-based empirical studies. It is therefore proposed that qualitative research via expert interviews with neuroscientists and organisational neuroscience experts can contribute to this evidence and provide an understanding of the commonalities in current neuroscience research studies that have been recognised in peer-reviewed articles. This will have both theoretical and developmental implications for understanding leadership behaviour. In addition, it can be an original contribution to add legitimacy to neuroscientific approaches and neuro-correlational research applied to leadership behaviour.

5. Chapter Summary

This chapter aimed to summarise and synthesise the literature on neuroscience-based leadership (NSBL) behaviour. The empirical studies reviewed gave the chance to understand the emerging complexity of the NSBL field, which is increasingly dense and diverse in scope. This literature review also established the current neuroscience-based leadership theories to advance neuroscience-based leadership as a new phenomenon or subfield of leadership.

More generally, the review contributed to the emerging literature that leadership may have an underlying biological basis. NSBL is an emerging construct in a theory-building stage, and practitioners in the field are operating in the absence of a solid theoretical foundation. This may detract from ethical practice or even negatively impact the credibility of NSBL as a nascent field. Due to the developing nature of the construct, there is a great deal of conceptualisation that needs to emerge, and so exploratory qualitative research will be appropriately utilised in this research based on the following six themes identified from the literature to conceptualise NSBL.

- Articulating leadership behaviour: In the context of this study, a leader's most important emerging behaviour is to facilitate the achievement of relationship-oriented and task-oriented goals driven by basic psychological needs.

- Defining Applied Organisational Neuroscience (AONS): A shared definition of applied organisational neuroscience (AONS) does not exist and is evolving rather than definitive. Providing a working definition implies that AONS can enable organisational scholars (including leader-managers) to look at the neurophysiological foundations on which psychological constructs draw, in combination with additional social and environmental factors.
- Defining Neuroscience-based leadership (NSBL). The literature showed common elements to describe NSBL, including knowledge of brain function, the biological micro-foundations and mechanisms of leadership constructs and behaviours, and achieving results through focusing on the individual, teams, and organisational-level processes like change management. The definition can be refined to initiate debate and move the field forward.

- The foundational neuroscientific concepts relevant to NSBL: The literature showed that integrative neuroscience shows how all brain processes are interrelated. This integration results in a diverse yet unified system, dynamic yet coherent. Seven fundamental organising principles (Gordon, 2000, 2003, 2016) were identified. Verifying these organising principles through further research is essential to overcome the confluence of multi-disciplinary theories like neuroscience-based leadership.

- Social Cognitive Neuroscience and Neuropsychotherapy as interpretive lenses: To conceptualise and describe NSBL, both SCN and NP were included based on their strength of evidence in the research literature.

- Core behaviours that describe a neuroscience-based approach to leadership: This study's key focus is articulating core NSBL behaviours. Leadership development can be enhanced if these core behaviours can be clearly articulated. This process will also add validation and legitimation to the field of neuroscience-based leadership (NSBL).

In the following chapter, a small-scale research project will explore the foundational neuroscientific concepts that may underpin NSBL.

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Appendices

Appendix A: Summary tabulation of peer-reviewed articles.

***Strength of evidence (High/Medium/Low)**

Citation	Article Title	Mode	Focus	*H/M/L
			(1) Leadership behaviour articles N=7	
Behrendt, Matz, & Goritz (2017)	"An integrative model of leadership behaviour."	Empirical study	A model of leadership behaviour informed by established psychological theories. Task-oriented behaviours: directed to the accomplishment of shared objectives, and Relation-oriented behaviours: Increasing coordinated engagement of team members. A meta-model that is parsimonious and comprehensive.	High
Contreras, Baykal, & Abid (2020)	E-Leadership and Teleworking in Times of COVID-19 and Beyond: What We Know and Where Do We Go.	Empirical study	This study showed that e-leadership must be able to consolidate and lead effective virtual teams to accomplish organisational goals.	Medium
Dinh, Lord, Gardner, Meuser, Liden, & Hu, (2014)	"Leadership theory and research in the new millennium: Current theoretical trends and changing perspectives."	Theoretical Overview	A framework that provides details on emerging themes and levels of analysis in leadership theory, specific attention is given to how micro and macro processes affect follower and leader outcomes.	High
Hogan & Kaiser, (2005)	"What we know about leadership"	Conceptual Study	A domain model of leadership and evolutionary psychology that proposes a meta-model and taxonomy of leadership: intrapersonal, interpersonal, business and leadership domains	High

Citation	Article Title	Mode	Focus	*H/M/L
Torre & Sarti (2020)	The "Way" Toward E-leadership: Some Evidence from the Field.	Case Study	This research sought to examine whether enterprises that use leadership as an important "tool" to manage workers as effectively as possible are conscious of the evolution of e-leadership and whether their behaviour supports the related needs. (A case study that involved 15 Italian companies. In-depth, face-to-face interviews using a semi-structured questionnaire with enterprises' representatives).	Medium
Van Knippenberg & Sitkin, (2013)	"A critical assessment of charismatic—transformational leadership research: Back to the drawing board?"	Conceptual Study	An argument for clearly defined constructs and empirical distinctiveness in leadership studies.	High
Yukl, (2012)	"Effective Leadership Behavior: What We Know and What Questions Need More Attention."	Empirical study	A hierarchical taxonomy with four meta (categories and 15 component behaviours representing effective leadership behaviour.	High
(2)	**Empirical Organisational Neuroscience studies relating to leadership N=14**			
Bagozzi et al. (2013)	"Theory of mind (TOM)and empathic explanations of Machiavellianism: A neuroscience perspective."	fMRI	Perspective-taking and emotional sharing in managers and its correlation with medial PFC activation provide a richer level of explanation.	High

Citation	Article Title	Mode	Focus	*H/M/L
Balthazard et al. (2012)	"Differentiating transformational and non-transformational leaders on the basis of neurological imaging."	(EEG)	The latent and dynamic Neural mechanisms that underpin transformational leadership behaviour. This research endorses taking alternative approaches to studying transformational leadership.	High
Boyatzis et al. (2012)	"Examination of the neural substrates activated in memories of experiences with resonant and dissonant leaders."	fMRI	Leadership impact on neural mechanisms of followers: Resonance activates (mechanisms relating to positive affect, social network) and Dissonance☹activate neural mechanisms related to avoidance, low compassion, and narrowed attention).	High
Dulebohn et al. (2009)	"The biological bases of unfairness: Neuroimaging evidence for the distinctiveness of procedural and distributive justice."	fMRI	Emotional neural systems are associated with distributive justice, whereas analytical neural systems are associated with procedural justice.	High
Dulebohn et al. (2016)	"Gender differences in justice evaluations: Evidence from fMRI."	fMRI	The influence of Fairness judgments on thoughts, feelings, and actions in males vs females.	High
Feldman Barrett & Satpute (2013)	"Large-scale brain networks in affective and social neuroscience: Towards an integrative functional architecture of the brain."	Theoretical review	A review of current research in affective and social neuroscience that argues for the emerging science of large-scale intrinsic brain networks that can provide a coherent framework for a domain-general functional architecture of the human brain.	High

Citation	Article Title	Mode	Focus	*H/M/L
Hannah et al. (2013)	"The psychological and neurological bases of leader self-complexity and effects on adaptive decision-making."	qEEG	Articulating the psychological and neurological underpinnings of decision-making of military leaders in complex environments.	High
Higgins, Peterson, Pihl, and Lee (2007)	"Prefrontal cognitive ability, intelligence, big five personality, and the prediction of advanced academic and workplace performance."	Neural Psychological Test Battery	Prefrontal cognitive ability and manager performance informed by neural underpinnings.	High
Mason et al. (2009)	"Neural mechanisms of social influence."	fMRI	Focused on neural mechanisms of social influence.	High
Molenberghs et al. (2017)	"The neuroscience of inspirational leadership: The importance of collective-oriented language and shared group membership."	fMRI	The neural mechanism underlying followers' experience of inclusive visions of the future is shared by leaders.	High
Peterson et al. (2008)	"Neuroscientific implications of psychological capital: Are the brains of optimistic, hopeful, confident, and resilient leaders different?"	EEG	Neurofeedback can be used to train the brain and develop psychological capacities in Business leaders.	High
Waldman et al. (2011)	"Leadership and neuroscience: Can we Revolutionise the way inspirational leaders are identified and developed."	qEEG	Inspirational leadership and the potential of neurofeedback interventions for the purpose of leadership development.	High
Waldman et al. (2017)	"A neurological and ideological perspective of ethical leadership."	qEEG	Integrating neuroscience and moral psychology and the role of the prediction of ethical leadership.	High

Citation	Article Title	Mode	Focus	*H/M/L
Waytz & Mason (2013)	"Neural mechanisms of social influence."	fMRI	How networks of brain regions work together to refute the oversimplification of how the brain works in management literature.	High
	(3) Neuroscience and its Application in Organisational and Leadership Behaviour N = 15			
Ashkanasy, Becker, and Waldman (2014)	"Neuroscience and organisational behaviour: Avoiding both neuro-euphoria and neuro-phobia."	Theoretical Overview	A roadmap for multidisciplinary research in organisational behaviour using neuroscientific approaches.	High
Becker, Cropanzano, and Sanfey (2011)	"Organisational Neuroscience: Taking organisational theory inside the neural black box."	Theoretical Overview	Raises meta-theoretical ethical questions -and how levels of analysis can advance and connect theories of Organisational behaviour.	High
Feldman Barrett (2017)	"The theory of constructed emotion: an active inference account of interoception and categorization."	Theoretical Overview	Emotions are dynamic, highly variable whole-brain constructions of what bodily sensations mean in the context of the immediate environment. Emotions are populated with highly variable instances rather than basic types.	High
Draguns, (2007)	"Review of Neuropsychotherapy: How the Neurosciences Inform Effective Psychotherapy (Neuropsychotherapy)."	Theoretical Overview	A neuroscientific explanatory model of psychological functioning based on consistency theory and the meeting of basic psychological needs.	High
Healey and Hodgkinson (2014)	"Rethinking the philosophical and theoretical foundations of organisational neuroscience: A critical realist alternative."	Theoretical Overview	A conceptual argument for a transitional, critical realist paradigm and socially situated cognition as a theoretical bridge to enhance organisational neuroscience.	High

Citation	Article Title	Mode	Focus	*H/M/L
Jack et al. (2019)	"Pitfalls in Organizational Neuroscience: A Critical Review and Suggestions for Future Research."	Critical Reflection	Highlights design logic issues in organisational neuroscience and argues for reverse inference and adopting a broader view of the brain and cognition.	High
Lee, et al. (2012)	"Leadership research and cognitive neuroscience: The state of this union."	Conceptual Study	Suggesting a future symbiosis between the fields of neuroscience and leadership.	High
Lieberman (2007)	"Social Cognitive Neuroscience: A Review of Core Processes."	Conceptual Study	A review of four subsections of social cognitive neuroscience: understanding oneself, understanding others, controlling oneself, and processes between self and others. Two distinct core processes cut across domains. Automatic vs controlled, internal vs external processes.	High
Lieberman, (2012)	"A geographical history of social cognitive neuroscience."	Theoretical overview	The history of social cognitive neuroscience: key contributions (theory of mind, mirror neurons, empathy) and the contributions focusing on self (self-knowledge, emotion regulation, implicit attitudes).	High
Lindebaum and Zundel (2013)	"Not quite a revolution: Scrutinising organisational neuroscience in leadership studies."	Conceptual Study	Scrutinises reductionist assumptions and inferential ambiguities of neuroscience in organisational leadership.	High

Citation	Article Title	Mode	Focus	*H/M/L
Murray & Antonakis (2015)	"Feature Topic: Neuroscience in Organizational Research"	Conceptual Study	A roadmap for the effective integration of neuroscientific methods into Organisational research.	High
Ochsner & Lieberman (2001)	"The emergence of social cognitive neuroscience."	Theoretical Overview	An introduction to and analysis of the field by reviewing current research and providing guidelines and suggested directions for future work. Research areas include stereotyping, attitudes and attitude change, person perception, self-knowledge, and interaction of emotion and cognition.	High
Ringleb & Rock, (2008)	The emerging field of NeuroLeadership: The formalization of NeuroLeadership is driven by the need worldwide.	Opinion Paper	An Opinion paper about NeuroLeadership, as an interdisciplinary field with the objective of improving leadership effectiveness within institutions and organizations by developing a science for leadership and leadership development that directly considers the physiology of the mind and the brain	high

Citation	Article Title	Mode	Focus	*H/M/L
Rossouw, (2013)	"The end of the medical model? Recent findings in neuroscience regarding antidepressant medication: implications for Neuropsychotherapy."	Conceptual Study	The brain as a neural system and the role of enriched environments, specifically talking therapies, to facilitate new effective patterns of neural firing.	High
Waldman & Balthazard, (2015)	Neuroscience of leadership	Theoretical Overview	An overview of how neuroscience as new lens into organisational leadership processes. A description of how neurological scanning can be applied to leadership research and its potential advantages over more traditional techniques, such as surveys, is given.	High
(4) Theory adaptation articles on Applied Organisational Neuroscience N=4				
Garnett, Venter, & Geldenhuys (2022)	"Experiences of emergent change from an applied neurosciences perspective."	Qualitative empirical study	Experiences of emergent change were found to threaten individuals' and teams' basic psychological needs, with a significant impact on the physiological, emotional and interpersonal levels. The participants' experiences reflected a dysregulation in mental operating network activation in response to their compromised needs.	High
Geldenhuys, (2020)	"Valuing and adapting appreciative inquiry to enhance wellbeing using a Neuropsychotherapeutic framework."	Conceptual Analysis	Refining Appreciative Inquiry as organisational development theory using a perspective from Neuropsychotherapy theory.	High

Citation	Article Title	Mode	Focus	*H/M/L
Geldenhuys, (2022)	"A conceptual analysis of the use of systems-psychodynamics as an organisation development intervention: A neuroscientific perspective."	Conceptual analysis	Argues for transformational learning by augmenting systems psychodynamics OD intervention experiences through a better alignment with neuroscientific principles.	High
Mayer & Geldenhuys, (2019)	"Workplace spirituality and wellness: An organisational neuroscientific perspective."	Conceptual Analysis	Spirituality within the workplace can be accelerated using neuroscientific perspectives on mindfulness.	High
(5) Self-report brain diagnostics articles N=5				
DeVarney et al. (2012)	MyBrainSolutions: A Science Overview.	Technical Manual (Empirical results)	Validated assessment methods and protocols for the qualification of brain functions are banked in a central database that can be queried to extract purpose-defined combinations of data to analyse. To date, individuals in the database include a large cohort of healthy norms and various cohorts across the clinical spectrum (Depression, ADHD, schizophrenia, Alzheimer's, PTSD, brain injury. www.mybrainsolutions.com www.brainresource.com www.brainnet.net	High
Gordon, Barnett, Cooper, Tran & Williams (2008)	"An integrative neuroscience platform: application to profiles of negativity and positivity bias."	Empirical study	A sample of 270 healthy participants (18–65 years old) were grouped into equal-sized matched subsets of high "Negativity Bias" and high "Positivity Bias" (n = 135 in each group). This paper provides a demonstration of how an Integrative Neuroscience infrastructure can be used to elucidate the	High

Citation	Article Title	Mode	Focus	*H/M/L
			brain-body basis of trait characteristics, such as Negativity Bias, that are key indicators of risk for poor wellbeing and psychopathology.	
Weinberg (2009)	Accessing the Chemistry of Wellness, Performance and Leadership	White paper	In this article, a working model of the Triangles Model is described, which forms the foundation for accessing the chemistry of wellness and performance. The fully quantifiable online diagnostic which measures stress profiles is explained.	High
Van der Walt, (2017)	Neurozone white paper: Theoretical construction – Model of brain performance	White paper	10 domains or drivers discovered through Neuroscience that can drastically affect the performance of the brain. The 10 “Drivers” of brain performance are underpinned by four core conditions/core competencies that precede brain performance. The white paper is backed up by empirical data.	High
van Wyk, Lipinska, Henry, Phillips, & Van der Walt (2022)	The development and validation of the Resilience Index.	Empirical study	Resilience comprises various neurobiological, developmental, and psychosocial components. Results from 686 participants revealed the emergence of three components: positive affect (α = 0.879), early-life stability (α = 0.879), and stress mastery (α = 0.683). Results confirm that the Resilience Index is a reliable and valid measure that can be utilized in both high- and low-to-middle-income settings.	High

Appendix B: Neuroscience-based dissertations

"United Kingdom

- EthOS http://ethos.bl.uk/
- The British Library's "Electronic Theses Online Service". Search the records of over 400,000 doctoral theses and register to download or order a scanned copy – if available. Many are free to access, and some may have a fee."

"Europe and international

- DART_Europe: http://www.dart-europe.eu/basic-search.php is an online portal for dissertations and theses from universities in 19 European countries.
- Networked Digital Library of Theses and Dissertations (NDLTD): http://www.ndltd.org/
- An international organisation dedicated to promoting the adoption, creation, use, dissemination and preservation of electronic theses and dissertations. Search the catalogue at: http://search.ndltd.org/index.php.
- Open Access Theses and Dissertations (OATD): http://oatd.org/ Search for graduate theses and dissertations from over 1,100 colleges, universities, and research institutions around the world (mainly the US). Currently indexes over 2,000,000 theses and dissertations.
- WorldCat: http://www.worldcat.org/
- A huge catalogue of resources from libraries around the world. Choose Advanced Search and then select "Thesis/Dissertation" in the drop-down "Content" menu."

"Other countries

Australia: http://trove.nla.gov.au/ Trove – the National Library of Australia database. Search and access full text of digital versions of Australian theses. Use the advanced search and limit the format to thesis.

Canada: http://www.collectionscanada.gc.ca/thesescanada/index-e.html Theses Canada portal aims to gather theses/dissertations from members of the Association of Universities and Colleges of Canada.

France:

- theses.fr – http://www.theses.fr/ Aims to include all ongoing and completed French doctoral theses, most have full-text. (You can select French or English language.)
- Theses en Ligne (TEL) – http://tel.archives-ouvertes.fr An open-access collection of multidisciplinary French Ph.D. theses, most are available to download.

Germany: http://www.dissertation.de/ A commercial dissertation provider for German theses. Search for theses via the Deutsche National Bibliothek catalogue (select catalogues then dissertations to see subject areas).

Greece: http://argo.ekt.gr/opac2/zConnectENU.html ARGO: National Documentation Centre – select which databases you want to search.

Hong Kong: http://hub.hku.hk/ The HKU Scholars Hub is the institutional repository of The University of Hong Kong. Select Theses to see HKU Theses Online from 1941 – primarily in English, some in Chinese.

Netherlands: NARCIS (National Academic Research and Collaborations Information System) – contains open-access publications from the repositories of all the Dutch universities and research institutes. Perform a search and select "doctoral thesis" under the Filter options. http://www.narcis.nl/search/coll/publication/Language/EN/genre/doctoralthesis.

New Zealand: http://nzresearch.org.nz/?locale=en Research includes undergraduate, Masters and Doctoral theses from universities and research institutions.

Pakistan: http://eprints.hec.gov.pk/ Pakistan Research Repository aims to archive and digitise all PhD theses.

Scandinavia: http://www.diva-portal.org/smash/search.jsf, an online portal containing research publications and student theses from 28 Scandinavian universities and colleges of higher education.

South Africa: http://www.netd.ac.za/ National ETD Portal – an index of South African theses and dissertations.

Spain: http://www.tdx.cat/ Thesis Doctorals en Xarxa (TDX) – is a digital cooperative repository of doctoral theses from some Spanish universities; most are downloadable.

Sweden: http://www.dissertations.se/ Search over 58,000 dissertations from Swedish universities written in English. Over half are downloadable as PDFs."

Appendix C: Additional Resources *used in Literature Review*

1. Books and journal issues based on theoretical research studies by academics.

The *Annals of the New York Academy of Sciences* dedicated a complete issue (No. 1118) to the social-cognitive neuroscience of organisations. The editors, Butler and Senior (2007), discussed the advantages and confines of cognitive neuroscience and defined the field of organisational cognitive research. Some of the topics covered were how fairness and cooperation are rewarding (Tabibnia & Lieberman, 2007), the neural correlates of camaraderie and teamwork (Levine, 2007), and the business change process and the brain (Yeats & Yeats, 2007).

In the e-book *Society, organisations and the Brain: Building a Unified Cognitive Neuroscience Perspective,* a compilation of articles previously published in the journal *Frontiers in Human Neuroscience*, editors Senior, Lee and Braeutigam (2015b) brought together scholars in both the neurosciences and organisational sciences who have adopted various approaches to studying the cognitive mechanisms mediating social behaviour within organisations. Journal articles featured in this compilation include: "Antagonistic neural networks underlying differentiated leadership roles" (Boyatzis, Rochford, & Jack, 2014), "The evolution of leader-follower reciprocity: The theory of service-for-prestige" (Price & Van Vugt, 2014); and "A sociogenomic perspective on neuroscience in organisational behaviour" (Spain & Harms, 2014).

Critical Neuroscience: A handbook of the social and cultural contexts of neuroscience (Choudhury & Slaby, 2012) covered topics such as the "neural correlates of depression" (Vidal & Ortega, 2012), the "origins of the social brain" (Young, 2012), and the "future of critical neuroscience" (Kirmayer, 2012). One conclusion reached in this book is that researchers in the social sciences should engage in constructive partnerships and collaboration with neuroscientists.

Organisational neuroscience (Waldman & Balthazard, 2015a) discusses research relating to leadership constructs like procrastination, empathy, and implicit bias.

Another textbook, *Neuroleadership: A journey through the brain for business leaders* (Ghadiri, Habermacher, & Peters, 2013), offers information about the application of neuroscience in leadership using Grawe's (2007) taxonomy of four basic human psychological needs: attachment, orientation and control, self-esteem, and pleasure-seeking.

Popular books by key proponents of NSBL were also perused, such as *The Neuroscience of Leadership* (Swart, Chisholm, & Brown, 2015); *Your Brain at Work* (Rock, 2009), and *Leadership Coaching for Results* (Stout-Rostron, 2014). These publications cover themes linked to the application of neuroscience in leadership practices, such as social cognition, the mirror neuron system, emotional contagion, cognitive bias, neuroplasticity, mindfulness, and cortisol contagion vs stress inoculation.

Advances in translating neuroscience into practice were provided by publications of the Royal Society (2011) and the Society for Neuroscience (2008). These publications focus on how neuroscience can inform education and also apply to leadership and organisational behaviour.

2. Neuroscience-based leadership dissertations

A review of NSBL dissertations demonstrated that this is a new field. This integrative literature review aimed to combine perspectives from diverse fields (Snyder, 2019); therefore, a search was also done on NSBL dissertations via various universities' institutional repositories. This search was done using the databases set out in Appendix A. There were 19 databases searched using the search criteria of "neuroscience-based leadership" and "neuroleadership". The search criteria resulted in 16 hits, of which five dissertations were of relevance to the current literature review.

The dissertation by Ramachandran (2011) attempted to pinpoint the "neural predictors of effective leadership decision-making". This study measured corporate leaders on various neuropsychological indices of prefrontal brain function. The findings indicated that executive function incrementally predicts complex decision-making and transformational leadership effectiveness beyond general mental ability. This research is an example of how the biological variables of leadership can be identified, although a replication study on a larger dataset is yet to be done to add to the validity of the findings.

The dissertation by Bloem (2012) explored the disparity between a dysfunctional and a highly functional mindset in personal leadership through both leadership literature and the field of neuroscience. This study proposed a brain-based perspective on personal development and highlighted five key themes of the functional mindset: "consciousness, connection, confidence, control and choice". The constructs of mindfulness and emotional regulation were also proposed as elements of the functional mindset. This research contributes to the study of brain-based leadership and provides potential for further development of the indicators of NSBL.

The thesis by Williams (2014), a qualitative content analysis study of 50 business schools, was done to determine the extent to which neuroscience findings were represented in business school curricula. Emerging themes indicated that interdisciplinary collaboration is key to advancing academic rigour in validating this new field. The findings also indicated emerging themes like problem-solving, decision-making, and self-regulation rather than a specific relevant model of NSBL.

The constructivist, grounded theory research by Cunningham (2017) demonstrated that neuroscience findings could inform the executive coaching process. The theory of brain integration derived from the field of interpersonal neurobiology by Siegel (2001) was deployed to link how the nine domains of integration can assist in deeper self-awareness, personal meaning, and wellbeing for coachees, enabling sustainability of the coaching impact.

These nine domains of integration provide behavioural indicators of an applied neuroscience-based approach, including.

> “The ability to cultivate the power of awareness to create choice and change (integration of consciousness); the ability to value both logic and feelings (bilateral integration); the ability to process intense emotional data without volatile reactions but with reflective awareness (vertical integration); and the ability to become an active author and sense-maker of one’s life story and past experiences -defined as memory integration” (Cunningham,2017)

The thesis by Coetzer (2019) provided evidence that teaching leaders about social cognitive neuroscience can accelerate behavioural change.

The reviewed research studies highlighted a promising collaboration between neuroscience and leadership research, which may offer positive results for leadership theory development and practices.

Appendix D: *Towards Neuroscience-based Leadership Behaviours*

A synthesis of the neuroscientific empirical studies conducted within the leadership domain as well as the theoretical review studies on NSBL, are shown as possible core behaviours in either the Task-Oriented or Relations-Oriented dimensions of leadership (Yukl, 2012; Behrendt, Matz, & Goritz, 2017) in Table 1. Behrendt, Matz, & Goritz (2017) proposed a meta-model of leadership behaviour informed by established psychological theories. Task-oriented behaviours are directed at accomplishing shared objectives, and relation-oriented behaviours increase the coordinated engagement of team members. These behavioural dimensions are also informed by recent neuroscience research that suggests that the division between task-oriented and socio-emotional leadership roles stems from a central neurobiological feature: an antagonistic relationship between two large-scale cortical networks in the human brain (Boyatzis et al., 2014), although criticism has been raised against this "split-brain theory" of behaviour (Lindebaum & Zundel, 2013). Neural activity in the task-positive network (CEN) is inclined to inhibit activity in the DMN and vice versa. The task-positive network is triggered during a wide range of non-social tasks (Andrews-Hanna, 2012). It is correlated with focusing attention, making decisions and solving problems. The DMN plays a key role in emotional self-awareness, social cognition and ethical decision-making. The anti-correlation between the task-positive network and DMN creates a fundamental neural constraint on cognition that is relevant to the different roles and capabilities that effective leaders must astutely manage and use in their leadership roles.

Empirical studies reviewed: Bagozzi et al. (2013) studied perspective taking and medial PFC activation; Balthazard et al. (2012), differentiated transformational and non-transformational leaders on the basis of neurological imaging; Boyatzis et al. (2012), studied the neural substrates activated in memories of experiences with resonant and dissonant leaders; Dulebohn et al. (2009); studied the biological bases of unfairness; Dulebohn et al. (2016), gave evidence from fMRI about gender differences in fairness evaluations; Feldman Barrett & Satpute (2013); Hannah et al. (2013), showed the psychological and neurological bases of leader self-complexity and effects on adaptive decision-making; Higgins, Peterson, Pihl, and Lee (2007), researched, prefrontal cognitive ability and manager performance informed by neural underpinnings; Mason et al. (2009) studied the neural mechanisms of social influence; Molenberghs et al. (2017) studied the neuroscience of inspirational leadership; Peterson et al. (2008) showed how neurofeedback can be used to train the brain and develop psychological capacities in business leaders.

Appendix D - Table 1: Task-Oriented and Relations-Oriented NSBL behaviours

Synthesis of NSBL behaviour	Author
Relations-oriented:	
Is aware of the minimise danger / maximise reward principle and the innate negativity bias in the brain. Deliberately focus on deploying positivity in interpersonal interactions. Acts fairly to ensure approach motivation is activated.	Gordon (2003); Lieberman (2007). Dulebohn et al. (2009; 2016)
Aligns non-conscious/conscious processing by cultivating awareness of facial expressions and body cues and training their brains to pick up on positive cues.	Lieberman (2007); Gordon et al. (2008).
Down-regulates distress by building perceived control into their lives through exercise, nutrition, mindfulness and sleep hygiene.	Ghadiri et al. (2013).
Uses affect-labelling and reappraisal to down-regulate emotional distress.	Lieberman (2007); Ringleb et al. (2012).
Understands social cognition, mirror neuron systems, and emotional contagion and how it impacts group sub-climates.	Becker et al. (2011); Ochsner and Lieberman (2001); Lieberman (2007); Ringleb et al. (2012); Mason et al. (2009); Peterson et al. (2008)
Minimises exclusion of team members and cultivates in-group dynamics through perspective-taking, empathy, and trust.	Lieberman (2007); Boyatzis, Passarelli et al. (2012); Ringleb et al. (2012); Eisenberger (2012); Bagozzi et al. (2013)
Builds enriched environments through non-directive conversations, reflective questioning, **resonance,** and acting as a thinking partner.	Grawe (2007); Boyatzis et al. (2012) Molenberghs et al. (2017);
Task-oriented:	
Differentiates between task-positive and task-negative (socio-emotional) leadership roles and is cognisant of deploying this when relevant to the assignment at hand.	Lieberman (2007); Boyatzis et al. (2014); Higgins et al. (2007),
Applies goal-directedness and intrinsic motivation to achieve goals.	Becker et al. (2011); Di Domenico and Ryan (2017).
Deploys brain-plasticity principles like attention density to develop new habits to build change resilience.	Kandel (1998); Grawe (2007); Rossouw (2013); Ghadiri et al. (2013). Hannah et al. (2013

Appendix E: Foundational Principles of NP theory

Source: Rossouw, 2014 p. 60

Neurospychotherapy is a new approach yet well-established it has deep roots in the writings of Sigmund Freud (1895). There are significant ties throughout contemporary psychiatry, psychology, and psychotherapy that may be found in Neuropsychotherapy. This method is both novel and long-standing at the same time. Foundational principles include:

1. Facilitate safety: physical safety by maintaining therapeutic respect, boundaries and ethical behaviour, and emotional safety through high levels of respect and acceptance;
2. Facilitating patterns of approach: down-regulate distress, establish a therapeutic rapport from right brain to right brain;
3. Enhance therapeutic attachment: the essence of the social brain and the basic need to connect;
4. Enhance a sense of control perspective through a non-directive, client-centred focus and effective pacing of the process, allowing down-regulation of stress chemical activation;
5. Enhance limbic control and down-regulate stress chemical activation by shifting unhelpful systems of forced forgetting (avoidance)to actively shift to narratives of survival (Rossouw, 2013b);
6. Increase hippocampal functioning through temporal contextualization (what happened then is not happening now and is not likely happening in the future)
7. Strengthen hippocampal capacity through the introduction of mindfulness (Wallwork & Rossouw, 2014) and caping controllable incongruence (Rossouw, 2013);
8. Facilitate a shift in cortical blood flow to the frontal regions through control and mindfulness;
9. Enhance solution-focused action through cognitive empowerment and support ongoing activation to strengthen new neural patterns; provide support to enhance dopamine and serotonin release (Rossouw, 2013 d);
10. Assess and provide psychoeducation in regard to medication in collaboration with other health professionals (Rossouw, 2013c);
11. Provide psychoeducation to support ongoing activation of new neural connections to shift the unhelpful neural activation of previous default patterns of pathology (avoid patterns of pathology) into new patterns of engaging (approach patterns) (Voelkerer & Rossouw, 2014);
12. Provide psychoeducation to enhance capacity through healthy patterns of sleep, nutrition, exercise (Chiang & Rossouw, 2014) and social interaction (Rossouw, 2014)

Chapter Three: Small-scale research project

Title: Towards articulating the foundational concepts and constructs of neuroscience-based leadership: Perspectives of experts in the field of neuroscience-based self-report diagnostics

Abstract

Background: A frequently used method of studying the brain correlates of behaviour is the use of neuropsychological assessments, which are unique in predicting brain function. These diagnostics are self-report inventories, adhere to psychometric principles, and are minimally intrusive in collecting brain-based data. This highlights the potential value of brain-based techniques for measuring and developing leadership behaviour.

Aim: Firstly, to investigate the core foundational neuroscientific concepts that underpin constructs measured in self-report brain diagnostics used in leadership development. Secondly, to articulate how applying a neuroscience-based approach is relevant to leadership behaviour in formal organisations.

Method: Semi-structured, in-depth interviews were conducted with three neuroscientists who have employed neuroscience-based diagnostics at the leadership level within a corporate context. A qualitative interpretive analysis was used to examine the research data.

Results: The study revealed the following foundational concepts of neuroscience-based leadership behaviour from the perspectives of experienced professionals: social safety is a primary operating principle; neurotransmitters and mood states; conscious thinking and non-conscious processes drive behaviour; nature-nurture dynamics influence behaviour; experienced-based neuroplasticity drives change; overlapping networks enable information processing in the brain and a complex brain-body system that continuously adapts to its current environment.

Secondly, the study showed that applying a neuroscience-based approach is relevant to leadership behaviour in formal organisations. This was captured in three themes demonstrating that incorporating a brain-based approach to leadership behaviour enables the development of resilience, group cohesion, problem-solving, and goal pursuit.

Conclusion: This chapter aimed to define core neuroscientific concepts that underpin leadership behaviour. This was done by synthesising literature and research from expert interviews. This synthesis of foundational concepts and their implications for leadership behaviour contributes to conceptualising NSBL.

Key words: neural foundations, core-concepts, neuroscience-based leadership, self-report diagnostics.

1. Introduction

This small-scale research project is an exploratory study using qualitative interpretive research methods. In-depth expert interviews were conducted with experts in the field of neuroscience-based diagnostics. The study aims to report on the perspectives of neuroscientists on the theoretical neural foundations and foundational concepts measured by neuroscience-based self-report diagnostics and the implications these foundational concepts have on gaining a deeper insight into leadership behaviour.

2. Background and Context of the study

Neuroscientific applications in leadership research have demonstrated that (a) neurological distinctions can be made based on leadership content conceptualisations, such as transformational leadership (Balthazard, Waldman, Thatcher, & Hannah; 2012) and ethical leadership (Molenberghs et al., 2017), and (b) neuroscientific assessments can enrich our understanding of leadership processes and outcomes beyond traditional psychometric measures (Waldman and Balthazard, 2015)

Neuroimaging and Neurosensing modalities provide a measurement approach with greater biological validity than self-report methods such as surveys. Neuroimaging can be performed when the brain is stimulated (i.e., reflexive) or when the brain is at rest (i.e., intrinsic) - both approaches are potentially helpful (Waldman and Balthazard, 2015)

This chapter explores neuroscience-based self-report diagnostics to understand the core neuroscientific concepts that inform a brain-based approach to leadership behaviour. The literature reviewed in Chapter Two delivered three empirical studies (DeVarney et al., 2012; Gordon et al.,2008; van Wyk, et al., 2022) and two white papers (Weinberg,2009; Van der Walt, 2017) on neuroscience-based self-report diagnostics.

To develop and articulate the foundational concepts that underpin NSBL behaviour, it is sensible to report on what good and clear conceptualisations entail. According to Gerring (2012, p. 112), concept formation lies at the heart of all social science endeavours; "It is impossible to conduct work without using concepts. It is impossible even to conceptualise a topic without putting a label on it. Concepts are integral to every argument, for they address the most basic question of social science research: what are we talking about?"

This quote talks about the importance of conceptual clarity in ensuring scientific progress. According to (Podsakoff, MacKenzie, & Podsakoff, 2016), inadequate conceptual definitions remain an issue for organisational, behavioural, and social science scholars. These authors also argue that concepts serve as fundamental building blocks of theory, allowing researchers to organise complex phenomena with a common language that, when implemented well, facilitates communication between researchers (Podsakoff et al. (2016).

Hopefully, this chapter will contribute to articulating the foundational neuroscientific concepts that underpin NSBL in a clear, adequate and correct manner, steering away from careless or subjective definitions. To guide this study, the definition of a concept by Podsakoff et al. (2016, p. 161) is adopted; they define concepts as "Cognitive symbols (or abstract terms) that specify the features, attributes, or characteristics of the phenomenon in the real or phenomenological world that they are meant to represent and that distinguish them from other related phenomena". Also, a concept is a "cognitive symbol that has meaning for the scientific community that uses it".

In view of this, the focus of this chapter is to build on the concepts discussed in Chapter Two's literature review. P1 Literature reviews establish the foundation for academic enquiries. So far, an appraisal has been done of the scholarly articles and white papers relating to three self-report brain diagnostics involved in leadership development that measure brain capacities that can contribute to identifying and articulating core behaviours of NSBL. These are the MyBrain Solutions Leadership Assessment (Gordon, Barnett, Cooper, Tran, & Williams, 2008), the NeuroSurge diagnostic (Weinberg, 2009), and the NeuroZone diagnostic (Van der Walt, 2017a).

The concepts identified in the literature relating to each self-report diagnostic were synthesized using the framework of Integrative Neuroscience, built on the evidence of coexisting rules of a dynamic working brain (Gordon, 2000, 2003, 2016). Integrative Neuroscience includes a multidisciplinary approach concerned with how all brain processes are interrelated. This integration leads to a diverse yet unified, dynamic yet coherent system, highlighting the following fundamental organising principles. The synthesis of the three instruments yielded the following seven concepts:

- Specialised survival networks help us to avoid danger and minimise pain.
- All information transfer in the brain consists of electrochemical processes.
- Incoming information is processed fast via reflexive networks or, if a mismatch occurs, more slowly via reflective networks.
- Inherited genetic thresholds modulate neural functions.
- Adaptive needs are met through neural pruning or neural plasticity (long-term potentiation).
- Multiple interconnected neurons constitute overlapping networks that interact to execute mental functions.
- The whole brain and body are a highly interconnected system, functionally and anatomically.

The relevance of these concepts to leadership behaviour relates to gaining insights into intrinsic brain processes that are important for workplace performance that can motivate leadership to build the capacity to self-regulate and co-regulate emotions, feelings and thinking. Thus, understanding these neuroscientific concepts and insights will help the productivity and mental health of the leader and those being led (Gordon, 2008).

Critique on neuroscience-based self-report diagnostics

The literature review highlighted three self-report diagnostic tools that measure brain capacities, brain drivers and archetype constructs that can contribute to identifying and articulating leadership core behaviours.

It would seem that, on the surface, comparing these self-report diagnostics is fraught with conceptual difficulties. The constructs measured are defined differently: the MBSLA measures "brain capacities", the Neurosurge instrument measures "archetypes", and the Neurozone instrument measures "drivers" of brain performance. See Appendix A for the constructs measured by these three self-report diagnostics.

Despite the various constructs measured, the underpinning foundational principles and core neuroscientific concepts reported in the technical manuals of these self-report diagnostics did show similarities. They were integrated with the broader literature as reported in Integrative Neuroscience.

3. Rationale for the Study

Although we are far from using neuroimaging techniques to gauge leadership behaviour, brain-based self-report diagnostics are available to infer brain functioning at work and aim to train the brain for optimal performance and wellbeing. Various "brain training" programmes emerge that use a systematic stance to shape multiple aspects of brain connection and behaviour.

This has motivated the researcher to explore the current thinking frameworks and diagnostics used by neuroscientists working in formal organisations. Groups that may benefit from this study include organisational psychologists, organisational development (OD) practitioners, and coaches and consultants working with individuals and organisations focusing on leadership development.

4. Study aims and research questions

The study has two main aims. Firstly, to investigate current neuroscience-based diagnostics or psychometrics used in leadership development, the constructs they measure, and the theoretical foundations that underpin these diagnostics. Secondly, to articulate the relevance for leadership behaviour with specific application to leadership in formal organisations.

This study is aimed at answering the following research questions:

Research Question 1: What foundational neuroscientific concepts underpin constructs measured in self-report brain diagnostics used in leadership development?

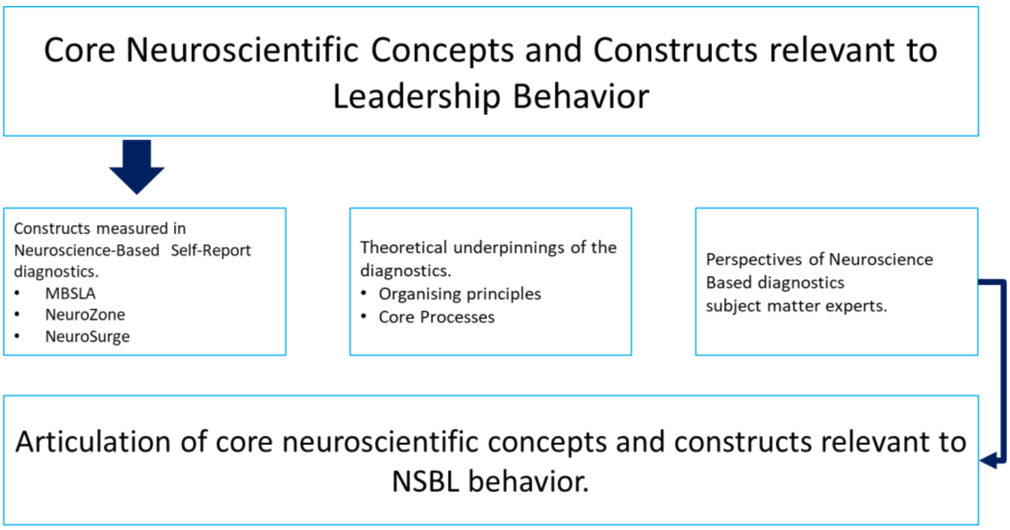
Research Question 2: What is the relevance of applying a neuroscience-based approach (neuroscience self-report diagnostic constructs and underpinning foundational concepts) for leadership behaviour in formal organisations?

This small-scale research project will contribute to the knowledge base of applied organisational neuroscience and leadership development by answering these questions.

The conceptual framework for the study is set out in Figure 1.

Figure 1

Conceptual framework of the study (developed by the researcher, 2018)



5. Delineations and assumptions of the study

This research focuses on neuroscientists' expert views in articulating the core behaviours of neuroscience-based leadership using neuroscience-based diagnostics as a cornerstone. Perceptions of leaders or practitioners applying neuroscience-based behavioural models may differ from subject experts in the field and are not included in the sample group.

The subject experts included in the study were neuroscientists who work with leaders in an organisational setting. The study was conducted primarily in South Africa. Still, the experts interviewed have a global reach (including the USA, United Kingdom, Australia and Canada), both as experts and via the neuroscience-based diagnostics they have developed.

This study assumes that using a neuroscience-based approach to leadership behaviour may help improve the deployment of approaches that enhance the sophistication of describing leadership behaviour (for example, understanding how suppressing emotions diminishes trust between conversation partners).

Understanding a construct's underlying brain mechanisms can increase trust and understanding. For example, in the setting of chronic pain management, Louw, Zimney, Puentedura, & Diener (2016, as cited in Tabibnia & Radecki, 2018, p. 74) provided convincing evidence from randomised controlled trials, that "therapeutic neuroscience education (educating patients about the neurophysiology of pain and how the brain can adjust the experience of pain) improves intervention outcomes, such as diminishing the experience of pain and disability". Thus, as with physical pain, workplace behavioural constructs might be better understood and managed with an improved insight into the underlying brain processes and mechanisms.

6. Research Methodology

This section presents the methodology used to explore the findings of the literature review in relation to the research questions. Exploratory Qualitative research was used to gain in-depth perspectives of neuroscientists who consult in formal organisations and conclude how these experts approach neuroscience-based leadership.

6.1 Research approach: Qualitative interpretive

This research aims to articulate the foundational neuroscientific concepts of a neuroscience-based approach to leadership behaviour. As such, it is based on expert perspectives and experiences. Babbie and Mouton (2005) hold that qualitative research allows the researcher to gain insights into and describe human behaviour rather than attempting to explain it statistically and quantitatively.

According to Bhattacherjee (2012, p. 105), the interpretive approach is best suited for exploring unknown reasons behind interrelated, complex, or multifaceted social processes. Interpretive research also helps find interesting and relevant research questions and issues for follow-up research, despite the current debate on and lack of standards for sample size associated with a qualitative research design.

One benefit of using this design is that data saturation can be easily achieved (Guest, Bunce, & Johnson, 2006). A disadvantage of the qualitative interpretive approach is that working with raw data results in the researcher being biased to individual subjectivity about neuroscience-based leadership phenomena. Participants had to recall their interpretations of neuroscience-based leadership, which may lead to inaccurate recollections (Creswell, Hanson, Clark Plano, & Morales, 2007).

6.2 Sample and sampling method

According to Klenke (2008), the focus of a qualitative inquiry is usually the deliberate selection of a single setting or group on a relatively small scale. Thus, a few information-rich cases will offer insights into the research question. The population of this project comprised neuroscientists, organisational neuroscience academics, and neuroscience expert consultants who developed or deployed neuroscience-based diagnostics in leadership development.

To conduct a trustworthy research interview, the requisite number of experts needs to be defined (Bogner, Littig, & Menz, 2009). Purposeful sampling matched the rationale of this project. The logic and substance of purposeful sampling lie in choosing information-rich cases for in-depth study (Fischer, 2006). Information-rich cases are those from which the researcher can identify several issues of importance to the purpose of the research.

Prospective participants were identified according to the following criteria: substantial experience in neuroscience-based leadership diagnostics, relevant work experience in NSBL, level of public recognition, and a track record of neuroscience-based leadership diagnostics experience. According to Bogner et al. (2009), both the experts' specific interpretive knowledge ("know-why") and procedural knowledge ("know-how") should be considered in their selection.

The profiles of the respondents are set out in Table 1. The sample may not be statistically significant in size. Still, the knowledge base of the respondents will provide information-rich insights. It is noteworthy that Freud founded the field of psychoanalysis based on less than ten client cases over a protracted period (Babbie, 2007).

Table 1

Profile of respondents

Description of respondent type	Number in sample
Consultant neurosurgeon	1
Consultant neurologist	1
Consultant neuroscientist	1
TOTAL number of respondents	3

6.3 Data collection method: Semi-structured expert interviews

Expert interviews aimed to validate and expand on the frameworks and models, theories and diagnostics found in the literature. The expert interview aims to attain supplementary unknown or trustworthy information, respected views, and professional appraisals of the research subject matter. Expert interviews involve open-ended questions allowing the expert to share their interpretation and view on the issue under study (Bogner et al., 2009).

The interview occupies a privileged position among the different qualitative research methods used in leadership research. It involves a conversation and negotiation of meaning between interviewer and interviewee. The interview is, in essence, a form of social interaction grounded in talk (Klenke, 2008).

The research instrument was an in-depth semi-structured interview schedule targeted specifically to gain experts' information in addressing the defined research questions. Expert interviews have substantial benefits over other approaches to data collection. For example, because the respondents are vastly experienced in the field under study, it eliminates the need to use further screening and explicatory questions to illuminate true but covert views. This type of survey is uniquely targeted at attaining reliable data because respondents are highly competent (Bogner et al., 2009).

According to Dorussen, Lenz, and Blavoukos (2005), the inclusion of closed-type questions in the expert interview has potential, but only with the full assurance of the researcher on the accuracy of their hypotheses. It is more likely that interviews would be semi-structured, allowing the researcher to probe and explore additional points of interest raised by the participants during the interview (Jamshed, 2014).

An invitation was sent out to experts to participate in an academic research study. This included an introductory letter that clarified the purpose of the research and stressed the interview's terms and conditions and the data to be collected. Appendix B (the PhD fact sheet) details the PhD study programme.

Participants who accepted the invitation did so voluntarily, and the highest degree of ethical standards was maintained. The confidential nature of the interview and the research findings were emphasised in the invitation.

The interview schedule /research instrument (See Appendix C) was divided into three sections:

- *Section 1* describes the key terms in the interview, such as defining a core behaviour and the scope of neuroscience-based leadership.
- *Section 2* included questions that addressed the professional biography and details of the respondents. Babbie and Mouton (2001) indicate that the sequence of collating the interview questions impacts responses. Therefore, they advocate shorter, less intimidating, and closed-ended questions at the commencement of the interview to lay a strong foundation for the remainder of the interview.
- *Section 3* addressed the experts' opinions on applying neuroscience-based diagnostics in leadership behaviour development. These were open-ended questions, endeavouring to mine meaningful data.

Participants who volunteered completed a consent form (Appendix D), which included details pertaining to the nature and purpose of the interview and indicated that it would be recorded.

The generation of knowledge took place through semi-structured, in-depth interviews. Virtual and face-to-face interviews with experts at their places of business were conducted and generally lasted 90 minutes. The interviewer established rapport, introduced the topic, and then directed the discussion with questions. To safeguard the reliability of the research, the interviews were recorded, and handwritten notes were taken. The interviews were subsequently transcribed by a professional transcriber. The researcher checked each transcription and made the necessary corrections to the recordings.

6.4 Data analysis and interpretation

Data were stored and analysed in NVivo 11. The three interviews were recorded, transcribed, and then imported into NVivo as an MS Word file. Written notes from field notes, Portable Document Format (PDF) documents and websites were all imported into the NVivo project. Data were exported from NVivo to MS Excel to produce figures and tables throughout the study.

Due to the developing nature of the neuroscience-based leadership knowledge base and the exploratory nature of the research question, this small-scale research project used thematic analysis to allow for meaning to arise. The guidelines set by Podsakoff et al. 2016 were used to articulate the concepts set out in Appendix E.

The data analysis was also conducted with the research questions in mind. As per the rules for generic qualitative research set out by (Percy, Kostere, & Kostere, 2015), the researcher used thematic analysis with constant comparison (CC). The data was analysed as it was collected. The analysis begins during the collection of data. The first participant's data was analysed, and as each subsequent participant's data was analyzed, they were compared to the previously analyzed data.

The analysis constantly moved back and forth between current data and the already coded and clustered data into patterns. Patterns and themes changed and grew as the analysis continued throughout the process (Percy et al., 2015). See Appendix F: Thematic Analysis with Constant Comparison (CC)

Hsieh and Shannon (2005, p. 1278) defined qualitative thematic analysis as "A research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns.

According to Hsieh and Shannon (2005), conventional data analysis is commonly employed as part of an inductive exploration when knowledge is inadequate. This was confirmed by the approach of Bhattacherjee (2012), who stipulated that analysing the data inductively allows for the theory to emerge from the data.

A “within-case” and a comparative “cross-case” data analysis were adopted

The researcher used the guidelines suggested by Bazeley (2013) for data analysis and to derive themes:

- Each of the transcripts was read from beginning to end at least three times to gain a deeper understanding of the data.
- Each transcript was then read word by word, highlighting concepts and meanings associated with neuroscience-based leadership behaviour.
- A within-case and a comparative cross-case data analysis were adopted, as Bazeley (2013) suggested. This involved analysing each participant’s data or “case” separately. This resulted in 91 codes and 26 nodes/categories being established.
- The in-depth within-case analysis laid the groundwork for further analysis, which entailed comparing the data sets from all three participants or cross-case analysis (Bazeley, 2013). This analysis phase aimed to determine if the patterns and relationships established in individual cases were similar across all cases.
- The cross-case analysis entailed the following actions:
- Identifying common themes across all three cases throughout the qualitative data analysis.
- Identifying and comparing patterns and relationships between concepts across the three cases. This aimed to determine whether the previously mentioned interpretations were unique to individual cases or common to all three cases.
- Distinguishing and explaining similarities and differences between the three cases.

Seven core themes were defined. See Appendix G for NVivo codes and word clouds.

7. Validity and reliability

In qualitative research, validity and reliability are not determined through statistically validated instruments. Instead, the trustworthiness of qualitative results can be described through the authenticity and exactness of the data (Babbie, 2007).

The trustworthiness of expert interviews was primarily achieved through the proper selection of participants. In this study, the participants were qualified neuroscientists who are experienced in neuroscience-based diagnostics and its application in formal organisations and for leadership development, thereby increasing the authenticity of the results. Secondly, data triangulation was carried out by deploying different diagnostics of data collection, and theoretical triangulation was done by comparing different theories and perspectives. The expert interview process allows participants to reflect on their understanding of the phenomenon. After completing the transcriptions, member-checking was done as a third strategy to ensure trustworthy results.

Member-checking is a quality control process by which a researcher seeks to improve the accuracy, credibility and validity of what has been recorded during a research interview (Harper & Cole, 2012). Member-checking was performed by sending the interview transcripts to the participants, requesting them to read them, and offering any essential comments or amendments (Carlson, 2010).

Member-checking also involved frequent contact with the participants throughout the data collection and analysis and verifying certain explanations and themes resulting from the data analysis (Curtin & Fossey, 2007). Follow-up or "validation interviews" were done to verify whether the findings had integrity (Buchbinder, 2011).

Finally, an audit trail was kept by monitoring and recording all the research-related undertakings and data, including the raw interview data, the audio recordings, the researcher's diary, and the researcher's coding book.

8. Ethical Conduct

According to Kerlinger and Lee (2000), the ethics of human science research relate to what is correct and what is incorrect in the conduct of the research. In this regard, the researcher signed and submitted all necessary documents as required by the Ethics Committee of Canterbury Christ Church University (CCCU).

Regarding this study, issues like voluntary participation, informed consent, confidentiality, anonymity, data storage, and dissemination of results and feedback were complied with. These issues were addressed within the current project in the following ways. Participation was voluntary; participants were truthfully and carefully informed about the nature of the research, and each signed a consent form. All information is kept confidential, and the names of the experts interviewed are not disclosed. The interview transcripts were sent to the participants, and the dissemination of results was made available to participants upon request.

To demonstrate the researcher's duty of care and commitment to ethical considerations, the following was provided to prospective participants:

- A PhD fact sheet (Appendix B).
- The interview schedule was distributed to the participants before the interview (See Appendix C).
- The Research Consent Form (Appendix D) was reviewed with the participants.

Participants and the researcher retained signed copies of these documents.

9. Results and Discussion

This section contains the results from the semi-structured interviews with experts in the field of neuroscience-based diagnostics. It answers the research questions delineated at the start of the chapter, and the data are interpreted in the context of the literature review.

The experts' views were elicited based on the two primary research questions, with the key focus being articulating the neuroscientific concepts that might underpin leadership behaviour. This was done within and across cases, as set out in the research design.

9.1 Research Question 1: Foundational neuroscientific concepts that underpin a neuroscience-based approach.

To ground the presentation of results in the respondents' feedback and examples provided, a writer's synthesis was done to infer relationships among the primary sources, namely, the literature, peer-reviewed articles, and expert interviews.

The following themes emerged:

1. Safety first dominates brain function.
2. Neurotransmitters and mood states.
3. Conscious and less conscious processing.
4. Epigenetics: nature-nurture dynamics.
5. Experienced-based neuroplasticity drives change.
6. Core processes and overlapping networks
    - 6.1 Core processes and overlapping networks: Body-feeling processes.
    - 6.2 Core processes and overlapping networks: Social-emotional processes.
    - 6.3. Core processes and overlapping networks: Cognitive thinking processes.
7. The brain is a self-organised system continuously adapting to the current environment.

The results of this research question are explained in Table 2. This is done per theme with associated quotations from the participants.

Table 2

Results for research questions per theme

Themes	Sample quotes from participants
1. Safety first: Threat avoidance overrides reward-seeking	"The brain pays attention to the most basic cue that threatens its survival, which is part of the brain state, and it unconsciously does that in a low-energy / high-yield way; simply, we avoid threats and maximise rewards."
2. Neurotransmitters: Mood states are electro-chemically correlated	"The archetypes, ultimately, were developed from their biological models because we actually profiled the *chemistry*. You would have to use a diagnostic which was based, originally, on a *chemical profile*."
3. Conscious (slow) vs less conscious processing (fast)	"I think leaders are always blown away by the fact that … where you make 99% of your decisions is at that non-conscious level, and if you can't elucidate some of that and bring it into conscious[ness] about why you have these biases and why you might make decisions in certain ways, you're certainly not effective as a leader." "The brain's processing is vastly unconscious – for example, value tagging is a process that motivates us to approach or avoid engagement."
4. Epigenetics: Nature-nurture dynamics	"If you come from a good nurture environment, you've got a bigger hippocampal-to-amygdala ratio. If you come from a fearful environment with high deprivation, your amygdala to the hippocampus [ratio] is much higher. You can actually measure this on an MRI. And, so, in deprivation in the child, you're going to have a high amygdala-hippocampal volume ratio."
5. Experience-based neuroplasticity	"Five core elements are the elements that have been shown in the literature, in our experience, in our research, and have been the things which *promote neuroplasticity*. And, by the way, those are the same things used in a neuro-rehabilitation environment because you also have to grow new neuronal processes there."
6.1 Core processes: Body / Feelings	"Physiologically speaking… before we even get to mind-stakes, is, obviously, adequate sleep, exercise is critical because it produces the correct neurotransmitters that drive mood."
6.2. Core processes: Social-emotional	"We're wired for empathy, and its *neurotransmitter is oxytocin*. Why are we wired for that? In our neurobiological heritage, there came a time when we had to start having offspring/children. Now, immediately, it wasn't just about me and my survival. It is about the support of another helpless entity that needs support."
6.3. Core processes: Cognitive / Thinking	"The learning capacity and innovation capacity form the problem-solving machine." "Goal-directedness can be seen in our model as the spring that propels you to achieve a goal."
7. A complex adaptive system: environment	"It's impossible to map the brain as a complex system, but at least we continue to build the brain code for high performance, from basic to sophisticated, from keeping us alive, to ensure we survive and enabling us to thrive. We continue to discover behaviours and sub-constructs contributing to this process."

These foundational neuroscientific conceptual foundations are discussed in detail in the following sections, in which each theme from the research findings is reviewed together with sample quotes from participants.

9.1.1 Theme 1: Safety first: Specialised survival networks help us to avoid danger and minimise pain.

All participants suggested that survival is the primal operating principle of the brain. The following interview quote from a participant highlights this:

> "The brain pays attention to the most basic cue that threatens its survival, which is part of the brain state, and it unconsciously does that in a low-energy / high-yield way; simply, we avoid threats and maximise rewards."

This is confirmed in the literature. Specialised survival networks help humans avoid danger and minimise pain (Gordon, 2000, 2016).

According to Jonas et al. (2014), all threats result in a discrepancy resolved by either an approach or an avoidant motivation state. A survival optimisation system accounts for humans' strategies to protect themselves against repeated and new threats (Mobbs, Hagan, Dalgleish, Silston, & Prévost, 2015). The survival optimisation system physically affects the nervous system; when the confrontation is an acute uncontrollable stressor or chronic and elevated, it can lead to compromised cognitive abilities such as working memory. Longer stressors can lead to long-term neuronal damage (Mobbs et al., 2015).

Sterling (2012) argued that the brain is not so much a singular "organ" as a metabolic process. The brain is an organ of predictive regulation, driving a vulnerable body through an uncertain world. The brain's number one task is coordinating the body to be energy-efficient for safety and survival. The scientific term is allostasis (Kleckner et al., 2017).

The brain uses predicting processing (by reinstating experiences from the past) to ensure it can effectively meet the body's energy needs to ensure the species' survival. This means that prediction beats reaction when it comes to survival (Sterling, 2012). Serving the body means keeping body systems coordinated, metabolism efficient, and keeping the body alive and healthy. The brain and core body systems, like the immune, endocrine, and autonomic nervous systems, communicate bi-directionally, with survival as their primary operating premise (Feldman Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019; Irwin, 2008).

9.1.2 Theme 2: Neurotransmitters: All information transfer in the brain consists of electrochemical processes (firing and wiring)

It is the combined view of the participants that neurotransmitters create and are shaped by human behaviour. The following quotation provides evidence of this:

> "The archetypes were ultimately developed from their biological models because we profiled the chemistry. You would have to use a diagnostic which was originally based on a chemical profile".

This theme concurs with the literature. A conceptualisation of the overall flow of the brain's chemistry remains contentious. According to Gordon et al. (2008), the brain processes information via a dynamic continuum of spatially interconnected processes with accompanying neural chemistry.

Mental states are complexly associated with neurotransmitters or neurochemicals (like serotonin and oxytocin), which have specific functions; neurotransmitters are excitatory or inhibitory (Adell et al., 2010). The overall balance of these excitatory and inhibitory neurochemical activities underlies all brain processes and the extent of their stability. This is succinctly captured in the widely cited article "The Biology of Being Frazzled" by Amy Arnsten (1998).

Weinberg (2009) reported that mind-state (resourceful, aggressive or helpless) configurations are associated with electrochemistry and impact the immune system, either pro-inflammatory or anti-inflammatory.

9.1.3 Theme 3: Incoming information is processed fast via reflexive networks or, if a mismatch occurs, more slowly via reflective networks.

Participants described this foundational concept differently. The following interview quotations substantiate this point:

> "I think leaders are always blown away by the fact that … where you make 99% of your decisions is at that non-conscious level, and, if you can't elucidate some of that and bring it into conscious[ness] about why you have these biases and why you might make decisions in certain ways, you're certainly not effective as a leader."

> "Becoming aware of default patterns is vital – the brain's processing is vastly unconscious."

This confirms the debate in the literature that the brain has classically been conceptualised as a dual system that uses two modes of achieving optimal processing: the subconscious and the conscious. This has also been articulated as an interaction between the reflexive/implicit (System 1) and the reflective/rational (System 2) (Epstein, 1994; Grawe, 2007; Kahneman, 2011).

According to Gordon (2008), the X-system (reflexive) gives "feedforward" concerning emotional "action tendencies", i.e., humans act on subjective cues within a split second. On the other hand, the C-system (reflective) can exert control over the X-system – the mechanism underlying self-control processes like impulse control and emotional regulation.

Lieberman (2007) also introduced the concept of quality in the reflective process. Quality is based on the cognitive load (the capacity of the brain and how that capacity is utilised) and the level of motivation. Higher-quality reflections are also more likely to be remembered. Human problem-solving occurs along a hypothetical "neural axis" from basic and reflexive (predominantly unconscious) to sophisticated (but also more conscious) (Van der Walt, 2017a).

A recent view based on predictive processing theory (Feldman Barrett, 2017b; Hutchinson & Feldman Barrett, 2019) postulates that the brain uses predictive and correction modelling to create all mental representations. More specifically, "The mind is a computational moment in a brain that creates a temporary continuous trajectory of neural activity. Tasked with regulating a body in the world" (Hutchinson & Feldman Barrett, 2019, p. 287).

According to these authors, references to dual systems are metaphors and not actual systems. Redefining these dual systems means that System-1 / automatic refers to the times when predictions are less corrected by prediction error. System-2 relates to times when predictions are more corrected by prediction error (Feldman Barrett, 2017b). This has far-reaching implications for how we see behaviour, and which is beyond the scope of this study.

9.1.4 Theme 4: Epigenetics: Inherited genetic thresholds modulate neural functions.

Participants held similar views on this theme. A content-rich interview quote captures this theme:

> "If you come from a good nurture environment, you've got a bigger hippocampal-to-amygdala ratio. If you come from a fearful environment with high deprivation, your amygdala to the hippocampus [ratio] is much higher. You can actually measure this on an MRI. And, so, in deprivation in the child, you will have a high amygdala-hippocampal volume ratio."

Inherited genetic thresholds govern neural functions (Gordon, 2016). Epigenetic mechanisms regulate the diverse biological properties of cells and tissues by altering gene expression through rapid response to environmental factors (Kandel, Schwartz, Jessell, Siegelbaum, & Hudspeth, 2013).

The literature on genes underscores that genes are not static. "Genes are not about inevitabilities; they are about potential and vulnerabilities. And they do not determine anything on their own. Gene/environment interactions are everywhere. Evolution is most consequential when altering the regulation of genes, rather than genes themselves" (Sapolsky, 2017, p.225).

Social interactions are vital for human development; it is clear that the quality of those interactions (i.e., nurturing vs compromised) is a critical feature of development (Sapolsky, 2017). This is in line with the premise that exposure to enriched environments (across a broad spectrum) enhances neural proliferation (Kandel, 2006; Weinberg, 2007), while compromised or deprived environments contribute to neural atrophy and immuno-suppression (Arnsten, 2009; Kandel et al., 2013; Weinberg, 2007). Cultivating positive environments results in a positive appraisal style, which builds a mental immune system.

9.1.5 Theme 5: Experienced-based neuroplasticity drives behavioural change

All participants confirmed this theme. The following interview quotes reflect how the experts see the role of neuroplasticity:

> "You can change your brain, as you are mainly a composite of your learned habits."

> "Encourage mistake-making – it promotes learning and new memories – that is what neuroplasticity is."

This is in line with the literature review. Adaptive needs are met through neural pruning or neural wiring (also known as long-term potentiation) (Gordon, 2000), meaning that synapses, or unions between neurons, become more solidified the more often the respective neurons "talk" to each other. This is known as neuroplasticity, enabled by Hebb's rule, proposed in 1949 by psychologist Donald Hebb (1949) as a theoretical mechanism for how neuronal circuits are modified by experience.

Neuromodulation results in resourceful neurochemical configurations (Weinberg, 2018) through rewiring nurture circuitry. This is done by engaging the environment. Thus, experience remodels the brain.

9.1.6 Theme 6: Core processes and overlapping purposeful networks.

The participants agreed that overlapping networks interact to give rise to mental functions, as shown for example in the following quotation:

> "It's impossible to map the brain as a complex system, but at least we continue to build the brain code for high performance, from basic to sophisticated, from keeping us alive, to ensure we survive and to enable us to thrive. Along the way, we continue to discover behaviours and sub-constructs contributing to this process."

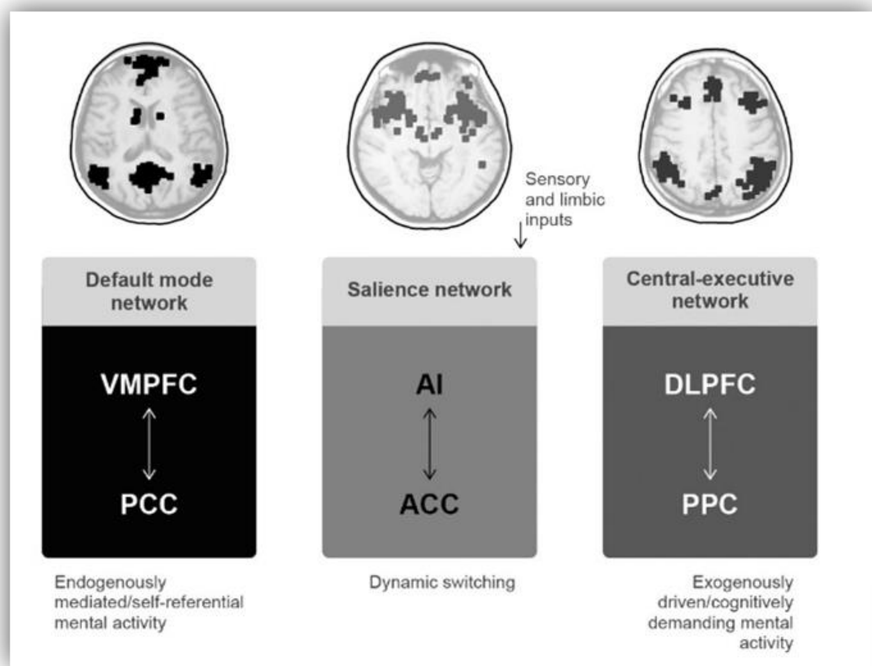
This aligns with the literature. The whole brain and body are highly interconnected systems functionally and anatomically, with multiple interconnected neurons that constitute overlapping networks (Gordon, 2000; Sporns, 2013). The belief that the brain evolved like a layer cake, with "cognitive" circuitry wrapped around "emotional" circuitry, supposedly permitting thoughts to control feelings, could be seen as a metaphor (Feldman Barrett & Satpute, 2013).

Psychological functions do not map directly onto spatially localised brain structures one-on-one. According to Feldman Barrett & Satpute (2013, p. 18), "different emotional states (such as anger, sadness, fear, etc.) cannot be localised explicitly to distinct brain regions or brain networks. The same is true for various social phenomena:" Instead, numerous brain areas work together spatially to execute a mental function known as a large-scale brain network (Sporns, 2013).

A large-scale brain network is defined as a collection of interconnected brain areas that interact to perform circumscribed functions (Bressler & Menon, 2010). Specific networks act as controllers or task switchers that coordinate, direct and synchronise the participation of other brain networks. On the other hand, other brain networks enable sensory or motor information flow and participate in the conscious execution of tasks (Bressler & Menon, 2010; Sporns, 2013), as depicted in Figure 2.

Figure 2

The brain as a network (Bressler & Menon, 2010, photo courtesy of Steven Bressler)



Theme 6.1: Core processes related to the brain and body-feelings.

The participants agreed on the importance of foundational drivers like sleep, nutrition, and exercise. This was captured in the reporting of constructs and is set out in Appendix H.

This result is anchored in the literature reviewed below.

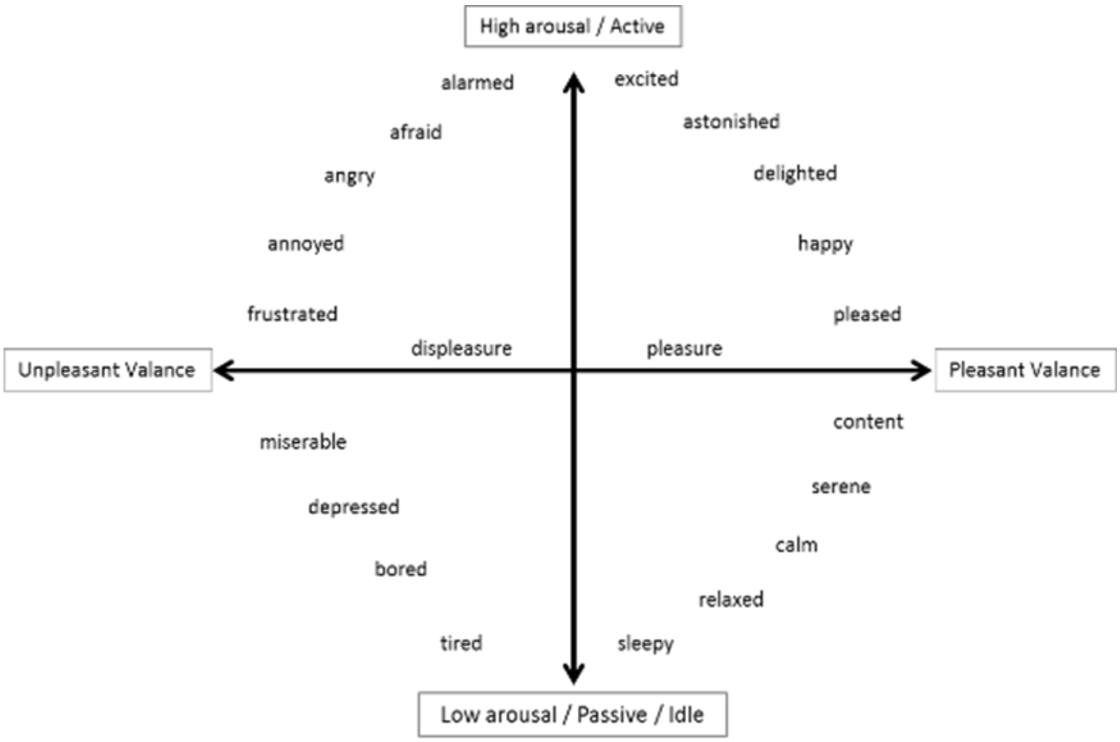
Interoception is the brain's interpretation of all sensations from the internal organs and tissues, the hormones in the blood, and the immune system. This sensory data about the state of the body is sent to the brain and produces elementary, affective feelings of pleasure, displeasure, arousal, and calmness (see Figure 3). Feldman Barrett & Satpute

(2013), consider Interoception to be one of the main ingredients of emotion, just as water or flour is to bread. Interoception is functionally distinct from exteroceptive senses (e.g., vision, audition) and proprioception (i.e., the position of muscles or joints). However, it interacts with these senses through sensory integration (Craig, 2014).

The **interoceptive network** is a system of brain regions important for allostasis (energy efficiency). Interoception enables sending sensory and motor predictions throughout the rest of the brain. This network overlaps with two intrinsic brain networks, the salience network (SN) and the default mode network (DMN), containing most of the limbic tissue in the cerebral cortex (Feldman Barrett & Satpute, 2013).

Figure 3

Conceptual system (Feldman Barrett, 2017a, p. 74)



Affective feelings of pleasure and displeasure, calmness and agitation are raw summaries of energy efficiency. Humans construct instances of emotion to make sense of the body’s pleasant and unpleasant moods or raw feelings and different levels of stimulation. According to Feldman Barrett & Satpute (2013), affect is the general term for the raw daily experience of feeling or mood by humans. It is not an emotion but a feeling, with two features. The first feature is how pleasant or unpleasant one feels, known as valence. The second feature of affect is whether one feels calm (passive) or agitated (active), also called arousal (Feldman Barrett, 2017a). Affect is a combination of valence and arousal, represented by one point on the affective circumplex illustrated in Figure 3.

Affect culminates in the belief that objects and people are inherently negative or positive. Valence and arousal are properties of consciousness that are always present (Feldman Barrett et al., 2019).

Theme 6.2: Core processes related to socio-emotional capacities.

The participants agreed on the importance of emotional and social capacities and the involvement of the underpinning large-scale default mode network. This was captured in the reporting of constructs and is set out in Appendix H.

This result is anchored in the literature reviewed below.

The **default mode network (DMN)** is what the brain does when it is not engaged in specific tasks. The DMN (shown in the left-hand image in Figure 4 above) comprises an integrated system for autobiographical, self-monitoring, and social cognitive functions (Bressler & Menon, 2010; Sporns, 2013).

Numerous brain regions that process language also control the inside of the body (the DMN). The DMN is also responsible for rapid episodic spontaneous thinking (REST), which forms part of mind wandering. This language network guides heart rate up or down. It adjusts the chemical messengers affecting immune cells and leads to immune function changes, including effects on inflammation (Feldman Barrett & Satpute, 2013).

Social reality provides the collective agreement and language that make the perception of emotion possible among people who share a culture. The human brain creates a conceptual system into its wiring (a dependable network of concepts) within the first year of life. This “conceptual system” is responsible for all the concepts humans employ to experience and perceive emotions (Feldman Barrett & Satpute, 2013).

Theme 6.3: Core processes related to cognitive thinking capacities

The participants agreed on the importance of higher-order thinking capacities and the involvement of the underpinning large-scale CEN network. This was captured in the reporting of constructs, and is set out in Appendix H.

This result is anchored in the literature reviewed below.

The **central executive network (CEN)** (shown in the right-hand image in Figure 4) becomes activated in situations that involve an emphasis or concentration. This is also called the analysing system, and requires the active maintenance of information (or task sets) in working memory (Shaked & Schechter, 2013). The salience network (shown in the centre image in Figure 4 above) is a controller or network switcher. Based on the task at hand, the controller decides which information is most important and which should receive priority in the queue of brain signals waiting to be sent. Salience, in this context, is every internal or external stimulus that the system signals as worthy of further attention and processing.

Feldman Barrett & Satpute (2013, p. 18) argues for "describing the psychological functions of domain-general networks as it produces a constructionist functional architecture of the human brain". According to these authors, it provides a valid level of description that links to other scales and levels of describing the brain.

The insight from this research is that the brain consists of purposeful, dynamic networks that are engaged according to the situation and the task demands.

9.1.7 Theme 7: A complex brain-body system continuously adapting to its current environment.

The participants confirmed this theme, as shown by the following quotes:

> "Everything is a system, and everything affects everything; an individual consists of incredibly complex components that make up a system. If you think about the individual, the team and even the organisation as an organism."

> "There is no such thing anymore as a physiological process's start and end. So, we now have to understand that everything is linked, and everything in the body is feedback cycles; take, for example, the immune system."

This concurred with and added to the literature review.

Feldman Barrett & Satpute (2013) state that all mental events, including cognition, emotion, perception, and action, are influenced by allostasis (energy efficiency). Thus, all decision-making is embodied, predictive, and concerned with balancing energy. These authors describe the human brain as "intrinsically organised into domain-general, distributed functional networks, and a range of affective, social, and cognitive phenomena arise from the interaction of these networks." (Feldman Barrett & Satpute, 2013, p. 18).

9.1.8 Synthesis of results

The participants described seven neuroscientific concepts that are relevant to leadership behaviour, all of which bear similarities to the literature reviewed. Table 3 identifies the overlap between the participants' views and the literature review framework (Gordon, 2000). There is a high level of similarity.

Table 3

Neuroscientific Concepts: Comparison between participants' views and literature review framework.

	Synthesis of themes of research results	Coding theme	Literature review
1.	Neural patternicity for survival (threat avoidance) overrides reward-seeking.	Safety first	Specialised survival networks help us *avoid danger and minimise pain*.
2.	Mindstates are electro-chemically correlated.	Neurotransmitters – firing and wiring	All information transfer in the brain consists of *electrochemical processes*.
3.	Conscious logical cognition vs less conscious processing.	Reflexive (fast) vs reflective (slow)	Incoming *information is processed fast via reflexive networks* or, if a mismatch occurs, more slowly via reflective networks.
4.	Nature-nurture dynamics (epigenetics).	Epigenetics	Inherited *genetic thresholds* modulate neural functions.
5.	Experience-based neuroplasticity – train the brain to change the brain.	Neuroplasticity	Adaptive needs are met through neural pruning or *neural plasticity* (also known as long-term potentiation).
6.	Core processes and overlapping networks: Body-feelings processes.	Body-feelings capacities (interoception)	Multiple interconnected neurons *constitute overlapping networks* that interact to *execute mental functions*.
7.	Core processes and overlapping networks: Social-emotional processes.	Socio-emotional capacities (DMN)	Multiple interconnected neurons *constitute overlapping networks* that interact to *execute mental functions*.
8.	Core processes and overlapping networks: Cognitive processes.	Thinking capacities (CEN)	Multiple interconnected neurons *constitute overlapping networks* that interact to *execute mental functions*.
9.	A complex adaptive system – continuously adapting to its current environment.	Dynamic interconnected brain-body systems	The whole *brain and body* are highly *interconnected systems* functionally and anatomically.

9.2 Research Question 2: Relevance to leadership

While the experts' views on foundational neuroscientific concepts were illustrated above, a more comprehensive discussion of findings on the relevance to leadership behaviour follows next.

The experts' views on how understanding and deploying a neuroscience-based approach is relevant to leadership resulted in three themes:

- Enabling resilience.
- Enabling group cohesion.
- Enabling problem-solving and goal pursuit.

Table 4 sets out the key themes with example quotes from the study.

Table 4

Neuroscience's relevance to leadership: Key themes with examples of quotes from participants

Theme	Examples of quotes from participants
Resilience (individual and team)	"By and large, having looked at especially resilience, self-leadership, learning capacity, and innovation capacity, you will always find, in the top ten, at least 50% are emotional constructs, and they are constructs which relate to goal-directedness, social safety, and collective creativity."
Group cohesion	"You still need social safety, you still need trust, you still need to establish that entrustment between individuals that enables them to say, 'I'm going to entrust myself to my buddies around me and to my leader and to the cause, and I believe in the cause', and that kind of … to establish that, I think, is vast … there's a very important genetic component, and then you can enhance it."
Problem-solving and goal-pursuit	"When I think about what good neuroscience-based leadership is, it is about people being able to understand each of the integrated dimensions, not just analysing and typical higher-order thinking capacities."

Next is the discussion of the results on the relevance of a neuroscience-based approach to leadership behaviour.

9.2.1 Theme 1: Enabling personal and team resilience.

Participants held similar views on this theme. Valuable interview quotes such as the following captured the importance of personal resilience to leadership behaviour:

> "What is really interesting about this tool is that we can say to leaders, 'When you're under stress, inhibition is lower, executive function is lower,' but what's quite interesting is it's different for most people."

This confirms the peer-reviewed literature on integrative neuroscience (Gordon et al., 2008) and that individuals can be taught how the brain functions, train new habits and behaviour for stress reduction, boost attention, improve working memory, and cultivate positive mood. Leaders can enable this capacity building.

> "It's that ability to read people and understand the kind of nuances in a social situation; most cues come from the face, body language – and to know that you can train new meaningful habits."

This means that leaders need to be able to read the cues of their team members and ensure conversations and decision-making that facilitate the building of new habits.

> "I saw many leaders who had burnt out due to several trigger factors, but, effectively, their resilience was eroded, or the prolonged (ongoing) stress overcame the resilience and led to brain/body system implosion and burnout – the foundational drivers are instrumental in building resilience".

This is in line with the emerging paradigm of the neuroscience of resilience, in that resilience is a bottom-up process that can be enhanced through intentional mental training (Dahl, Wilson-Mendenhall, & Davidson, 2020) and also through promoting a culture of measuring and building foundational drivers like sleep, nutrition exercise, and mindfulness practices at work (Van der Walt, 2017b). The relevance to leadership is that leaders need to consider the severity of individuals' stress. Distress uniquely compromises cognitive capacity (Gordon et al., 2008).

This quote also shows the difference between bottom-up and top-down brain approaches. A critical aspect of integrative neuroscience is that cortical capacity must be facilitated rather than simply assuming cortical capacity (Gordon et al., 2008). In other words, if an individual is experiencing high levels of distress, giving them more cognitive task demands is not going to lead to higher performance.

9.2.2 Theme 2: Enabling group cohesion.

Supporting quotations that provide evidence of this theme are set out below.

> "Along that axis, we discovered that we don't exist as individuals, and so we need each other, and that there's the group brain, the individual brain is the same intricately interconnected whole, and because of that, leadership came into play … Good leaders establish commonalities. They ensure social safety. So, they find ways of establishing trust, cultivating trust between people."

This aligns with the literature about creating social safety. Brain-based leaders understand the relevance of "social safety" at a very basic level – in that social safety ensures the group stays alive, survives and thrives. Since these needs are so crucial for human survival, the brain unconsciously incorporates these needs to assign a value to any incoming cue (Van der Walt, 2017b).

"If the team is collectively creative, it trumps individual problem-solving – and enhances individual innovativeness through allostasis – a culture of innovation."

Cognitive ability follows only once psychological safety is facilitated. By developing a safe physical and emotional environment, a leader can build trusting relationships through safe and secure conversations (Allison & Rossouw, 2013). Only once this is done can innovation be accomplished, biases tackled, and personal blind spots addressed.

The following quote speaks to unconscious bias and how to remedy it using a neuroscience perspective:

> "I think a neuroscience-based leader tries to make themselves aware of their biases and certainly tries to be basing their decisions on more of an even hand."

The relevance to leadership is that leader-managers can cultivate social safety by spending time with team members, creating shared experiences to generate a sense of belonging within a group, and building a culture where biases are pointed out to enable efficient functioning in a system. Leader-managers can lead the way by creating awareness of automatic non-conscious brain biases (Gordon, 2016) and even sharing some of their biases.

9.2.3 Theme 3: Enabling problem-solving and goal pursuit.

A supporting quote that provides evidence of this theme is set out below.

> "A neuro-effective leader understands how their brain works in that integrative way and then applies that, practically, when working with people, teams, divisions and society. Some leaders are highly skilled in the conscious brain but lack non-conscious capabilities. So, again, we've got a nice discussion point for them and training apps to help them get that into a bit more alignment. We start with goal setting and focused attention."

This is in line with the literature suggesting that pursuing meaningful goals and purpose sustains wellbeing (McKnight & Kashdan, 2009), and that the neurobiological pathway of goal pursuit involves both motivation and identity-related goals, as well as procedural goals (Berkman, 2018).

> "Simply put, our goal is to stay alive, survive, and ultimately thrive. To achieve this, the brain has developed a system that avoids threats and seeks rewards – understanding goal-directedness is key."

To enable goal pursuit, leaders also need to understand goal-directedness, an unconscious brain state crucial for goal achievement (Van der Walt, 2017b). This is not the same as goal setting.

To conclude, this quote by one of the participants captures the essence of this project:

> "An effective neuro-leader is just what we have always seen as an effective leader; we now just have some words and descriptives for it, but I think what they do is they work in harmony with their brain."

Thus, brain-based leadership is about safety first. Leaders can train their brains to switch off intrusive conscious negative thoughts, increase calm, expand rewards, and realise meaningful goals.

10. Contribution, limitations, recommendations

This small-scale research project articulates the neuroscience-based self-report diagnostics used in the developing field of neuroscience-based leadership. The literature has identified behavioural pointers via neuroscience-based diagnostics. These diagnostics are all self-report inventories, which are minimally intrusive ways to collect brain-based data and highlight the potential value of brain-based techniques for measuring and developing leadership behaviour.

10.1 Contribution

This research makes two significant contributions to the NSBL field of study: (1) evidenced-based research and (2) synthesis of underpinning concepts and relevance to core behaviours of NSBL. The conclusions are discussed guided by these two contributions.

The first contribution is deploying an evidence-based approach that ensures the selection of reputable, neuroscience-based diagnostics, the constructs measured, and the theoretical operating premise of these diagnostics. This was more than just a speculative approach. The evidence-based practice also gave insights into different levels of analysis (both neuroscientific and behavioural). It can contribute to integrating neuroscience with effective leadership behaviour.

The study's second contribution is synthesising the range of concepts of neuroscience-based diagnostics and accompanying constructs advocated in the literature. This synthesis is helpful as the complexity presented by different diagnostics reduces the diagnostic constructs' clarity and practicality for developing leadership behaviour.

10.2 Possible limitations

The following elements are acknowledged as the most pertinent limitations to this study: as a qualitative design, the project does not provide statistical analysis or a measurement of a causal relationship, the sample size is small (three experts were interviewed), Qualitative research is open to the researcher's bias, where the researcher is not considered to impartially interpret the data but rather provides a personal interpretation. The reliability of participants' recall of specific experiences with leaders is a further limiting factor.

According to Vidal and Ortega (2012), it is a challenge to prove that neuroscience can deconstruct complex leadership processes into basic components that can be studied in neural terms. Thus, it might be seen that it is over-ambitious to identify the neurobiological markers of leadership at this stage. However, it does hold promise for elucidating behavioural descriptions of leadership. The research aimed to gauge the relevance of understanding neuroscientific concepts to effective leadership behaviour, yet the perspectives provided by interviewees did not clearly distinguish between leadership and non-leadership behaviours. There was no clear association with a specific leadership theory or stance.

While this has proven to be a complex topic, the self-report brain diagnostics contribute to clarifying the neuroscientific concepts that may underpin a brain-based approach to leadership insofar as they confirm the theory that the brain is a highly interconnected system, particularly in the interplay between cognitive, emotional, social, and physiological systems.

10.3 Recommendations for future research

Fittingly for an emerging concept, this research applied an explorative qualitative approach using semi-structured interviews.

Self-report neuroscience-based diagnostics were the primary source of information for this study. This included the underpinning models and neural foundations that have emerged through a multidisciplinary effort involving neurologists and neurosurgeons working with psychologists and computer scientists. Interdisciplinary research has changed (and will continue to change) the landscape of psychology, and this "integrative" symbiosis seems likely to yield increasingly realistic models of human brain function and behaviour. Multidisciplinary approaches are recommended to enhance the findings of this project.

Brain diagnostics that have been methodically validated and have proven to be a reliable screening tool for brain health should be included in leadership development due to the detailed level of analysis they offer in addition to behavioural assessments.

This project reviewed neuroscience-based self-report diagnostics to study the neural basis of leadership behaviour. There is a further opportunity to draw on additional disciplines to articulate the core behaviours of NSBL, for example, social cognitive neuroscience and the human sciences of leadership behaviour. Exploring the evolving framework for NSBL requires additional qualitative studies to ensure contribution towards theory building and conceptualisation of NSBL.

11. Chapter Summary

This chapter aimed to define foundational neuroscientific concepts that underpin leadership behaviour to answer this thesis's overarching research question: "*How do experienced professionals describe and conceptualise NSBL*?" Through its evidence-based approach, this research aids in making some theoretical contributions to ground the construct of NSBL in the neuroscience self-report diagnostics body of knowledge. The brain-based self-report diagnostics provided valid and reliable measures to make inferences about brain functioning at work and to conceptualise NSBL behaviour.

This chapter provided expert perspectives on the foundational neuroscientific concepts that inform a neuroscience-based approach to leadership behaviour. The participants described seven neuroscientific concepts relevant to leadership behaviour, all of which bear similarities to the literature reviewed in Chapter Two.

The seven foundational concepts of neuroscience-based leadership behaviour include: social safety is a primary operating principle; neurotransmitters and mood states; conscious thinking and non-conscious processes drive behaviour; nature-nurture dynamics influence behaviour; experienced-based neuroplasticity drives change; overlapping networks enable information processing in the brain and a complex brain-body system that continuously adapts to its current environment.

Secondly, the participants articulate how applying a neuroscience-based approach is relevant to leadership behaviour in formal organisations. This was captured in three themes. Incorporating a brain-based approach to leadership behaviour enables the development of resilience, group cohesion, problem-solving, and goal pursuit.

A helpful critique of the study findings is that these diagnostics are not selectively focused on leadership behaviour but gauge general brain functioning at any level of the organisation. This does not mean one cannot venture beyond the organisational sciences to define NSBL as one expert put it:

> "An effective neuro-leader is just what we have always seen as an effective leader; we now just have some words and descriptives for it, but I think what they do is they work in harmony with their brain."

The next chapter will present the applied research study.

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Appendices

Appendix A: The constructs measured by the self-report diagnostics.

1. The MyBrainSolutions Leadership Assessment

The MyBrainSolutions Leadership Assessment (MBSLA) developed by Brain Resource (DeVarney, 2012; Gordon et al., 2008) offers a personalised brain training application to improve brain health and facilitate behaviour change.

Constructs measured

The MBSLA assessment is built on evidence-based brain data from the Brain Resource international database using standardised assessments of multiple aspects of brain health within various norm groups. The Brain Resource database provides a standardised framework for establishing psychometric qualities of the assessment and a unique validation of the biological basis of these tasks through direct correlates of brain function and genetic variation (DeVarney, 2012; Gordon et al., 2008).

The MBSLA measures four core systems: emotion, feeling, thinking, and self-regulation. Twelve critical capacities measure these core systems. The assessment provides a cognitive real-time test battery of questionnaires yielding markers of (1) thinking (selective awareness of information processing, i.e. working memory, focus and planning); (2) emotion (automatic and non-conscious processes that help minimise danger and maximise reward); (3) feeling (conscious experience of negative emotions linked to depressed mood, anxiety and perceived stress); and (4) self-regulation (shaping and planning of thinking and emotion over time to maximise wellbeing).

The questionnaires include items from previously validated depression, anxiety and stress scales (Lovibond & Lovibond, 1995), which are prominent in many mental health difficulties.

The 12 capacities fluctuate continuously along a performance continuum from wellbeing to the risk of mental health conditions such as depression and anxiety. The MBSLA is web-based and takes approximately 40 minutes to complete.

Theoretical underpinnings of the MyBrainSolutions Leadership Assessment

The MyBrainSolutions Leadership Assessment (MBSLA) developed by Brain Resource (DeVarney, 2012; Gordon et al., 2008) offers a personalised brain training application to improve brain health and facilitate behaviour change.

The MBSLA is built on Integrative Neuroscience Theory that outlines the brain's core motivations and key modes of function (Gordon et al., 2008). Firstly, the brain's core organising principle is safety first: a motivation to "minimise danger and maximise reward". This motivation helps a person deal with immediate threats. It drives the search for rewards over longer time scales – from nourishment through social connectivity to purpose in life. The core “minimise danger, maximise reward” principle continually organises the fundamental brain processes of emotion, thinking, feeling and self-regulation.

Secondly, the brain has two modes of processing: conscious (rational, verbal, and detail-oriented) and non-conscious (intuitive and based on awareness of and response to external cues). Thirdly, the brain’s highly interconnected networks self-organise into four core systems: emotions (responses to threat or reward signals); feelings (physiological changes in heart rate, breathing, and perspiration); thinking (focusing, memorising, and planning); and self-regulation of these functions. The INTEGRATE model highlights the timing of the brain’s key processes. These include noradrenaline release for the fight-flight response, dopamine for reward cues, serotonin for enhancing mood, and oxytocin for bonding (Gordon et al., 2008). Feedforward or predictive processing is integral to harm avoidance.

2. The NeuroSurge diagnostic

Constructs measured

The NeuroSurge diagnostic quantifies neuropsychological states and the neuro-chemistry underpinning wellness, performance, and leadership (Weinberg, 2009). The diagnostic plots three archetypes of personal leadership that indicate the risk of developing raised pro-inflammatory cytokines (which negatively impact the immune system). The three archetypes are summarised in Table 1.

Table 1

Weinberg’s archetypes (Weinberg, 2009)

Archetype	Description
Bravo archetype	Traits: Ambitious, aggressive, insensitive, judgemental. Drives: Need for recognition, fear of failure. Illnesses: Hypertension, cardiac, stroke, diabetes.
Charlie archetype	Traits: Unmotivated, poor self-esteem, poor self-image. Drives: Hypochondriac, diminishing others’ successes. Illnesses: Chronic inflammation, infections, tumours.
Alpha archetype	Traits: Confident, self-sufficient, non-judgemental. Drives: Personal development, environmental development, enjoyment. Illnesses: Illness occurs very rarely.

The three archetypes mediate chronic conditions such as Type 2 diabetes, cardiac disease, osteoporosis, and even dementia (Weinberg, 2007). Each archetype comprises a determining nature-nurture heritage, inherited processing traits, values, needs, beliefs and drives, and a chemical configuration.

Theoretical underpinnings of The NeuroSurge diagnostic

The field of psychoneuroimmunology is the foundational theory of this assessment. According to Bower, Kuhlman, Haydon, Boyle, & Radin (2019, p. 1), psychoneuroimmunology "examines interactions between psychological and behavioural states, the brain, and the immune system". Examples include the effects of stress at multiple levels of the neuro-immune network and the implications for physical and mental health (Irwin, 2008). Although the brain and the immune system are generally considered independent systems, research in psychoneuroimmunology has documented their complex connections at multiple levels (Bilbo & Schwarz, 2012; Bower et al., 2019; Filiano, Gadani, & Kipnis, 2017).

The influence of mind-states, either positive or negative, on immune and endocrine function is a cornerstone of the diagnostic. The Triangles Model is central to the NeuroSurge diagnostic (Weinberg, 2009) and forms the basis for the chemistry of wellness and performance.

The Triangles model depicts the relationship between meaning or purpose and wellbeing with a specific focus on work-life application, family and interpersonal relationships, as well as recreation. (Weinberg, 2009). The Y-axis or height of the triangle denotes purposeful energy input. In contrast, the X-axis denotes the spectrum of the environment that has been integrated with the subjective worldview. The volume within the triangle has been shown statistically to represent the psychoneuroimmunology chemical resilience as manifested in wellness and performance (Weinberg, 2009).

3. The NeuroZone brain performance diagnostic

Constructs measured

The NeuroZone diagnostic of brain performance (Van der Walt, 2017b) offers insight into the brain's constituents for innovative performance. The model consists of real-brain structures around a hypothetical axis from basic to most sophisticated, supporting the functional need to solve various daily problems. This largely unconscious process keeps humans alive and also enables thriving. The model clusters ten key drivers (Van der Walt, 2017b) into four performance conditions for individuals and organisations to thrive: resilience, learning, leadership and innovation. These brain-performance conditions are outcomes of actively enhancing the ten drivers of brain performance. The specific drivers that most directly optimise each of the four brain-performance conditions for thriving are set out in Table 2.

Table 2

The brain-performance conditions and key drivers

Brain-performance conditions for thriving	Optimising brain-performance drivers
Resilience	Exercise – sleep/wake cycle – social safety – silencing the mind.
Learning capacity	Exercise – sleep/wake cycle – nutrition – learning (as a driver) – silencing the mind.
Self-leadership	Social safety – goal-directedness – collective creativity – silencing the mind.
Innovation	Learning – abstraction – execute function – silencing the mind.

The brain-performance conditions are defined as follows:

- *Resilience* is the ability of the brain/body system to resist pressures that threaten its steadiness (Van der Walt, 2017b). The resilience index has been validated and contributes to the reliability of the NeuroZone diagnostic (Van Wyk, Lipinska, Henry, Phillips, & Van der Walt, 2022).
- *Learning capacity* is defined as "the ability of the brain/body system to register, accumulate and consolidate information as insightful knowledge, and to be able to retrieve this helpful information when needed" (Van der Walt, 2017b, p. 13).
- *Self-leadership* is defined as "the ability to have a clear vision of the goal that needs to be achieved, accurately calculate the strengths and resources available to achieve the goal, provide adequate energy to drive the process, and effectively integrate learning. In this sense, self-leadership is imperative for collective leadership" (Van der Walt, 2017b, p. 16).
- *Innovation capacity* is defined as "the collective capacity of the brain/body system to solve problems and fashion novel products" (Van der Walt, 2017b, p. 15).

Theoretical underpinnings of The NeuroZone brain performance diagnostic - The theoretical underpinnings of the NeuroZone assessment are centred on the principle of the brain-body as a complex adaptive system (Van der Walt, 2017b).

Appendix B: PhD fact sheet

PhD: Psychological Perspectives of Professional Practice

Information sheet

Ms Ingra du Buisson-Narsai is a PhD candidate in the PhD Degree Programme in Professional Practice: Psychological Perspectives with Canterbury Christ Church University (CCCU), UK, which is run in association with Professional Development Foundation (PDF), UK.

PhD facts

"The PhD that the above-named candidate is pursuing is a degree unique in Europe and differs from traditional approaches in that the focus of study is on the application of research to practice. This means that students admitted to the programme are experienced professionals who are adjudicated by the university as being in a position to make a contribution to both knowledge and practice. Candidates constitute a cohort of experienced professionals from across the globe who have been admitted to the PhD as their expertise puts them in a position to impact on practice. The global nature of the programme also attracts a diversity of academics and practitioners available to work with the candidates throughout their studies. The degree is operated on a non-profit basis in order to open up opportunity to professionals who may otherwise not have the opportunity to pursue further study to engage theory with their practical experience."

About Canterbury Christ Church University

"CCCU is a modern university with an international profile, attracting students from across the globe. It has a network of five campuses that reach across Kent and Medway. The university offers thousands of courses in the arts and humanities, applied and social sciences (including business), and health, serving a student community 17,000. 96% of the university's most recent UK undergraduates and 98% of postgraduates were employed or further studied within six months of completing their studies.* It received a prestigious Silver rating in the Teaching Excellence Framework, exceeding national quality requirements for UK universities. Nearly 90% of CCCU research submitted to the 2014 Research Excellence Framework (REF) was assessed as world-leading, internationally excellent or internationally recognised. Further details are available on www.canterbury.ac.uk.

*Destinations of Leavers from Higher Education, includes full-time and part-time (all degrees) 2015/16."

About PDF

"PDF Net is a separate limited company whose purpose is to enable individuals and organisations to develop work-based research, consultancy and educational activities. It is a recognised institution for the development of work-based postgraduate awards and research. It provides the programmes listed on this website unless otherwise stated. Through its partner institutions, it creates bespoke work-based accreditation. It currently provides practitioner-based Masters and Doctorate programmes. PDF draws upon nearly 40 years of experience with a network of world-class professionals and is uniquely placed to help senior professionals achieve their learning goals.

Further details are available on http://www.pdf.net/

For further information about the PhD, please contact Prof David Lane at the above website."

Appendix C: Research instrument

Interview guide (questions directed to experts)

Introduction: Interview protocol for articulating constructs and concepts that underpin Neuroscience-based Leadership (NSBL) as informed by self-report diagnostics.

Researcher responsibilities

1.1 Introduce self as the researcher and present CCCU PhD fact sheet (Appendix B).

Section 1: Describe research purpose, and background.

The terms **neuroscience-based leadership (NSBL)** or **brain-based leadership** are often used to describe leaders that exemplify the knowledge of how their brain functions, and develop specific competencies to manage the zone of optimal personal, team and organisational performance.

Behavioural anchors – explanation

According to Bersin (2015), a "behavioural anchor" (or "defined behaviour"/" core behaviour") is a specific example of a competency level used to aid in the understanding of how to use a competency model. Evidence of a behavioural anchor/ core behaviour could be clarified as follows: for a high standard of proficiency (say level 5) in "perspective taking" (a competency), the behavioural anchor/ core behaviour may be "Actively includes and welcomes diverse individuals and groups". Consequently, behavioural anchors/ core behaviour are unambiguous and represent behaviours demonstrating competency and proficiency level. Behavioural anchors/ core behaviour are specific, easy-to-apply examples of behaviours demonstrating the desired competency and proficiency level.

Describe the outcome

A small-scale research project that provides insight on the constructs and underpinning concepts of a neuroscience-based approach to leadership as reported in self report diagnostics.

Describe benefits of the study

Leadership development can be accelerated if the underpinning concepts and specific core behaviours of neuroscience-based leadership can be clearly articulated. This process will also add validation and legitimation to the field of neuroscience-based leadership.

Describe confidentiality and format of the interview and that it will be recorded

Interview script: "Interviews will be audiotaped and later transcribed. A semi-structured interview guide will be used to lead the interview. Due to the nature of the semi-structured interview (it allows flexibility and free-flowing conversation), the researcher anticipates further, probing questions to be added to the list below, during the interviews. The interview questions are designed to test the propositions from the literature review and the research questions themselves."

The following semi-structured questions will be used to guide the interview.

Section 2: Professional Biography

- Please tell us about your current role and responsibilities.
- How long have you been exposed to neuroscience-based leadership, and what is the value of it to your work?
- What are your qualifications and experience in this field?

Section 3: Describing Neuroscience based leadership behaviour

- Can you describe your preferred brain-based leadership thinking framework or model like triune brain theory, network model of the brain and how this is captured in the supporting diagnostics.
- Can you give examples of behaviours that describe brain-based leadership? These behaviours should be both effective and ineffective at different levels of organisational functioning.
- What, in your opinion, are aspects of leadership behaviour that are associated with brain-based processes? – What is so important about the aspects you mentioned? Which of the aspects mentioned above should be prioritised?
- Is there anything that I have not asked you would have liked me to ask, or is there anything more you feel is valuable or important to add?

Please sign the consent form prior to the interview.

Appendix D: Consent form

Faculty of Social and Applied Sciences
Salomons Centre for Applied Psychology
School of Psychology, Politics, and Sociology
Canterbury Christ Church University
In partnership with the Professional Development Foundation

Letter of Consent for the Expert Interview

"I, ____________________, (name and surname), agree voluntarily to take part in the small-scale service project being conducted by Ingra du Buisson-Narsai (CCCU ID: DUB17159003) as part of the requirements for her pursuit of a PhD in Professional Practice.

I have read the Participant Information Sheet, and I understand its contents. Any questions which I have asked have been answered to my satisfaction.

I understand that the information I will supply is confidential, that it will be anonymised, and that it will only be used in the findings of the research.

I understand that I do not have to answer all the questions which may be put to me.

The information which I provide will be held securely until the research has been completed.

I understand that I am entitled to ask for a debriefing session or a copy of the research at the end of the project.

I have been informed that I may withdraw from this study at any time.

Signed………………………… Date…………………………

Researcher Commitment (Ingra du Buisson-Narsai)

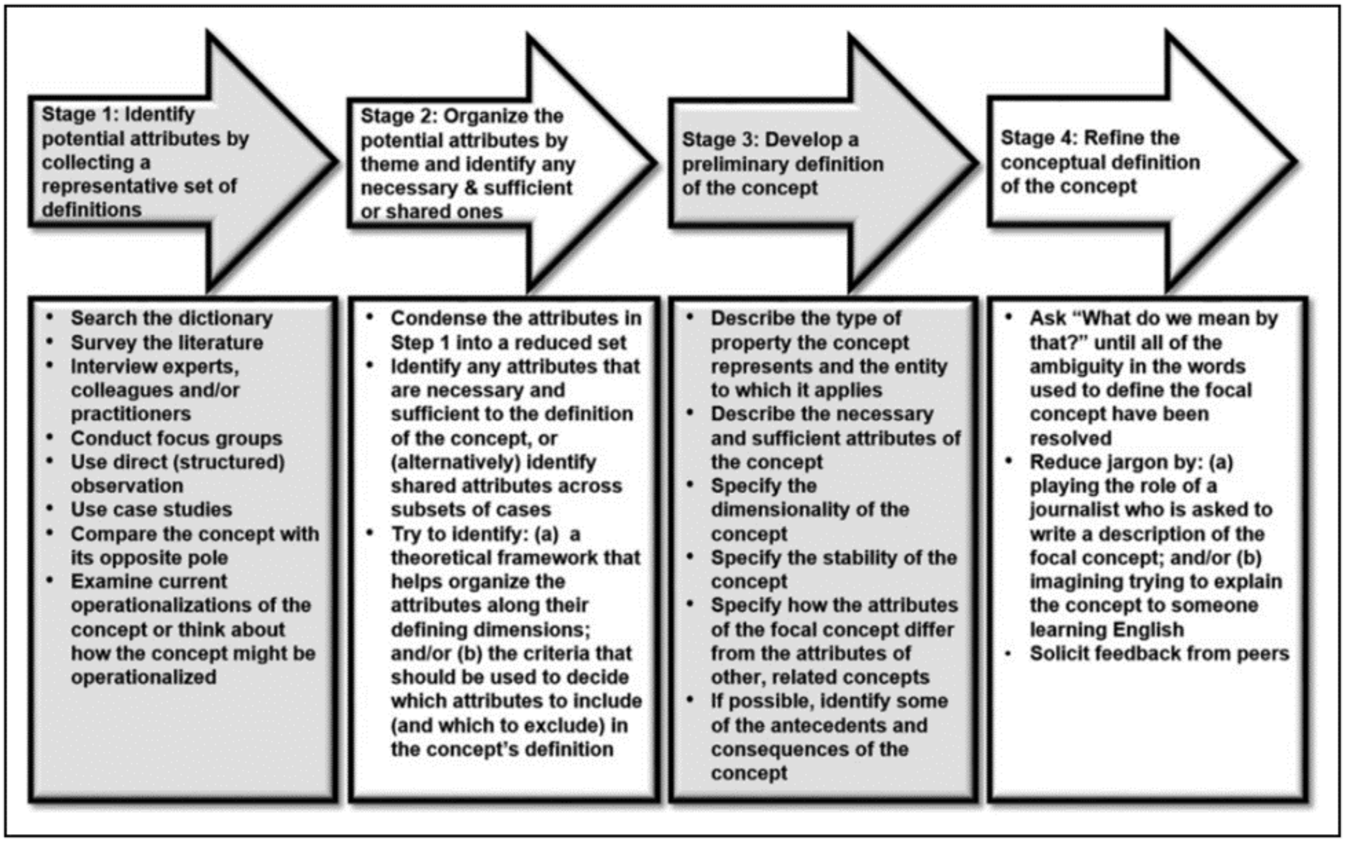
I commit to treating all information garnered in this study with complete confidentiality.

A summation of the research outcomes will be what is reported and shared."

Signature: **Date**: 1 June 2018

Ingra Du Buisson-Narsai
Student number: DUB17159003

APPENDIX E: Summary of stages for developing good conceptual definitions *(Podsakoff, MacKenzie, & Podsakoff, 2016, p. 169)*



Appendix F: Thematic Analysis with Constant Comparison (CC)

Thematic analysis with constant comparison can be either inductive analysis or theoretical analysis. The difference is that the data collected are analyzed as they are collected. The analysis begins during the collection of data. The first participant's data are analyzed, and as each subsequent participant's data are analyzed, they are compared to the previously analyzed data. The analysis constantly moves back and forth between current data and the data that have already been coded and clustered into patterns.

Step-By-Step Analysis

	Data Analysis Procedure	Action by researcher
1	Review and familiarize yourself with the data collected from the first participant (interviews, journals, field notes, records and documents). Read the documents and highlight intuitively any sentences, phrases, or paragraphs that appear to be meaningful.	✓
2	Review the highlighted data and use your research question to decide if the highlighted data are related to your question. Some information in the transcript may be interesting but not related to your question.	✓
3	Eliminate all highlighted data that are not related to your question. However, start a separate file to store unrelated data. You may want to come back and reevaluate this data in the future.	✓
4	Take each set of data and code or name the data.	✓
5	Cluster the sets of data that are related or connected in some way and start to develop patterns.	✓
6	Complete this process for the first participants' data. The researcher will code and cluster the first participant's data and as each subsequent participant's data are analyzed, they are compared to the previously analyzed data. Throughout this process, each participant's data are reviewed and analyzed, and the researcher is comparing the data being analyzed with the data that have been previously analyzed in the study. Thus, a constant comparison emerges.	3 participants ✓
7	Throughout this process, data that correspond to a specific pattern are identified and placed with the corresponding pattern and direct quotes are taken from the data (transcribed interviews, field notes, documents, etc.) to elucidate the pattern.	Within -case analysis ✓
8	Throughout the process, take all the patterns and look for the emergence of overreaching themes. This process involves combining and clustering the related patterns into themes.	Across-Case analysis ✓
9	Patterns and themes may tend to shift and change throughout the process of analysis, as previously completed analyses are compared with new data.	✓
10	After all the data have been analyzed, arrange the themes to correspond with the supporting patterns. The patterns are used to elucidate the themes.	✓
11	For each theme, the researcher writes a detailed analysis describing the scope and substance of each theme.	✓
12	Each pattern should be described by supporting quotes from the data.	✓

Reference: Percy, W. H., Kostere, K., & Kostere, S. (2015). Generic qualitative research in psychology. *Qualitative Report*, *20*(2), 76–85. https://doi.org/10.46743/2160-3715/2015.2097

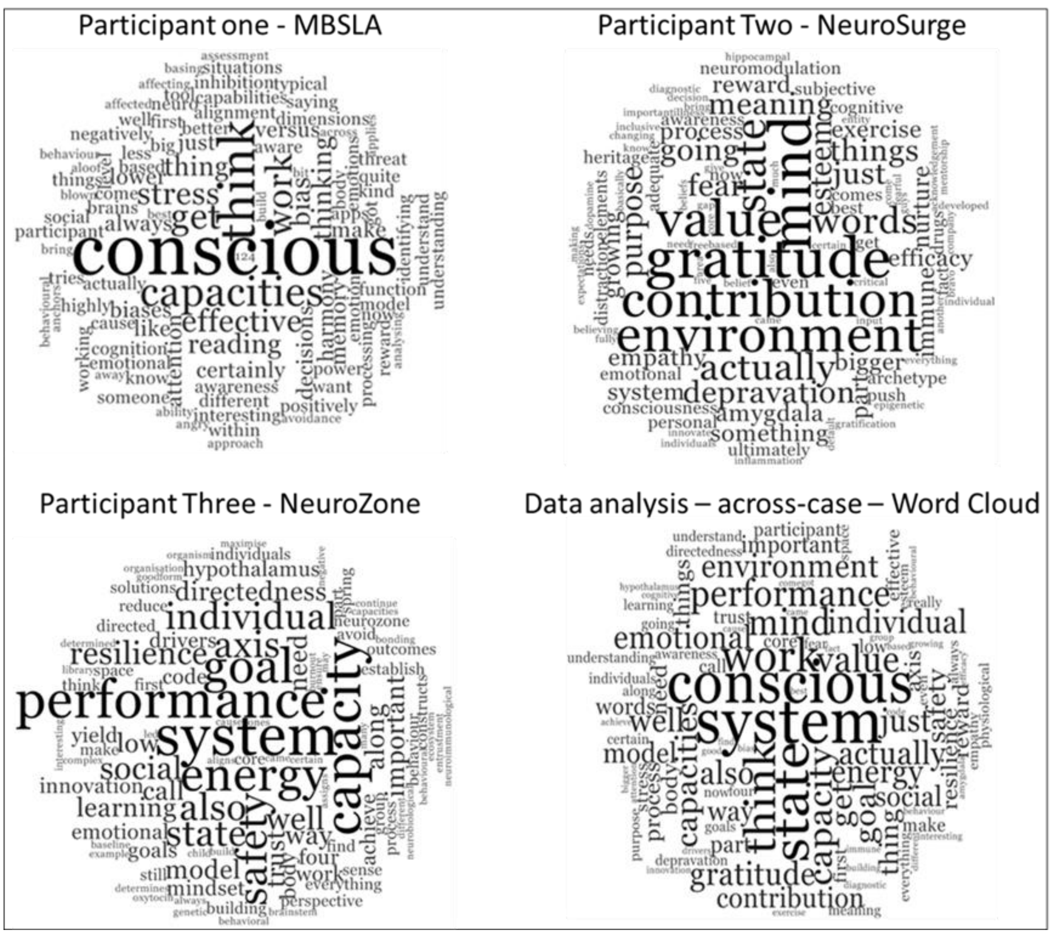
Appendix G: Codes, nodes and word clouds

NVivo code hierarchies:

Note the 9 across-case themes included three sub-themes (core processes/ overlapping networks)

	Participant	Within-case codes	Within-case nodes	Across-case themes
1.	Participant 1: MBSLA	22	8	
2.	Participant 2: NeuroSurge	35	9	
3.	Participant 3: NeuroZone	34	9	
	Total	**91**	**26**	**9**

Illustrating across-case and within-case overarching themes: Foundational principles and core neuroscientific concepts relevant to NSBL – word clouds



Appendix H: Across-case and within-case themes

Overall theme (across case)	**MBSLA (within-case themes)**	**NeuroSurge (within-case themes)**	**NeuroZone (within-case themes)**	**Researcher's synthesis of neural foundations themes (across case)**
1. Safety: Survive then thrive	**Safety first**: once you feel safe, you approach rewards; if not, you avoid pain.	The brain and immune system communicate bi-directionally, with **survival** as its primary operating premise.	**Social safety**. The brain is functionally structured to be social for survival – returning to a baseline relaxed physiological state (assigns energy and relaxes, assigns energy, relaxes).	• Neural patternicity for social safety. • Threat avoidance overrides reward-seeking.
2. Neurotransmitters	Dynamic interconnected brain-body systems.	Identifiable **mind state configurations** are associated with the secretion of neurotransmitters and neuropeptides.	**Ecosystem** of mood state, social safety and value tagging, etc. (springboard is social safety).	Mind-states are electro-chemically correlated.
3. Conscious vs non-conscious processing	Conscious logical cognition and non-conscious emotional cognition.	**Default patterns** of archetypes.	Problem-solving occurs along a hypothetical "neural axis" from basic and reflexive (**predominantly unconscious**) to **conscious**.	Attention deployment is conscious vs less conscious.
4. Epigenetics	Unconscious bias.	**Nature-nurture heritage** configurations.	**Complex adaptive brain/body system** with genetic make-up to assign energy to tasks (low energy / high yield).	Nature-nurture dynamics (epigenetics).

Overall theme (across case)	**MBSLA (within-case themes)**	**NeuroSurge (within-case themes)**	**NeuroZone (within-case themes)**	**Researcher's synthesis of neural foundations themes (across case)**
5. Neuroplasticity-promoters	Brain alignment of core processes. Via habit building (training apps).	Neuromodulation results in resourceful neurochemical configurations (Weinberg, 2018) through **rewiring nature-nurture circuitry**. This is done by engaging the environment (nurture).	**Latent growth capacity** through adaptive mistake-making.	Self-directed neuroplasticity.
Core processes and overlapping networks				
6. Physiological processes	**Subjective emotional cues** are automatic / reactive and contagious identifying emotions: - Emotion bias (negative faster than positive). **Feelings capacities** (physiological changes in heart rate, breathing, perspiration): • anxiety level; • low mood level; • stress level.	**Physiological process** neuromodulation: mindfulness, sleep, exercise, diet.	**The foundational drivers**: • sleep; • exercise; • nutrition; • silencing the mind, regulated by the brainstem structures.	Core processes and overlapping networks: • Brain-body. • Interoceptive network.

Overall theme (across case)	MBSLA (within-case themes)	NeuroSurge (within-case themes)	NeuroZone (within-case themes)	Researcher's synthesis of neural foundations themes (across case)
7. Social-emotional processes	**Self-regulation capacities**: • conscious negativity. • resilience. • social capacity.	Social and emotional process neuromodulation: • enhance positives. • distance from negatives. • exercise empathy. • apply dialogue and move to patience and trust.	**The emotional drivers**: • value tagging. • collective creativity. • goal-directedness, structurally respond to the limbic system of MPFC and PFC (Van der Walt, 2016).	Core processes: Social brain / default mode network.
8. Thinking capacities	**Thinking capacities**: • attention: sustained and controlled. • memory: working and recall. • planning.	**Cognitive process neuro-modulation**: • Develop personal meaning and purpose statement (why goal) with ongoing reviews (how goals). • Contribute value.	**The higher-order drivers**: • learning; • abstraction; • - executive function, structurally respond to hippocampus, dorsolateral pathways and PFC.	Core processes: Cognitive processes / central executive network.
9. Brain-body an adaptive system	Integrated functioning		Complex adaptive system	

Chapter Four: Applied research project

Title: Articulating neuroscience-based leadership behaviour: a Delphi study

"If you don't know where you are going, any road will take you there" – *Alice in Wonderland*.

Abstract

Background: This study aims to bridge the gap between two research fields, namely leadership behaviour and neuroscience, as perceived by experienced professionals. Neuroscience-based leadership (NSBL) is based on the premise that ongoing research in the neurosciences can ultimately advance the descriptive accuracy and explanatory power of concepts in leadership behaviour. Descriptive accuracy and explanatory power are achieved by explaining brain processes and improving the micro-foundation of human behaviour at work. The findings of the Delphi study, although emerging, can be directly or indirectly extended to formal organisational settings, thereby improving the efficacy of an organisation.

Aim: To construct a conceptual framework of neuroscience-based leadership by creating a well-defined, comprehensive portrait of NSBL behaviour entailing a working definition for neuroscience-based leadership, identifying neuroscientific conceptual underpinnings of behaviour, and articulating the critical descriptors of the core behaviours of neuroscience-based leaders in formal organisations.

Method: A three-round qualitative Delphi study involving a panel of experts to gain consensus on responses to three key research questions: What is a working definition of NSBL? What are key neuroscientific concepts that underpin NSBL behaviour? What key words or phrases describe the core behaviours that differentiate NSBL from other approaches to leadership?

The following groups were represented on the panel of experts: (a) neuroscientists, (b) authors, (c) educators, (d) expert consultants, and (e) leadership coaches. The first-round Delphi survey was open-ended. The second round expanded opinions by adding a Likert scale to the results of the first round. The third-round Delphi instrument used a Likert scale instrument to gather views from each panel member. Each panellist received the statistical information calculated from the second round in the third round.

Results: Forty-one panellists participated in the first round of the survey, and 33 panellists in each of the second and third rounds of the Delphi study. A neuroscience-based leader behavioural anchor framework was created from the data. The definition,

foundational concepts and core behaviour descriptors, as agreed upon consensually by the panel of experts, are presented and discussed.

Contribution: This study contributes to AONS literature by furthering theoretical and empirical knowledge regarding the conceptualisation of neuroscience-based leadership. The study contributed to the existing leadership and applied neuroscience literature by developing a theoretically sound conceptual framework to describe and cultivate these NSBL behaviours. The contribution to practice is that this study advances the understanding of how formal organisations can apply a neuroscientific lens to improve leadership development.

Key words: leadership behaviour, Delphi, applied neuroscience, core behaviours.

1. Orientation to the research

1.1 Introduction

This chapter adopts an exploratory qualitative research design to articulate NSBL. This includes a definition, foundational concepts and core behaviours and descriptors. The background to the research, leading to the research problem, is discussed. Next, the research aims are stated, and the research paradigms are discussed. The research design and method are presented, followed by a discussion. The research methodology, using a Delphi study, is formulated. Limitations are noted, and recommendations for future research are made.

1.2 Background and Context

"A science of the relations of mind and brain must show how the elementary ingredients of the former correspond to the elementary functions of the latter" – William James, *The Principles of Psychology: Volume 1*, 1890, republished in 2007.

The Proximity of Leadership behavior to leadership effectiveness

Leaders play a pivotal role in organisations. Their behaviour significantly impacts employee behaviour, performance, wellbeing and leadership effectiveness (Avolio, Walumbwa, & Weber, 2009; Day & Antonakis, 2012; Inceoglu, Thomas, Chu, Plans, & Gerbasi, 2018). Meta-analytic evidence exists for the link between leader characteristics and leader behaviour (DeRue, Nahrgang, Wellman, & Humphrey, 2011), showing that leadership behaviour tends to explain more of the variance in leadership effectiveness than leadership traits. Because of this proximity of behaviour to the performance and wellbeing of team members rather than leader characteristics such as personality traits (DeRue, Nahrgang, Wellman, & Humphrey, 2011), this exploratory study focuses on describing the core behaviours of NSBL

The leadership literature, however, has primarily neglected research on the neurobiological underpinnings of leadership behaviour in favour of "types" of leadership behaviour like authentic leadership, situational leadership and transformational leadership (Day & Antonakis, 2012). A reason for the slow uptake is the criticism against this emerging field. The scrutiny mainly relates to challenges in collecting, integrating, interpreting, and using information from the brain-level analysis.

The central idea of this criticism is that brains don't think, feel, act, or communicate. Instead, such intricate processes are the responsibility of entire individuals and groups of individuals (Powell, 2011, as cited in Ward, Volk, & Becker, 2015). As such, it can be problematic to try and establish a direct causal relationship between a particular neurological activity and a person's behaviour. However, a point of agreement is that "the brain unquestionably plays an important role... [although] it may not always be the starting point triggering human behaviour," according to Lindebaum and Zundel (2013, p. 871).

Fortuitously, Healey and Hodgkinson (2014) presented a logical solution for handling the reductionism issue, specifically their socially situated cognition (SSC) viewpoint of how neurophysiological processes play a contributing, but not always a deterministic role, in leadership and organisational processes. This recursive interaction between individuals, their neurological processes, and the larger environmental context is highly compatible with Bandura's (1999 as cited in Waldman, Balthazard, & Peterson, 2015) social cognitive theory of personality, which highlights the role that environment, learning from others, and individual traits play in the development of personality and subsequent behaviours.

It is interesting to note that such thinking is also aligned with the biopsychosocial (BPS) model of health discussed in Chapter One, which introduced this research. The BPS model attributes complex phenomena or events to multiple causes (Engel, 1981, cited in Bott, Radke, & Kiely, 2016).

Some prominent scholars argued compellingly for the unrealised value of neuroimaging as a new tool in the toolbox of psychological science (Cacioppo, Berntson, & Nusbaum, 2008) and called on psychologists to utilise neurobiological research findings as neurobiology and brain-level data could contribute to the understanding of cognitive architecture and function. According to these authors, understanding the relevant neurobiology is strongly influenced by our existing theoretical models regarding cognitive architecture and function. Bass and Bass (2009) envisioned that applying brain scanning and neuroscience within a business context will accelerate economics, marketing, and business ethics and ultimately explain leadership thinking and behaviour.

An effective science of the mind depends on having sophisticated measurements of the brain and a theoretical framework to connect those data to psychological constructs significantly and generatively (Lindquist & Feldman Barrett, 2012). The problem with such integrative approaches is that neuronal mechanisms have limited explanations of mental functions and, thus, interdisciplinary problems (Kotchoubey et al., 2016). According to these authors, an explicit methodology of integrative human neuroscience should be developed to link different fields and levels and help understand psychological phenomena.

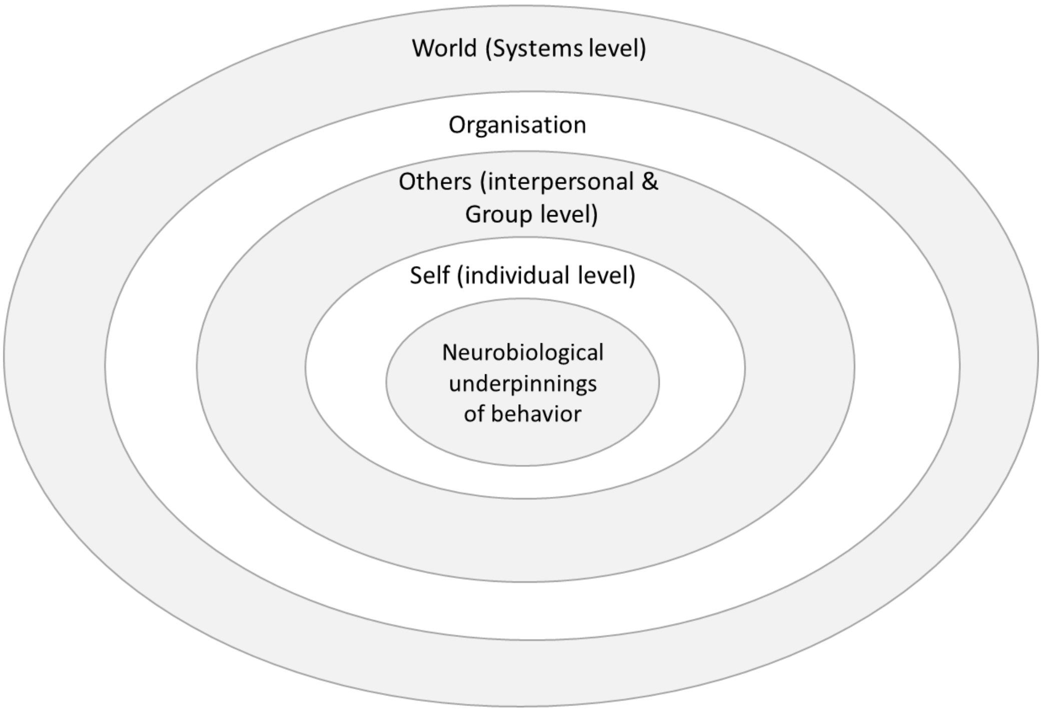
While controversial, applied neuroscience's merits impact many fields, including educational leadership and organisational and leadership behaviour (Geldenhuys, 2022; Hoffman, 2009; Joldersma, 2016). There remains an opportunity to examine further research endeavours that integrate leadership’s neurobiological and organisational roots. This exploration can enhance understanding and even create organisational developmental interventions to comprehend further and leverage the neurobiological signature of human-specific social behaviour.

Using neuroscience to engage with the territory of Leadership.

Using neuroscience or neurobiology as an interpretive lens requires a decision on the application domain regarding the relationships in which leadership stands: Self, Others, Organisation, and the world (Veldsman & Johnson, 2016). This exploratory research aims to add insights into leadership at the individual level of functioning, using neurobiological underpinnings to enhance the explanatory power of core leadership behaviour. (See Figure 1 below). This was an evidenced approach using results from neuroscientific studies on leadership (N=14) and theoretical review studies (N=15) to prevent making false claims that are impossible to sustain or beyond the range of convenience.

Figure 1

Levels of Organisational functioning (compiled by the researcher)



The topic of NSBL constitutes a new domain with largely unstudied potential. However, some vital questions and notions are still not critically discussed in the literature, including a working definition of a neuroscience-based leader and the essential behaviours of effective neuroscience-based leaders. How, then, to proceed? The research undertaken in Chapter Two (literature review) showed that NSBL is challenging due to the lack of precision and conciseness. Overall, the literature review and the work done in Chapter Three have focused on the following themes of NSBL:

A working definition of NSBL

The literature reviewed in Chapter Two showed that whilst there is much published on defining leadership (Bass & Bass, 2009; Behrendt, Matz, & Göritz, 2017; Dinh et al., 2014; De Haan, 2016), the academic literature is sparse on defining NSBL (Ghadiri, Habermacher, & Peters, 2013; Senior, Lee, & Braeutigam, 2015). This discussion of definitions calls for consensus on a single definition that comprehensively and succinctly captures NSBL. This research advocates for a broad definition of NSBL, which embraces a variety of methods which explore the mechanisms of people's attitudes and actions in work contexts.

The foundational neuroscientific concepts informing NSBL

The conceptual foundations of NSBL were also found to be a problematic topic (researched in Chapter Three). An integrative neuroscience approach was adopted to study the foundational concepts that underpin NSBL and based on evidence in the literature that there are already coexisting rules of a dynamic working brain (Feldman Barrett, 2017a; Gordon 2000; Kandel, Schwartz, Jessell, Siegelbaum, & Hudspeth, 2013; Sapolsky 2017; Ward 2016).

Gordon's (2000) review cites multiple seminal researchers. It provides a framework for further research: Specialised survival networks help us avoid danger and minimise pain. Multiple interconnected neurons constitute overlapping networks (for example, the default mode network, the central executive network, and the salient / control network). Incoming information is processed fast via reflexive networks or, if a mismatch occurs, more slowly via reflective networks; all information transfer in the brain consists of electrochemical processes, Inherited genetic thresholds modulate neural functions, Adaptive needs are met through neural pruning or neural plasticity (also known as long-term potentiation), The whole brain and body are a highly interconnected system functionally as well as anatomically (Gordon, 2000, p. 27).

Rather than attempting to define complex linkages between these concepts and brain processes as well as hypothesised behaviours, the researcher adopted the stance suggested by Jack, Rochford, Friedman, Passarelli, & Boyatzis (2019) and Amaro and Barker (2006) to utilise simple yet rigorous paradigms and convergent methods to translate neuroscientific findings into behavioural applications.

Core behaviours of a neurally aware leader in the workplace

This theme relates to core behaviours that differentiate neuroscience-based leadership (NSBL) from other approaches to leadership. The literature review of current empirical neuroscience studies undertaken in the organisational domain was reported in Chapter Two, which highlighted groundbreaking work done in this field. The key themes of these studies collectively represent the empirical foundation of organisational neuroscience, and most of these studies have been undertaken in the domain of leadership. These studies show that empirical neuroscience research can deepen our understanding of constructs beyond what is possible from solely looking at self-report psychometric data. Notably, none of the work discussed considers conceptualising the construct of NSBL. The literature review shows no suitable conceptual framework to delineate and define NSBL behaviours.

Although there is a lack of neuroscientific research results on leadership behaviour, organisational neuroscience provides some answers by extrapolating from mature fields of neuroscience dealing with topics relevant to leadership (Waldman, Ward, & Becker, 2017). A synthesis of the leadership and neuroscience literature provided evidence for relations-oriented and task-oriented behaviours.

Admittedly, leadership behaviour is inherently complex, and there are many possible perspectives to view leadership. When using neuroscience to enhance the scientific understanding of leadership behaviour, the research contribution must be simple. The information must be accurate, not overly reductionist, and promote ethical conduct (Beers, 2014). This requires becoming knowledgeable and engaged in the evidence to prevent a management fad approach to neuroscience-based leadership (Ashkanasy, Becker, & Waldman, 2014) and to overcome the justified scrutiny of this integration attempt (Healey & Hodgkinson, 2014; Lindebaum & Zundel, 2013; Van Ommen & Van Deventer, 2016).

1.3 The research problem

The research problem is that despite presenting NSBL as a leadership construct, the theorists in this new field have not yet convincingly anchored the construct in the leadership body of knowledge through building a theoretical alliance between leader behaviour and complex neurobiological concepts. In solving the research problem, it is essential to recognise that observable leadership behaviours, as operationalised in this research, are not the same as personality traits, values or leadership skills. Traits, values and skills can help understand effective leadership, but they differ in essential ways from observable behaviours (Yukl, 2012).

As evident in the literature reviewed, building a theoretical alliance between complex leader behaviour and even more complex neurobiological activity is undoubtedly a challenging and perplexing endeavour (Balthazard, Waldman, Thatcher, & Hannah, 2012; Boyatzis, Good, & Massa, 2012; Waldman, Balthazard, & Peterson, 2011a; Waldman & Balthazard, 2015).

1.4 Research aims and questions.

The primary aims

- To refine a working definition of NSBL.

- To identify and describe neuroscience concepts that are used in the application of NSBL behaviour development.
- To identify and articulate core NSBL behaviours as portrayed beyond existing literature but as viewed by experienced professionals in the field of organisational neuroscience, with reference to leadership in formal organisations.
- To conceptualise neuroscience-based leadership within a well-defined theoretical framework.

Research questions

> "We are not students of a specific subject, but students of problems. And problems can cross the boundaries of any subject or discipline" (Popper, 2014, p. 88).

As Karl Popper implied in the quote above – solving problems and asking questions is how we grow scientific knowledge. This study is reliant on three main questions relating to the cross-boundary subject of NSBL:

1. What is a working definition of NSBL?
2. What are the foundational neuroscientific concepts that underpin NSBL behaviour?
3. What core behaviours differentiate NSBL from other approaches to leadership?

1.5 Conceptual framework for the Delphi study

A comprehensive conceptual framework is a key part of a research project (Ravitch & Riggan, 2016; Van der Waldt, 2020).

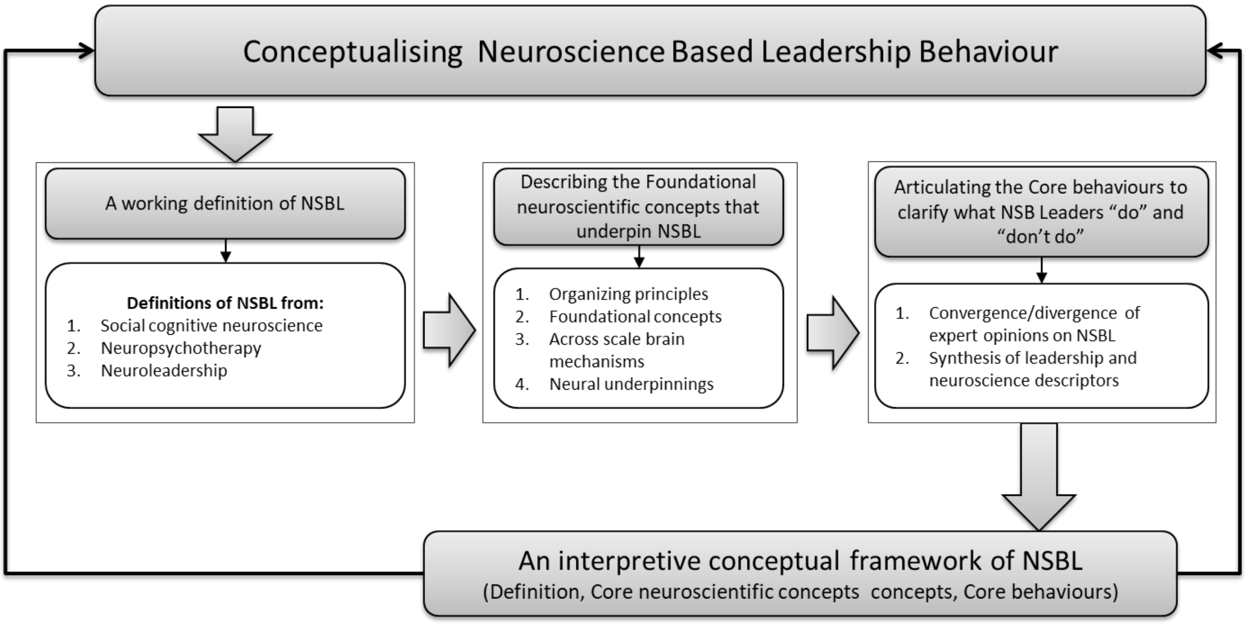
According to Van der Waldt (2020, p. 4)

> "a conceptual framework should be viewed as both the results and focus of a literature review. As a result of a literature review, the researcher has to consult the literature to (1) identify relevant and related concepts, (2) determine the potential connections (interrelationships) between these concepts, and (3) identify a suitable theory or theories by which to embed the study in a particular theoretical perspective."

The conceptual framework of this study is set out in Figure 2. The conceptual framework was compiled to ensure that the investigation is focused, contains related theory and has solid methodological arguments (Van der Waldt, 2020).

Figure 2

Conceptual framework of NSBL: Articulating a definition, foundational concepts, and core behaviours



1.6 The research paradigm and disciplinary context

The critical realism paradigm by Bhaskar (2008) was adopted for this research as it provides an ideal means to bridge social neuroscience and organisational science. Also, given how comparatively little research appears to have been carried out on NSBL behaviour, the study was operationalised pragmatically. Pragmatism accepts a flexible and pragmatic approach to solving research problems (Klenke, 2008). Before beginning any endeavour, it is crucial to realise where one stands in terms of theory and to take stock of the tools at one's disposal.

1.6.1 Applied neurosciences and leadership behaviour

Applied neurosciences is an umbrella term that applies neuroscientific research findings to other domains, such as psychology, leadership, economics, education, and marketing. The main aim is to develop new perspectives and insights into the neurological mechanisms that influence human behaviour (Ashkanasy, Becker, & Waldman, 2014; Becker, Cropanzano, Sanfey, 2011; Garnett, Venter, & Geldenhuys, 2022). In the case of this research, the field of leadership behaviour (Yukl, 2012) is the domain theory of the study.

The most relevant theories to NSBL in the organisational context are social-cognitive neuroscience (Lieberman, 2007; Ochsner & Lieberman, 2001), affective neuroscience (Feldman Barrett, 2017a), and integrative neuropsychotherapy (Grawe, 2007; Rossouw, 2013). Integrating these perspectives (leadership behaviour and neuroscience theory) can offer distinctive insights into how neuroscientific theory may explain leadership behaviour. Specific research studies were included in the literature review in Chapter Two. They were used predominantly in this chapter as well.

2. Research Method: A Delphi study

An exploratory qualitative Delphi study was chosen to contribute to the conceptualisation of NSBL. This approach can have both theoretical and developmental implications for understanding leadership behaviour. In addition, it is an original contribution to adding legitimacy to neuroscientific approaches applied to leadership behaviour.

Methods are the procedures, tools, and techniques a researcher utilises to generate, analyse and understand data (Bazeley, 2013; Schwandt, 2007). A qualitative Delphi study was used to examine the three research questions, with the assumption of safety in numbers or, as Hasson, Keeney, and McKenna (2000, p. 2013) put it, “several people are less likely to arrive at a wrong decision than a single individual”.

The Delphi method is mainly suitable in areas of inadequate research since survey instruments and ideas are generated from a knowledgeable participant pool (Hasson et al., 2000). It is appropriate for use in research areas where controversy, debate or a lack of clarity exist. According to Linstone and Turoff (1975), two conditions justify the use of the Delphi technique in research: (1) “the problem does not lend itself to precise analytical techniques but can benefit from subjective judgements on a collective basis”; and (2) “individuals who need to interact cannot be brought together in a face-to-face exchange because of time or cost constraints” (Linstone & Turoff, 1975, p. 275). Both conditions are pertinent to the elusiveness found in the empirical evidence on NSBL.

The Delphi technique has proven to be the most suitable way of compiling data, seeking answers to the research questions, and constructing more accurate descriptors relating to the core behaviours of NSBL. The Delphi method has been included in some leadership studies, for example, to define leadership competencies (Choi, Torralba, & Willsky, 2012; Traynor, Borgelt, Rodriguez, Ross, & Schwinghammer, 2019) and to define servant leadership (Abel, 2000). This research study sought consensus among experienced professionals in the applied fields of organisational neuroscience and NSBL on defining the core behaviours of an NSBL approach.

The current study applied qualitative and quantitative methodologies across the consensus-building procedure (Avella, 2016). Qualitative data from open-ended questions in the Round One (R1) questionnaire was formulated into descriptive statements. These descriptive statements were returned and ratified in a Round Two (R2) online survey, asking participants to rate their agreement with the statements. In Round Three (R3), participants received individualised surveys comprising the same descriptive statements, each statement displayed with their previous (R2) response and the average response from all participants.

Participants were invited to re-rate statements if they wished, in comparison to the groups' responses, with the intention to confirm consensus and divergence of "expert" opinions (Fenton, Joscelyne, & Higgins, 2021; Hasson et al., 2000).

2.1 Participant recruitment

2.1.1 Sample: Purposive sampling

To conduct good qualitative research, it is important to determine the required number and level of expertise of potential informants (Bogner, Littig, & Menz, 2009; Neuman, 2013). The population for this research comprised experienced applied organisational neuroscience professionals.

2.1.2 Identification and selection of the sample

Panellists form the lynchpin of the Delphi study, and clear inclusion criteria should be applied and outlined as a means of evaluating the results (Iqbal and Pipon-Young, 2009). Participants were selected for a specific purpose: to apply their knowledge to a certain problem (how to articulate the core behaviours of NSBL). The researcher used the purposive sampling technique to identify and select "experts" or "experienced professionals" who practise in applied organisational neuroscience, including NSBL. Purposive sampling assumes that a researcher's knowledge about the population can be used to hand-pick the cases to be included in the sample (Hasson et al., 2000).

According to Bogner et al. (2009), both the expert's specific interpretive knowledge ("know-why") and procedural knowledge ("know-how") should be considered in their selection to participate in qualitative research. The selection of the panel of experts was carefully deliberated, as their collective expertise would finally determine the research results. Because the study was designed to define NSBL and identify core behaviours of NSBL in general, the following criteria were used for the selection of the panel of experts:

- *Education and skills*: Postgraduate qualifications in applied organisational neuroscience.
- *Formal work position related to the research topic of NSBL behaviour*: Established academic or consulting professional in the applied field of organisational neuroscience.
- *Work experience in NSBL or Organisational Neuroscience and the level of public recognition*: Presentations at conferences, books and or articles published in the field.

A snowball sample approach was also adopted to recruit additional participants, where the initial participants were asked to provide a list of additional subject experts to participate in the Delphi study (Hsu & Sandford, 2007). The proposed list for the expert panel was presented to the researcher's PhD supervisory panel for further recommendations. (See Appendix A: The Delphi panel member purposive sample list, which demonstrates how the criteria were operationalised to compile the proposed panel.)

Given the amount of data and subsequent analyses each panellist generates, Linstone and Turoff (2002) recommend Delphi panels of between 10 and 50 people. For this study, the researcher sent out a total of 60 invitations to join the Delphi panel.

2.2 Ethical considerations and project feasibility

As an Industrial Psychologist registered with the Health Professions Council of South Africa (HPCSA), the author practises within the *Rules of conduct pertaining specifically to the profession of psychology* stipulated by the Professional Board for Psychology of the HPCSA. "Chapter 10: Research and Publication" of these *Rules of conduct* were followed throughout and included standards relating to institutional approval, informed consent, reporting on research, and plagiarism (HPCSA, 2006).

This Delphi study was directed within the basic design of a Delphi study that involves "assembling groups of experts without concern for geography" (Avella, 2016, p. 306).

The proposed participants were contacted via email and invited to participate in the Delphi study (Stone Fish & Busby, 2005). The researcher sent an invitation letter to the potential panellists (see Appendix B for the invitation letter to participants). The confidential nature of the research and the research findings was emphasised in the introductory letter, which clarified the aim of the study, stressed the terms and conditions of participation, and explained how the data would be collected.

Participants who accepted the invitation did so voluntarily, and the highest ethical standards were maintained. Participants who volunteered completed a consent form. The consent form included details about the Delphi study's nature and purpose. Following the CCCU ethics protocols governing the research, panel members were sent a letter of consent stating anonymity and confidentiality. Details about the PhD study programme were also made available to participants (see Appendix C for the research consent form, the participants' information document, and the CCCU PhD Fact Sheet).

For the first round of the study, participants had to indicate that they had accepted the informed consent statement as well as the terms and conditions of the study on the survey link. Once this was complete, they were able to commence with the survey. Upon completion, an autogenerated response was generated stating that the survey had been completed.

After the due dates of each round (three-weekly cycles for Round Two and Three), the data was transferred from the Q-Research survey database to a spreadsheet to calculate each individual's actual response per statement. The spreadsheet also displayed the group average for each statement.

Bazeley (2013) provided advice on how to manage research data. In this research, the data were managed as follows. Data were stored electronically by the researcher on a secure memory drive, and all data files were password-protected. A backup was created in the cloud that was password-protected. Data will be stored for five years as per university guidelines. After the five-year period, all data, including participant information, will be discarded in a secure manner. No data will be shared with any third parties.

Panel members' identities were kept private by contacting participants individually. There was no joint forum or panel member information exchange. Once the study was completed, the results were made available to all participating panel members on request.

2.3 Quality assurance and trustworthiness

Instead of reliability and validity measures used in quantitative research, several authors propose using Lincoln and Guba's (1986) criteria for qualitative studies to ensure that credible translations of the findings are given (Avelle, 2016; Hasson et al., 2000).

These parallel criteria, namely, credibility, transferability, dependability, and confirmability, were incorporated into this study and are set out in Table 1 on the next page.

Table 1

Trustworthiness of the study (adapted from Lincoln & Guba, 1985,1994)

Characteristic	Description	Application in this study
Credibility (Truthfulness)	*Are the research findings believable?*	The expertise and experience of the panellists were considered. Triangulation of data collection was carried out and is discussed in detail below.
Transferability (Descriptive)	*Are there adequate and detailed descriptions for all the relevant research details?*	The research questions and aims were straightforward. Thematic analysis and Delphi consensus panels as an analytical model enhance the transferability of findings.
Dependability (Auditability)	*Where does the data come from?* *How was the data collected? How was the data used?*	The background for this study and the description of the theory in the NSBL behaviour field were stipulated. This addressed the need to account for changing conditions in the phenomenon studied.
Confirmability	*Are the findings grounded in the data collected from informants?*	Another experienced professional confirmed the findings of the literature review and data of the Delphi study in organisational neuroscience.

Lincoln and Guba (1985) suggested several techniques to address the criteria for trustworthiness. Activities such as prolonged engagement, data collection, and researcher triangulation are used to address credibility.

In this study, data collection triangulation was used extensively to better understand neuroscience-based leadership: an initial NSBL framework was developed through a literature review, expert interviews with three neuroscientists who deploy self-report diagnostics in leadership development were conducted in the small-scale research project, and only experienced professionals who were considered to have specific and appropriate knowledge of NSBL were contacted as panel members in this applied research project (ARP).

The requirements for rigour have been adequately met for this research and will be further discussed in the section addressing the project activity.

2.4 The research instrument: A Delphi questionnaire

The Delphi method seeks experts' opinions through a series of thoroughly designed questionnaires interspersed with data and feedback to determine convergence of opinion (Mulder, 2017). This was a three-round Delphi study to answer the three research questions via an online survey. The development of each survey is set out in Section 4.

This section outlined the research methodology regarded as suitable for this study.

3. Project activity

3.1 Introduction

This section describes the role of the researcher in the Delphi study and the data collection and analysis procedures involved in the three-round Delphi process.

3.2 The role of the researcher in this Delphi study

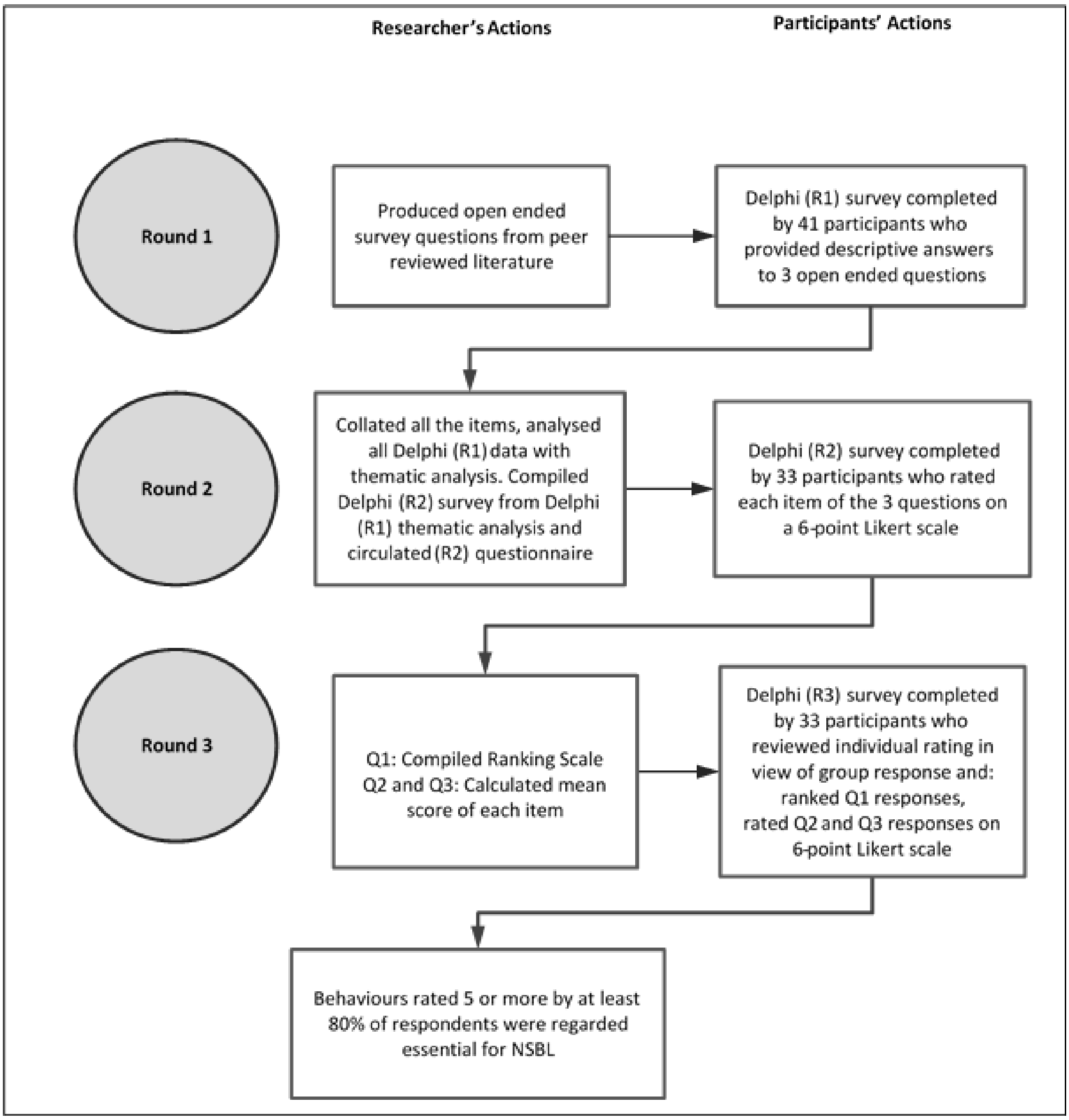
Following the guidelines set by Avella (2016) regarding the role of the researcher in academic studies, the researcher performed a twofold role – "planner" and "facilitator". Planning of the study design and roll-out involved compiling an open-ended questionnaire given to the panel of selected experts to get specific information on the subject of NSBL.

The researcher took on the role of "facilitator" in subsequent rounds of the procedure. The researcher communicated the rounds and what was required in each round and expedited panel members to complete each round. Participants rated the individual items and also made changes to the phrasing or substance of the items. Through a series of three rounds, a consensus was reached. Compared to the usual qualitative designs, the researcher was not an "instrument" who interpreted the panel members' experiences (Avella, 2016, p. 307).

Researcher bias was minimised by following the guidance of Avella (2016, p. 307), who states that "the risk of researcher bias is minimal in thoroughly designed and executed panels, as the researcher's primary task is that of planner, coordinator and recorder". This back-and-forth communication between the researcher and panel members provides for internal process auditing". See Figure 3, which depicts the three-round Delphi procedure.

Figure 3

Flow diagram depicting the three-round Delphi procedure.



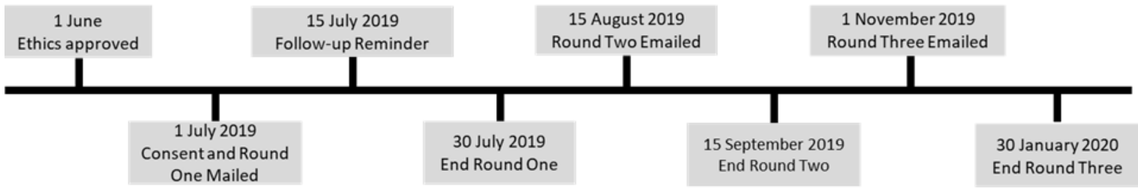
3.3 Data collection method: A Delphi study

3.3.1 Procedure for data collection: Consecutive rounds of a Delphi study

The research procedure entailed a three-round Delphi study to gain consensus on responses to three key research questions. As Brooks (1979) discovered, a three-round Delphi study is usually sufficient to achieve consensus, with a fourth-round eliciting only marginal difference. Each online survey was constructed based on the results of the preceding round (Toma & Picioreanu, 2016). This is described further in the project activity section. The three-round Delphi process took six months between June 2019 and January 2020. The data collection took four weeks for the first Delphi round and three weeks per round for the next two rounds. See Figure 4.

Figure 4

Delphi study timeline



The development, administration and analysis of each Delphi round are discussed next.

3.3.2 Delphi Round One (R1)

3.3.2.1 Development of (R1) open-ended survey

The researcher developed the first-round (R1) questionnaire as an open-ended survey. This was done as NSBL is a nascent field of study with an inadequate research base (Linstone & Turoff, 2002; Toma & Picioreanu, 2016). The research questions were devised from peer-reviewed literature, and from the learnings gained in the small-scale research project that was conducted by the researcher. The online survey was piloted with one experienced professional in the NSBL field, and reviewed by the research supervisors (Vosmer, Hackett, & Callanan, 2009). Changes were made to enhance the clarity of survey questions and rewording of survey instructions.

3.3.2.2 Administration of (R1) open-ended survey

The survey distribution, data collection, and survey management were done electronically using the Alchemer software platform (Alchemer, 2021). The participants were requested to fill in and answer all the questions posed (Avella, 2016). Two reminders were sent to participants for the completion of this Delphi round questionnaire. (See Appendix D: Delphi survey Round One for the survey questionnaire sent to panel members).

3.3.2.3 Analysis of (R1) open-ended survey

The researcher consolidated the responses from (R1) as follows:

Research Question 1: What is the definition of “neuroscience-based leadership”? A thematic analysis was used to compile key themes of a working definition of NSBL.

Research Question 2: What are key neuroscientific concepts that underpin neuroscience-based behaviour? The researcher consolidated the list of items provided by the experts. A thematic analysis was used to compile key themes of the concepts underpinning NSBL.

Research Question 3: What are the key words or phrases that describe the behaviours that distinguish NSBL?

The list of items provided by the experts was consolidated by the researcher. A thematic analysis was used to compile themes of descriptors of core behaviours of NSBL.

After the survey was closed, all data entries were downloaded and recorded on an MS Excel spreadsheet to capture the full meaning of what the participants were saying. After that, written MS Word documents were created for each participant. These documents were reviewed precisely, and any mistakes, missing words or typographical errors were removed. The cleaning procedure and preparation of the data files for coding involved a systematic review of the data files. The relevant phrases were highlighted in this preliminary reading to ease the data analysis process (Creswell & Creswell, 2017).

A thematic data analysis methodology was employed to assess the data provided by the 41 participants, following Braun and Clarke's (2006) thematic analysis protocol. Thematic analysis is a detailed conventional procedure intended to recognise and examine themes from written data in a distinct and trustworthy manner (Guest, MacQueen, & Namey, 2011, p. 15). In other words, thematic analysis takes several chunks of text and categorises them into codes, similar categories, and finally, themes. The researcher also used the detailed theoretical thematic analysis guidelines Percy et al. (2015) set out to code the data on defining the neuroscientific foundational principles underpinning NSBL as pre-determined themes existed (Gordon, 2000).

After creating the necessary MS Word documents, the data were organised, coded and grouped, and themes were developed, refined and finalised. The analysis followed the process of thematic analysis outlined in Table 2 by Braun and Clarke (2006).

The thematic analysis was used to make sense of the information provided by the participants. It provided suitable themes which spoke to the research questions and objectives of the study. Rigour was ensured by following the trustworthiness criteria of Lincoln and Guba (1986) and interweaving these into the thematic analysis (Nowell, Norris, White, & Moules, 2017).

Table 2

Using thematic analysis in psychology (Braun & Clarke, 2006, p.87)

Phase	Description of the process
1. Familiarising yourself with your data	Transcribing data (if necessary), reading and re-reading the data, and noting down initial ideas.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic “map” of the analysis.
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back to the research question and literature analysis, producing a scholarly report of the analysis.

The identity of the participants was removed from the completed questionnaire documents to maintain their confidentiality. Pseudonyms were allocated to participants to protect their identity while providing information relating to their backgrounds and their roles in the different organisations they work for.

Data were then stored and analysed in NVivo 12 Plus. Each of the three questions per participant file was imported into NVivo as an MS Word file. In the initial phase, the files were checked through lexical queries such as word frequency and text search queries to augment the coding. Written notes from field notes, Portable Document Format (PDF) documents and websites were imported into the NVivo project. Throughout the study, data were exported from NVivo to MS Excel to produce figures and tables. The next step involved data coding.

Qualitative coding is a process of reflection and a way of interacting with and thinking about data (Savage, 2000). Coding allows the researcher to simplify and focus on specific characteristics of the data. Coding of the information happens when the information is examined and categories are defined from the whole data set. It is a process of organising the knowledge emerging from the data set. The coding method followed was that set out by Braun and Clarke (2006). The researcher focused on themes of the working definition of NSBL, the neuroscience concepts underpinning NSBL, and the core behaviours of NSBL in formal organisations as units of analysis. The coding process was carried out per the research questions.

The researcher used open coding by assigning initial codes or labels. Codes are "tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study" (Basit, 2003, p. 144; Fereday & Muir-Cochrane, 2006). The aim was to develop content-rich codes, or as Boyatzis (1998, p. 1) suggested, a "good code" captures the qualitative richness of the phenomenon. Coding was done inductively and deductively to identify theory-driven and data-driven codes (Booth & Carroll, 2015). An extract of the coding is set out in Appendix E: Data Coding, which sets out an example of the data clean-up, the code book for core behaviours/question three), the code book for question two (foundational concepts) and the Trustworthiness checklist (Nowell et al., 2017) are provided.

The preliminary codes created were then systematically structured into a codebook according to broad categories and relationships. These codes were further refined by merging themes, and some irrelevant codes were finally removed. Coded data extracts were then collated under sub-themes and themes. The main themes and sub-themes that emerged out of the data analysis process of the study were reported per research question.

To ensure credibility, accuracy and transparency, the researcher involved two qualitative data analysis experts (otherwise uninvolved in the project) in the coding process. In qualitative exploration, these kinds of checks are sometimes seen as indicators of the trustworthiness and reliability of the coding process. They add to the rigour and validity of the suggestions extracted from the codes and categories created (Bazeley & Jackson, 2013). Minor changes to codes, sub-themes and themes were made in consultation with these data analysis experts. The results of the coding are presented in Table 3 below. The number of sources and the number of quotations contributing to each theme are also shown.

Table 3

Summary of data analysis across three research questions in Delphi (R1)

Name	Files (sources)	References	Sub-themes	Themes	Statements
Definitions of NSBL	41	131	14	6	6
Foundational concepts of NSBL	41	252	19	5	13
Core Behaviours of NSBL	41	244	16	4	40

From Table 3, it is clear that Research Question 2 on the foundational concepts of NSBL received the most responses, with 252 references covered by 41 participants. Research Question 3 regarding the core behaviours of NSBL was second with 244 references. Finally, Research Question 1 regarding the definitions of NSBL was third, with 131 references covered by all 41 participants.

The following step included the researcher's interpretation of the created themes. Statements were then formulated according to the codes, sub-themes and themes to reflect panellists' articulated replies to the research questions, using their words where feasible (Hasson and Keeney, 2011). These statements were going to be used in the Delphi Round Two (R2) survey. This process of making meaning of the data formed the crux of the research. The researcher constantly kept in mind the main research objectives of the study. The statements pertaining to the research questions and the specific themes under each research question were stated in a neutral way to be relevant to respondents.

3.3.3 Delphi Round Two (R2)

3.3.3.1 Development of (R2) survey

The questionnaire became more quantitative and closed-ended on the second (R2) and third (R3) rounds of data-gathering, as it was deemed that this would enhance the consensus-gaining (Hasson et al., 2000; Wilkes, 2015). (R2) probed the panel members to rate the compiled statements from (R1) using linear numerical scoring scales as described by Likert (1932).

A six-point Likert scale was used from "strongly disagree" to "strongly agree" (see Table 4 for an example). A six-point scale forces choice, giving scholars and decision-makers better data. To accommodate a neutral point, the "slightly agree" and "slightly disagree" can be averaged together (Fenton, 2018). A comment box was provided to allow participants to include qualitative responses about each item. (See Appendix F for the Round Two survey instructions and questionnaire sent to the Delphi panellists.)

Table 4

Example of (R2) statement relating to Research Question 1 on the definition of NSBL

Delphi Round Two (R2) – Instructions:

Please rate how strongly you agree or disagree with each statement as being an essential part of a working definition of being a neuroscience-based leader.

Please tick your response on the following 6-point scale	Strongly disagree 1	Disagree 2	Slightly disagree 3	Slightly agree 4	Agree 5	Strongly agree 6
Definition 1: Has a scientifically grounded working knowledge of the brain.						

3.3.3.2 Administration of (R2) survey

The survey distribution, data collection, and survey management were done electronically (Avella, 2016). The participants were requested to fill in and answer all the questions asked. Two reminders were sent to participants for the completion of this Delphi round questionnaire. The survey took approximately 30 minutes and was available online for four weeks.

3.3.3.3 Analysis of (R2) survey

The statements compiled in (R1) for each research question were sent to the panel. The (R2) questionnaire was analysed by using descriptive statistics to calculate the mean, median, standard deviation, minimum and maximum of responses to each statement of the entire sample on the six-point Likert rating scale.

3.3.4 Delphi Round Three (R3)

3.3.4.1 Development of (R3) survey

In the third round (R3), participants were given the opportunity to review their own responses in light of the overall group feedback to enable them to adjust their scores and reach a consensus. (R3) thus probed the panel members to re-rate the results of the previous Delphi round (Hasson et al., 2000).

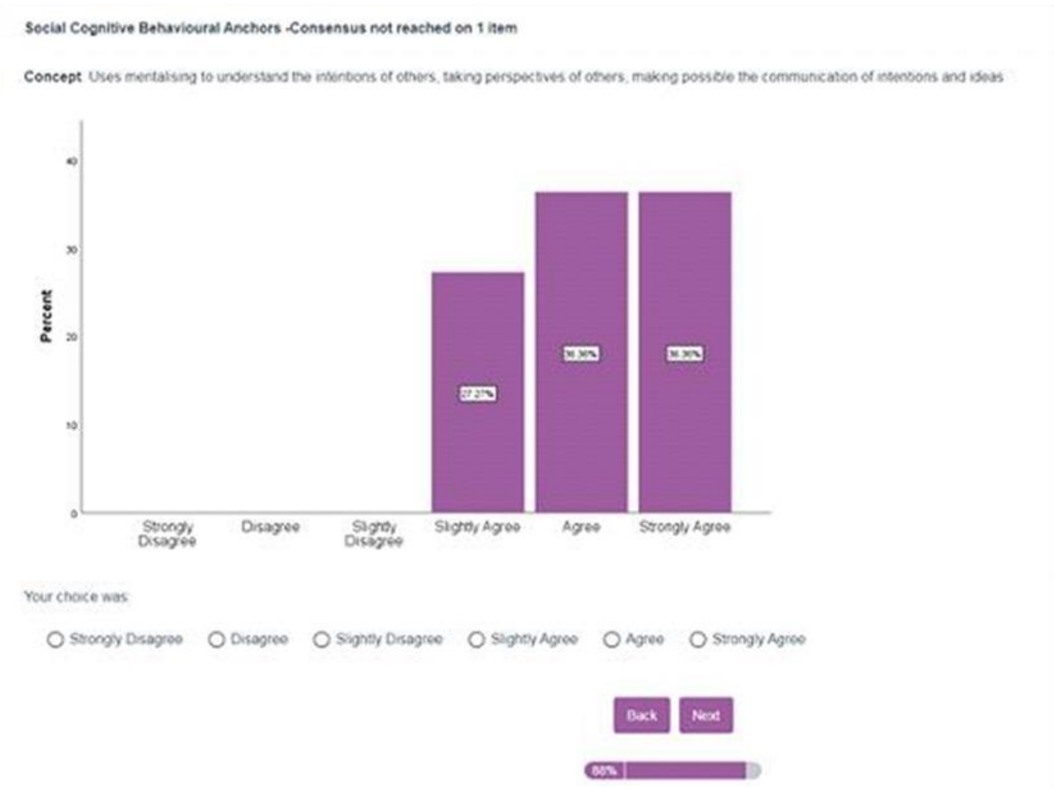
Research Question 1 relating to defining NSBL (R3) was treated as a ranking stage (Schmidt, Lyytinen, Keil and Cule, 2001). In this round, panellists were requested to rank the selected top six statements for the first research question in order of importance.

Research Question 2 (relating to NSBL underpinning concepts) and Research Question 3 (relating to NSBL behaviours) had identical statements as in (R2), except for statements that had already achieved ≥80% consensus, leaving five statements for concepts and one statement for behaviours to be re-rated.

(R3) surveys (see Appendix G for Round Three instructions and questions) were individualised for each (R2) participant, where each statement was presented with their previous response and the groups' overall responses (see Figure 5).

Figure 5

Sample of (R3) re-rating of items that did not achieve consensus.



Qualitative (R2) comments were anonymously displayed at the top of each section. Participants were invited to consider the groups' ratings and comments and review and re-rate statements if they wished.

Round Three (R3)

In this final round you will see the same statements shown in the previous round. This round has fewer statements, because the ones with high levels of agreement among participants have not been included. With each statement you will see your response (indicated in bold orange), and figures demonstrating the overall group responses.

Some of the comments made by participants in the previous round will be anonymous, presented at the top of each page. This is your opportunity to either change or validate your previous responses.

If you would like to change your rating, please select your new rating on the Likert scale below each statement. If you want to keep the same rating you gave on the previous round, please leave the boxes blank for that statement and move onto the next statement.

3.3.4.2 Administration of (R3) survey

The (R3) surveys were accessible online for three weeks and took roughly 30 minutes to complete. Participants were reminded via email one week before the survey was taken offline. This resulted in a high completion rate (Iqbal and Pipon-Young, 2009).

3.3.4.3 Analysis of (R3) survey

As stated by Avella (2016, p318), Delphi panels are built on two principles: "(1) the opinion of experts is a mixture of knowledge and speculation, and (2) the averaging of separately collected opinions provides a more accurate picture than a collective opinion resulting from a face-to-face group discussion".

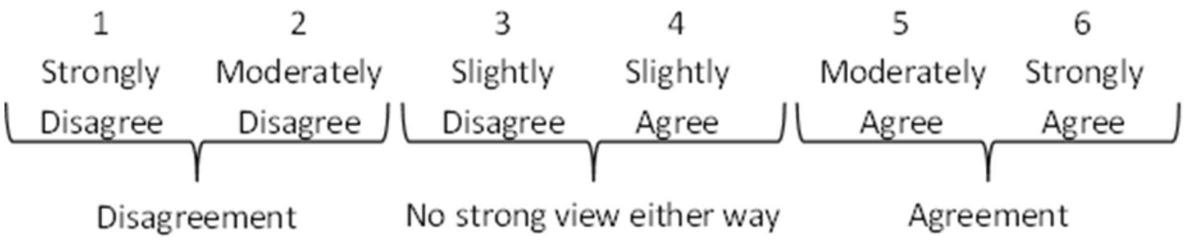
Upon receipt of the final completed questionnaire, the researcher checked whether any changes had been made in comparison with the scores received in (R2) of the Delphi survey process, in which case the data were re-analysed compared to the scores of (R2). A statistical group response was calculated and compiled at the end of (R3), which included percentages, medians, mean scores, and standard deviations. This offered valuable information on the distribution and variability of the data.

3.4 Quantitative analysis of consensus and divergence

After the final data collection in Round Three (R3), the six-point Likert scale was collapsed into three categories to indicate participants' disagreement or agreement with statements, as shown in Figure 6. Aligning with recent Delphi studies (Fenton, 2018; South, Jones, Creith, & Simonds, 2016), only strong or moderate views are shown in the results (see Figure 5). Percentages of disagreement (sum of the percentage of participants selecting ratings 1 and 2) and agreement (sum of the percentage of participants selecting ratings 5 and 6) were calculated for each statement.

Figure 6

Disagreement or Agreement with statements reflected via collapsed categories of Likert scale ratings.



Consensus categories vary vastly across Delphi studies (Hsu and Sandford, 2007). Because there are no definitive guidelines, Delphi studies have used varying levels of consensus ranging from 51% to 100% (e.g. Bisson et al., 2010; Berk, Jorm, Kelly, Dodd, & Berk, 2011, Fenton, 2018).

This study chose, in advance, to operationalise strong consensus as 80% or more (Toma and Picioreanu, 2016) and followed other Delphi studies (e.g. Fenton, 2018; South et al., 2016), where less than 55% was applied to describe a lack of consensus.

The remaining 55%–80% was halved to classify weak and moderate consensus (see Table 5 for the breakdown of the consensus categories).

Table 5

Consensus Categories

Consensus categories	Level of agreement ("moderately agree" and "strongly agree") or disagreement ("moderately disagree" and "strongly disagree")
Strong consensus	≥80%
Moderate consensus	67.5%–79.9%
Weak consensus	55%–67.4%
Lack of consensus	<55%

Consensus measurement is an essential component of Delphi analysis and interpretation. Descriptive statistics were used to interpret each statement's consensus and divergence results, including mean, median and standard deviation calculations (Toma and Picioreanu, 2016).

3.5 Summary of project activity

This section describes the data collection and data analysis process. The thematic analysis was automated in NVivo 12 Plus using the data from the expert interviews as input. The analysis identified codes, code families / sub-themes and themes for a definition of NSBL, underpinning concepts and core behaviours. The questionnaire became more quantitative and closed-ended on the second (R2) and third (R3) rounds of data-gathering, which required rating statements derived from the expert opinions of panellists on a 6-point Likert scale. Quality assurance and trustworthiness were ensured throughout the project activity stage. The entire study followed the quality assurance guidelines by Toma and Picioreanu (2016) and are set out in Appendix H: A Delphi study reading template.

The code families / sub-themes have been verified by including expert panellists' quotes from the Delphi survey results, keeping the findings as close to the data as possible, as necessary in an inductive and deductive data analysis of this nature.

4. Results and discussion and construction of NSBL framework

4.1 Introduction

This section documents the Delphi panel participant information and illustrates the themes emerging from the Delphi study data analysis. Each theme includes the definition of the core behaviour, a description of the core behaviour and its level of consensus, and a comparison of the theme to the existing body of knowledge, concluding with the possible implications of the theme for leadership behaviour. The conceptual framework for NSBL is then presented.

4.2 Participant information

Sixty experts active in organisational neuroscience were invited to participate in the study, and a total of 41 participants contributed to the first round (R1) of the study (41/60 = 68% response rate). Thirty-three panellists contributed to Round Two (R2), which is 33/41 = an 80% response rate. The rate of 33/33 (a 100% response rate) continuing from Round Two (R2) to Round Three (R3) exceeds the completion rates expected in Delphi studies (40%–75%) (Gordon, 1994). Table 6 details the demographic characteristics of participants in Round Two (R2) and Round Three (R3).

Table 6

Display of participant demographics

Demographic information		Number of participants in Rounds 2 and 3 (N=33)
Age	30 – 49	10
	50 – 69	18
	70+	1
	Other	4
Gender	Male	12
	Female	21
Profession	Neuroscientist	16
	Leadership consultant	14
	Psychologist	2
	Other	1
Educational attainment	Grade 12 (Secondary school)	0
	University degree	22
	Postgraduate and higher	11
Length of time in the role		10.07 years

4.3 Results and discussion on Delphi rounds per research question

The results are related to the research aims of:

1. Articulating a working definition of NSBL.

2. Identifying and describing underpinning neuroscience concepts that are used in the application of NSBL behaviour.
3. Identifying and refining key NSBL behaviours as portrayed beyond existing literature but as viewed by experienced professionals in the field of organisational neuroscience, with a specific focus on leadership behaviour in formal organisations.

The results for each research question are discussed in the following sections.

4.3.1 Results and Discussion on Research Question 1: What is a working definition of NSBL?

To collect and analyse data for Question 1, the researcher adopted the three-round ranking-type Delphi method (Schmidt et al., 2001). The first round was a brainstorming stage, the second round a narrowing-down stage, and the last round a ranking stage. In this final round, participants were requested to rank the chosen top six items in order of importance (D'Amato and Wang, 2015).

4.3.1.1 Defining NSBL: Thematic analysis (R1)

The results for (R1) for Research Question 1 are presented by primary themes with supporting quotations from the participants. This was done to ground the results in the respondents' descriptors. The presentation of the results is tabulated in Table 7.

Table 7

Delphi Round One (R1): Definition of NSBL from the perspective of panellists

Theme	Description of theme	Panellists' quoted descriptions
1. Practical application	Deploys a **positive and practical application of brain-based processes** to optimise social collaboration, innovation, decision-making, change, resilience, diversity, and wellness.	*"A neuroscience-based leader is someone who recognises that to run a successful business or organisation in the 21st century, the need is for a people-centric approach, with the emphasis on: 1. developing growth-oriented mindsets and patterns of thinking to optimise performance, flexible and agile thought, and 2. developing greater awareness of self and the need for self-care and 3. the integration of emotional and social intelligence skills to foster engagement, effective teams and great places to work."*
2. Cultivates psycho-logical safety	**Cultivates psychological safety** through positive, inclusive workplaces.	*"Creating an environment which fosters a 'toward' state in which people are open, curious, expansive and productive."*
3. Individual, team, and organisational levels of focus	Builds brain-friendly processes at the **individual, team, and organisational levels**.	*"A neuroscience-based leader needs to understand the brain-basis of leadership tasks and apply and share this understanding. First, this includes what happens in individual brains as people attempt day-to-day work, collaborate, innovate, or go through change. This includes but is not limited to issues around working memory capacity, emotional responses, decision-making processes, biases, social cognition mechanisms, and habit-formation processes. Second, this looks at these issues at a team level, and third, at an organisational and system level. A leader who understands the brain has a different understanding of why people are doing what they are doing and how to intervene most effectively."*
4. Leverages brain-based processes	**Leverages brain-based processes** like attention regulation, memory capacity, emotional regulation, social cognition, and habit formation for optimum wellbeing and performance.	*"In its simplest form, a neuroscience-based leader needs to understand how the brain works – and the impact of those workings. The neuroscience-based leader can also communicate the complexities of the brain in a manner that can be understood by their colleagues who do not have her/his level of knowledge by translating the neuroscience principles into day-to-day activities using words and phrases in common parlance."*

Theme	Description of theme	Panellists' quoted descriptions
5. Scientifically grounded working knowledge	Has a **scientifically grounded working knowledge** of the brain.	*"Neuroscience-based leaders need to have:* *1. gained a general understanding of the human brain's anatomy, electrochemical environment and principles of operation;* *2. gained a more specific, personal understanding of their brain and* *3. bridged the knowing–doing gap with a productive, positive and healthy practical application of their knowledge of the brain to optimise collaboration, innovation, decision-making, growth and wellbeing."*
6. Understand the basic human psychological needs	**Understands the basic human needs** of pain avoidance/pleasure-seeking, control, attachment, and self-esteem and fulfils these needs through workplace solutions.	*"A neuroscience-based leader needs to know the main drivers of human behaviour and their origin in the human brain. Based on Neuropsychotherapy (Grawe), the SCOAP model of Ghadiri, Habermacher and Peters applies these needs into the leadership context: self-esteem, control, orientation, attachment and pleasure.* *A neuroscience-based leader needs to identify the needs in the first step. Building upon this, brain-based leadership means to fulfil the employee's needs with matching HR and Organisational tools."*

(a) Summary of the findings in Table 7

Participants defined NSBL as drawing on the advances in neuroscience to add to the understanding of leadership behaviour. Specifically, foundational neuroscientific principles were mentioned, such as attention regulation, memory capacity, emotional regulation, social cognition, and brain plasticity.

4.3.1.2 Defining NSBL: Consensus-seeking (R2)

Consensus (defined as > 80% agreement) was achieved for 100% (n = 6) of statements relating to the definitions of NSBL. A 100% agreement was reached on the statement " that NSBL is exemplified by cultivating psychological safety by building trust and mutual respect in the workplace". There was also 100% agreement that NSBL deploys a positive and practical application of brain-based processes to optimise organisational outcomes like innovation". No Delphi panellists disagreed with any statements under this theme (see Table 8).

Table 8

Delphi Round Two (R2): Consensus on statements relating to the definition of neuroscience-based leadership (NSBL)

Definition of neuroscience-based leadership	Disagree	Agree
Strong consensus on definitions:		
1. Cultivates psychological safety by building trust and mutual respect in the workplace.	0%	100%
2. Deploys a positive and practical application of brain-based processes to optimise social collaboration, innovation, decision-making, change, resilience, diversity, and wellness.	0%	100%
3. Leverages brain-based processes like attention regulation, memory capacity, emotional regulation, social cognition, and habit-formation for optimum wellbeing and performance.	0%	97%
4. Builds brain-friendly processes at the individual, team, and organisational levels.	0%	97%
5. Understands the basic human needs of pain avoidance/pleasure-seeking, control, attachment, and self-esteem and fulfil these needs through workplace solutions.	0%	88%
6. Has a scientifically grounded working knowledge of the brain.	9%	85%
Moderate consensus on definitions:		
(None)	–	–
Weak consensus on definitions:		
(None)	–	–

4.3.1.3 Defining NSBL: Ranking (R3)

Table 9 indicates the most important statements of defining NSBL behaviour as identified by the participants. Deploying a practical application of brain processes, cultivating psychological safety, and focusing on multiple organisational levels were identified as the top three elements of NSBL.

Table 9

Delphi Round Three (R3): Ranking of NSBL definitions by panellists.

Definition of NSBL behaviour	N	Mean	Rank[1]
1. Deploys a positive and practical application of brain-based processes to optimise social collaboration, innovation, decision-making, change, resilience, diversity, and wellness	27	3.07	1
2. Cultivates psychological safety by building trust and mutual respect in the workplace	27	3.15	2
3. Builds brain-friendly processes at the individual, team, and organisational level	27	3.78	3
4. Leverages brain-based processes like attention regulation, memory capacity, emotional regulation, social cognition, and habit formation for optimum wellbeing and performance	27	4.00	4
5. Has a scientifically grounded working knowledge of the brain	27	4.41	5
6. Understands the basic human needs of pain avoidance/pleasure-seeking, control, attachment, and self-esteem and fulfils these needs through workplace solutions	28	4.75	6
Scale of rankings is 1= high importance to 6 = low importance.			

4.3.1.4 Defining NSBL: Comparison to literature.

The results demonstrated that NSBL is built on several neuroscientific frameworks with many aspects. Simplifying this body of knowledge into a concise explanation or definition is no easy task (see Table 10).

Table 10

NSBL definitions comparison with literature review

Resource	Findings from literature	Study findings
Ringleb and Rock (2008)	Neuroleadership studies the neural basis of leadership and management practices. The aim is to bring about the interface between the tools of various neuroscience fields like social-cognitive neuroscience and constructs from organisational sciences. Including: • regulation of emotions; • collaboration with others; and • facilitating change.	Concurs and extends: By emphasising multiple levels and dimensions of leadership applications.
Becker et al. (2011, p.237)	"ONS is an **interpretive framework"**. The primary focus is on the "brain's physical substrata and the connection between them. The three mature areas of neuroscience that have relevance to leadership in formal organisations are: "Combatting procrastination: goal selection and maintenance; mirror neurons and group sub-climates – modelling others; how attitude structures resist organisational change – change" (Becker & Cropanzano, 2010, p. 1056 -1058).	Concurs: This supports the theory that NSBL focuses on goal selection, mirror neurons, group sub-climates, and attitude structures.
Ghadiri et al. (2013, p. 139)	"NSBL is leadership through the knowledge of the brain; specifically, the neuroscientifically founded four basic needs".	Concurs and extends: Beyond psychological needs to include organisational applications.
Spain & Harms (2014)	The **socio-genomic leadership** perspective assumes "that both genes and the environment operate by modifying gene expression. This leads to a conception of genetic and environmental effects in leadership that is fundamentally dynamic" (Spain & Harms, 2014, p. 1). It gives an understanding of the biological substrates of leadership and provides a meta-theoretic framework of biological models showing that there is a basic interplay between genes and the environment over the life course.	Concurs and extends: Provides practical application of sociogenomics.
Gordon (2016)	A brain-based leader exemplifies the knowledge of the organising principle of the human brain to "minimise danger, maximise reward" and actively cultivates the neurobiological proficiencies that underlie effective decision-making and work relationships, collaboration with others, and self-regulation to ensure positive change and human performance optimisation.	Concurs

(a) Definition of neuroscience-based leadership

The initial NSBL definition from the literature review was:

> *A neuroscience-based leader has a scientifically grounded working knowledge of the brain, an understanding of basic psychological human needs, and uses insights from neuroscience to achieve goals and wellbeing at the individual, team and organisational level.*

A second and updated synthesised definition, inclusive of the literature review (theories plus concepts) and the Delphi study of NSBL, is offered by the writer as:

> *Neuroscience-based leadership is a neuroscientifically informed framework for leadership behaviour that conceptualises leadership behaviour as enabling the enhancing of basic psychological needs, as well as influencing and facilitating individual and collective efforts to accomplish shared objectives through cultivating stress resilience-oriented, affect and emotional-oriented, relations-oriented, and task-oriented behaviours.*

This definition incorporates many things, such as that leadership should understand how the brain works, that it is an enabler of meeting the basic needs of employees, NSBL leadership does not limit itself to predefined objectives or goals, but it also cultivates core behavioural capacities to deal with leadership in practice where it happens.

4.3.2 Results and discussion on Research Question 2: What are the foundational concepts underpinning NSBL?

To collect and analyse data for Research Question 2, the researcher adopted a three-round Delphi method (Schmidt et al., 2001). The first-round Delphi questionnaire was open-ended. The second round expanded opinions by including a six-point Likert scale to the results of the first round. In the third round, each panellist received the statistical information calculated from the second round.

4.3.2.1 Thematic analysis (R1)

The results for Round One (R1) for Research Question 2 are presented by primary themes with supporting quotations from the participants. A process of reflection and grouping the statements into similar concepts allowed the researcher to present a higher-order conceptualisation of the statements more meaningfully.

In order to ground the presentation of results in the respondents' experience and expertise, the findings are tabulated (see Table 11).

(a) Summary of the findings in Table 11

Participants reported the underpinning concepts of NSBL, as noted in Table 11, and applied these neuroscientific principles to improve stress management, change management, social relations, and organisational efficiency.

Table 11

Concepts that underpin NSBL from the perspective of panellists

Theme	Description of theme	Participant's quoted descriptions
1. Theories and thinking frameworks	Applying evidence-based neuroscientific theories and thinking frameworks to leadership and organisational settings.	*"If you put a picture of an MRI in your PowerPoint, people will be more willing to accept your content."*
2. Safety and survival	The brain's primary organising principle is to maximise safety and minimise the threat. Wired for survival.	*"The brain's overarching objective is to ensure our safety. The default setting is to assume danger when presented with a new situation. The threat is magnified by negative affect, fatigue, poor emotional regulation, lack of social support and poor interpersonal relationships."*
3. Neuroplasticity	Experienced-based neuroplasticity drives habit formation.	*"Neurons that fire together wire together. When neuronal patterns are activated repeatedly (experienced based), they form a pattern or more enduring circuit."*
4. Conscious / non-conscious processing	The brain operates in two modes – conscious and non-conscious processing to overcome the working limitations of the PFC and enhance energy efficiency.	*"The brain tries to save time and energy required by complex conscious thought by resorting to cognitive rules-of-thumb, mental shortcuts (biases)."*
5. Epigenetics	Nature/genetics and nurture/environment influence individual, team and organisational behaviour.	*"The brain is a pattern-making (sense-making) machine. It is in constant interaction with the environment and body, regulating the body for optimum performance. This is done mostly automatically."*
6. Neuro-transmitters	Neurotransmitters and their effect on behaviour.	*"The brain's 85 billion highly interconnected neurons and over 100 interacting chemicals create a highly synchronised yet fragile electrochemical environment."*

4.3.2.2 Consensus-seeking on concepts underpinning NSBL (R2) and (R3)

Round Two (R2): Results from (R2) and (R3) were tabulated (see Table 12) using the statements created in the thematic analysis derived in Round One (R1). Table 12 also displays statements pertaining to that theme, and overall levels of agreement and disagreement are displayed with each statement. Statements were grouped according to the consensus categories within which the overall level of agreement fits, starting with strong consensus (Fenton, 2018; South et al., 2016). Levels of consensus were listed in descending order (Avella, 2016)

Round Three (R3): Consensus (defined as > 80% agreement) was achieved for 8/13 (n = 13) statements relating to the concepts underpinning NSBL. The Round Three (R3) results are presented, followed by a discussion of the results. Findings are then interpreted in the context of the reviewed literature (Avella, 2016).

Table 12

Consensus for statements relating to core concepts that underpin NSBL.

Theme	No.	Core concept	Disagree	Agree	Sub-theme
Theories and thinking frameworks		***Strong consensus on concepts:***			
	1.1	The inverted U-curve of performance. Conscious, focused-attention is energy-intensive. A high focus over time fatigues the PFC and impairs downstream decision-making (**Arousal curve**).	0%	94%	12
	1.2	Social drivers like status, certainty, autonomy, relatedness, and fairness determine inclusion/exclusion perception (**SCARF model**).	0%	94%	11
	1.3	The use of neuroscience techniques to understand the social and emotional aspects of the human mind and human behaviour (**social-cognitive affective neuroscience theory**).	0%	90%	2
	1.4	The autonomic nervous system and fight/flight/freeze response – including the friend response (**polyvagal theory**).	0%	81%	4
	1.5	The 1–2–4 Model of Brain functioning and the interaction of the four processes of emotional cue-interpretation, feelings, thought, and self-control (**integrative neuroscience theory**).	6%	81%	5
		Moderate consensus on concepts:			
	1.6	Down-regulation of distress and fostering enriched environments through leveraging basic human needs, i.e., orientation and control, attachment, pleasure maximisation, and self-esteem enhancement (**neuropsychotherapy theory**).	3%	75%	7
	1.7	Neural functioning results from activating neural networks – task-positive networks and default networks enable task and relationship behaviours. The salient network acts as a task switcher (**opposing domains theory**).	0%	70%	13
		Lack of consensus on concepts:			
	1.8	The three hypothetical layers of the brain have differentiated functions (**triune brain theory**).	9%	44%	14

Theme	No.	Core concept	Disagree	Agree	Sub-theme
		Strong consensus on concepts:			
Safety and survival	**2.**	The brain's primary organising principle is to maximise safety and minimise threat (**wired for survival**).	0%	97%	10
Neuro-plasticity	**3.**	**Neuroplasticity**: Neurons that fire together wire together. When neuronal patterns are activated repeatedly (experienced based), they form a pattern or more enduring circuit.	0%	91%	1
Conscious / non-conscious processing	**4.**	The brain operates in two modes – **conscious and non-conscious processing** to overcome the working limitations of the PFC and enhance brain efficiency.	3%	85%	3
		Moderate consensus on concepts:			
Epigenetics	**5.**	Epigenetics (nature/genetics and nurture/environment) influence individual, team and organisational behaviour.	6%	79%	6
Neuro-transmitters	**6.**	Neurotransmitters and their effect on behaviour.	0%	75%	8

There were 13 statements pertaining to underpinning concepts of NSBL, structured into six themes: (1) theories and thinking frameworks; (2) safety and survival; (3) neuroplasticity; (4) conscious / non-conscious processing (5) epigenetics; (6) neurotransmitters. This is discussed further, based on the six key themes, in the following sections.

4.3.2.3 Discussion and Comparison of findings to the literature

(a) Theme One: Theories and Thinking frameworks

Eight statements pertained to theories and thinking frameworks.

A strong consensus was reached by panellists on five of these statements.

This corresponds to the organisational neuroscience literature that captures several theories with a sound scientific, research-based underpinning, attempting to translate neuroscientific research results into organisational and leadership theories. Most of these theories propose an organising framework and intervention process to facilitate change and shift leadership behaviour toward higher levels of wellbeing and performance levels (Boyatzis, Rochford, & Jack, 2014; Donde, 2012; Geldenhuys, 2020; Ghadiri et al., 2013; Gordon, 2016; Henson & Rossouw, 2013; Swart et al., 2015; Waldman, Wang, & Fenters, 2019; Waldman et al., 2011a).

The contribution of neuroscience to interpreting human behaviour can be systematically explained within related models and frameworks.

Moderate consensus was reached on the statement (1.7) relating to the opposing domains theory.

This aligns with recent literature that questions opposing domains; according to Spreng (2012), the opposing domains network theory is a fallacy. Feldman Barrett and Satpute's (2013) study on domain generic networks promoted a systems neuroscience perspective, with large-scale brain networks that act as integrative architecture rather than only opposing domains. In addition, Bressler & Menon (2010), Menon (2011) and Spreng (2012) argued that the brain does not function within isolated structures but as a complex, self-organising system of functional networks and feedback loops.

Large-scale network theory and systems neuroscience is increasingly used in the applied fields of wellbeing, mental health and leadership (Arden, 2019; Cole, Repovš, & Anticevic, 2014; Dixon et al., 2017; Geldenhuys, 2020).

The implication for leadership behaviour is that although it is impossible to observe overlapping neural networks or detect alterations in blood flow in the brain, one can "observe these networks' cognitive, emotional and behavioural correlations and changes through cultivating self-awareness" (Henson & Rossouw, 2013. p. 23)

The thinking (CEN), feeling (salience network), and story brain (DMN) parlance aids in operationalising brain network theory (Arden, 2019). Observing own behaviour and internal reactions in different contexts and noting the impact on others is a first step in building self-awareness, a root construct in leadership theory (Bass & Bass, 2009; Behrendt et al., 2017; Henson & Rossouw, 2013).

A lack of consensus was reached on the statement (1. 8) relating to the three hypothetical brain layers that are purported to have differentiated functions (triune brain theory).

This is in line with the literature that posits that the triune brain arrangement is a misconception in "psychology which holds that (1) as vertebrate animals evolved, "newer" brain structures (like the neo-cortex) were added over "older" brain structures (like the limbic system), and (2) these newer, more complex structures gifted humans with more complex psychological functions, behavioural flexibility, and language" (Cesario, Johnson, & Eisthen, 2020, p. 1).

The triune brain hypothesis was developed by Dr Paul Maclean, a neuroscientist and psychiatrist who constructed the fascinating theory of the "triune brain" to describe the brain's evolution and try to reconcile rational human behaviour with its more primal origins. This sequence was hypothesised to have a significant effect on neural firing and information flow in the brain, and to give insight into the manifestation of mental health and pathogenic conditions, such as narcissism, schizophrenia, and other mental disorders (Feldman Barrett, 2017a; MacLean, 1990).

The triune brain model has now been replaced with more sophisticated models. Although widely accepted by the general public, it has been discredited among neuroscientists and stands in contrast to the unanimous agreement on these issues among those studying nervous system evolution (Cesario et al., 2020).

The implication for leadership behaviour is that leaders need to become aware of their unique assumptions about examining human behaviour at work. Leaders should also be cautious about using conclusive language to talk about brain-based behaviours such as “amygdala flip” or “reptilian brain”. Leaders should contextualise their language within the organisational neuroscience theories or models they support.

(b) Theme Two: Safety and survival as a primary operating premise

Strong consensus was reached on this theme. This aligns with the neuroscientific literature that captures the role of threat (and defence) plus safety (and approach).

The basis of environmental (physical and psychological) safety is the key to neural development (Kandel, 2006). Compromised environments facilitate neural change, and when the environment is violated, the neural adaptation process is changed to survive the onslaught of infringement. Albeit detrimental to long-term survival, short-term survival becomes paramount. It results in neurochemical changes and, eventually, neural organisation (networks) changes. From a molecular neuroscientific perspective, the brain changes to enhance survival (Kandel, 2006).

Safety seems to be the key to neural proliferation, and compromised safety facilitates neural protection. Grawe (2007), using a neuropsychotherapy perspective, suggests the development of functional motivational schemata in relation to enriched and compromised environments. This is in line with Kandel's findings. In high-order mammals, the concept of safety is expressed in terms of three basic needs – pain/pleasure, control, and attachment (Grawe, 2007).

It is clear that patterns of unwellness (pathology) develop from the bottom (deeper neural functions) to the top. Although the prefrontal regions (especially the left prefrontal cortex) are exceptionally powerful in changing neural patterns (Furmark et al., 2002), fear-based activation in deeper systems can inhibit effective frontal cortical activation. The facilitation of safety is paramount in enhancing changed neural patterns (Allison & Rossouw, 2013).

The implication for leadership behaviour is for leaders to understand that humans (like other animals) act in diverse ways when confronted with a threat based on contextual contingencies. The brain’s survival-first principle should never be underestimated if one wants to maximise brain function. Also, leaders can cultivate safety in the workplace to down-regulate stress responses (both stress chemicals as well as stress pathways). The facilitation of safety is closely linked with the construct of trust and understanding this down-regulation of the stress responses. These principles are now well established from a neuroscience perspective.

(c) Theme Three: Neuroplasticity: Experience remodels the brain

Strong consensus was reached on this theme.

This theme confirms the literature on neuroplasticity, which stipulates that neuroplasticity is about the brain forming new memories and building new knowledge (Van der Walt, 2017b). As stated by (Kleim and Jones, 2008, p.225), neuroplasticity is believed to be “the basis for learning in the intact brain and relearning in the damaged brain that occurs through physical rehabilitation”. Doidge (2007) provided evidence that reflecting and narrating to another person fosters learning and development because of the significant change effect of language and meaningful social relationships on the brain’s form and functions (enhancing neuroplasticity).

The implication for leadership behaviour is that understanding the core concept of neuroplasticity empowers leaders to change their behaviour. As Henson and Rossouw (2014, p. 16) point out, “leaders should recognise that from the most simple to the most complicated aspect of their personality or leadership style, is derived from the activation (firing) of neural networks”. The insight on Neuroplasticity is that any behavioural pattern, thought, feeling or emotion can be unlearned and replaced through habit formation.

(d) Theme Four: Conscious / non-conscious processing

Strong consensus was reached on this theme.

This theme concurs with the literature which was captured in chapter three. The two views are (1) The reflexive and reflective systems (Epstein, 1994; Grawe, 2007; Lieberman, 2007; Kahneman, 2011). (2) The predictive processing view (Feldman Barrett, 2017b; Hutchinson & Barrett, 2019) postulates that the brain uses predictive and correction modelling to create all mental representations. According to these authors, references to dual systems are metaphors, not actual systems. Non-conscious processing can be surfaced by developing sensory awareness or tuning into gut feelings (Damasio, 1999).

The implication for leadership behaviour

Leaders should develop sensory awareness or tune into gut feelings (Damasio, 1999) or somatic markers. These markers are feelings in the body that strongly influence subsequent decision-making. The somatic marker hypothesis proposes that emotional processes, particularly decision-making, guide (or bias) behaviour. These messages are sensations that something “feels” right, such as the association of a rapid heartbeat with anxiety or nausea with disgust. Somatic markers simplify decision-making by guiding attention toward better-known options, but they are hardly fail-safe.

This links to affective realism (Feldman Barrett, 2017a), which postulates that we "see what we feel". Affect is the general term for the raw experience of feeling, outlook or mood one experiences throughout each day. It is not "an emotion but a more unassuming feeling, with two features. The first is how pleasant or unpleasant one feels, which is known as valence. The second feature of affect is whether one feels calm (passive) or agitated (active), also called arousal" (Feldman Barrett, 2017a, p. 72)

(e) Theme Five: Epigenetics

Moderate consensus (79%) was reached on this theme. Epigenetics (epi = that which sits above) is the study of "how the expression of genes changes in response to experience with the environment" (Henson & Rossouw, (2013, p. 225) 143. Both genetics (template genes) and the environment (transcription genes) interact in the brain to shape our brains and influence our behaviour. According to Gordon (2008), genes (nature) are not destiny – they are our disposition templates, and one can ignore them at your peril.

Our social reality (bonding and conditioning experiences or "nurture") can have a lasting effect from childhood that shapes ongoing personal experiences throughout the human life cycle (Feldman Barrett, 2017a). Notably, the brain has a remarkable capacity for change – "plasticity". With the right insights and training, transformative brain change that translates into new behaviours is possible.

The implication for leadership behaviour is to cultivate social relationships that manifest in the desired culture at work. Thus, modifying neural systems and, eventually, behaviour at work.

(f) Theme Six: Information transfer in the brain consists of electrochemical processes: Firing and wiring

Moderate consensus (75%) was reached on this theme.

This concurs with the findings in chapter three and with the literature; according to Gordon, Barnett, Cooper, Tran and Williams (2008), the brain processes information via dynamic, spatially interconnected processes with accompanying neural chemistry. Also, as reported in Chapter Three, mental states are associated with neurotransmitters, which have specific functions (Adell et al., 2010).

The implication for leadership behaviour is that mind-states (resourceful, aggressive, or helpless) are associated with electrochemistry and impact the immune system, either pro-inflammatory or anti-inflammatory. Mind-states can be altered by conversations (Doidge, 2007).

4.3.2.4 *Summary of the core concepts*

A clear perspective emerging in this section on underpinning concepts is a move towards whole-brain models and parsimonious frameworks that can aid in extrapolating neuroscience findings to the workplace.

Although the relation between neuroscience theory and data and leadership behaviour is more casual than causal, the emergence of applied organisational neuroscience increasingly provides realistic integrations of neuroscience into workplace behaviour.

4.3.3 Results and discussion on Research Question 3: What key words or phrases describe the behaviours that differentiate NSBL from other approaches to leadership?

To collect and analyse data for Question Three, the researcher adopted a three-round Delphi method (Schmidt et al., 2001).

4.3.3.1 *Core Behaviours of NSBL (R1) – Thematic analysis*

Four primary and several sub-themes present the results for (R1) for Research Question 3 with supporting quotations from the panellists (See Table 13). The findings are tabulated to ground the presentation of results in the panellists' responses (Avella, 2016).

Table 13

Delphi Round One (R1): Descriptions of the behavioural anchors of NSBL from the perspective of panellists

Behaviours:			Panellists' quoted descriptions
Primary Themes	**Sub-set**	**Sub-themes**	
1. Stress resilience	1.1	Understanding foundational functional principles of the brain-body system.	*"Understands the thriving state of the human brain and puts into place measures that allow that to happen."*
	1.2	Down-regulating distress and leverages optimum arousal.	*"Arousal (pressure) management: awareness of individuals' optimal levels of arousal for highest performance. Too little will create disengagement, and too much will trigger a non-productive stress state. Individual brains differ."*
	1.3	Practising optimum sleep, exercise, nutrition, and breathing.	*"Stress mastery: neuroscience-based leaders have embedded stress mastery strategies to optimise their performance and wellbeing – this enables them to facilitate optimal arousal levels for individuals, teams and the organisation to generate the best decision-making, collaboration, innovation and overall wellbeing."*

Behaviours:			Panellists' quoted descriptions
Primary Themes	**Sub-set**	**Sub-themes**	
2. Affect and emotions	2.1	Cultivating sensory awareness of mind and body states.	*"Tunes into affective cues such as facial expressions, speech space, and tone, body language to detect fears and instil social safety."*
	2.2	Dialling-down negativity bias/mood states.	*"Emotion management (self and others): Attuned to emotion contagion. Has created and embedded strategies for self-control and regulation to transmit a positive, engaged, supportive emotional state to others."*
	2.3	Generating, distinguishing and regulating emotions.	*"Do pre-appraisal and reappraisal as strategies to reduce the arousal impact of emotions."* *"Uses mindfulness to self-regulate emotions and stress levels."*
3. Relations-oriented	3.1	Facilitating psychological Safety (threat avoidance /reward-seeking).	*"Uses inclusive language and genuinely values diversity in all respects of the term."* *"Builds psychological safety in teams – does this by asking powerful questions, listening, clarifying, affirming, use of simple metaphors for joint understanding."*
	3.2	Role modelling behaviour – imitation system.	*"People make a deliberate effort day-to-day to "walk the talk" and demonstrate an attitude of exemplarity, self-control and growth mindset."*
	3.3	Taking others' perspectives and empathetic concern – mentalising system.	*"Encourages feedback from others so that she/he can become more self-aware and gain insight."*
	3.4	Building in-group climates.	*"Builds in-group culture through shared goals, outsourcing of effort and celebration of outcomes (team dynamics)."*
	3.5	Identifying and mitigating subjective biases.	*"Identifies own cognitive biases and attributional errors."* *"Enhances collective intelligence by including men and women in the group, increasing social sensitivity and providing equal participation."*
4. Task-oriented	4.1	Builds mindful attention awareness practices to enhance focus.	*"Conscious thought energy management: Is sensitive to the energy required for complex, conscious thinking and the risk of brains defaulting to shortcuts, and faulty, unproductive bias. Manages length of meetings facilitates collective decision-making and challenges potential bias."* *"Ensures that multitasking and constant interruptions are discouraged by the leader."*
	4.2	Leveraging goal-directedness to facilitate behaviour change.	*"Management of expectations is aware of the power of the brain's' if-then' coding and the negative cognitive impacts of unmet expectations. Takes special care in setting expectations/goals."* *"Frames goals into social causes – prosocial behaviour is reward circuitry-driven."*

Behaviours:			Panellists' quoted descriptions
Primary Themes	**Sub-set**	**Sub-themes**	
	4.3	Facilitating change through attention density and habit formation.	*"Understand that neuroplasticity is a function of attention density."* *"Develops the skill set to change their behaviour using self-awareness and to make a conscious choice to install a new habit using practice and repetition."*
	4.4	Leveraging learning through memory systems.	*"Knows that learning is a physical process in the brain and understands the principles of encoding and recall."*
	4.5	Enhancing breakthrough decision-making – exploitation/exploration systems	*"Builds downtime into the calendar for silent reflection and insight creation."* *"Change/innovation management: Is aware that the brain translates change into an 'unknown code' which can trigger the brain's threat circuits and derail thinking and behaviours. The leader creates certainty and normalises feelings of uncertainty to optimise performance."*

(a) Summary of the findings in Table 13

Participants described core NSBL behaviours as moving toward a more science-driven way of expressing leadership behaviour. NSBL includes core behaviours relating to the brain-body as a system for optimum performance, mood states and emotion core behaviours, relation-oriented and task-oriented.

4.3.3.2 Consensus-seeking on behavioural anchors of NSBL (R2) and (R3)

Results from (R2) and (R3) are organised per research question derived from the statements created in the thematic analysis in (R1). Each theme is tabulated and displays statements on that theme, overall levels of agreement and disagreement are also displayed for each item. Statements were grouped according to the consensus categories within which the overall level of agreement fits, starting with strong consensus (Fenton, 2018; South et al., 2016). Levels of consensus were listed in descending order (Avella, 2016)

There were four (4) themes and 15 sub-themes with 40 behavioural statements overall. Consensus (defined as > 80% agreement) was achieved for 98% (n = 40) of statements relating to the core behaviours of NSBL.

The presentation of the final results in each of the following sections is accompanied by a discussion of the results for each of the sub-themes. Findings are interpreted in the context of the available literature (Avella, 2016).

(a) Theme 1: Stress resilience-oriented

Seven statements pertained to stress-resilience anchors and are set out in Table 14. Participants agreed strongly on six statements, with 100% agreement on being aware of potentially triggering a threat response through tone of voice, body language, and exclusion of others. A weak consensus was reached on Statement 7, relating to understanding the neurochemistry of mind-states. However, a lack of consensus does not suggest that the results are not important (Fenton, 2018). According to Toma & Picioreanu (2016, p. 56), a lack of consensus needs to be viewed within “managing minority opinions”. In this study, a high percentage of disagreement items was not dropped.

Table 14

Stress resilience-oriented core behaviours

	Statement	Disagree	Agree	Sub-theme
	Strong consensus on behaviours:			
1.	Is aware of potentially triggering a threat response through tone of voice, body language, and exclusion of others.	0%	100%	1.2
2.	Has a scientifically grounded working knowledge of the brain, its form and functions.	0%	91%	1.1
3.	Recognises that change triggers a threat response and encourages rhythmic living through sleep, nutrition and exercise.	0%	88%	1.3
4.	Pays attention to individuals’ unique optimal levels of arousal for the highest performance. Too little will create disengagement; too much will trigger a non-productive stress state.	0%	88%	1.2
5.	Practising good sleep hygiene, exercise nutrition, and breathing to enhance memory consolidation, positive mood regulation and down-regulation of stress.	0%	82%	1.3
	Moderate consensus:			
6.	Gains insights into the current state of research about the brain with particular reference to what is relevant in the workplace.	0%	79%	1.1
	Weak consensus:			
7.	Understands and leverages the electrochemistry of the brain and the role it plays in mind-states, oxytocin in trust and belonging, serotonin in regulating mood, adrenalin to sharpen attention	3%	58%	1.2

(i) Sub-theme 1.1: Understanding foundational functional principles of the brain-body system

Statements:

- Has a scientifically grounded working knowledge of the brain, its form and functions.
- Gains insights into the current state of research about the brain with particular reference to what is relevant in the workplace.

The high consensus levels on these statements align with the existing literature that argues for an evidence-based approach to reducing neuromyths within different psychological fields, as described by Kagee and Lund (2012). With the proliferation of content within the domain of neuroscience, scholars should distinguish between fact and fiction.

There is sometimes a temptation to embrace the latest trends and approaches to organisational research without first critically evaluating the methodological, analytical and interpretive limitations thereof. Knowledge of the evidence base, a sound critique thereof, and at least an awareness by organisational scholars as this psychology discipline gains momentum are paramount to ensure best practice (Voegtlin, Walthert, & Robertson, 2019).

The literature also acknowledges that empirical organisational neuroscience research has received little systematic attention in organisational psychology, which is now changing (Waldman et al., 2019). These authors considered the added value of NSBL approaches and concluded that it increases the understanding of leadership constructs by associating psychometrically-based operationalisation of leadership with neural assessments.

The implications for leadership behaviour are that trust increases by understanding the underlying brain mechanisms of leadership behaviour, thereby enhancing the opportunity for intentional change. For example, as (Louw, Zimney, Puentedura, & Diener, 2016 as cited in Tabibnia & Radecki, 2018, p74) report, “in the setting of chronic pain management, there is convincing evidence from multiple randomised controlled trials that therapeutic neuroscience education – that is, educating patients about the neurophysiology of pain and how the brain can temper the experience of pain – improves intervention outcome, such as diminishing the experience of pain.”

As with this physical pain example, leadership behaviours can be developed with improved insight into the core brain mechanisms and processes that enable it.

(ii) Sub-theme 1.2: Down-regulating distress and leveraging optimum arousal of attention

Statements:

- Is aware of potentially triggering a threat response through tone of voice, body language, and exclusion of others.
- Pays attention to individuals’ unique optimal arousal levels for highest performance. Too little will create disengagement; too much will trigger a non-productive stress state.

- Understands and leverages the electrochemistry of the brain and its role in mind-states, oxytocin in trust and belonging, serotonin in regulating mood, and adrenalin to sharpen attention.

The high consensus finding on statements relating to this theme is confirmed in the literature.

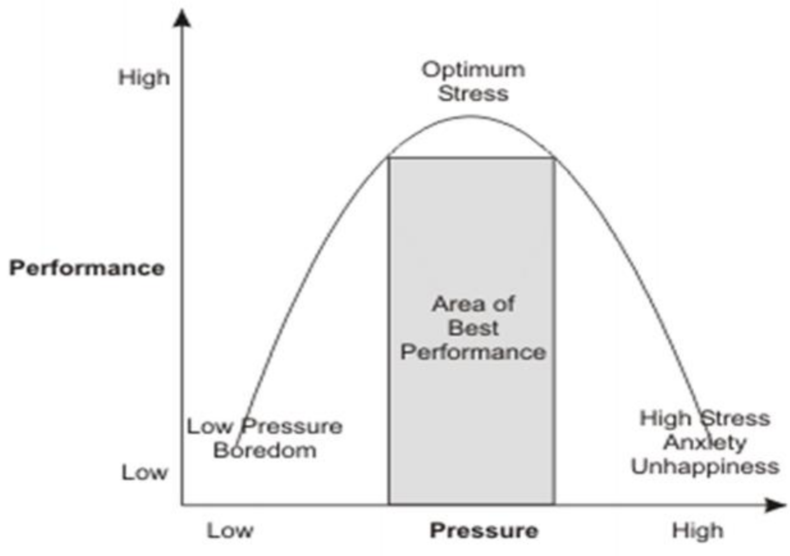
Stress is considered a critical factor in the ability of leaders to function optimally. Conversely, it has long been argued that leader-manager behaviour significantly determines employee stress levels. In a meta-analytic study by Harms et al. (2017), the relationship between three leadership constructs (transformational leadership, leader-member exchange, and abusive supervision) and stress and burnout confirmed that leader stress influences leader behaviour and that leadership behaviour and relationships between leaders and followers are key determinants of stress and burnout among subordinates. Stress and leadership are, therefore, inextricably linked.

Literature on this topic by, Becker, Volk, & Ward (2015, p. 63) found that "Environmental and interpersonal stressors provide a common source of mental distraction because they induce superfluous thoughts that compete for cognitive resources". The inverted U-curve of performance (or the optimal arousal curve) explains the relationship between cognitive demands, arousal or stress, and level of performance (see Figure 7 for the inverted U-curve).

Optimal performance is achieved at the peak of the curve (Arnsten, 1998). A mentally stimulating state characterises this midpoint. Below the midpoint, performance declines as a result of insufficient arousal. Above the midpoint, arousal builds to levels that induce stress and anxiety caused by the task being perceived as beyond the individual's capability. Some thrive amid these challenges and experience being at the top of the arousal curve or in a state of "flow".

Figure 7

The inverted U-curve (Source: Yerkes-Dodson, 1908)



The Inverted-U relationship between pressure and performance

Flow has been defined as the state of optimal experience that manifests as a high motivational state where one may feel separated from the outside world (Csikszentmihalyi, 1991, cited in Ghadiri et al., 2012). According to Rossouw (2014), fulfilling the basic psychological needs essentially meet the requirements of flow through setting clear goals, regular and consistent feedback, the balance of challenge to skills, and a lack of fear and stress

Flow is an acknowledged construct. Studies by seminal researchers confirmed that flow is associated with optimal performance and mental health benefits, including a better mood and a sense of meaningfulness. (Csikszentmihalyi, 2014; Demerouti, 2006; Fullagar & Kelloway, 2009 as cited in Van der Linden et al., 2021).

Despite this growth of knowledge on flow, neuroscientific research on the topic remains scant in the literature (Arnsten, 1998, 2013). A theoretical discussion by Bakker, Petrou, Op den Kamp and Tims (2020), as well as Rossouw (2014), aimed to contribute to this field by reviewing large-scale brain network systems whose broad functionalities may explain the core dimensions of flow.

The implications for leadership behaviour:

The explanations at the neurological level allow more detailed and precise scrutiny of peak performance (Arnsten, 1998) specifically, that peak performance or flow states are more likely in intrinsically motivating, meaningful or enjoyable tasks (e.g., Csikszentmihalyi & Nakamura, 2010). Leaders could leverage this behaviour by ensuring that employee roles at work are allocated based on intrinsically motivated, meaningful tasks.

It is reasonable to assume that optimal arousal is unique and complex; therefore, leaders must cultivate self-awareness and self-regulate their arousal/stress levels.

Leadership and stress are inextricably linked, and stress can cause leaders to make poor decisions. Individuals whose psychological resources are overloaded or depleted are typically unable to exhibit positive leadership behaviours and may even be more likely to behave in destructive ways toward their followers when pressured (Collins and Jackson, 2015; Harms et al., 2017).

(iii) Sub-theme 1.3: Practising optimum sleep, exercise, nutrition, breathing

Statements:

- Recognises that change triggers a threat response and encourages rhythmic living through sleep, nutrition and exercise.
- Practises good sleep hygiene to enhance memory consolidation, positive mood regulation and down-regulation of stress.

The high consensus on the above statements aligned with the existing neuroscientific literature on the interrelatedness of sleep, stress and mood (Kim and Payne, 2020). Blaxton, Bergeman, Whitehead, Braun and Payne (2017) identified that chronically elevated stress levels selectively impair brain regions responsible for problem-solving, memory, and emotional regulation.

The application of this research relates to the interaction among three experiences: "(i) chronically elevated stress negatively impacts sleep and positive affect; (ii) poor sleep makes stress and positive affect worse; and (iii) negative affect is likely to make sleep and stress worse. High levels of all three experiences can result in excessively high-stress experiences with substantial cognitive impairment, impacting perception, judgement, and decision-making". It reduces working memory, increases pessimism, reduces insight, and reduces verbal fluency (https//neuroleadership.com/your-brain-at-work/).

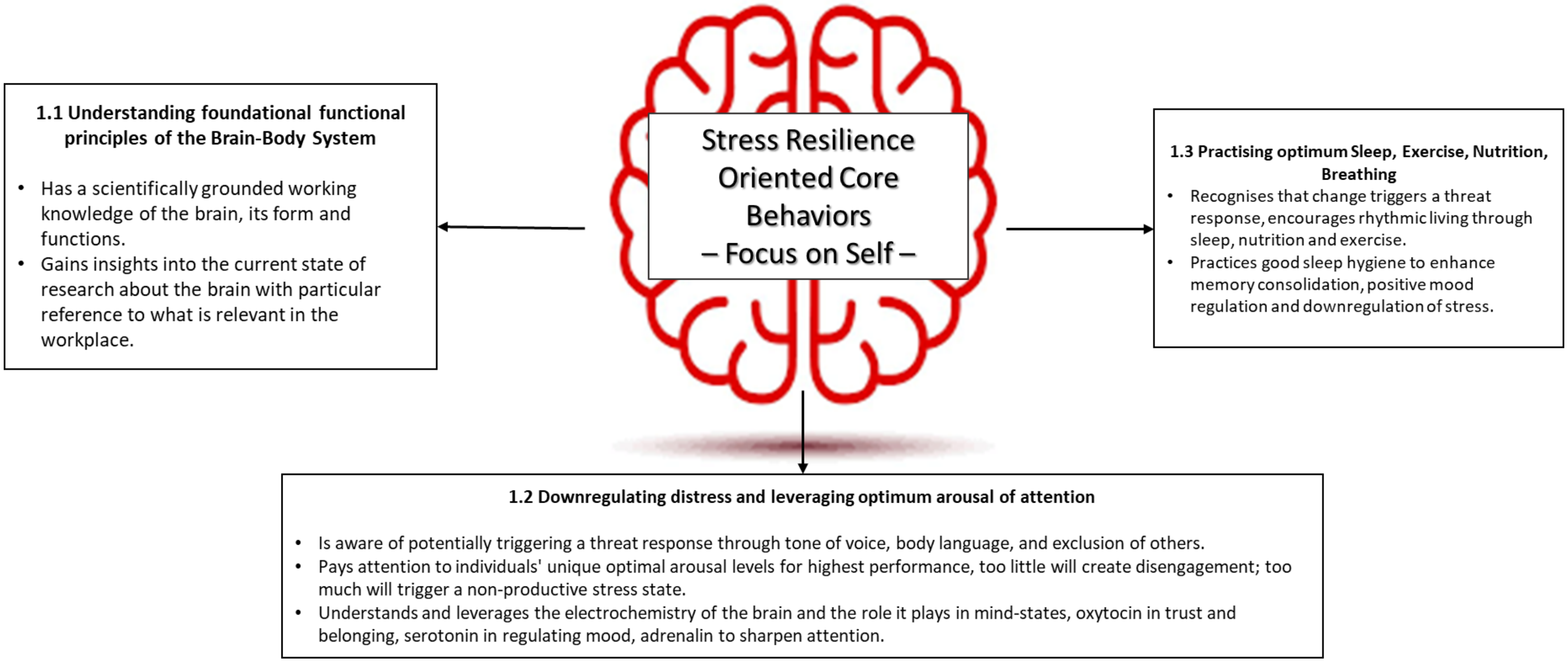
The implication for leadership behaviour is that leaders are responsible for creating healthy work environments (Behrendt et al., 2017). At a personal level, neuroscience-based leaders should embed stress mastery strategies (by managing their sleep habits, stress levels, and mood states) to optimise their performance and wellbeing. This self-management enables them to facilitate optimal arousal levels for individuals, teams and the organisation, to generate the best decision-making, collaboration, innovation and overall wellbeing.

(iv) Conceptual framework for stress resilience-oriented NSBL behavioural anchors

Based on the results of this study, the core behaviours and descriptors of the stress resilience-oriented theme of NSBL are set out in Figure 8.

Figure 8

Stress resilience-oriented core behaviours and supporting behavioural descriptors.



(b) Theme 2: Affect and emotion-oriented

Eight statements pertained to affect and emotional behaviours (See Table 15). Participants demonstrated a strong consensus on all eight statements, with 100% agreement that being attuned to affective cues, such as tone of voice, speech, and language, is a descriptor of NSBL. This is in line with the literature. No participants indicated disagreement with any statements under this theme. A strong consensus was reached on all statements at (R2), and participants were not asked to re-rate their level of agreement with these statements at (R3).

Table 15

Affect and emotion-oriented core behaviours.

	Statement	Disagree	Agree	Sub-theme
	Strong consensus on behaviours:			
1.	Tunes into affective cues such as facial expressions, speech pace/ tone, and body language to detect fears and instil social safety.	0%	100%	2.1
2.	Activates the right self-regulation strategies at the right time to manage mental states like affect labelling, emotional granularity, humour, distancing, and reappraisal.	0%	100%	2.3
3.	Identifies and harnesses the power of emotion in self and others to enhance thinking processes and social engagement.	0%	97%	2.2
4.	Pays attention to subjective cues like nonverbal, non-conscious action tendencies (for self and others) with the ability to adapt to optimise the present experience.	0%	94%	2.1
5.	Enhances a positive affect (using healthy lifestyle choices, practising gratitude and compassion, mirroring and smiling).	0%	94%	2.2
6.	Aware of the impact of emotional contagion and creates strategies for self-control and regulation to transmit a positive, engaged, supportive emotional state to others.	0%	94%	2.3
7.	Avoids emotional-regulation strategies that enhance limbic system arousal like suppression, rumination, venting, catastrophising, etc.	3%	88%	2.3
8.	Dials down negativity bias through deliberately generating a 3:1 to 6:1 positivity to negativity ratio and to optimise social and cognitive functions.	0%	84%	2.2
	Moderate consensus:			
	(None.)	–	–	–
	Weak consensus:			
	(None.)	–	–	–

The participants described three primary affect and emotional-related core behaviours, which bear marked similarities to both frameworks set out by the social-cognitive neuroscience (Frith & Frith, 2010; Lieberman, 2007) and affective neuroscience (Feldman Barrett & Bar, 2009) models discussed above.

(i) Sub-theme 2.1: Cultivating sensory awareness of mind and body states

Statements:

- Tunes into affective cues such as facial expressions, speech pace/tone, and body language to detect fears and instil social safety.
- Pays attention to subjective cues like nonverbal, non-conscious action tendencies (for self and others) with the ability to adapt to optimise the present experience.

The high consensus on the above statements is aligned with the existing neuroscientific literature. Feldman Barrett and Bar (2009) provided an abridged version of how affective feelings arising from autonomic and hormonal changes in the core of the body makeup part of the brain's prediction (guessing based on past experiences) of what visual sensations stand for in the present, including how to act on them in the near future.

(ii) Sub-theme 2.2: Dialling down negativity bias and cultivating positive mood states

- Identifies and harnesses the power of mood and emotion in self and others to enhance thinking processes and social engagement.
- Enhances a positive affect (using healthy lifestyle choices, practising gratitude and compassion, mirroring and smiling).
- Dials down negativity bias by deliberately generating a 3:1 to 6:1 positivity-to-negativity ratio to optimise social and cognitive functions.

The high consensus on statements relating to the theme of understanding mood states is reflected in the literature; neuroscientific evidence exists that human emotions share core affective properties. These affective feelings of "positivity vs negativity (valence) and activation vs quiescence (arousal) are differentially correlated with blood oxygenation level-dependent (BOLD) activation" (Wilson-Mendenhall, Feldman Barrett, & Barsalou, 2013, p.1).

Implications for leadership behaviour: A leader's job begins and ends with creating experiences where employees can excel. Reframing the negative into a positive is considered a cost-free, cognitive neutraliser of potentially negative emotion-eliciting situations (Gross, 2001), which leaders can deploy across the organisational landscape.

(iii) Sub-theme 2.3: Generating, distinguishing and regulating emotions

- Activates the right self-regulation strategies at the right time to manage mental states like affect labelling, emotional granularity, humour, distancing, and reappraisal.
- Aware of the impact of emotional contagion and creates strategies for self-control and regulation to transmit a positive, engaged, supportive emotional state to others.

- Avoids emotional-regulation strategies that enhance limbic system arousal like suppression, rumination, venting, and catastrophising.

The high consensus on these statements is confirmed in the literature. Neuroscience research clarifies emotions' critical role in cognition (Gross, 2014; Immordino-Yang, 2016; Siegel et al., 2018). Specifically, regulating emotions is vital for cultivating socio-emotional competence (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011; Woltering and Shi, 2016).

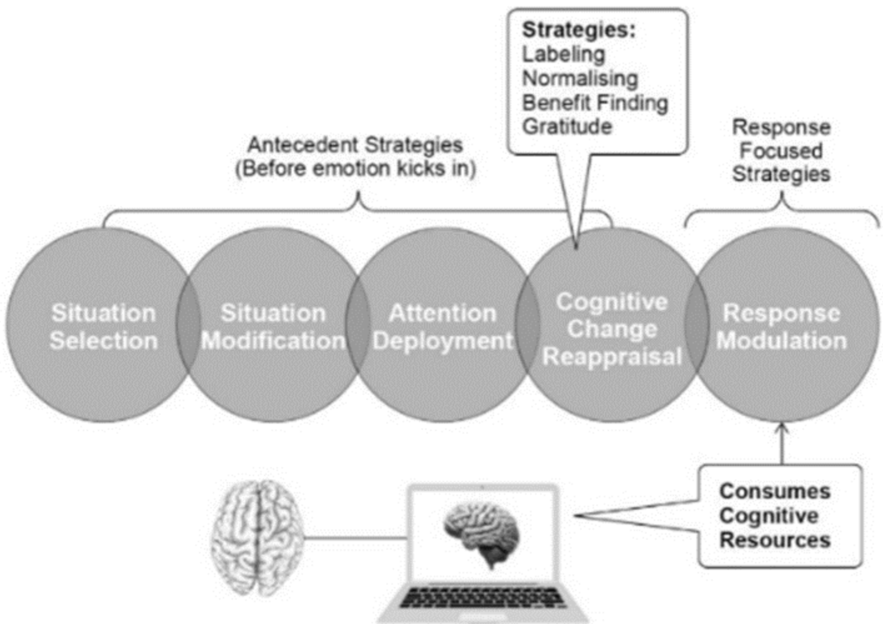
Eisenberg and Spinrad (2016) defined emotion-related self-regulation as the process of "initiating, avoiding, inhibiting, maintaining or modulating the occurrence, form, intensity, or duration of internal feeling states and the behavioural concomitants of emotion in the service of accomplishing affect-related biological or social adaptation or achieving individual goals" (Eisenberg and Spinrad, 2016, p. 338).

Research by Aldoa and Nolen-Hoeksema (2010) has demonstrated that many emotion regulation strategies are used (some even concurrently) to manage emotional responses. According to Gross and John (2003), emotions can be managed by adopting a stepwise or process model of emotional regulation (as set out in Figure 9), which details five major focus points during emotion regulation.

Antecedent strategies are tactics implemented before emotion response tendencies have become fully activated, including situation selection, situation modification, attentional deployment, and cognitive change. Response modification strategies refer to things people do, once an emotion is underway. (for example, suppression of emotions).

Figure 9

The stepwise model of emotional regulation choices (Gross, 2008)



The distinction between these strategies (or tactics) does seem blurred and has been contested in the literature. However, emotional regulation through reappraisal and suppression has consistent findings in the literature. These findings include that higher emotional intelligence abilities are associated with better cognitive reappraisal strategies and less expressive suppression strategies for regulating emotions (Garnefski & Kraaij, 2006; Megías-Robles et al., 2019). Positive reappraisal and mindfulness report to "serially and mutually enhance one another, creating the dynamics of an upward spiral" by reducing the semantic evaluation associated with an event (Garland, Gaylord, & Fredrickson, 2011, p. 1; Fredrickson & Losada, 2005).

The existing literature on affect and emotions also recognises the tendency to experience emotions in a highly specific manner known as emotional granularity (Feldman Barrett, Gross, Christensen, & Benvenuto, 2001; Demiralp et al., 2012) or "emotional differentiation" (Boden, Thompson, Dizén, Berenbaum, & Baker, 2013; Kashdan et al., 2015).

Emotion differentiation is contingent on developing emotion concepts (Feldman Barrett, 2006; Lane & Garfield, 2005; Lindquist & Feldman Barrett, 2008; Siegel et al., 2018). Finely grained feelings allow more agile regulating of emotions. Relationships also improve when people are attuned to emotions (Kashdan, Feldman Barrett, & McKnight, 2015).

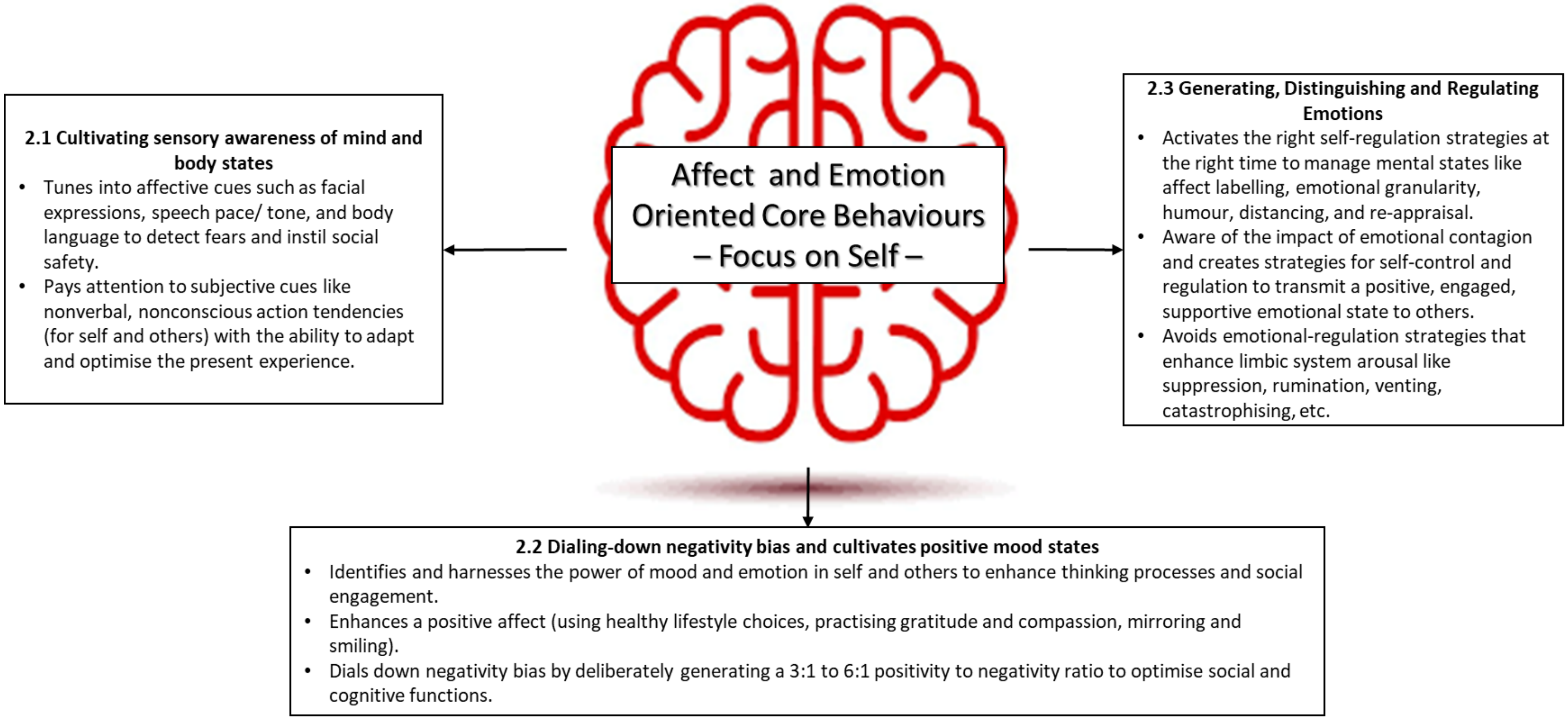
Implication for leadership behaviour: Self- and other awareness emerged in this section as essential considerations for NSBL behaviours. Existing neuroscientific literature on affect and emotion recognises that these are critical elements of a neuroscientific approach.

(iv) Conceptual framework for affect and emotion-oriented NSBL core behaviours

The core behaviours and descriptors of the affect and emotion-oriented theme of NSBL are set out in Figure 10.

Figure 10

Affect and emotion-oriented core behaviours and supporting behavioural descriptors.



(c) Theme 3: Relations-oriented core behaviours (social cognition)

"We intuitively believe social and physical pain are radically different kinds of experiences, yet the way our brains treat them suggests that they are more similar than we imagine" (Lieberman, 2013, p. 5).

A relations focus was a widespread description of NSBL among panellists. The panellists described five primary core behaviours that distinguish the relations orientation of NSBL: (1) facilitating psychological safety, (2) role-modelling and imitating behaviour, (3) understanding others through perspective-taking and empathetic concern, (4) building in-group climates, and (5) identifying and mitigating subjective biases.

Fourteen statements pertained to the relations-oriented focus of NSBL core behaviours (see Table 16). Panellists strongly agreed with the statements.

Table 16

Relations-oriented core behaviours

	Statement	Disagree	Agree	Sub-theme
	Strong consensus on behaviours:			
1.	Builds in-group culture through shared goals, outsourcing of effort and celebration of outcomes (team dynamics).	0%	97%	3.1
2.	Spends time to create an environment that fosters a toward state in which people are open, curious, expansive and productive.	0%	97%	3.1
3.	Finds common ground among disparate team members. This, in turn, will build team cohesion and create a sense of unity.	0%	94%	3.4
4.	Builds psychological safety in teams – does this by asking powerful questions, listening, clarifying, affirming, use of simple metaphors for joint understanding.	0%	94%	3.1
5.	Senses the micro and macro threat/safety climates in the organisation. Recognises mini-wins and offers immediate tangible or intangible rewards to optimise engagement and motivation. Mitigate threats to avoid micro / macro cognitive and emotional derailment.	0%	91%	3.5
6.	Down-regulates distress and facilitates enriched environments through active listening, the inclusion of others and perspective-taking.	0%	91%	3.4
7.	Meets the basic human needs of others, i.e. self-esteem, control, attachment and pain avoidance / pleasure-seeking through workplace solutions.	0%	91%	3.4
8.	Enhances collective intelligence by including gender and racial diversity in the group, increasing social sensitivity and providing equal participation.	0%	88%	3.5
9.	Is more attuned to social cues of others, and the true meaning of what people are experiencing.	0%	88%	3.5
10.	Makes a deliberate effort day-to-day to walk the talk and demonstrate an attitude of exemplarity, self-control and growth mindset.	0%	88%	3.2

	Statement	Disagree	Agree	Sub-theme
11.	Uses mentalising to understand the intentions of others, taking perspectives of others, making possible the communication of intentions and ideas.	0%	85%	3.3
12.	Shows empathic concern for others through other-oriented feelings of sympathy and takes perspectives of others through active listening and questioning.	0%	85%	3.3
13.	Identifies and mitigates subconscious biases through reflective, and thoughtful interactions.	0%	85%	3.5
14.	Is aware of the influence of mirror neurons and how we copy others, specifically those in power, and deliberately role-models desired behaviour.	0%	81%	3.2
	Moderate consensus:			
	(None.)	–	–	–
	Weak consensus:			
	(None.)	–	–	–

The relations approach is highlighted across the social-cognitive and affective neuroscience theories (Adolphs, 2009; Frith & Frith, 2010; Lieberman, 2007); neuropsychotherapy (Ghadiri et al., 2013; Grawe, 2017; Rossouw, 2014); as well as meta-studies on leadership behaviour (Behrendt et al., 2017; Yukl, 2012). This confirms the literature that social-cognitive and affective neuroscience can offer a neuroscientific framework for leadership behaviour.

(i) Sub-theme 3.1: Facilitating psychological safety (threat avoidance/reward seeking)

- Builds in-group culture through shared goals, outsourcing of effort and celebration of outcomes.
- Spends time to create an environment that fosters a “toward” state in which people are open, curious, expansive, and productive.
- Builds psychological safety in teams – does this by asking powerful questions, listening, clarifying, affirming, use of simple metaphors for joint understanding.

A growing and interdisciplinary body of research capture how humans have evolved to be prosocial and that feeling psychological safe influences human development and learning (De Waal, 2015; Hare, 2017).

(ii) Sub-theme 3.2: Role modelling behaviour (imitation system)

- Makes a deliberate effort day-to-day to walk the talk and demonstrate an attitude of exemplarity, self-control, and growth mindset.
- Is aware of the influence of mirror neurons and how we copy others, specifically those in power, and deliberately role-models desired behaviour.

The finding is consistent with the literature on the initial neuroscience research on mirror neurons (Gazzaniga, 2006), which can inform the behaviour of leaders and the impact that it has on followers. Research by Spunt, Satpute and Lieberman (2011) also illustrated the engagement of mirroring and mentalising networks while observing others perform actions. The research by these authors showed that the mentalising network is modulated based on whether actions are described using intention-based words, but that regions associated with mirroring are not.

The implication for leadership behaviour is that followers mirror their leaders. Therefore, leaders need to pay attention to the signals or examples they set through salient visual and auditory cues.

(iii) Sub-theme 3.3: Taking others' perspectives, showing empathetic concern (mentalising system)

- Uses mentalising to understand the intentions of others, taking perspectives of others, making possible the communication of intentions and ideas.
- Shows empathic concern for others through other-oriented feelings of sympathy and takes perspectives of others through active listening questioning.

The high consensus on the statements pertaining to mentalising, empathy and perspective-taking is confirmed in the literature. Mentalising theory argues that we interpret the mental states (thoughts, feelings, beliefs, needs, or goals) of others by activating our own mechanisms for producing that behaviour (Frith, 2009). As such, mentalising is an appealing way of explaining empathy (Frith & Frith, 2010; Ward, 2016). In an fMRI-based quantitative meta-analysis, Fan et al. (2011) found that empathy involves multiple systems corresponding to distinct kinds of empathy. Empathy is not a single phenomenon; instead, it consists of separate systems for empathy driven by cognitive evaluative (thinking empathy) and affective-perceptual (feeling empathy) sources (Fan et al., 2011).

The implication for leadership behaviour is that to understand another person's thought processes; leaders need to enquire about or make inferences about their experiences. The process by which this occurs is critical, as it refines the leader's interpretation of social signals, leading to a better understanding of others, which is vital for successful social interaction at work. This understanding is generated through perspective-taking, simulations, active learning, and dynamically updated predictions (Feldman Barrett, 2017b; Silston, Bassett, & Mobbs, 2018).

(iv) Sub-theme 3.4: Building in-group climates (team dynamics)

- Meets the basic human needs of others, i.e., self-esteem, control, attachment and pain avoidance / pleasure-seeking through workplace solutions.

- Finds common ground among disparate team members. This, in turn, will build team cohesion and create a sense of unity.
- Down-regulates distress and facilitates enriched environments through active listening, and perspective-taking.

The core behaviours of building in-group culture are well outlined in the social-cognitive neuroscience literature. Being included is rewarding, and being excluded is painful, with similar neural network activation as physical pain (Lieberman & Eisenberger, 2008; Eisenberger, 2012).

What is more is that social exclusion is a predictor of poor wellbeing, both mentally and physically (Baumeister, Twenge, & Nuss, 2002).

The social-cognitive neuroscience literature also shows that we tend to read emotions and intentions in others based on whether we see them as part of our in-group or an out-group (Mitchell, Macrae, & Banaji, 2006). By favourably viewing ourselves, we tend to be more effective at recognising other facial expressions when they are similar to us.

However, when others are seen as dissimilar, we often use unconscious biases to make sense of their expressions and interpersonal dynamics, and then make false assumptions that their thoughts, feelings, and intentions are different to ours. Only after a sense of relatedness, or seeing others as part of the "in" group has been established, can social differences be effectively addressed (Lieberman, 2012). This requires building trust across the organisational landscape.

Implications for leadership behaviour extend to the challenge of elevating the in-group without demeaning others. Leaders can do this by ensuring that the team engages in ways that will surface points of resemblance, strengthen resonances, cultivate empathy and contribute to feelings of trust.

(v) Sub-theme 3.5: Identifying and mitigating subjective biases

- Senses the organisation's micro and macro threat/safety climates: Recognise mini-wins and offer immediate tangible or intangible rewards to optimise engagement and motivation. Mitigate threats to avoid micro / macro cognitive and emotional derailment.
- Enhances collective intelligence by including gender and racial diversity in the group, increasing social sensitivity, and providing equal participation.
- Is more attuned to the social cues of others and the true meaning of what people are experiencing.
- Identifies and mitigates subconscious biases through reflective and thoughtful interactions.

Strong consensus was achieved on the above statements and is aligned with the literature; for example, Gutsell, Simon and Jiang (2020) reported that taking the perspective of a racial out-group member can reduce group biases in sensorimotor resonance, potentially fostering an intuitive understanding across groups. Focusing on constructive conversations at work is vital, as these can help individuals change conceptual models (explanatory styles) and modify neural systems. This results in new constructions and positive predictions (Feldman Barrett, 2017a).

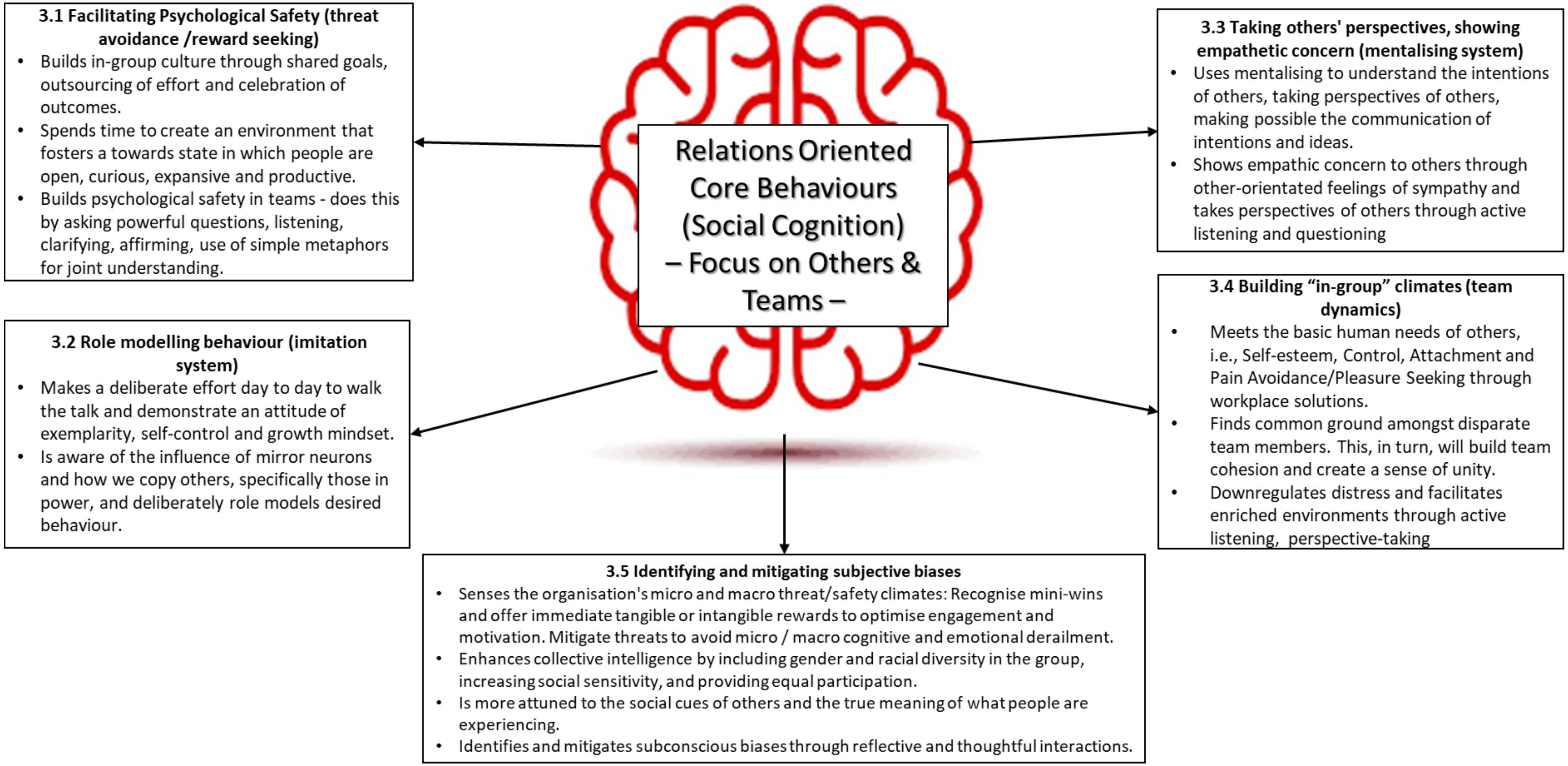
The implication for leadership behaviour is that although cultural stereotypes are the first basis of understanding others, NSBL understands the power of the unconscious, is attuned to their thoughts, and considers the possibility of bias and habit. NSBL asks powerful questions to explore and test thoughts, emotions, and behaviours and generate the most productive, relevant, fresh solutions.

(vi) Conceptual framework for relations-oriented NSBL core behaviours

As guided by the results of this study, the core behaviours and descriptors of the relations-oriented theme of NSBL are set out in Figure 11.

Figure 11

Relations-oriented core behaviours and supporting behavioural descriptors.



(d) Theme 4: Task-oriented key behaviours

Of the 11 statements relating to task-focused behaviour (Table 17), participants strongly agreed with all descriptors.

Table 17

Task-oriented core behaviours

	Statement	Disagree	Agree	Sub-theme
	Strong consensus on behaviours:			
1.	Is sensitive to the working limitations of the PFC and the risk of the brain defaulting to unproductive bias, and practises focus through mindfulness-based exercises and attention training.	0%	97%	4.1
2.	Encourages goal setting and goal achievement by encouraging shorter-term accomplishments, shared goals and goal hierarchies (why and how goals).	3%	97%	4.2
3.	Sets realistic expectations/goals – is aware of the power of the brain if-then coding and the negative cognitive impacts of unmet expectations.	0%	97%	4.2
4.	Deploys mindfulness practices to enhance focused attention, and emotional regulation, lower stress, and reduce risky decision making.	0%	97%	4.1
5.	Is aware that the brain translates change into an “unknown code” which can trigger a threat state and derail thinking. Creates certainty and normalises feelings of uncertainty to optimise performance and build change resilience.	0%	94%	4.3
6.	Deploys learning strategies that enable people to reflect and learn in groups and in spaced periods of time to enhance memory – recall, retention, and consolidation.	0%	94%	4.4
7.	Builds attention density to overcome unhelpful habits using practice and repetition, to embed new neural pathways that, when sufficiently strengthened, become the brain’s default automated pathway of choice.	0%	88%	4.3
8.	Provides explicit, mutually agreed upon organisational processes to enhance decision-making and reduce emotional contagion.	6%	82%	4.5
	Moderate consensus:			
9	Discourages multitasking/task-switching and constant interruptions to ensure focused and sustained attention and memory recall.	3%	79%	4.1
10.	Understands cognitive dissonance and builds controllable incongruence (creative tension) into work projects. Avoids uncontrollable incongruence (emotional tension).	0%	79%	4.3
11.	Builds cognitive flexibility and breakthrough thinking by tapping into unconscious thought, e.g., reflective conversations, visualisation, exploration and novelty.	0%	76%	4.5
	Weak consensus:			
	(None.)	–	–	–

(i) Sub-theme 4.1: Builds mindful attention awareness practices to enhance focus

- Is sensitive to the working limitations of the PFC and the risk of the brain defaulting to unproductive bias, and practises focus through mindfulness-based exercises and attention training.
- Discourages multitasking (task-switching) and constant interruptions to ensure focused and sustained attention and memory recall.
- Deploys mindfulness practices to enhance; focused attention, emotional regulation, lower stress, and reduce risky decision-making.

There are common elements between mindful attention awareness and task-switching behaviours identified by the Delphi panellists and the literature on attention awareness.

Mindful attention awareness

The neuroscientific literature relates to:

- The positive impact of mindfulness training on working memory capacity, being a core cognitive function necessary to preserve psychological resilience.
- Mindful attention awareness practices may enable long-term increases in the ability to focus on body feelings or interoceptive sensations (Farb, Segal, & Anderson, 2013) and even improve cognitive function (Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010; Jha, Morrison, Parker, & Stanley 2017).
- Mindful attention practices significantly affect brain structure and function (Feldman Barrett, 2017b)

The implications for leadership behaviour are that mindful attention awareness can contribute to leadership presence. Being present as a leader includes being attentive to the current moment, remaining open to an emerging future, and being able to suspend preconceived ideas and enhance self-awareness (Senge, 2006).

Task-switching

Working memory is indispensable to executive functions typically associated with multitasking, such as attention, reasoning, decision-making, and task-switching (Becker et al., 2015). From a leadership development perspective, it can be valuable to train leaders to develop focused attention and monitor their propensity to task switching.

(ii) Sub-theme 4.2: Leveraging goal-directedness to facilitate behaviour change

- Encourages goal setting and goal achievement by encouraging shorter-term accomplishments, shared goals, and goal hierarchies (why and how goals).
- Sets realistic expectations/goals – Is aware of the power of the brain's if-then coding and the negative cognitive impacts of unmet expectations.

> *"A goal is any desired outcome that wouldn't otherwise happen without some kind of intervention. A goal is a detour from the path of least resistance"* – Elliot T. Berkman (2018).

The consensus on goal-directed statements is confirmed in the existing literature that talks about certainty (being able to predict the future) and control being primary rewards for the brain (Berkman, 2018). Thus, goal pursuit is a strategy to use to reduce certainty and control threats by giving clarity about the way forward. In fact, most accomplishments, great or small, have started with an intention that became a purpose and, finally a goal.

A neural hierarchy of goals – the why and the how

Goals can be depicted in a neural hierarchy, stretching from the motivational or abstract (the "why" of a goal) to the "how" or actionable part of the goal. This is called action identification theory, and these different levels of goals engage different brain systems. The "why" of a goal engages the mentalising system in the brain. The "how" of achieving a goal engages the motor cortex system, involving more concrete thinking. These should be separate components, as the brain struggles to focus on them all at the same time. Encoding personal, team or company goals on these two levels ensure stronger goal encoding and retrieval.

It can be useful to move up and down within the goal hierarchy from "why" to "how" in order to get unstuck from a task or to become more practical by focusing on the "how". The "how" of goal attainment involves focused attention, working memory, impulse control or self-governance, and planning (Berkman, 2018). This is enabled by the CEN and the task-positive network. These tasks take mental bandwidth from the brain's resources and are addressed in the literature by opposing domains theory (Bressler & Menon, 2010).

The implications for leadership behaviour: Aligning individual goals with organisational goals can be very effective. Leaders can let team members choose the "how" of achieving goals – as this gives employees "choice" or authority, a key "towards" strategy that drives motivation and employee engagement in their work (Deci & Ryan, 2014). Thus, use higher-level goals for motivation and lower-level goals for progress tracking and make the connection between the different hierarchies of goals through goal alignment. In this way, a scaffolding of goal alignment can be built (Berkman, 2018).

(iii) Sub-theme 4.3: Facilitating change through attention density and habit formation

- Is aware that the brain translates change into an "unknown code", which can trigger a threat state and derail thinking. Creates certainty and normalises feelings of uncertainty to optimise performance and build change resilience.

- Understand cognitive dissonance and builds controllable incongruence (creative tension) into work projects. Avoids uncontrollable incongruence (emotional tension).
- Builds attention density to overcome unhelpful habits, using practice and repetition to embed new neural pathways that, when sufficiently strengthened, become the brain's default automated pathway of choice.

The strong consensus on facilitating change is confirmed in the existing literature that primarily discusses the importance of developing a new lens for managing change by understanding the brain's threat response and the importance of habit formation (Eichinger, 2018).

Schwartz, Stapp, & Beauregard (2005, p. 1321) argue that it is both awareness and attention that change the brain through a process of "attention density", which infers "conscious effort". Thus, learning and change are enabled through an intensive focus on a learning activity that generates structural changes in the brain.

The implications for leadership behaviour are that leaders need to understand the complexity of making change happen. It might not be the change that causes fear but rather the pain that might be experienced when individuals are not in control of change. Involving employees in change initiatives is vital to give them a sense of control and orientation.

Leaders can enable employees to maintain focus, mitigating resistance to change. Practising the principle of attention density (as stated by the panellists) implies that the more leaders sustain employees' focus on something, the denser their attention gets and the more hard-wired that habit becomes (Schwartz et al., 2005). In other words, practising new behaviours until proficiency is gained.

(iv) Sub-theme 4.4: Leveraging learning through activating memory systems

- Deploys learning strategies that enable people to reflect and learn in groups and in spaced periods to enhance memory – recall, retention, and consolidation.

The literature confirms the strong consensus on this theme. Kandel et al. (2013, p. 1441) state that learning is a "change in behaviour that results from acquiring knowledge about the world, and memory is the process by which that (knowledge) is encoded, stored and later retrieved". Learning thus requires overriding current memory systems and forming neural pathways, which take effort to develop.

The learning process also requires the activation of both affective and cognitive neural processes (Cozolino & Sprokay, 2006). Learning is both a thinking and a social-emotional experience.

The implications for leadership behaviour are for leaders to understand that learning depends on multiple factors. Therefore, numerous strategies must be used to embed learning, such as spacing, scaffolding, social learning strategies, and positive emotions. As stated by (Cozolino & Sprokay, 2006, p.11), “Brains grow best in the context of interactive discovery and through co-creation of stories that shape and support memories of what is being learned”.

(v) Sub-theme 4.5: Enhances decision-making through insights into exploitation / exploration systems

- Builds cognitive flexibility and breakthrough thinking by tapping into unconscious thought, e.g., reflective conversations, visualisation, exploration and novelty.
- Provides explicit, mutually agreed upon organisational processes to enhance decision-making and reduce emotional contagion.

The consensus on the statements above aligns with the cognitive neuroscience literature on insight, the process that occurs when a person suddenly reinterprets a stimulus, situation or event as non-obvious (Kounios & Beeman, 2014). According to these authors, insight follows a pattern: explore a topic, gather the data, work on a solution, take a break, have a breakthrough, and work to make the insight into something functional.

The literature also covers the inducement of optimism, as it broadens creative thinking and performance (Fredrickson, 2009). Another key driver in innovation is diversity in thinking. Østergaard, Timmermans and Kristinsson (2011) found a positive relationship between an open culture toward diversity and innovative performance. Diverse companies are more likely to be innovative, especially when they combine inherent diversity with the diversity they acquire through varied experiences. A diverse workforce adds a variety of perspectives.

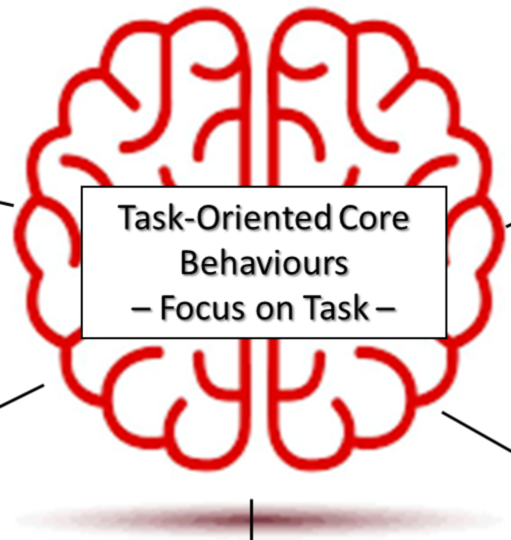
The implications for leadership behaviour are that by clarifying the brain basis of an insight, leaders can cultivate creativity and innovation in the organisation by acting as thinking partners, valuing unstructured time as a key factor in innovation, and being deliberate in asking reflective questions that facilitate the neural connections in others' minds. Knowing when to switch from analytical (prefrontal cortex) to quiet mode (take a walk, listen to music, doodle) in order to move beyond mental impasse to insight, and also broadening employees' perspectives by having teams from different disciplines interact can promote innovation and nudges employees to seek wider information.

(vi) Conceptual framework for task-oriented NSBL core behaviours

As suggested by the results of this study, the core behaviours and descriptors of the task-oriented theme of NSBL are set out in Figure 12.

Figure 12

Task-oriented core behaviours and supporting behavioural descriptors.



4.1 Builds mindful attention awareness practices to enhance focus

- Is sensitive to the working limitations of the PFC and the risk of the brain defaulting to unproductive bias and practices focus through mindfulness-based exercises and attention training.
- Discourages Multi-tasking(Task-Switching) and constant interruptions to ensure focused and sustained attention and memory recall.
- Deploys Mindfulness practices to enhance focused attention, emotional regulation, lower stress, and reduce risky decision-making

4.2 Leveraging goal-pursuit to facilitate behaviour change

- Encourages goal setting and goal achievement by encouraging shorter-term accomplishments, shared goals, and goal hierarchies (why and how goals).
- Sets realistic expectation/goals - Is aware of the power of the brain's if-then coding and the negative cognitive impacts of unmet expectations.

4.3 Facilitating Change through attention density and habit formation

- Is aware that the brain translates change into an 'unknown code' which can trigger a threat state and derail thinking - Creates certainty and normalizes feelings of uncertainty to optimize performance and build change resilience.
- Understand cognitive dissonance and builds controllable incongruence (creative tension) into work projects. Avoids uncontrollable incongruence (emotional tension).
- Builds attention density to overcome unhelpful habits, using practice and repetition, to embed new neural pathways that, when sufficiently strengthened, become the brain's default automated pathway of choice.

4.4 Leveraging learning through memory systems

- Deploys learning strategies that enable people to reflect, learn in groups and in spaced periods of time to enhance memory - recall, retention, and consolidation.

4.5 Enhances decision making through insights on exploitation/exploration systems

- Builds Cognitive flexibility and breakthrough thinking by tapping into unconscious thought, e.g., reflective conversations, visualization, imagination, exploration and novelty.
- Provides explicit, mutually agreed upon organisational processes to enhance decision-making and reduce emotional contagion.

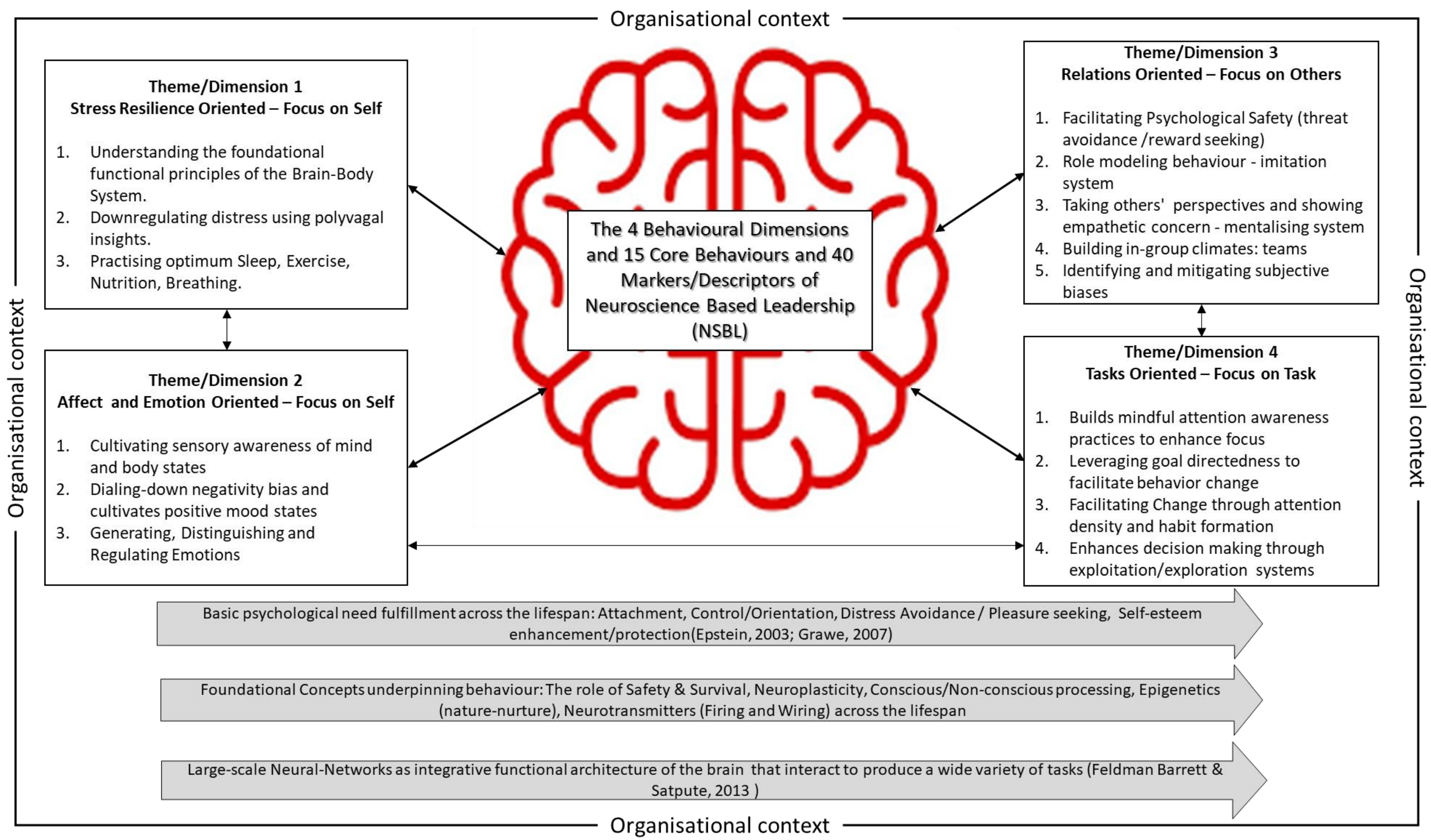
4.4 Towards an Interpretive Conceptual Framework of NSBL

Contemporary leadership behaviour research has been criticised for its weak theoretical foundation (Van Knippenberg & Sitkin, 2013). This Delphi study increased the knowledge base of how neuroscientists, leaders, and OD professionals conceptualise NSBL. A theoretical framework of leadership behaviour based on a good understanding of the brain can significantly enhance leadership abilities and, hopefully, leadership outcomes.

As suggested by the results of this study, a conceptual framework to contain the theoretical content of NSBL is set out in Figure 13. This is a graphical representation of the interrelatedness of core behaviours (and supporting psychological constructs), as reported by the panellists.

Figure 13

The conceptual framework of neuroscience-based leadership core behaviours and foundational neuroscientific concepts (NSBL)



This theoretical framework represents the themes emerging from the study and their relationship to one another. The framework is contextualised within formal workplaces and illustrates the respective domains, core behaviours and descriptors of NSBL from the study outcomes.

The four key themes of the core behaviours of NSBL discussed in this chapter have been translated into this framework, providing an integrated perspective on the study's outcomes:

- Theme 1 considers *stress resilience as an NSBL dimension* with underpinning key behaviours at the level of the individual (focus on self). The supporting behavioural descriptors for the three behaviours of the stress resilience-oriented dimension/theme are set out in Figure 11.
- Theme 2 outlines the *affect and emotion-related* dimension of NSBL with underpinning core behaviours at the level of the individual (focus on self). The supporting behavioural descriptors for the three behaviours of the affect and emotional-oriented dimension/theme are set out in Figure 13.
- Theme 3 includes the *relationship-focused dimension* of NSBL with underpinning core behaviours at the interpersonal and group level (focus on others). The supporting behavioural descriptors for the five behaviours of the relationship-oriented dimension/theme are set out in Figure 14.
- Theme 4 is associated with the *task-focused dimension* of NSBL with underpinning core behaviours at the organisational level (focus in and on the business). The supporting behavioural descriptors for the four behaviours of the task-oriented dimension/theme are set out in Figure 15.

The arrows at the bottom of Figure 16 show that visible core behaviours are influenced dynamically throughout the lifespan as a system by-product of satisfying psychological needs, the interplay with the environment, contexts, and individual differences in brain networks.

The image of a human brain in the background signifies that core behaviours and supporting psychological constructs are enabled by the brain in conjunction with core systems like the central nervous system. This aligns with the argument that the brain-to-behaviour link cannot be reduced to constituent brain regions (Alexander, Aragón, Bookwala, et al., 2021).

The framework attempts to depict optimal functioning and is associated with proper balance within and between systems in the brain, body and behaviour, as also shown in important research studies (Alexander et al., 2021; Arnsten, 2009).

4.5 Summary of the results section

This section described the themes that emerged from the data, linking them to the existing literature. The findings from this study show that their key areas of overlap with the literature. These themes were summarised within a conceptual framework derived from a combination of the current literature on NSBL and the outcomes of this study. The organisation of the themes in this framework provides an integrated view of the link between the emerging themes of the study of NSBL. Implications for leadership behaviour were offered.

5. Contribution, limitations and recommendations

This section presents the conclusions drawn from the research. The conclusions are based on an appraisal by the researcher of the degree to which the NSBL conceptual framework has met the research aims. The contributions and limitations of the study are also discussed. Lastly, recommendations are made for future research regarding applied organisational neuroscience, specifically leadership behaviour and development. The section concludes with a summary.

5.1 Contributions of the Study

At this stage, it might be over-ambitious to fully identify the core behaviours of NSBL according to what participants indicated as currently being practised. Nevertheless, this study is a valuable contribution to the field as it suggests that neuroscience research results can be translated into richer and fuller descriptions of leadership behaviour at the individual level of functioning.

This research makes four main contributions to the body of knowledge, namely:

1. an evidence-based study;
2. a working definition of NSBL;
3. synthesis of underpinning concepts and behaviours of NSBL; and
4. a conceptual framework.

The conclusions outlined in this chapter are structured within these four contributions and the founded differences with published literature.

The first contribution is deploying an evidence-based approach, which included experienced organisational neuroscience professionals in the Delphi study and reputable, peer-reviewed literature publications. The evidence-based approach also integrated practical expertise (from the perspective of expert practitioners) and academic rigour, relying on the best available evidence as suggested in the guidelines by Briner and Rossouw (2011).

The evidence-based approach also gave insights into different levels of analysis (both neuroscientific and behavioural). It can contribute to integrating neuroscience with effective leadership behaviour, albeit aware that interdisciplinary methodological problems are not yet resolved (Kotchoubey et al., 2016).

A strong point of this Delphi study was that it accommodated many opinions on NSBL applications, connected existing knowledge, and pinpointed areas of agreement and disagreement on what NSBL is and is not. In addition, the Delphi study provided a way to test the themes from the small-scale research project.

Despite presenting NSBL as a leadership construct, the theorists in this new field have not yet credibly anchored the construct in the leadership behaviour literature by incorporating relevant evidence or a comparative overview (Lindebaum, 2016). This was evident in the Delphi results, as there was no specific mention of or clear association with a particular leadership theory or stance. Nevertheless, through its evidence-based approach, this research aids in making some theoretical contributions to ground the construct of NSBL in the literature.

This research contributes to the emerging literature that leadership may have neurobiological foundations. This research showed that nature and nurture might shape leadership's neurological and behavioural aspects.

Secondly, the study includes a working definition of NSBL. This working definition is helpful as it contributes to clarifying and understanding what NSBL is and is not.

The emergent nature of the NSBL field requires additional research; as such, the working definition offered of NSBL is not considered definitive. It is an initial view or baseline from which to perform further scientific investigations.

Thirdly, the study synthesised underpinning concepts of NSBL and accompanying core behaviours. This synthesis brought opposing evidence to what Lindebaum referred to as "motherhood statements" in brain-based management studies deficient in conceptual and theoretical foundations (Lindebaum, 2016, p. 542). The focus on synthesising the behavioural descriptors of what neuroscience-based leaders "do" is helpful as these descriptors contribute toward clarifying NSBL behaviours. The research findings gave preliminary evidence that SCN and NP theory predominantly informs the neuroscience-based approach to leadership behaviour.

It is noted that the complexity of relating a brain structure to a psychological function or a brain molecule to a mental function is "still highly contested" (Kotchoubey et al., 2016, p. 11), but this research contributed toward an integrative human neuroscience as argued by Kotchoubey et al.

(2016). This was done by gaining expert views and consensus from experienced professionals via the Delphi panel.

Despite the value of brain-based leadership approaches, there is a gap in the theoretical body of knowledge and associated theoretical models. As a result, organisational neuroscience practitioners work without a solid academic foundation, which may diminish good practice or even negatively impact the credibility of leadership development and modalities like leadership coaching.

This study has addressed the defined gap in the body of knowledge by contributing to developing a theoretical understanding of NSBL. Finally, the study offers an integrative framework of NSBL to contribute to advancing a unified conceptual framework.

5.2 Possible limitations

Qualitative research permits meaning to be derived from the experiences and expertise of the study participants. Thus, consensus achieved via the Delphi methodology does not indicate "correct" opinions or answers (Hasson et al., 2000). Instead, this study identified areas important to the participants based on their areas of expertise.

The consensus of opinion was calculated on the overall consolidated results rather than a single stakeholder perspective. This could have been provided by giving similarities and differences between groups. The consensus could also be substantiated by referring to the views of specific expert groups like neuroscientists and organisational neuroscience consultants. However, this would have intensified the complexity of the themes.

5.3 Implications and recommendations for research

A key premise of NSBL is that by becoming aware of how their brains function, leaders would develop the skills required to become more effective as leaders. Several authors have emphasised the use of neuroscience to enhance leadership development (Balthazard et al., 2012; Boyatzis, Passarelli et al., 2012; Waldman & Balthazard, 2015; Waldman et al., 2011a, 2011b).

There needs to be a unified framework of NSBL behaviour to enhance leadership development. Although this project offers a conceptual framework of both neuroscience-based core behaviours and their neural foundations, there could be additional research on developing a unified framework of NSBL.

As conceded by Boyatzis et al. (2014, p. 11), "There is a considerable distance between neurophysiological observations (through neuroscientific methods) and leadership behaviour". Consequently, more research is required to anchor neuroscience research findings into leadership behaviour and to elaborate on the conceptual framework outlined here. Practitioners are encouraged to develop new research hypotheses to understand the nature of NSBL.

In a world that is progressively characterised by interdisciplinary, multidisciplinary and transdisciplinary studies, there does not seem to be a need for behaviour specialists working in organisations to do imaging studies like functional magnetic resonance imaging (fMRI). Translating and researching the contribution of neuroscientific principles seem to be more appropriate and valuable. The conceptualisation of NSBL, using the Delphi consensus method, is a valuable contribution to such translational efforts and should be continued.

The field of organisational neuroscience is still in its early stages. Empirical research to validate current hypotheses about the correlations between neuroscientific principles and leadership behaviours in the workplace is still largely lacking. Multidisciplinary research, particularly neuroscience, can assist by identifying and offering insights into a neuroscience approach to leadership. It is recommended that leadership development researchers partner with neuroscience researchers in multidisciplinary work that is currently lacking or insufficient.

A transdisciplinary research approach is also suggested for future studies (Leavy, 2016). "Transdisciplinary research is an approach to social research that involves synergistic collaboration between two or more disciplines with high levels of integration between the sets of knowledge" (Leavy, 2011, p. 9). Organisational neuroscience represents a transdisciplinary merging of neuroscience, organisational behaviour, and psychology.

5.4 Implications and recommendations for practice

This study proposes a conceptualisation of the emerging domain of NSBL. It offers a useful contribution to advancing the theoretical body of knowledge of NSBL. Furthermore, this research is also essential to inform the observable behaviours leaders in contemporary organisations require to improve organisational functioning in virtual and remote work environments.

Regarding future practice, it is argued that applied neuroscientific knowledge can form an additional theoretical component of leadership skills training interventions, thereby equipping participants with a relevant understanding of how the brain functions. This will assist in grounding leadership development interventions and creating a deeper account of workplace behaviour.

Regarding advancing leadership development, ignoring the neuroscience findings from this and other studies that are currently known to inform leadership practice would be a disservice to students. The conceptual framework of this study provides a starting basis for establishing a systematic set of leadership development core behaviours.

Further qualitative studies could be conducted to link leadership's psychological needs with the implications for workplace behaviour, such as the core behaviours that demonstrate how to support these basic needs and their neuroscientific underpinnings.

As AONS is constantly adapting to new findings in neuroscientific research, influencing the reliability of neuroscientific theory, a refinement of the NSBL framework will be required. It is recommended that empirical studies be conducted on facilitating the refined framework and determining its impact in formal organisations.

6. Chapter Summary

This applied research project aimed to provide insights into how experienced professionals and practitioners conceptualise NSBL behaviour. The conclusion is that the applied organisational neurosciences (AONS) can provide a scientific basis and neuroscientific language for leadership behaviour in the work context.

This Applied research project attempted to fill the gap in the literature on NSBL core behavioural descriptors, i.e. "What do NSBL do? But without punting NSBL as the silver bullet to any and all leadership challenges.

The research delivered a conceptual framework and synthesis: a working definition of NSBL, foundational concepts that inform a neuroscience-based approach to leadership and core behavioural descriptors of what neuroscience-based leaders "do". This contributes to clarity and an understanding of what NSBL is and is not.

This study extends the descriptive accuracy and explanatory power of concepts in leadership behaviour by explaining underpinning neuroscientific concepts that can enhance the micro-foundation of leadership behaviour at work. The results of this study also provide guidance on NSBL theory and practice. It is offered as a tool to generate discussion and increase awareness about leadership behaviour based on organisational psychology and applied neuroscientific evidence.

To conclude, this research holds promise for further elucidating the behavioural descriptions of NSBL by providing actionable knowledge and theory-informed practice about leadership where it matters at the organisational front line. This research study has also formulated and described NSBL's contribution to theory building.

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Appendices

Appendix A: Delphi panel list

"The selection of the panel of experts was given careful deliberation, as it was their collective opinions that would finally determine the results of the research. Because the study was designed to define NSBL and identify core behaviours of NSBL in general, the following criteria were used for the selection of the panel of experts:

- Education and skills – postgraduate qualifications in applied ONS.
- Formal work position related to the research topic of NSBL behaviour – established academic or consulting professional in the applied field of ONS.
- Work experience in the subject in question and the level of public recognition – presentations at conferences, books and or articles published in the field.

Table 1

Spreadsheet sample of panellists

No.	Name		Title	Scope	Email	Phone
1	[…]	[…]	Chief Scientific Officer	Consultant	[…]	[…]
2	[…]	[…]	Co-founder and managing partner; Regional Vice-President	Consultant	[…]	[…]
3	[…]	[…]	Professor of Work Psychology	Academic	[…]	[…]
…	…	…	…	…	…	…

A snowball sample approach was also adopted to recruit additional participants. The initial participants were asked to provide a list of additional subject experts to participate in the Delphi study (Hsu & Sandford, 2007).

Once all data were obtained, the proposed list for the expert panel was presented to the researcher's PhD supervisory panel for further recommendations. The proposed participants were contacted via email and invited to participate in the Delphi study (Stone Fish & Busby, 2005)."

No.	Name		Title	Qualifications	Scope	Email	Phone

Appendix B: An invitation letter to participate in the research

Hi [Name]

I am conducting research for a PhD degree in Professional Practice: Neuroscience-Based Leadership at Canterbury Christ Church University in the United Kingdom. I am extending this invitation to you personally given that you are an experienced professional in this young field. [**Individualised line per panel member.**]

I am conducting my research on the behavioural anchorsof neuroscience-based leadership. The research design is a Delphi method that aims to create consensus among the opinions of experienced professionals in the discipline through three rounds of **iterative and anonymous refinement** of opinions. This methodology allows individual experienced professionals to compare and refine their responses via rating the descriptors of neuroscience-based leadership behavioural anchors.

This study will be online, and no group discussions will be conducted with panel members participating in the study. The research will be conducted by way of a Delphi study over three rounds. It will take approximately 30 minutes of your time in total per round. I am aiming to complete the panel rounds by 1 August 2019. This Delphi study will be managed electronically, and therefore the geographical location of respondents is not a barrier. The distribution of questionnaires and collection of the data will be electronic. The objective will be to identify and articulate such behavioural descriptors that might be useful in clarifying brain-based leadership behavioural anchors/core behviours.

Duration: the study will run over three months and require 30 minutes of your time at each round.

All responses will be treated as confidential. You will not be identified in the research report emanating from this research. Should you decide to participate, please indicate a yes/no response via the link below (Q-Research database link to be inserted) by 30 June 2019. Please know that your participation is important. You will be making a contribution to the growing knowledge base of this emerging field; as such, your participation will be greatly valued and remembered.

I look forward to hearing back from you

Warm regards,

Ingra Du Buisson-Narsai
Organisational Psychologist
Cell: 082 612 2378 Email: ingra@neurocapital.co | www.neurocapital.co

Appendix C: Research consent form

Letter of Consent for the Delphi panel participation

"Faculty of Social and Applied Sciences
Salomons Centre for Applied Psychology
School of Psychology, Politics, and Sociology
Canterbury Christ Church University In partnership with Professional Development Foundation

I, ______________________, (name and surname) agree voluntarily to take part in the applied research project being conducted by Ingra du Buisson-Narsai (CCCU ID: DUB17159003) as part of the requirements for her pursuit of a PhD in Professional Practice.

I have read the Participant Information Sheet (see below), and I understand the contents thereof. Any questions which I have asked have been answered to my satisfaction.

I understand that the information which I will supply is **confidential** and that it will be **anonymised** and will only be used in the findings of the research.

I understand that I do not have to answer all the questions which may be put to me.

The information which I provide will be held securely until the research has been completed and will be held for five years afterwards in a secure and confidential manner.

I understand that I am entitled to a summary of the project findings via a supplied link provided by the researcher.

I agree that the data provided by me can be used for future publications.

I have been informed that I may withdraw from this study at any time.

Signed…………………………   Date…………………………

Researcher Commitment (Ingra du Buisson-Narsai)

I commit to treating all information garnered in this study with complete confidentiality.

A summation of the research outcomes will be what is reported and shared."

Signature: **Date**: 20 June 2019

Ingra Du Buisson-Narsai
Student number: DUB17159003

Interview – Participants' Information Document

Issue	Response
1. Name of researcher Contact details	Ingra du Buisson-Narsai E-mails: Ingra@neurocapital.co Cell: 082 612 2378
2. Title of the research project	Articulating the behavioural anchorsof neuroscience-based leadership in formal organisations.
3. Purpose of the study	To identify and refine behavioural anchors of neuroscience-based leadership behaviour as portrayed beyond existing literature but as viewed by experienced professionals in the field of organisational neuroscience, with specific reference to leadership in formal organisations.
4. Description of the study	Formal academic research for a PhD degree which requires primary data from expert academics, consultants and practitioners involved in neuroscience-based leadership via an online Delphi study.
5. Duration of the study	4 months.
6. What will be your involvement, and how long will it take	Panel members will be asked to define and evaluate the statements relating to the definition, underpinning concepts and behavioural anchors relating to the new field of neuroscience-based leadership behaviour. The structure of the data collection will be a three-round Delphi study. The study will be managed electronically, and therefore geographical location of respondents is not a barrier. The distribution of questionnaires and collection of the data will be electronic.
7. Why have you been asked to participate?	You have been asked to partake in this study due any of the following criteria: (1) your expertise in neuroscience-based leadership and/or organisational neuroscience as applied in in formal organisations; (2) your formal qualifications in this new applied field; (3) your publications in this new field.
8. What will happen to the information which will be given for the study?	The information gathered over the Delphi rounds will be used to create a framework of behavioural anchor descriptors.

9. What will be done with the results of the study?	The results will be made available via a summary report to all participants and will be send out via email link. The researcher will also pursue formal publication of the results in peer-reviewed journals.
10. What are the possible disadvantages?	Apart from your time invested in this study. There are no costs to you associated with your involvement with this study. It is not envisaged that any negative consequences will accrue to you from your contributions in this research.
11. In what way will the study be beneficial, and to whom?	It is hoped that this study will provide a useful framework into how neuroscience can be used as a lens to clarify leadership behaviour.
12. Who has reviewed this study to ensure that it complies with all the requirements and ethical standards of the university?	The Ethics Committee of CCCU has approved this research proposal and granted permission for the research to commence.
13. Can permission be withdrawn having previously been granted?	Yes, all contributors shall retain the right to have their contributions to the research withdrawn at any time.
14. Can you refuse to answer any questions?	Yes. The contributor has the right to refuse to answer any question that is part of the Delphi panel questionnaire.

Professional Development International

Canterbury Christ Church University

PhD: Psychological Perspectives of Professional Practice

Fact Sheet

"Ms. Ingra du Buisson-Narsai a PhD candidate in the PhD Degree Programme in Professional Practice: Psychological Perspectives with Canterbury Christ Church University (CCCU), UK. Which is run in association with Professional Development Foundation (PDF), UK.

PhD Facts: The PhD that the above-named candidate is pursuing is a degree unique in Europe and differs from traditional approaches in that the focus of study is on application of research to practice. This means that students admitted to the programme are experienced professionals who are adjudicated by the University as being in a position to make a contribution to both knowledge and practice. Candidates constitute a cohort of experienced professionals from across the globe who have been admitted to the PhD as their expertise puts them in a position to impact on practice. The global nature of the programme also attracts a diversity of academics and practitioners available to work with the candidates throughout their studies. The degree is operated on a non-profit basis in order to open up the opportunity to professionals who may otherwise not have the opportunity to pursue further study to engage theory with their practical experience."

"About Canterbury Christ Church University: CCCU is a modern university with an international profile, attracting students from across the globe. It has a network of five campuses reaches across Kent and Medway. The University has thousands of courses on offer in the arts and humanities, applied and social sciences (including business) and health serving a student community of 17 000. 96% of the university's most recent UK undergraduates and 98% of postgraduates were in employment or further study within six months of completing their studies* It received a prestigious Silver rating in the Teaching Excellence Framework, exceeding national quality requirements for UK universities. Nearly 90% of CCCU research submitted to the 2014 Research Excellence Framework (REF) was assessed as world-leading, internationally excellent or internationally recognised. Further details are available on www.canterbury.ac.uk.

*Destinations of Leavers from Higher Education, includes full-time and part-time (all degrees) 2015/16."

About PDF: PDF Net is a separate limited company whose purpose is to enable individuals and organisations to develop work-based research, consultancy, and educational activities. It is a recognised institution for the development of work-based postgraduate awards and research. It provides the programmes listed on this website unless otherwise stated. Through its partner institutions, it creates bespoke work-based accreditation. It currently provides practitioner-based Masters and Doctorate programmes. PDF draws upon 40 years' experience with a network of world class professionals and are uniquely placed to help senior professionals achieve their learning goals. Further details available on http://www.pdf.net/

For further information about the PhD, please contact Prof David Lane at the above website."

Appendix D: Delphi survey Round One

Dear Participant,

20 June 2019

"Delphi study to articulate the behavioural anchors of neuroscience-based leadership

Thank you for your willingness to serve as a panel member for the study on the behavioural anchors of neuroscience-based leadership. The focus of the study is to compile a working definition of Neuroscience-Based Leadership, to identify key neuroscience principles that inform the essential behavioural anchors of neuroscience-based leadership and to articulate the behavioural anchors of neuroscience-based leadership in formal organisations.

As set out in the invitation letter – you will be involved in a three-round Delphi study to examine three research questions.

1. From your perception and experience as a consultant in the applied field of **organisational neuroscience / brain-based leadership / neuroleadership** can you define what it means to be a neuroscience-based leader?
2. From your perception and experience, what are key neuroscience concepts that underpin your approach to neuroscience-based leadership behaviour?
3. From your experience and observation, what are the key words or phrases that describe the behaviours that differentiate neuroscience-based leadership from other leadership approaches?

The **first round (Delphi I)** is open-ended. The survey is accessible from the link below from today 20 June 2019, and the return date is **20 July 2019**. (A 3-week turn-around time.)

Survey link: www.QReserch/delphineuroSBL.com.

The **second round (Delphi II)** will probe you to rate the compiled responses from Round One, using a four-point Likert scale. This will be emailed to you in early **September** with a 2-week turnaround time.

The **third round (Delphi III)** will again probe you to use a four-point Likert scale to rate the results of the previous Delphi round. You will receive via an electronic database link the mean and standard deviation for each item, your personal rating response from Round Two and the overall percentage rating for each survey item. This will be emailed to you in **October** with a 2-week turnaround time. Once the study is complete, the results will be made available to you on request via an email link."

Biodata:

Can you please provide the following details to ensure panel member qualifications and experience is recorded:

1. ***Age:***
2. ***Educational Attainment: Provide specific qualification levels and details:***
3. ***Profession:***
4. ***Scope of practice/consulting in the neuroscience field:***
5. ***Years of experience in neuroscience or applied neuroscience:***

Delphi Round 1 – Instructions

1. Definition of neuroscience-based leadership

Question 1 to the Participant: From your perception and experience as a consultant in the applied field of **organisational neuroscience / brain-based leadership / neuroleadership**, can you define what a leader needs to be a "neuroscience-based leader"?

Example: A neuroscience-based leader needs...." Please identify specific knowledge bases or models, application of specific principles and/or strategies, skill sets, etc. Do not feel you must limit yourself to these; just describe what you feel qualifies a "neuroscience-based leader."

Enter comments here:

2. Neuroscientific concepts that underpin neuroscience-based leadership behaviour

Question 2 to the participant: From your perception and experience, what are key Neuroscience concepts that underpin your approach to neuroscience-based leadership behaviour?

Examples include Threat avoidance overrides pleasure-seeking, Experienced based neuroplasticity drives habit formation, Positive affect enhances cognition and Negative affect dampens cognition, Mirroring/ Mindreading is self-referential and drives social cognition, Implicit emotional processing is faster than explicit cognitive processing, Opposing domains (task-positive networks and default networks) enables task and relationship related behaviours.

Enter comments here:

3. Behavioural anchor /Core behaviours descriptors

Question 3 to the participant: From your experience and observation what are the key words or phrases that describe the behaviours that differentiate neuroscience-based leadership from other leadership approaches?

Behaviours are any actions or inactions by the leader in facilitating individual and collective efforts to accomplish shared objectives.

Examples: Builds in-group work climates through empathy and perspective-taking; deploys reappraisal, affect labelling and mindful awareness as emotional-regulation strategies; tunes into affective cues such as facial expressions, speech space, and tone, body language to detect fears and instil social safety; identifies own cognitive biases and attributional errors.

Enter comments here:

Thank you for your participation.

Appendix E: Data coding

An example of (1) data clean-up for Behavioural anchors/core behaviours, (2) the code book developed and (3) the code book developed for foundational concepts

1. Clean-up of data for Research Question 3: Behavioural anchors

Reference	Behaviours	CNR	Code Description	Theme	Theme Description
1	Spends time to ensure that others are in a reward state not a threat state	3	Anchors (Relations Oriented)	3.1	Facilitating Psychological Safety (threat/award)
1	Uses words and phrases that are positively oriented not negative	3	Anchors (Relations Oriented)	3.1	Facilitating Psychological Safety (threat/award)
1	**Builds psychological safety in teams - does this by asking powerful questions, listening, clarifying, affirming, use of simple metaphors for joint understanding**	3	Social Cognition Behavioral Anchors (Relations Oriented)	3.1	Facilitating Psychological Safety (threat/award)
1	Role models vulnerability - opens self to others in a non-narcissistic manner ... encourages others to do the same	3	Social Cognition Behavioral Anchors (Relations Oriented)	3.2	Role modeling behaviour - imitation system
1	Encourages feedback from others so that she/he can become more self-aware and gain insight	3	Social Cognition Behavioral Anchors (Relations Oriented)	3.3	Taking others' perspectives and empathetic concern- mentalising system
1	Inculcates brain-friendly personal, inter-personal and team practices e.g. first encouraging individual thought in brain-storming sessions, taking breaks every forty-five minutes or so ...	4	Cognitive Behavioral Anchor (Tasks Oriented)	4.1	Deploying mindful attention awareness (PFC processing)
1	Openly practices mindfulness techniques	4	Cognitive Behavioral Anchor (Tasks Oriented)	4.1	Deploying mindful attention awareness (PFC processing)
2	understands the electrochemistry of the brain and induces the states for optimal performance	1	Foundational and Survival Behavioural Anchors (Stress Resilience Oriented)	1.1	Identifying (Fight/Flight/Freeze responses)
2	practices body awareness to track somatic markers of stress or relaxation response	1	Foundational and Survival Behavioural Anchors (Stress Resilience Oriented)	1.1	Identifying (Fight/Flight/Freeze responses)
2	knows about the neural correlates of stress and the flipover into dysfunction signs.. poor sleep, low or volatile mood, memory loss	1	Foundational and Survival Behavioural Anchors (Stress Resilience Oriented)	1.1	Identifying (Fight/Flight/Freeze responses)
2	**Down regulates distress and facilitates enriched environments**	1	Foundational and Survival Behavioural Anchors (Stress Resilience Oriented)	1.2	Downregulating distress using polyvagal insights
2	Practices good sleep health for memory consolidation and mood regulation	1	Foundational and Survival Behavioural Anchors (Stress Resilience Oriented)	1.3	Practicing optimumSleep, Exercise, Nutrition, Breathing
2	is aware of neuro-nutrition and the impact of stimulants and blood sugar regulations	1	Foundational and Survival Behavioural Anchors (Stress Resilience Oriented)	1.3	Practicing optimumSleep, Exercise, Nutrition, Breathing

2 Code Book for Behavioural Anchors/Core Behaviours

Code book from Delphi study, 2 October 2019

Behaviour themes	Subset no.	Sub-themes	Old codes	New codes
1. Foundational and survival behavioural anchors (*Stress resilience-oriented*)	1.1	Identifying (fight/flight/freeze triggers/ responses)	5.1	2.1
	1.2	Down-regulating distress using polyvagal insights	5.2	2.2
	1.3	Practising optimum: sleep, exercise, nutrition, breathing, mindfulness	5.3	2.3
2. Affective emotion behavioural anchors (*Emotion and affect-oriented*)	2.1	Identifying subjective emotional cues and action tendencies	6.1	3.1
	2.2	Dialling-down negativity/positivity bias / mood states	6.2	3.2
	2.3	Regulating emotions – strategies	6.3 + 6.4	3.3
3. Social cognition behavioural anchors (*Relations-oriented*)	3.1	Facilitating psychological safety (threat/award)	9.1	4.1
	3.2	Role-modelling behaviour – imitation system and social contagion	9.2	4.2
	3.3	Taking others' perspectives and empathetic concern – mentalising system	9.3	4.3
	3.4	Building in-group enriched climates	9.4	4.4
	3.5	Identifying and mitigating subjective biases	9.5	4.5
4. Cognitive behavioural anchor (*Task-oriented*)	4.1	Deploying mindful attention awareness (PFC processing)	8.3 + 10	5.1
	4.2	Leveraging goal-directedness and goal-achievement	8.1	5.2
	4.3	Facilitating change through attention density and habit formation	8.5 + 7	5.3
	4.4	Leveraging learning though memory systems	8.2	5.4
	4.5	Enhancing breakthrough decision-making – exploitation/exploration systems	8.4	5.5
		Social-cognitive and affective neuroscience can offer a scientific framework for leadership behaviour		

3. Code Book for Foundational Concepts (Question 2)

CONCEPTS		CODE BOOK from DELPHI STUDY		
		October 2, 2019	old codes	new code
Concepts Themes	**subset NR**	**Sub-themes**		
1. Foundational Principle & Brain Anatomy	1.1	Survival First: Pain Avoidance/pleasure seeking	1+2	1.1
	1.2	2 Processing Modes: Conscious/Unconscious	4	1.2
	1.3	Neurochemistry/"Fire & Wire"	3	1.3
2. Survival & Stress	2.1	Polyvagal: Stress Symptoms & responses: Flight Fight Freeze +chemistry + U CURVE	5.1	2.1
	2.2	Polyvagal:Relaxation response: Friend + chemistry	5.2	2.2
	2.3	Foundational drivers: Sleep, Exercise, Nutrition & Breathing	5.3	2.3
3. Affective & Emotion Concepts	3.1	Subjective ques & Emotional processing	6.1	3.1
	3.2	Mood & Affect positive/negativity Bias	6.2	3.2
	3.3	Emotional Regulation Strategies (helpful and unhelpful)	6.3 + 6.4	3.3
4. Social Cognitive Concepts	4.1	Psychological safety (Thread/Reward) (Bonding/belonging)	9.1	4.1
	4.2	Mirroring - contagion & learning	9.2	4.2
	4.3	Mentalising - empathy, perspectives	9.3	4.3
	4.4	Groups & In/Out	9.4	4.4
	4.5	Subconscious Bias	9.5	4.5
5. Cognitive Concepts	5.1	Working Limits PFC + Focus Attention Regulation + serial processing	8.3+10	5.1
	5.2	Goal Diectedness + Alignment	8.1	5.2
	5.3	Change Plasticity + habits + attention density	8.5 +7	5.3
	5.4	Memory + Learning + Consolidation strategies	8.2	5.4
	5.5	Cognitive exploration/exploitation Decisionmaking	8.4	5.5
		SCAN can offer a scientific framework for leadership behaviour		

3.4 Trustworthiness checklist **Establishing trustworthiness during each phase of thematic analysis (Nowell et al., 2017)**				
Phases of thematic analysis	**Means of establishing trustworthiness**	**Yes**	**No**	**Comments**
Phase 1: Familiarising yourself with your data	Prolong engagement with data.	✓		
	Triangulate different data collection modes.	✓		
	Document theoretical and reflective thoughts.	✓		
	Document thoughts about potential codes/themes.	✓		
	Store raw data in well-organised archives.	✓		
	Keep records of all data field notes, transcripts, and reflexive journals.	✓		
Phase 2: Generating initial codes	Peer debriefing.	✓		
	Researcher triangulation.	✓		
	Reflexive journaling.	✓		
	Use of a coding framework.	✓		
	Audit trail of code generation.	✓		
Phase 3: Searching for themes	Researcher triangulation.	✓		
	Diagramming to make sense of theme connections.	✓		
	Keep detailed notes about the development and hierarchies of concepts and themes.	✓		
Phase 4: Reviewing themes	Researcher triangulation.	✓		
	Themes and sub-themes are vetted by team members.			
	Test for referential adequacy by returning to raw data.	✓		
Phase 5: Defining and naming themes	Researcher triangulation.	✓		
	Peer debriefing.	N/A		
	Team consensus on themes.	N/A		
	Documentation of team meetings regarding themes.	N/A		
	Documentation of theme naming.	✓		
Phase 6: Producing the report	Member checking.	✓		
	Peer debriefing.	N/A		
	Describing the process of coding and analysis in sufficient detail.	✓		
	Thick descriptions of context.	✓		
	Description of the audit trail.	✓		
	Report on reasons for theoretical, methodological, and analytical choices throughout the entire study.	✓		

Appendix F: Delphi Survey Round Two

Delphi study to articulate the behavioural anchors of neuroscience-based leadership.

Round 2

Dear [Name],

Thank you for your input to Round One of the Delphi panel on the behavioural anchors of neuroscience-based leadership.

The focus of the study is to compile a working definition of neuroscience-based leadership, to identify key neuroscience **concepts** that underpin neuroscience-based leadership and to articulate specific behavioural anchors of neuroscience-based leadership in formal organisations.

This **second round (Delphi II)** will probe you to rate the compiled responses received from the expert panel members from Round One, using a six-point Likert scale. There are three (3) questions and one (1) open-ended commentary statement.

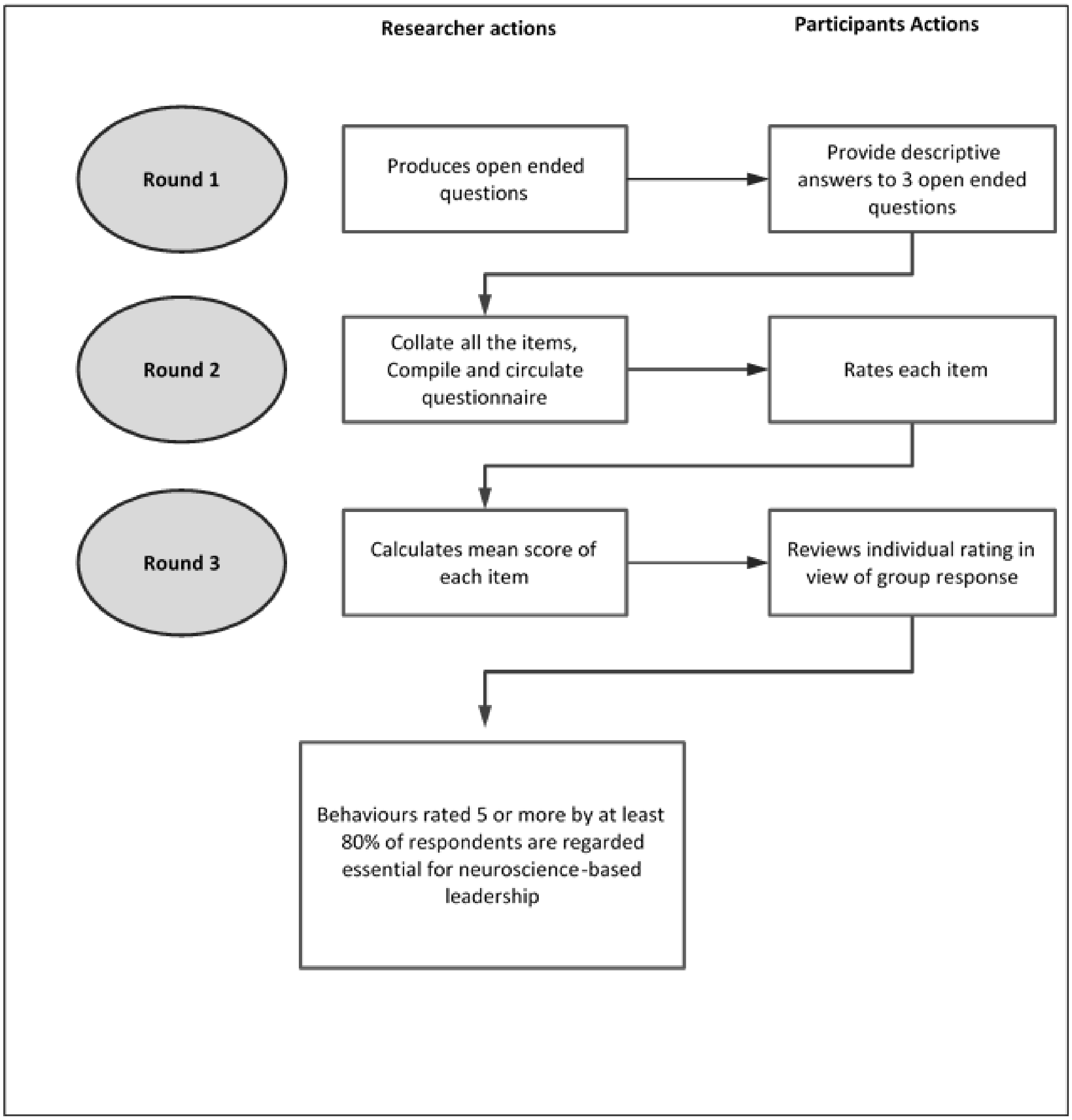
There is a two-week response turnaround time on this survey.

The **third round (Delphi III)** will again probe you to use a six-point Likert scale to rate the results of the previous Delphi round. You will receive via an electronic database link, the mean and standard deviation for each item, your rating response from Round Two and the overall percentage rating for each survey item.

This will be emailed to you after the Round Two **Delphi is completed** with a two-week turnaround time.

Once the study is complete, the results will be made available to you on request via an email link.

The Delphi Rounds Process Map is attached below:



Delphi Round 2 – Instructions

1. Definition of neuroscience-based leadership

Please rate how strongly you agree or disagree with each statement as being an essential part of a working definition of being a neuroscience-based leader.

Definitions of neuroscience-based leadership	Please tick your response on the following 6-point scale:					
	Strongly disagree 1	Disagree 2	Slightly disagree 3	Slightly agree 4	Agree 5	Strongly agree 6
Definition 1: Has a scientifically grounded working knowledge of the brain.						
Definition 2: Cultivates psychological safety by building trust and mutual respect in the workplace.						
Definition 3: Leverages brain-based processes like attention regulation, memory capacity, emotional regulation, social cognition, and habit-formation for optimum wellbeing and performance.						
Definition 4: Deploys a positive and practical application of brain-based processes to optimise social collaboration, innovation, decision-making, change, resilience, diversity, and wellness.						
Definition 5: Builds brain-friendly processes at individual, team, and organisational levels.						
Definition 6: Understands the basic human needs of pain avoidance / pleasure-seeking, control, attachment, and self-esteem and fulfils these needs through workplace solutions.						

If you have anything you would like to say about your answers, please comment in the box below *optional*.

2. Neuroscientific concepts that underpin neuroscience-based leadership behaviour

Please rate how strongly you agree or disagree with each statement as being a key concept underpinning neuroscience-based leadership.

To enable the rating of statements the responses are clustered into five broad categories:

1. Theories and thinking frameworks.
2. Safety and survival.
3. Neuroplasticity.
4. Conscious / non-conscious processing.
5. Epigenetics.
6. Neurotransmitters.

Concepts underpinning neuroscience-based leadership	**Please tick your response on the following 6-point scale:**					
	Strongly disagree 1	**Disagree 2**	**Slightly disagree 3**	**Slightly agree 4**	**Agree 5**	**Strongly agree 6**
Concept 1: Down-regulation of distress and fostering enriched environments through leveraging basic human needs i.e. orientation and control, attachment, pleasure maximisation, and elf-esteem enhancement. (Neuropsychotherapy theory)						
Concept 2: The autonomic nervous system and fight/flight/freeze response – including (the friend response). (Polyvagal theory)						
Concept 3: The three hypothetical "layers" of the brain have differentiated functions. (Triune brain theory)						
Concept 4: The 1-2-4 Model of Brain functioning and the interaction of the four processes of emotional cue-interpretation, feelings, thought and self-control. (Integrative neuroscience theory)						

Concepts underpinning neuroscience-based leadership	**Please tick your response on the following 6-point scale:**					
	Strongly disagree 1	**Disagree 2**	**Slightly disagree 3**	**Slightly agree 4**	**Agree 5**	**Strongly agree 6**
Concept 5: Neural functioning is a result of activating neural networks. Task-positive networks and default networks enable task and relationship behaviours. The salient network acts as a task switcher. (Opposing domains theory)						
Concept 6: The use of neuroscience techniques to understand the social and emotional aspects of the human mind and human behaviour. (Social-cognitive and affective neuroscience theory)						
Concept 7: Neurotransmitters and their effect on behaviour.						
Concept 8: The brain operates in two modes – conscious and non-conscious processing to overcome the working limitations of the PFC and enhance brain efficiency.						
Concept 9: Neuroplasticity: Neurons that fire together wire together. When neuronal patterns are activated repeatedly (experienced based), they form a pattern or more enduring circuit.						
Concept 10: Epigenetics (nature/genetics and nurture/environment) influence behaviour at the individual, team and organisational level.						
Concept 11: The primary organising principle of the brain is to maximise safety and minimise threat.						
Concept 12: Social drivers like status, certainty, autonomy, relatedness, and fairness in determining inclusion/exclusion perception.						

Concepts underpinning neuroscience-based leadership	Please tick your response on the following 6-point scale:					
	Strongly disagree 1	Disagree 2	Slightly disagree 3	Slightly agree 4	Agree 5	Strongly agree 6
Concept 13: The inverted U-curve of performance. Conscious, focused attention is energy-intensive. A high focus over time fatigues the PFC and impairs downstream decision-making.						

If you have anything you would like to say about your answers, please comment in the box below *optional*.

3. Neuroscience-based leadership behavioural anchor descriptors

Please rate how strongly you agree or disagree with each statement as being a behavioural anchor in articulating what neuroscience-based leaders "DO" at work.

To enable the rating of statements, the responses are clustered into 4 broad categories:

1. Stress resilience-oriented.
2. Affect and emotions-oriented.
3. Relations-oriented.
4. Task-oriented.

3.1 Stress resilience-oriented behavioural anchors

Please rate how strongly you agree or disagree with each statement as being a behavioural anchor in articulating what neuroscience-based leaders "DO" at work.

Neuroscience-based leadership behavioural anchor	Please tick your response on the following 6-point scale:					
	Strongly disagree 1	Disagree 2	Slightly disagree 3	Slightly agree 4	Agree 5	Strongly agree 6
Understanding the foundational functional principles of the brain-body system:						
Behaviour 1: Gains insights into the current state of research about the brain with particular reference to what is relevant in the workplace.						
Behaviour 2: Has a scientifically grounded working knowledge of the brain, its form and functions.						
Down-regulating distress and leveraging optimum arousal of attention:						
Behaviour 3: Understands and leverages the electrochemistry of the brain and the role it plays in mind-states, e.g. oxytocin in trust and belonging, serotonin in regulating mood, adrenalin to sharpen attention.						
Behaviour 4: Is aware of potentially triggering a threat response through tone of voice, body language, and exclusion of others.						
Practising optimum sleep, exercise, nutrition, and breathing:						
Behaviour 6: Practises good sleep hygiene to enhance memory consolidation, positive mood regulation and down-regulation of stress.						
Behaviour 7: Recognises that change triggers a threat response, and encourages rhythmic living through sleep, nutrition and exercise.						

If you have anything you would like to say about your answers, please write this in the box below *optional*.

3.2 Affect / mood and emotions-oriented behavioural anchors

Please rate how strongly you agree or disagree with each statement as being a behavioural anchor in articulating what neuroscience-based leaders "DO" at work.

Neuroscience-based leadership behavioural anchor	**Please tick your response on the following 6-point scale:**					
	Strongly disagree 1	**Disagree 2**	**Slightly disagree 3**	**Slightly agree 4**	**Agree 5**	**Strongly agree 6**
Cultivating sensory awareness of mind and body states:						
Behaviour 8: <u>Tunes into affective cues</u> such as facial expressions, speech pace/ tone, and body language to detect fears, and instil social safety.						
Behaviour 9: <u>Pays attention to subjective cues</u> like nonverbal, non-conscious action tendencies (for self and others) with the ability to adapt to optimise the present experience.						
Dialling-down negativity bias and cultivating positive mood states:						
Behaviour 10: <u>Enhances a positive affect</u> (using healthy lifestyle choices, practising gratitude and compassion, mirroring and smiling).						
Behaviour 11: <u>Dials down negativity bias</u> through deliberately generating a 3:1 to 6:1 positivity to negativity ratio and to optimise social and cognitive functions.						
Behaviour 12: <u>Identifies and harnesses the power of mood and emotion</u> in self and others to enhance thinking processes and social engagement.						
Generating, distinguishing and regulating emotions:						
Behaviour 13: Aware of the impact of emotional contagion and <u>creates strategies for self-control</u> and regulation to transmit a positive, engaged, supportive emotional state to others.						

Neuroscience-based leadership behavioural anchor	**Please tick your response on the following 6-point scale:**					
	Strongly disagree 1	**Disagree** 2	**Slightly disagree** 3	**Slightly agree** 4	**Agree** 5	**Strongly agree** 6
Behaviour 14: Avoids emotional-regulation strategies that enhance limbic system arousal like suppression, rumination, venting, catastrophising, etc.						
Behaviour 15: Activates the right self-regulation strategies at the right time, to manage mental states like affect labelling, emotional granularity, humour, distancing, and reappraisal.						

If you have anything you would like to say about your answers, please write this in the box below *optional*.

3.3 Relations-oriented behavioural anchors

Please rate how strongly you agree or disagree with each statement as being a behavioural anchor in articulating what neuroscience-based leaders "DO" at work.

Neuroscience-based leadership behavioural anchor	**Please tick your response on the following 6-point scale:**					
	Strongly disagree 1	**Disagree** 2	**Slightly disagree** 3	**Slightly agree** 4	**Agree** 5	**Strongly agree** 6
Facilitating psychological safety (threat avoidance/reward seeking):						
Behaviour 16: Spends time to create an environment that fosters a "toward" state in which people are open, curious, expansive and productive.						
Behaviour 17: Builds psychological safety in teams – does this by asking powerful questions, listening, clarifying, affirming, use of simple metaphors for joint understanding.						

Neuroscience-based leadership behavioural anchor	Please tick your response on the following 6-point scale:					
	Strongly disagree 1	Disagree 2	Slightly disagree 3	Slightly agree 4	Agree 5	Strongly agree 6
Behaviour 19: Builds in-group culture through shared goals, outsourcing of effort and celebration of outcomes.						
Role-modelling behaviour (imitation system):						
Behaviour 20: Is aware of the influence of mirror neurons; and how we copy others, specifically those in power, and deliberately role-models desired behaviour.						
Behaviour 21: Makes a deliberate effort day-to-day to "walk the talk" and demonstrate an attitude of exemplarity, self-control and growth mindset.						
Taking others' perspectives, showing empathetic concern (mentalising system):						
Behaviour 22: Uses mentalising to understand the intentions of others, taking perspectives of others, making possible the communication of intentions and ideas.						
Behaviour 23: Shows empathic concern to others through other-oriented feelings of sympathy and takes perspectives of others through active listening and questioning.						
Building in-group climates (team dynamics):						
Behaviour 24: Down-regulates distress and facilitates enriched environments through active listening, and perspective-taking.						
Behaviour 25: Finds common ground among disparate team members. This, in turn, will build team cohesion and create a sense of unity.						
Behaviour 28: Meets the basic human needs of others, i.e. self-esteem, control, attachment and pain avoidance / pleasure-seeking through workplace solutions.						

Neuroscience-based leadership behavioural anchor	**Please tick your response on the following 6-point scale:**					
	Strongly disagree 1	**Disagree 2**	**Slightly disagree 3**	**Slightly agree 4**	**Agree 5**	**Strongly agree 6**
Identifying and mitigating subjective biases:						
Behaviour 29: Senses the organisation's micro and macro threat / safety climates in the organisation. Recognises mini-wins and offers immediate tangible or intangible rewards to optimise engagement and motivation. Mitigates threats to avoid micro / macro cognitive and emotional derailment.						
Behaviour 30: Enhances collective intelligence by including gender and racial diversity in the group, increasing social sensitivity, and providing equal participation.						
Behaviour 31: Identifies and mitigates subconscious biases through reflective and thoughtful interactions.						
Behaviour 32: Is more attuned to social cues of others and the true meaning of what people are experiencing.						

If you have anything you would like to say about your answers, please write this in the box below *optional*.

3.4 Task-oriented behavioural anchors

Please rate how strongly you agree or disagree with each statement as being a behavioural anchor in articulating what neuroscience-based leaders "DO" at work.

Neuroscience-based leadership behavioural anchor	Please tick your response on the following 6-point scale:					
	Strongly disagree 1	Disagree 2	Slightly disagree 3	Slightly agree 4	Agree 5	Strongly agree 6
Builds mindful attention awareness practices to enhance focus:						
Behaviour 32: Is sensitive to the working limitations of the PFC and the risk of the brain defaulting to unproductive bias and practises focus through mindfulness-based exercises and attention training.						
Behaviour 33: Discourages multitasking / task-switching and constant interruptions to ensure focused and sustained attention and memory recall.						
Behaviour 34: Deploys mindfulness practices to enhance focused attention, emotional regulation, lower stress, and reduce risky decision-making.						
Leveraging goal pursuit to facilitate behaviour change:						
Behaviour 35: Encourages goal setting and goal achievement by encouraging shorter-term accomplishments, shared goals and goal hierarchies (why and how goals).						
Behaviour 36: Sets realistic expectation/goals. Is aware of the power of the brain's if-then coding and the negative cognitive impacts of unmet expectations.						
Facilitating change through attention density and habit formation:						
Behaviour 37: Is aware that the brain translates change into an "unknown code" which can trigger a threat state and derail thinking. Creates certainty and normalises feelings of uncertainty to optimise performance and build change resilience.						

Neuroscience-based leadership behavioural anchor	**Please tick your response on the following 6-point scale:**					
	Strongly disagree 1	**Disagree 2**	**Slightly disagree 3**	**Slightly agree 4**	**Agree 5**	**Strongly agree 6**
Behaviour 38: Understand cognitive dissonance and builds controllable incongruence (creative tension) into work projects. Avoids uncontrollable incongruence (emotional tension).						
Behaviour 39: Builds attention density to overcome unhelpful habits using practice and repetition, to embed new neural pathways that, when sufficiently strengthened, become the brain's default automated pathway of choice.						
Leveraging learning through memory systems:						
Behaviour 40: Deploys learning strategies that enable people to reflect, and learn in groups and in spaced periods of time to enhance memory – recall, retention, and consolidation.						
Enhances decision-making through insights on exploitation/exploration systems:						
Behaviour 41: Provides explicit, mutually agreed upon organisational processes to enhance decision-making and reduce emotional contagion.						
Behaviour 42: Builds cognitive flexibility and breakthrough thinking by tapping into unconscious thought, e.g. reflective conversations, visualisation, imagination, exploration and novelty.						

If you have anything you would like to say about your answers, please write this in the box below *optional*.

4. Please comment on the statement below (optional)

"Neuroscience-based leadership and its behavioural anchors should emerge from rigorous, forward inference imaging studies designed to test specific hypotheses based on theory. Such studies must include or be directly linked to other studies showing the impact on leadership effectiveness and related outcomes."

Thank you for your participation.

Appendix G: Delphi Survey Round Three

Dear [Name],

DELPHI STUDY TO ARTICULATE THE BEHAVIOURAL ANCHORS OF NEUROSCIENCE-BASED LEADERSHIP

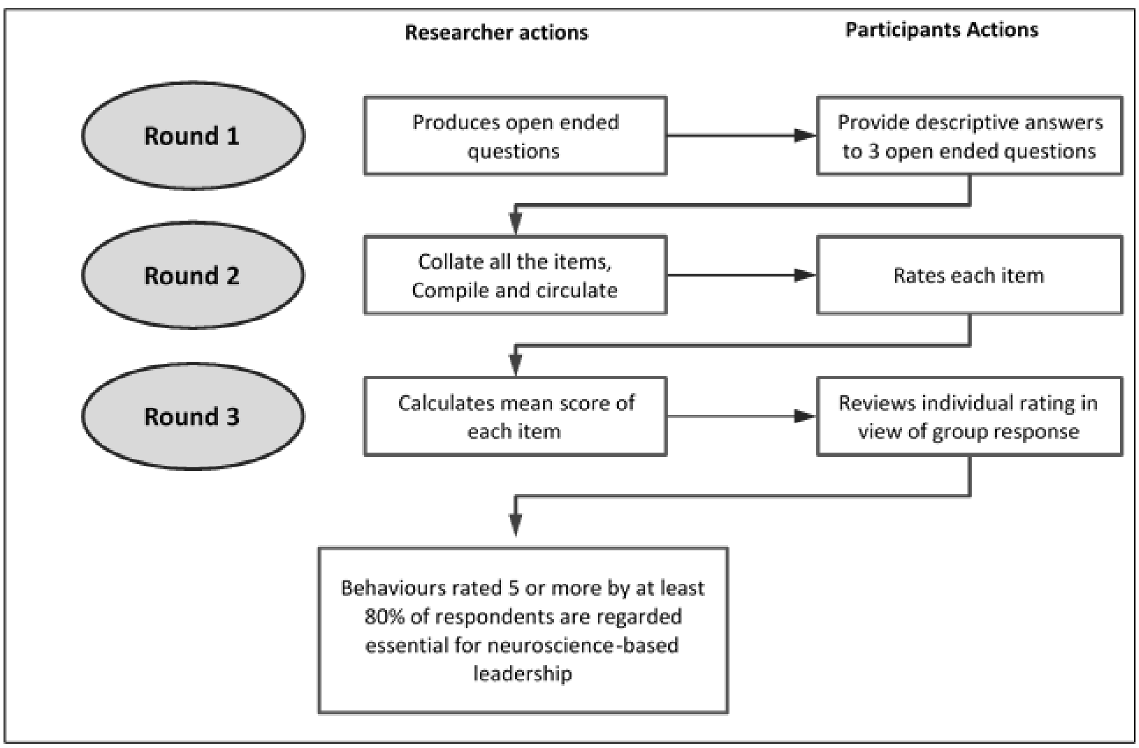
Welcome to the FINAL round of the Delphi Consultation!

1. Round 3

"Thank you for your input to Round One of the Delphi panel on the behavioural anchors of neuroscience-based leadership.

Please note that the feedback received from each round is consolidated by the researcher. The data received is the expert opinion of the panel members, not that of the researcher.

The Delphi Rounds Process Map is attached below:



There is a two-week response-turnaround time on this survey. Once the study is complete, the results will be made available to you on request via an email link. This survey closes at 11 pm on Wednesday, 14 December 2019. Upon completion of this final survey, you will be entered into the prize draw for a 1 in 5 chance of winning a $30 Amazon voucher."

"2. Instructions round (Delphi III)

In this final round you will see the same statements shown in the previous round. This round has fewer statements, because the ones with high levels of agreement among participants have not been included. With each statement you will see your response (indicated in bold orange), and figures demonstrating the overall group responses.

Some of the comments made by participants in the previous round will be anonymous presented at the top of each page.

This is your opportunity to either change or validate your previous responses.

If you would like to change your rating, please select your new rating on the Likert scale below each statement.

If you want to keep the same rating you gave on the previous round, please leave the boxes blank for that statement and move onto the next."

"3. Round (Delphi III) – Definitions of Neuroscience-Based Leadership

3.1 Comments from the previous round on the Definition of Neuroscience-based Leadership

- "For the leader it is important to exhibit brain-based skills and he/she does not have to know the neuroscience in detail. My thinking is a high-level awareness but the practical skill to apply is of the greatest importance. Being a leader in the workplace will not always require brain-based behaviour as certain situations must be addressed on a different level."
- "I think that a neuroscience-based leader, first and foremost must have a scientifically current working knowledge of the brain. The statements I rated strongest speak to having current scientific knowledge AND the ability to bridge the knowing-doing gap by building and deploying brain-friendly processes and finally … the self-regulation to manage their own brain to better manage others for optimal performance and wellbeing."
- "If pressed to rank order the responses, that would be more challenging for me, but might tease out the subtleties. In my opinion of good leadership, these are all 'strongly agree'. However, I could give a little room on a few (making them 'agree')."

3.2 Instructions: Definitions of Neuroscience-Based Leadership

There was a majority consensus (greater than 80%) by the panel on the statements that define neuroscience-based leadership. Thus, the third round is a ranking stage."

	Please rank the statements in order of importance in constituting a working definition of neuroscience-based leadership. (1= high importance to 7 = low importance)	**Ranking: 1= high importance to 7 = low importance**
Definition 1	Has a scientifically grounded working knowledge of the brain.	
Definition 2	Cultivates psychological safety by building trust and mutual respect in the workplace.	
Definition 3	Leverages brain-based processes like attention regulation, memory capacity, emotional regulation, social cognition, and habit-formation for optimum wellbeing and performance.	
Definition 4	Deploys a positive and practical application of brain-based processes to optimise social collaboration, innovation, decision-making, change, resilience, diversity, and wellness.	
Definition 5	Builds brain-friendly processes at individual, team, and organisational levels.	
Definition 6	Understands the basic human needs of pain avoidance/pleasure-seeking, control, attachment, and self-esteem and fulfils these needs through workplace solutions.	

"4. Round (Delphi III) – Neuroscientific Concepts that underpin neuroscience-based leadership behaviour

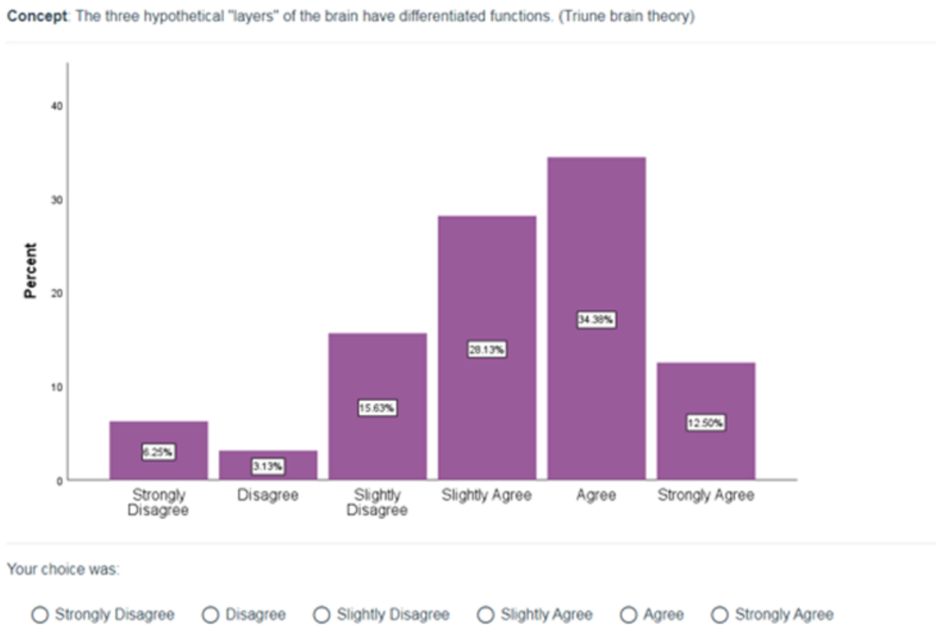
4.1 Comments received from the previous round on Foundational Concepts

- "I think the triune brain theory is controversial – I don't think neuroscientists embrace it … "
- "Understanding the two modes is important in the workplace to understand the limitations of possible workload."
- "A basic understanding is enough. Leaders need not be experts on neurology. It serves more to understand why people react as they do than to 'treat' unwanted behaviour – scope of practice has consequences."

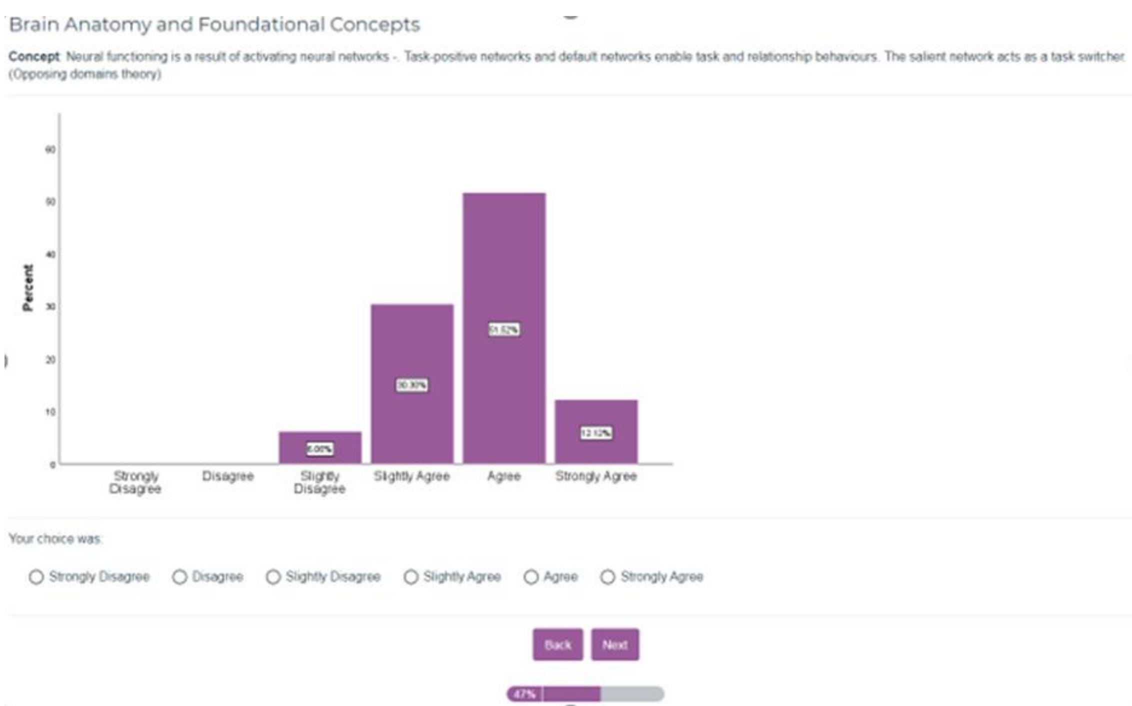
4.2 Underpinning Concepts of NSBL – Consensus (80%) not reached on five statements

In the previous round, you were asked to rate the extent to which you agree or disagree with the statements. This round has fewer statements because the ones with high levels of agreement among participants have not been included. Would you please look at the responses given by other panel members in the previous round and decide whether you would like to change your response (highlighted in orange) or keep it the same?"

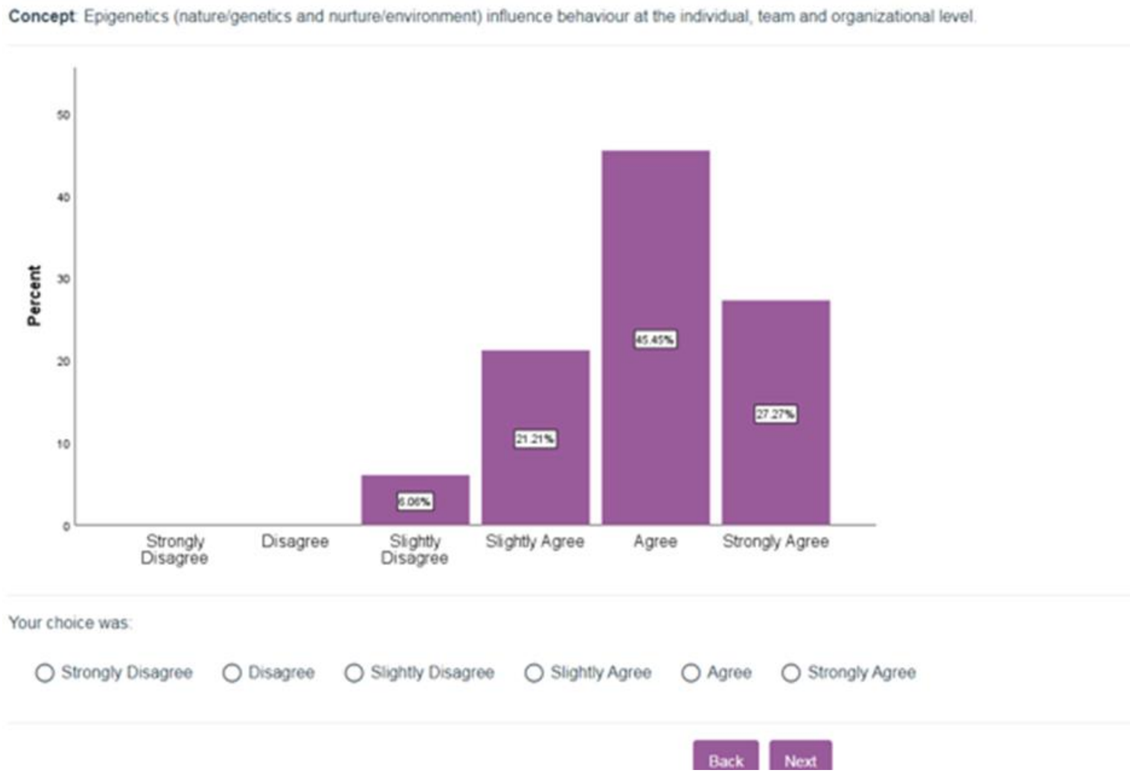
Concept One (1): The three hypothetical "layers" of the brain have differentiated functions. (<u>Triune brain theory.</u>)



Concept Two (2): Neural functioning is a result of activating neural networks. Task-positive networks and default networks enable task and relationship behaviours. The salient network acts as a task switcher. (<u>Opposing domains theory.</u>)



Concept Three (3): Epigenetics (nature/genetics and nurture/environment) influence behaviour at the individual, team and organisational level.



"5. Round (Delphi III) – Neuroscience-based Leadership Behavioural Anchor

5.1 Behavioural Anchors Comments

Comments received from the previous round on Stress Resilience behavioural anchors

- "Less science and more practical is what will always work in corporations. A little science goes a long way. They want to know that things have been properly vetted and that the science is real and robust. But they really want to roll their sleeves up to get to the day-to-day use of the concepts. That said, they do dig on the science."
- "Leaders are not neuroscientists. They need a working knowledge on a high level of brain-based concepts, not an in-depth knowledge." " ... and each individual's optimal level of arousal may be different ... "

Comments received from the previous round on Relations-Oriented / Social-Cognitive behavioural anchors

- "I think 'mentalising' is covered in the more specific statements about active listening, empathy, powerful questions, affirmations ... The idea of being 'exemplary' in self-control, etc., is useful since we are attempting to illustrate the ideal neuroscience-based leader – though, there is an aspect of authenticity and transparency that makes a 'neuroleader' relatable ... when the leader shares his negative emotions 'I am frustrated ... mad ... what else can we do?' Or when the leader does 'lose it' in a meeting ... to then say, 'I lost it, this is what happened in my brain ... I'm back with you now ... what is the best way for us to move forward ... ?' We are human – emotions drive everything – they are powerful – we all fluctuate ... it's about how a neuroscience-based leader consciously navigates mind over brain in a way that inspires and influences others positively ... "

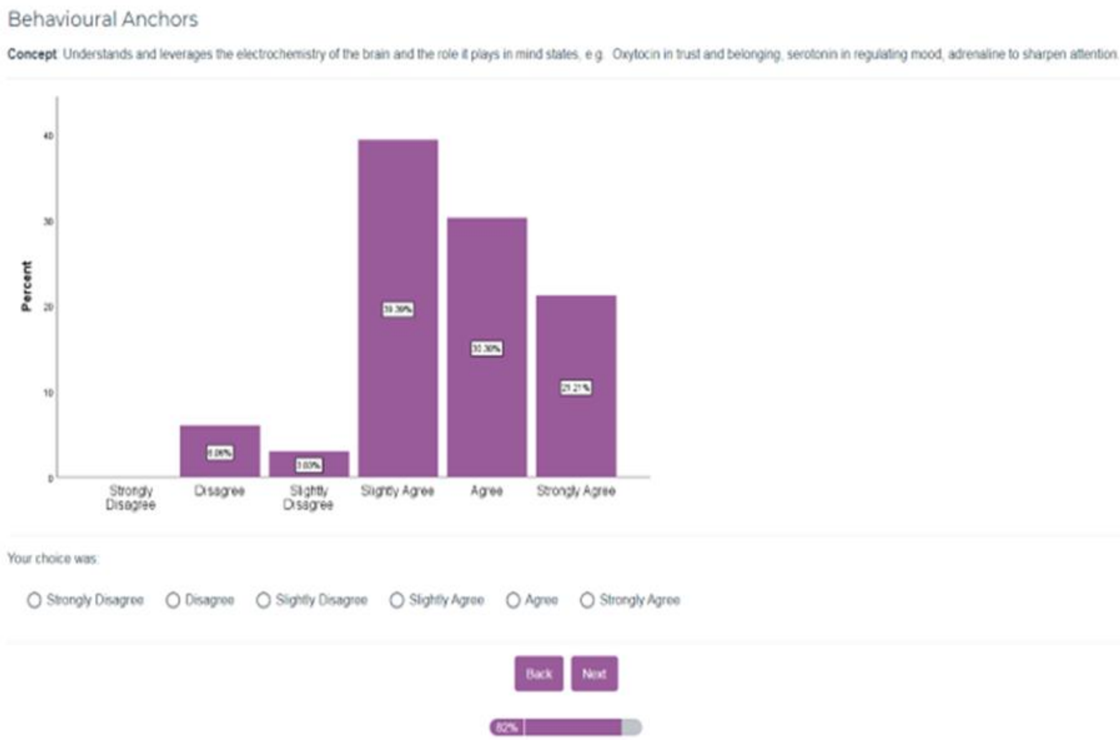
Comments received from previous round on Task-Oriented behavioural anchors

- "Part of this is critical for the leader of today because of things rapidly moving and changing. An intermodal on uncertainty would go far. I think some of the lower ones are HR and OD professional's domain and not that of the leaders. The last three in particular."
- "Feedback and performance management."

5.2 Behavioural Anchors of NSBL – Consensus not reached on one statement

This round has fewer statements because the ones with high levels of agreement among participants have not been included. In the previous round, you were asked to rate the extent to which you agree or disagree with the statements. Please look at the responses given by other panel members in the previous round and decide whether you would like to change your response (highlighted in orange) or keep it the same."

Anchor One (1): Understands and leverages the electrochemistry of the brain and the role it plays in mind state, e.g. Oxytocin in trust and belonging, serotonin in regulating mood, adrenalin to sharpen attention.



Thank you for your participation.

Thank you for completing the final round of this study. Your contribution to this is greatly appreciated. The hope is that this project will provide more significant insights into the behavioural anchors of neuroscience-based leadership. If you have any questions or comments regarding this study, don't hesitate to contact Ingra du Buisson-Narsai at Ingra@neurocapit–l.co (Researcher).

Many thanks for making a valuable contribution to this area of research.

Appendix H: A Delphi study reading template

Adapted from Toma and Picioreanu (2016)

Reporting items	Yes	No	Not clear
Are the expert definition criteria reported?	✓		
Expert selection process description reported?	✓		
Is the expert panel management procedure described	✓		
Study dropouts' management explained?	✓		
Were the final results of the study sent to the panel experts?	On request		
Expert experience with the study collected?	✓		
Number of respondents for each round reported?			
Is the form administration procedure reported and/or explained?	✓		
Type of form used for the first step of the study: is the author option explained?			
Qualitative data analysis process described/referenced?	✓		
Likert items: how many response options?	✓		
Likert items: is a midpoint used?	✓		
Likert items: how are the response options ordered?	✓		
Likert items: response options labelling reported (end points or continuous)?			
Likert items: the display of response options reported?	✓		
Data analysis and reporting between quantitative rounds explained?	✓		
Is the consensus level defined?	✓		
The planned duration of the study mentioned?	✓		
Consensual themes management reported (themes are being kept or removed after reaching consensus)?	✓		
Minority opinions management (criteria for dropping the themes) reported?			SCOAP was mentioned by one panel member.
Rules for stopping the study (n rounds, consensus reached for a number of themes) presented?	✓		

Appendix I: Data Analysis Theoretical Coding

Theoretical Analysis (ThA)

Theoretical analysis is employed when the research has some predetermined categories (themes) to examine during the data analysis. In this situation, the research may use his/her pre-understandings when conducting the data analysis.

Researchers might approach this analysis in two phases: In the first phase, after preparing the data (steps 1-4 below), one works on assigning the data units to the **predetermined themes derived from previous research** and theory and carries out the analyses as described in steps 5 through 13.

Then, **in phase two**, return to the data and work with data units and patterns that did not seem to fit the pre-determined categories, again following steps 5-13. The themes derived from this analysis will likely not be found in previous research but may contribute to it.

Step-By-Step Analysis:

Conceptualising NSBL: definition of NSBL, foundational concepts, core behaviours

	Data Analysis Procedure	**notes**
1.	Read, review, and familiarize yourself with the data collected from each participant (interviews, journals, field notes, records and documents). Re-read the documents and highlight intuitively any sentences, phrases, or paragraphs that appear to be meaningful. Keep in mind the **predetermined categories (themes)** related to the theory and research question posed and remain open to any new patterns and themes related to the research question that have emerged from the data analysis. During this process, the researcher immerses himself/herself in each participant's data. **Research Questions:** 1. How is NSBL defined? – inductive analysis 2. What are the foundational principles of NSBL? – deductive/inductive using: Gordon (2000) 3. What are the core behaviours of NSBL? -inductive	**Data:** Delphi-Panel using open-ended questions in round one
2.	For each participant, review the highlighted data and **use your research question** to decide if the highlighted data are related to your question. Some information in the transcript may be interesting but not related to your question.	33 Participants ✔
3.	Eliminate all highlighted data that are not related to your question; however, start a separate file to store unrelated data. You may want to come back and reevaluate these data in the future.	✔
4.	Take each item of data and code or give a descriptor for the data. The descriptor or name will often be a characteristic word from within the data.	✔
5.	Cluster the items of data that are related or connected in some way and start to develop patterns.	✔
6.	Patterns that are related to a preexisting theme are placed together with any other patterns that correspond with the theme, along with direct quotes taken from the data (transcribed interviews, field notes, documents, etc.) to elucidate the pattern.	✔

7.	Any patterns that do not relate to preexisting themes should be kept in a separate file for future evaluation of the meanings as they relate to the overall topic. Repeat steps 1-7 for all participants.	✔
7.	Take all the patterns and look for the emergence of overarching themes. This process involves combining and clustering the related patterns into the preexisting themes.	✔
9.	After all the data have been analyzed, arrange the themes to correspond with the supporting patterns. The patterns are used to elucidate the themes.	✔
10.	Now, **revisit the patterns** that did not fit the preexisting categories and remain open to any new patterns and themes that are related to the research topic and have emerged from the data analysis.	All theoretical themes captured in *Fig.13* p.216
11.	For each theme, the researcher needs to write a detailed analysis describing the scope and substance of each theme.	✔
12.	Each pattern should be described and elucidated by supporting quotes from the data.	✔
13.	Finally, the themes are synthesized together to form a composite synthesis of the question under inquiry.	✔

Reference: Percy, W. H., Kostere, K., & Kostere, S. (2015). Generic qualitative research in psychology. *Qualitative Report*, *20*(2), 76–85. https://doi.org/10.46743/2160-3715/2015.2097

Chapter Five: Professional practice case study

Title: Assimilating Neuropsychotherapy into Leadership Behaviour

Abstract

Background: Organisational neuroscience is an emerging discipline exploring human behaviour's neural correlates in organisations. However, although the claimed concreteness and rigour of this new science may give it the potential to improve organisational capabilities, there is a lack of clarity about how it can be translated and practically applied to organisational and leadership behaviour.

Aim: To define AONS and identify emerging perspectives on NP theory and its practical integration with leadership behaviour to refine the conceptualisation of NSBL and the core behaviours of NSBL using NP as an interpretive lens.

Method: A case study method was chosen, as it has the potential for theory-building and understanding AONS and NSBL's real-life contextuality. Data were gathered using open-ended, semi-structured, in-depth interviews to develop a detailed understanding of the participant's insights into the science and practice of AONS and neuroscience-based leadership behaviour. A theoretical thematic analysis was carried out using a qualitative interpretive approach.

Results: A working definition of applied organisational neuroscience was provided, and a practical interpretive framework of NP-informed leadership behaviour was given.

Conclusion: The exploratory nature of this study generates several questions, such as how this research can be further operationalised. The interpretive framework cannot be used as a scientifically validated framework and needs further exploration and operationalisation. It can aid as a roadmap to advance NSBL research and practice.

Key words: applied organisational neuroscience, neuropsychotherapy, neuroscience-based leadership, translational research.

1. Introduction

Neuroscience as an interpretive lens is increasingly applied in organisational psychology research and practice, specifically in leadership development. The challenge is to make such an application in an ethical, rigorous, and relevant way. In this exploratory study, the view of an expert scholar and practitioner in the field was deployed to substantiate such rigour and relevance using Neuropsychotherapy as an interpretive lens.

2. Background and context

"No one moves a muscle without a motivation."

According to Stein & Allcorn (2014, p. 346 as cited in Flotman, 2020), "the complexity of the leader as a person and leadership as a role is encapsulated in the concept of a psychological leadership black box" Within this black box resides the leader's "basic psychological needs, personality, values and beliefs, attachments, projections, transferences, valence, language use, interests, past experiences, and unconscious motivations" (Flotman, 2020).

A key focus of this chapter is to peer into the "psychological leadership black box", explore behavioural examples of basic psychological needs and provide a practical framework for its application in leadership behaviour, specifically articulating the core behaviours of leaders that can facilitate the meeting of basic psychological needs in the workplace.

Contemporary research on AONS and NP in the work context

Applied Organisational Neuroscience (AONS)

There is no well-established and consensual definition for applied organisational neuroscience (AONS), as shown in Chapter Two's literature review. Several broad definitions have been proposed to define organisational neuroscience (Becker, Cropanzano, & Sanfey, 2011; Healy & Hodgkinson, 2014; Beugré, 2010; Passarelli, 2015). One of the challenges for research in this field is how to translate neuroscience findings into practical application in the work context.

Neuropsychotherapy (NP)

Studies on neuropscyhotherapy and its application to leadership behaviour are still scarce. The knowledge of this topic is in an early stage of development. The researcher could only find four studies that examined Neuropsychotherapy in business settings (Geldenhuys, 2022; Geldenhuys, 2020; Garnett, Venter, & Geldenhuys, 2022; Mayer & Geldenhuys, 2019). The three peer-reviewed conceptual articles proved that NP theory provides an interdisciplinary, integrated perspective on human functioning on constructs relevant to leadership, including appreciative inquiry, systems psychodynamics as organisational development intervention and workplace spirituality and wellness. The study by Garnett et al. (2022) provided evidence that traditional Change models can be enhanced by using a neuroscience perspective to explore participants' experience of the neurobiological impact of emergent change.

The literature reviewed in Chapter Two also gave evidence of how basic psychological needs can be adapted to descriptors of leadership behaviours (Ghadiri, Habermacher, & Peters, 2013). These authors argue that one of the most essential dimensions of leadership behaviour is the emphasis on understanding and meeting basic psychological needs. Also, Deci and Ryan (2000) showed that meeting psychological needs is important for optimal functioning and wellbeing in the workplace. Research on the role of managers in satisfying psychological needs showed behaviours relating to trust and the support of employees reduced employees' intention to leave and enhanced work engagement (Rothmann, Diedericks, & Swart, 2013).

Peering into the psychological leadership black box: Basic Needs Models

It is worth defining what makes a basic psychological need distinct from any other need. Dweck (2017, p. 690) qualified criteria for a basic need as follows: "irreducibility to other needs, universal high value from very early in life, and importance for wellbeing and optimal development from very early in life. Thus, basic psychological needs drive goals that support psychological life and health over the life-span in much the way that physical needs drive goals that support physical life and health.

According to Habermacher (2020), a needs model can inform practice and argues that it provides a general model of human psychological drives, motivation and resulting behaviours. It gives the essential requirements for healthy (optimal) psychological wellbeing and informs organisational practitioners in a simplified manner about how human wellbeing can be increased in organisational contexts, education, or public policy.

Examples of needs models include Deci and Ryan's (2000) extensively published Self Determination Theory (SDT) which is built on the premise that the satisfaction of the three psychological needs, namely, Autonomy, Competence, and Relatedness, is a prerequisite for intrinsic motivation, internalisation of work behaviour and flourishing (Deci & Ryan, 2008a, 2008b; Gagne & Deci, 2005 as cited in Wissing, Potgieter, Guse, Khumalo, & Nel, 2014). A neuroscientific perspective on basic psychological needs has been captured in the study by Reeve and Lee (2019), which demonstrated that psychological need satisfaction is associated with striatum-based reward processing. Thus, fulfilling basic needs is rewarding, and primes approach motivation schemas where one moves toward new challenges and goals.

According to Dweck (2017), a triad of basic psychological needs—Acceptance, Optimal predictability, and Competence— are there from birth or shortly thereafter and run over the life-span. These needs give rise to goals designed to meet the needs. This aligns with Rossouw's (2014) argument that basic psychological needs are at the core of each human being and form part of anthropological survival.

The basic human needs identified by Epstein (1994) and refined by Grawe (2007) constitute a 'neuro psychotherapeutic approach and set out how human genes convey basic instinctual overlapping priorities (needs) for psychological safety and immediate physical safety. The four basic psychological needs are present among all humans, and violation or enduring non-fulfilment leads to impairments in mental health and wellbeing. These are the need for attachment – belonging, orientation and control, pleasure and avoidance of pain, and self-esteem and its protection and development. These four needs are closely related to each other, and the satisfaction of one will influence the others.

The essence of these basic needs models is that motivation derives from basic human needs, including psychological needs, which give rise to goals designed to meet the needs. Humans pursue need-fulfilling goals, and their behaviours reflect need fulfilment (Dweck, 2017; Ghadiri, Habermacher, & Peters, 2013; Ryan & Deci, 2000; Grawe, 2007).

A Neuropsychotherapeutic Approach to Basic Psychological Needs

This single-case study focuses on a neuroscientific approach to satisfying basic psychological needs within the context of leadership behaviour. The work of Klaus Grawe (2007) on basic psychological needs is particularly relevant, as it ties the basic psychological needs to neuronal processes and hence directly connects neuroscience to the brain and to psychology.

These basic needs that Grawe (2007) defines are at the deeper level of all human goals and interactions. Therefore, it forms a solid foundation on which to build a practical framework of NSBL behaviour. The NP approach also addresses "motivational behaviour" in that, meeting basic psychological needs, people are driven by two basic tendencies to either approach or avoid situations. Over time, they develop routine patterns of behaviour in trying to meet their needs, called motivational schemas. These schemas are hardwired neural systems that motivate avoidance and approach to stimuli. These insights are relevant to enabling personal and organisational change or transformation efforts as these schemas often operate automatically and at an implicit level, so individuals may not be routinely aware of how they respond to day-to-day situations.

Neuropsychotherapy theory is a therapeutic approach that utilises the brain's ability to change itself (neuroplasticity) in physical form (neurobiology and networks) and processes (neurochemistry and electrical activity) to enable resilient, adaptive changes in thinking patterns and behaviour (Ramachandran, Siegel, & Cozolino, 2010).

The relevance to leadership behaviour is that becoming aware of approach or avoidance patterns gives the leader the opportunity to reframe goals that drive approach behaviour towards higher levels of personal functioning and need fulfilment.

One of the critical aspects of Neuropsychotherapy is its emphasis on building a safe and supportive therapeutic environment (Grawe, 2007). Extrapolating this to the workplace, it is argued that leadership is about helping team members regulate their emotional states and build strong relationships, which can positively impact the brain's ability to adapt and rewire (Henson and Rossouw, 2013; Geldenhuys, 2022).

NP theory aims to explain how leaders influence employee engagement (Henson & Rossuw, 2013). On a neurological level, all people are motivated by satisfying basic needs while avoiding threats (Dahlitz 2015). Leaders who cultivate healthy relationships create a safe environment and give employees the foundation to take initiative at work.

Understanding NP theory may help leaders recognise that they are constantly communicating unconsciously (mainly through facial expressions) and improve their behavioural repertoire to convey a sense of openness and trust through nonverbal means. This way, they can signal to employees that the environment is safe, and they can take the risk of thinking carefully without going into protect/avoid mode. Leaders can develop core behaviours consistent with basic psychological needs theory to create an enriched environment. This includes deep listening as a behaviour that aims to be fully present with another person.

It contributes to an interpersonal environment that recognises and values the uniqueness of the individual, which in turn contributes to the satisfaction of basic psychological needs (security, stress avoidance, control and increasing self-esteem). This enriched environment favours the development of new neural pathways, particularly those associated with approach motivation (proactivity) rather than avoidance. On a neurological level, these new pathways are strengthened (wired) through their use.

The context for this study is a gap in the scientific body of knowledge for (1) defining Applied Organisational Neuroscience (AONS) and (2) how basic psychological needs can be translated into actionable core leadership behaviours using NP as a theoretical framework. This chapter will attempt to fortify the increasing interest in Neuropsychotherapy theory to inform and describe leadership behaviour.

3. Rationale for this study

The problem, that is, the starting point for this research chapter, is aligned with the overall research question of this study to explore how experienced professionals conceptualise NSBL and describe the core behaviours of NSBL. Neuropsychotherapy is an applied neuroscience approach reported as having relevance as an explanatory lens for describing leadership behaviour and enhancing leadership development.

The rationale for this chapter is not to reject other neuroscientific frameworks used in leadership development but rather to define AONS and to provide practical evidence of how NP theory can be used as a meta-theory that focuses on the underlying essence (the basic psychological needs) of all human functioning while offering neuroscientific guidelines to develop resilient and adaptive leadership behaviour and ultimately adaptive organisations.

4. Research aims and research questions

This chapter offers exploratory qualitative research using a case study to contribute to defining applied organisational neuroscience and further conceptualising NSBL behaviour using a Neuropsychotherapy theory. A further aim is to secure detailed descriptions by gaining insights from a subject matter expert in the field of organisational neuroscience.

This research seeks to define AONS and to illuminate how Neuropsychotherapy can be translated into core leadership behaviour within applied organisational neuroscience. Defining AONS and integrating NPT with leadership behaviour in formal organisations could move NSBL beyond the anecdotal level to a more integrated, legitimate, and ethical practice of neuroscience-based leadership.

The specific research questions for this chapter arose from the literature review in chapter Two and the Delphi study in Chapter Four. In the Delphi study, participants indicated that neuroscience theories (including processes, core concepts, and mechanisms) could be used to inform NSBL behavioural descriptors. Most respondents stated that Social Cognitive Neuroscience is most relevant to leadership behaviour. Two mentions were made about Neuropsychotherapy and a basic psychological needs approach to articulating NSBL. In other words, what drives the behavioural repertoire that leader-managers display in formal organisations.

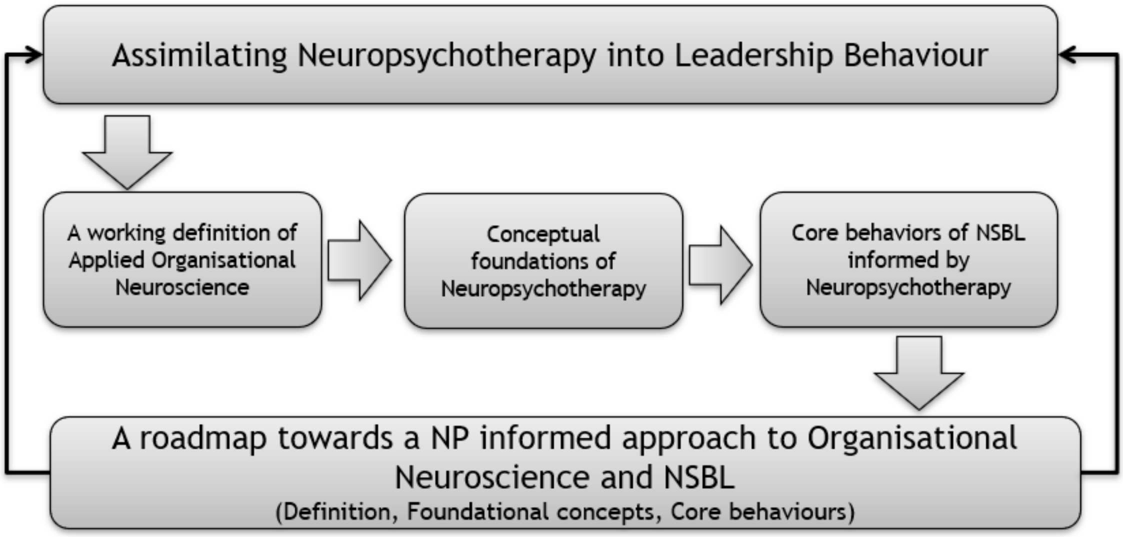
This inquiry into coupling NPT with leadership behaviour centres around two research questions:

Q1: How is applied organisational neuroscience (AONS) defined?
Q2: How can NP theory inform leadership behaviour in formal organisations?

Answering these questions may also allow organisational psychologists, consultants, and organisations to gain competence in AONS and apply NP in leadership development. The conceptual framework for this chapter is set out in Figure 1.

Figure 1

Conceptual framework of NSBL using a Neuropsychotherapy lens



The conceptual framework in Figure 1 is operationalised through a case study approach using an expert open-ended interview.

5. Research Methodology

5.1 Research design: a single case study

This study adopted a qualitative exploratory research design because NSBL is a nascent field. A case study method was selected to refine the quest for defining AONS and articulating how NP theory can be adapted to describe the core behaviours of NSBL.

According to Klenke (2008), the case study method has the potential for both theory-building and understanding of the real-life contextuality of a phenomenon (in this case, neuroscience-based leadership behaviour and applied organisational neuroscience) when, as Yin (1994, p 63, as cited in Klenke, 2008) put it, “how and when questions are to be answered”. The case study research method is an “empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are unclear; and when multiple sources of evidence are used” (Yin, 1994, p. 23, as cited in Klenke, 2008).

In this way, the case study approach seems to be a good fit for the research question. A strong point of this case study comes from numerous techniques in the data-gathering part in an earnest effort to gain patterns and insights from a comprehensive set of data points. (See Appendix A for stages of the research design.)

Critics claim that case studies offer limited evidence for the reliability of findings, as the case study method does not adhere to predetermined procedures and analytical techniques. The researcher is open to modifying data collection, analysis, and interpretation as new insights are gained in the research process (Klenke, 2008). Case studies are even dismissed as useful only as exploratory research tools (Flyvbjerg, 2006).

The current exploratory study adopted a generic qualitative design to advance the quest for an AONS interpretive framework through conducting an expert interview. Percy, Kostere, & Kostere (2015) defined a generic qualitative design as "a qualitative approach that allows participants to describe the content of a given real-world problem by offering opinions, beliefs, feelings, and perspectives. A qualitative approach allows a researcher to investigate, identify, and seek to comprehend the rich descriptions and explanations of real-world experiences" (Percy et al., 2015, p. 79).

5.2 Selection and description of participant

Academic experience and registration as an IOP were the only selection criteria for participation in the research. The case study sought to interview an experienced professional who actively conducts research in applied organisational neuroscience. The participant is a full professor at one of the eleven mega-universities globally and engaged in tuition relating to organisation development and organisation psychology coaching at both Master's and Doctoral levels.

The participant presented papers on organisational neuroscience at international conferences and workshops. The participant had also published chapters in peer-reviewed books on neurosciences and resilience development. The participant had been focusing on applying neuroscience to organisations for the previous six years and had spent 23 years in academic tuition in organisational psychology.

See Appendix B for the research consent form and Appendix C for the participant information sheet.

5.3 Data collection

In line with the generic qualitative study design, data was gathered using open-ended, semi-structured, in-depth interviews to create a detailed understanding of the participant's insights into the science and practice of AONS and neuroscience-based leadership behaviour. Yin (2017, p. 121) states, "Interviews are an essential source of case study evidence because most case studies are about human affairs or actions."

Interviews are deemed appropriate for this research because the research seeks to understand the broad scope of the AONS field within the context of organisational psychology. Due to the COVID-19 pandemic, no face-to-face interviews were performed.

The interviews were conducted using an online meeting platform and within Zoom security protocols (Zoom Video Communications, Inc., 2020). See Appendix D for the Interview protocol and questions.

The expert interview was recorded and saved as an electronic file on the researcher's desktop computer. The recording was transcribed into MS Word, and the researcher edited the transcription by repeatedly listening to the audio recording to ensure the accuracy of the transcript. The transcript was then imported into NVivo as an MS Word file.

5.4 Data analysis

The primary purpose of this case study was to explore how applied organisational neuroscience (AONS) is defined and to describe the core behaviours of NSBL using insights from NP theory and practice. Thematic analysis is the best approach to building an understanding from collected data and was performed as per the procedures provided by Braun and Clarke (2006), Braun, Clarke, & Gray (2017), and Percy et al. (2015). Thematic analysis is detailed and intended to recognise and examine themes from written data that are distinct and trustworthy (Guest, MacQueen, & Namey, 2011).

The analysis followed the broad guidelines of thematic analysis delineated in Table 1, which shows how several chunks of texts are categorised into codes, similar categories, and then, finally, themes. The researcher specifically deployed theoretical thematic analysis used by Percy et al. (2015) to analyse the raw transcribed data. These authors point out that predetermined theories and themes from previous research and theories guide theoretical thematic analysis. Thus, the researcher may use their "pre-understandings when conducting the data analysis" (Percy et al., 2015, p. 81). In addition, these authors advise that the researcher remains open to the options of new themes emerging from the thematic analysis. In answering question one (defining AONS), predetermined themes of Applied Organisational Neuroscience (AONS) were not found in the literature. Therefore, a mostly inductive thematic analysis was followed to define AONS.

See Appendix F - for a detailed procedure of Theoretical Thematic Analysis used in this study.

Table 1

The process of thematic analysis (Adapted from Braun & Clarke, 2006, p.87; Percy et al., 2015, p.83)

Phase	Description of the process carried out.
1. Data familiarisation	After the transcription of data was completed, the data was read and re-read, noting down initial ideas.
2. Generating initial codes	Coding relevant features of the data systematically across the entire set of collated data relevant to each code. (30 codes were identified.)
2. Searching for themes	Collating codes into potential themes (including pre-existing themes) and gathering all data relevant to each potential theme. (Three primary themes for Q1 and three primary themes for Q2 were identified.)
4. Reviewing themes	Checking whether the themes work for the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic "map" of the analysis. This was done for both Q1 and Q2 – and overall.
5. Defining/naming themes	Ongoing analysis to refine the specifics of each theme and the overall story the analysis tells, generating clear definitions and names for each theme. The final theme: A roadmap for rigour and relevance in AONS.
6. Producing the report	The final opportunity for analysis. Vivid, compelling extract examples were selected. This was related to the research question and literature analysis, producing the Chapter Five report on this learning journey.

In answering question two (describing core behaviours of NSBL), the researcher found predetermined themes from a review of the literature on Neuropsychotherapy theory and its possible application to NSBL, specifically the NP theory set out by Grawe (2007).

The researcher remained open-minded while finding new emerging themes during data analysis. Therefore, the researcher employed deductive and inductive approaches (Braun and Clarke, 2006) to analyse the data answering question Two.

A tabulation of the predetermined thematic codes for question two is set out in Table 2

Table 2

Predetermined thematic codes derived from "Neuropsychotherapy: How the Neurosciences Inform Effective Psychotherapy" (Grawe, 2007).

Thematic code no.	Label	Page no.
1.	Explicit and implicit mental processes	106
2.	Neural plasticity	114
3.	Basic human needs	165
4.	Consistency regulation as a basic principle of mental functioning	168
5.	The attachment needs	174
6.	The need for orientation and control	211
7.	The need for self-esteem enhancement as a specifically human need	230
8.	The need for pleasure maximisation and distress avoidance	240
9.	Consistency and consistency regulation	283
10.	Psychotherapy works via consistency improvement	353

The results of the analysis conducted allowed the researcher to answer the research questions and will be discussed under the "Results" section.

5.5 Quality control in the case study

Because of the power of case studies to provide generalisable knowledge if done correctly, it becomes important to justify the respective study's validity and reliability. The sound interpretation of the case study data was conducted in line with the spirit of exploratory qualitative research and is set out in Table 3.

Table 3

Quality control in the research project (Klenke, 2008)

Criterion	Description	Strategies used in this study
Construct validity	Establishing correct operational measures for constructs being studied. Measures must be valid representations of constructs for valid inferences to be made.	The case study report and multiple sources of evidence, like peer-reviewed articles, textbooks, and applied NP websites, were used.
Internal validity	Establishing causal relationships by demonstrating co-variation between variables under investigation.	Explanation-building strategy with a logical chain of evidence. Review of the case study report by key informant Tying propositions to the existing literature regarding translations, theory adaptation, and the discipline of IOP.
External validity	Establishing a domain within which a study's findings can be generalised.	Analytic generalisation. Tying propositions to existing literature in ONS and articles published by IOPs.
Reliability	Demonstrating that the operations of a study can be repeated with the same results.	A fellow psychologist carried out the validation of the coding scheme. The case study was done via a case study protocol.

5.6 Ethical conduct

According to Kerlinger and Lee (2000), the ethics of human science research addresses the questions about what is correct and what is incorrect in conducting the research. More specifically, this includes issues like voluntary participation, informed consent, confidentiality, anonymity, data storage, and dissemination of results and feedback. The researcher signed and submitted all necessary documents as required by the Ethics Committee of Canterbury Christ Church University.

Ethical conduct requirements were incorporated into the current project as follows. Participation was voluntary, and each prospective participant was truthfully and carefully advised about the nature of the research before signing a consent form (see Appendix B). All information was kept confidential, and the name of the expert interviewed was not disclosed.

Also, all electronic information was encrypted and secured in password-protected file format. The recordings of the interviews will be erased from the media after the required storage period has elapsed. The data will, therefore, be deleted once they have served their purpose in the study. The researcher also conducted this research within the guidelines of the HPCSA (See Appendix E – Ethical Conduct for the Profession of Psychology).

6. Results and discussion

This section summarises the findings of the case study. The goal of data interpretation is to make meaning of the case analysis or, as Klenke (2008, p. 69) suggests, the researcher reports "the lessons learned from the case, considering both agreements between the findings and the literature and disagreements between the findings and the literature". The research findings and interpretations are made to answer the specific research questions.

6.1 Defining Applied Organisational Neuroscience (AONS)

Q1: What is a workable definition of applied organisational neuroscience (AONS)?

The thematic analysis delivered three key themes that were derived from the expert interview:

(1) AONS provides an interdisciplinary interpretive lens with an explanatory value for NSBL.

(2) AONS provides multiple levels of analysis

(3) AONS is a translational approach between neuroscience and organisational phenomena

This is set out in Table 4 on the next page

Table 4:

Themes and quotes in the transcript identified through data analysis.

Theme	Description	Quote in transcript
Theme 1 An interdisciplinary interpretive lens	This theme describes how the interpretation of Neuroscience research informs organisational behaviour interpretations and interventions.	"AONS is an interdisciplinary field of study that offers scientific theoretical frameworks that serve as a benchmark for assessing, expanding on, or refining existing theories, and even proposing new theories and interventions to facilitate organisational development."
Theme 2 Multiple Levels of Analysis	This theme describes how multiple levels of analysis, i.e. the neurobiological, individual, team and organisational levels of functioning, can add to the rigour.	"It is a level of analysis which is not reductionism; rather, it can advance and connect leadership and organisational psychology theories." "It is reductionistic when you only look at psychology and not at biology, to have the one-sided approach to the human being, or to see the human as a [sic] individual and not as a part of a social system and everything."
Theme 3 A translational approach	This theme describes how translational research and theory adaptations can be done using neuroscience as a **method theory and organisational phenomena as a domain theory.**	"Translational approaches and theory adaptation can be done. "The starting point is the **specific organisation phenomena being studied** – for example, leadership behaviour, workplace resilience or group dynamics (the domain theory), etc., and then to incorporate empirical findings, methodologies, mechanisms and overarching themes from neuroscience (the method theory) and its supporting brain systems (large-scale brain networks) as well as neural processes."

Discussion of results for delineating AONS

The insights gained from the interview underscored that AONS is beginning to be the field of study that takes findings in neuroscience research and translates them into practical use by decoding and translating knowledge and making it accessible and practically valuable in organisations.

The specific findings of the research are discussed next.

6.1.1 Theme 1: An Interdisciplinary Interpretive Lens

This theme describes how the interpretation of mature Neuroscience research informs organisational behaviour interpretations and interventions to enable a broad and inclusive understanding of organisational phenomena.

Supporting quotes in text:

> "Organisational neuroscience is not neuropsychology – which depends on the study of the behaviour of humans with nervous system dysfunction (i.e., a non-experimentally-based biological manipulation)."
>
> "It's applied science: we don't undertake neuro/scanning/imaging/sensing studies; we (IOPS) interpret and integrate the results of current neuroscience research findings like NP, SCN, affective neuroscience, etc., and apply [them] to a domain theory; for example, group dynamics."
>
> "Applied organisational neuroscience is the application of neuroscience within coaching, within wellness, within leadership development, within whatever it is that we are working within the organisation in the very same way that we would apply system psychodynamics in team development and organisational development".

Similarly, according to Nissani (1995, p. 121) in the published article *"Fruits, Salads, and Smoothies: A Working Definition of Interdisciplinarity"*, one can define Interdisciplinarity as the "bringing together of *distinctive components* of two or more disciplines. In academic discourse, interdisciplinarity typically applies to four realms: knowledge, research, education, and theory".

The *distinctive components* in applied organisational neuroscience are organisational psychology phenomena like resilience, engagement, and, in this study, leadership behaviour. Organisational psychology involves consulting with organisations on individual, group, and organisational behaviour processes and practices and applying this knowledge to solve problems at work (Van den Bos, 2007). The discipline of organisational psychology is an applied research field because it seeks to solve real-world problems. Examples include assessing and coaching individuals, improving team functioning, and enhancing the quality of the organisational system working at the individual, group, or organisational level.

Organisational psychologists are especially well-equipped to improve the people side of organisations. What makes this approach psychology and not business administration or OD? Three features seem to be defined: "(a) the insistence on measurement, (b) the insistence on assessment, and (c) concern with ethics and values" (Lowman, 2002, p. 2).

The distinctive components in Neuroscience include multiple neuroscience fields., each with a different focus, theories, and measuring methods with touchpoints to organisational settings. This includes social-cognitive neuroscience (SCN) (Ochsner & Lieberman, 2001); organisational neuroscience (Becker et al., 2011); psychoneuroimmunology (Irwin, 2008); neurofeedback (Thibault & Raz, 2017); and Neuropsychotherapy (NPT) (Draguns, 2007; Rossouw, 2014). NeuroLeadership (Ringleb & Rock, 2008) has been very popular as an application approach.

The critical Insight from reviewing these various neuroscience branches to explain the neural mechanisms that underpin organisational and leadership behaviour is that there is a deliberate aim to amalgamate concepts from different fields pitched at varying levels of explanation (Royal Society, 2011). The conceptual and evidenced-based linking between these 2 fields were reported in the literature review (Chapter Two) and linked to NSBL behavioural domains in Chapter Four. According to Becker et al. (2011), this conciliatory integration provides robust, content-rich theories.

6.1.2 Theme 2: Multiple levels of analysis.

This theme describes how multiple levels of analysis, i.e., the neurobiological, psychological and behavioural levels of functioning, can add to rigour and ethical practice.

Supporting quotes in text:

> "Reductionistic is only to see the one part of a human being, only the problematised way or perspective and not also the positive and the health and the wellness of people and how they function".
>
> "It is about the level of analysis and not being neuro-centric; instead, one must use meta-studies or meta-models to make inferences from."
>
> "It is an applied science with ethical practice as a key contribution. "

This theme focuses on the argument that using multiple levels of analysis adds to the explanatory power of neuroscience as an interpretive lens. The key operating premise in this approach is that any cognitive or emotional faculty involves connecting descriptions of phenomena across levels of analysis (Ochsner & Kosslyn, 2014; Ochsner & Lieberman, 2001). These levels include descriptions "at the level of behaviour and experience, psychological processes (or information-processing mechanisms), and neural systems" (Ochsner & Kosslyn, 2014, p. 2).

The benefits of these multiple levels of analysis include the ability to use brain and behavioural data in combination in an integrative manner instead of drawing inferences about psychological processes.

The following interview quote clarifies the "integration" of approaches:

> "When we talk about integrating, academically, neuroscience with industrial psychology, this is what we mean: To evaluate the interventions, we have to identify the shortcomings and how we can improve them. What can we tweak? And we've been able to change how appreciative inquiry and system psychodynamics can be implemented for greater effectiveness".
>
> "Multiple levels of analysis also encourage ethical practice."

The participant also stressed the value of valid Neuroscience research for enhancing ethical practice in psychology. This is due to neuroscience giving an additional level of description to psychological constructs and thereby contributing to the ethical practice of doing "no harm" and contributing to human wellbeing and flourishing.

The participant mentioned how NP theory, its principles and practices enable practising ethics as a living philosophy set out by Kantar & Bynum (2021) as "Flourishing ethics", in which it is assumed that human flourishing is the central ethical value as all people strive towards flourishing.

According to Flourishing ethics, all humans share a common nature that is aligned with basic psychological needs. Therefore, adopting NP as a meta-model can guide ethical practice, equating to an enriched environment that activates approach-based motivational schemas that facilitate wellbeing and flourishing.

6.1.3 Theme 3: Building a translational bridge.

This theme describes how translational research and theory adaptations can be done using neuroscience as a method theory and organisational phenomena as a domain theory.

A supporting quote in text:

> "The starting point is the specific organisation phenomena being studied – for example, workplace resilience or group dynamics (the domain theory), etc., and then to incorporate empirical findings, methodologies, mechanisms and overarching themes from neuroscience (the method theory) linking it to its supporting brain systems (large-scale brain networks) as well as neural processes."

As such, applied organisational neuroscience is seen as a translational bridge. Similarly, Healy and Hodgkinson (2014) encouraged doing translational research, arguing that it is well suited for using basic neuroscientific insights to enrich organisational behaviour while exploiting social scientific research methods that are more familiar to organisational researchers.

The promises of translational research in using neuroscience in social science have been illustrated in research studies (Loewenstein, Rick, & Cohen, 2008). The research conducted by these authors on the pain and pleasure of information in economic decisions uses neuroimaging studies to show that information signalling negative scenarios activates regions of the brain's pain matrix. This research shows that humans derive pain (and pleasure) from information directly, not only from the material benefits it confers.

Some researchers have taken this translational approach in connecting neuroscience concepts to leadership processes, for example, Hannah, Balthazard, Waldman, Jennings, and Thatcher (2013) and Waldman, Balthazard and Peterson (2011). These researchers referred to neuroscience findings in existing SCN literature covering topics such as empathy, perspective-taking, and moral reasoning.

Gay and Kreiselmaier (2016) proposed that to ethically translate neuroscience research into organisational psychology theories and practices, scholars need a useful definition of their subject matter and the core concepts being researched.

Building a translational bridge between neuroscience and leadership can be done by employing theory adaption as an approach (Jaakkola, 2020). Theory adaptation enlarges or fine-tunes the conceptual scope of a specific domain by presenting an alternative point of view (Lukka & Vinnari, 2014).

Quotes in this expert interview expand on the translational strategies as set out above:

> "A way forward with developing the field of AONS is through conceptual analysis, and they speak about which is your domain theory and which is your method theory."
>
> "You will use your method theory to improve your domain theory. So your domain theory can be leadership behaviour. Your method theory would be organisation neuroscience. In this instance, you'll use NP theory and principles to enhance or improve your domain theory, which is leadership behaviour."

An example of such translation is the research on how appreciative inquiry (AI) can enhance wellbeing using a neuropsychotherapeutic framework (Geldenhuys, 2020). Appreciative inquiry (AI) is a positive approach to facilitating change. It assists in seeing Organisational Behaviour in new ways (Bushe, 2013). Organisations often use appreciative inquiry (AI) as a strategic conversational tool by organisational leadership and is well-recognised in the management and organisational sciences.

In this example of a conceptual analysis with theory adaption as an approach, Appreciative Inquiry (AI) was selected as a domain theory, and neuropsychotherapy (NP) was chosen as a method theory. Firstly, AI was discussed, after which the emphasis fell on

Neuropsychotherapy, which focuses on wellbeing. Neuropsychotherapy was then used to appraise and refine AI as an intervention directed at wellbeing.

Workplace spirituality was also studied using a Neuropsychotherapeutic framework (Mayer & Geldenhuys, 2019) and a conceptual analysis of systems psychodynamics as an organisation development intervention from a neuroscientific perspective by Geldenhuys (2022).

It also seems possible to adopt translational research by using mixed, multi-level methods to transfer insights from base sciences to different applications in a manner that suits the needs of the application domain (Sharp, Monterosso, & Montague, 2012).

Comparison of interview results with literature review

These findings align well with the definitions set out in the literature review done in Chapter Two. Table 5 sets out the comparison between the literature and the study findings, aiming to consolidate the literature and enhance the conceptual level of the research contribution.

Table 5

Defining AONS: Comparison of Interview results with the literature

Resource	Findings from the literature	Study findings
Becker, Cropanzano, & Sanfey (2011, p. 937)	ONS "is an approach to spanning the divide between neuroscience and organisational science and represents a paradigm or **interpretive framework** that sheds new light on existing problems."	**Concurs:** Supports the finding by Becker et al. (2011) of ONS being an **interpretive framework** and proposes a meta-model of psychological needs and their corresponding neural systems.
Beugré (2010)	Neuro-organisational behaviour is "the study of the impact of the brain on behaviours that occur in organisations". Neuro-OB includes the (1) neural, (2) cognitive and (3) behavioural **levels of analysis.**	**Concurs:** Supports Beugré's 2010 findings about **levels of analysis** and OB **level of individual, team, and organisation.**
Passarelli (2015)	ONS is complementary to organisational behaviour. It offers a **multi-level social neuroscience** approach relevant to social phenomena in organisational contexts.	**Concurs** Passarelli's finding of neural substrates relating to OB phenomena.
Healy & Hodgkinson (2014)	The term "socially situated cognition" was proposed to encapsulate situatedness, grounding and embodiment principles.	**Concurs**: Supports Healy and Hodgkinson's findings of complex adaptive systems and that **translational research** enables enrichment of organisational behaviour and development through neuroscience. **Extends:** Proposes that AONS is new; many of the resources in ONS are drawn from outside disciplines and focus on **theory adaptation.** (Domain theory and method theory) to build a body of AONS knowledge

As a result of the literature review and expert interview findings, a revised working definition for applied organisational neuroscience (AONS) is suggested.

Revised definition.

AONS is a multidisciplinary field of research and practice that translates and applies evidence-based neuroscientific findings into real-world organisational behaviour interventions to stimulate growth in individuals, teams and cultures.

Explicit in this definition is the focus on translating neuroscience evidence into the workplace to "stimulate growth", which means resilient and adaptive organisations.

This concludes the discussion on articulating a workable definition of applied organisational neuroscience, mainly how the application to leadership and organisational phenomena can be done. These findings support the notion that organisational psychologists can conclude from existing neuroscience literature as a foundation for building AONS literature. This is no easy endeavour and indicates the challenges involved in interdisciplinary research in an emerging field.

The translation of NP theory to leadership behaviour is discussed next.

6.2 Translating Neuropsychotherapy theory into leadership behaviour.

The research question was stated as follows:

How can NP theory inform leadership behaviour in formal organisations?

The thematic analysis delivered two key themes.

Theme 1: Neuro-education on foundational neuroscientific concepts.

The thematic analysis delivered five sub-themes;

(1) Sub Theme 1: Consistency Regulation
(2) Sub Theme 2: Building Safety
(3) Sub Theme 3: Large Scale overlapping Neural Networks or Systems
(4) Sub Theme 4: Neuroplasticity
(5) Sub Theme 5: Memory systems (implicit and explicit)

Theme 2: Activating basic psychological needs to develop resilient, adaptive leaders and organisations.

The Theoretical Thematic Analysis delivered two sub-themes;
Sub Theme 1: Facilitating Enriched Environments.
Sub Theme 2: Activating of Basic Psychological Needs through core NP behaviours
Findings are discussed next with supporting quotes from the interview text.

6.2.1 Theme 1: Providing Neuro-education

"What should leaders know about the brain?"

This theme was about introducing neuroscientific concepts and information to set the scene for "knowing the brain, training the brain and self-regulating". This is to support leaders and employees in their personal and professional development.

Supporting quotes in text

> "The one component we speak about is what we call Neuro-education. This is purely where we tell people how the brain functions. So, that creates a form of understanding and sense-making on the foundational concepts in NP like consistency theory, brain networks or systems, providing safety, memory systems, basic psychological needs."
>
> "To engage with brain science, one needs to be competent in the theory or the foundational principles of brain functioning and still use organisational psychology methods, i.e. self-report inventories."

This theme was underscored by the importance of leaders understanding the neuroscientific underpinnings of NP theory and its relevance to leadership behaviour to enable resilient, adaptive workplace behaviour. The thematic analysis delivered five sub-themes: Consistency, Safety, Large-scale overlapping Neural Networks or systems, Neuroplasticity and Memory systems (implicit and explicit). Findings are discussed next, with supporting quotes from the text.

Findings and discussion of the results

6.2.1.1 Sub-Theme 1: Consistency Regulation

Supporting quotes in text:

> "If your basic needs are not met consistently from infancy… Grawe's model of basic needs. Suppose those needs are not met consistently. In that case, it negatively impacts the balance and the integration between these different systems – that is the role of leaders, to ensure basic needs are met."
>
> "It is not about work-life balance but rather understanding the basic psychological needs and its consistent application in the work context and across organisational levels."

Discussion:

The in-depth interview findings are in sync with the literature on the importance of "consistency" as the overarching concept of brain-body systemic harmony and a "core principle of mental functioning" (Grawe, 2007, p. 168). It confirmed that as individuals seek to satisfy their basic needs (from birth and over their life-span), every sensory experience has a meaning and will be stored in the memory system, creating a pattern of behaviour (approach or avoidance) in the brain (Arden, 2019). When basic needs are unmet, humans experience incongruence, which drives them to regain consistency (Rossouw, 2014). Incongruency is the foundation of life, of positive change and growth (Grawe, 2007). "Controllable incongruence" is facilitated when faced with controllable triggers that can effectively activate the frontal (executive) neural networks without over-activating the stress response. Decision-making and problem-solving are possible in this state, and approach patterns emerge that result in effective change (Rossouw, 2104).

Uncontrollable incongruences are facilitated when the individual is confronted with triggers that activate the HPA axis to such an extent that they reduce the activation of the frontal executive network. Constant activation of "uncontrollable incongruence" increases fear-based neural patterns and becomes a fixed survival pattern, resulting in avoidance patterns, impaired personal growth, and adaptability (Rossouw, 2014).

The implication for the workplace is that the leader determines, to a large extent, the team or organisational climate through their actions and non-actions in meeting basic needs. Employees use these behavioural encounters as feedback to their motivational schemas in either the approach or avoidance direction. Thus, although these motivational schemas are developed early in life, relationships with leaders and colleagues reshape behavioural patterns and mould the underlying neural structures throughout life.

Thus, consistency in meeting basic needs is essential to human development and plays a significant role in the leader's daily interactions with others. Grawe (2007) argued that the consistency with which these fundamental needs are met establishes the standards for optimal neural functioning. This optimal neural functioning equates to concrete optimal mental functioning at work (Arden, 2019). The call to action for leaders is to no longer think of employees' mental processes like problem-solving, moods and emotions but also to start considering the neurological functioning or brain basis of workplace behaviour.

6.2.1.2 Sub-theme 2: Safety

Supporting quotes in text:

> "Survival is the core function of the human brain – when we are threatened, all brain resources are directed to ensure survival and directed away from other functions needed to problem solve, change and innovate at work."

> "Safety is about creating enriched environments where individuals can thrive and problem-solve it is about safe physical environments and psychological wellbeing in organisations."

Discussion:

The interview mentions are primarily aligned with the NP theory, in which it is argued that experiencing a sense of safety is fundamental to psychological wellbeing, especially regarding the development of approach or avoidance motivational schemata (Grawe, 2007). Establishing a safe environment involves a downregulation of avoidance motivational schemas that may be activated. Cultivating safety is essentially a bottom-up approach to dealing with the physiological stress response before facilitating effective neural change and proliferation (Allison & Rossouw, 2013; Rossouw, 2013)

The implication for leadership behaviour is that Leaders can facilitate safety by maintaining respect, boundaries, and ethical behaviour. Providing clear boundaries and resources to do what is expected enhances safety, enabling focused attention and dealing with complex challenges. In addition, team safety can be cultivated through mutual respect, inclusion, acceptance of differences and encouraging diversity. This facilitation of safety in an organisation is mediated via the mirror neuron system (MNS) activity, in which co-workers mimic leader-managers by down-regulating limbic reactivity and building an empathic, supportive relationship that satisfies the basic need for attachment (Schore, 2012).

6.2.1.3 Sub-Theme 3: The nervous system: From neurons to neural networks

Interview quotes that capture this theme are set out below:

> "We don't even speak about brain regions but about brain networks."
>
> "Just recognising a face engages about twenty-five neural regions, which does not help you focus on that."
>
> "We focus on the different networks, and not even all the networks but just those that are important for us to change or to change behaviour in organisations: We have identified the three major systems (networks) in the brain, how these systems self-organise to create wellness, and what we do with our interventions."

Discussion:

This finding is consistent with the literature on NP revolving around three main operational networks: the task-positive or Central Executive Network (CEN), the Default Network (DNW), and the Salience Network (SN) initially researched by (Bressler & Menon, 2010). Also called the mind's operating networks that work together to maintain a coherent sense of self (Arden, 2019). Considering ' the brain's primary operating premise to prioritise safety, these networks jointly ensure this is done optimally.

The central executive network (CEN) is accountable for higher-level functions such as complex decision-making, planning, and goal-oriented behaviour. It also regulates emotions that could otherwise hinder long-term planning and relationships.

The CEN is in the cerebral cortex, encompassing the final brain regions that mature and operate at peak efficiency (Cozolino, 2017; Rossouw, 2013). Excessive activation of the CEN is linked to a lack of emotional awareness, an incapacity to connect with others emotionally, and attention disorders (Arden, 2019).

The DMN plays a vital role in forming identity and has been correlated with functions such as autobiographical memory recall, imagining the future (prospection), self-referential knowledge, and moral sensitivity (Cozolino, 2017). Mental simulation of several potential futures is adaptive, enabling one to plan to maximise the chances of meeting a goal (Spreng et al., 2009). This capacity builds upon autobiographical recall, utilising one's ability to retrieve historical information to further improve one's current state. Reflecting on the past often involves dwelling on negative experiences to avoid future dangers (Cozolino, 2017). Excessive activation of the DMN during stressful situations can lead to rumination, negatively impacting an individual's sense of control, self-confidence, and self-worth. Given the brain's inclination for consistency (Grawe, 2007), the DMN utilises long-term memory to anticipate the future, enabling reflection, daydreaming, and fostering creativity (Cozolino, 2017).

The salient network (SN) encompasses bodily sensations and the formation of emotions, allowing the perception of the self as an emotional being. The SN detects stimuli and directs immediate attention towards those perceived as beneficial. Suppose these stimuli are new or potentially harmful. In that case, the stress response is activated, preparing the body for defensive actions like fighting, fleeing, or freezing to ensure survival (Dahlitz & Rossouw, 2014). In this regard, visceral and emotional information consistently influence functions related to the CEN, including decision-making, judgment, and even interpersonal responses (Arden, 2019; Cozolino, 2017). The SN acts as a toggle between focusing on the internal or external world, self and others, and stability and adaptability. Excessive activation is linked to inappropriate sensitivity to threats, hypervigilance, and anxiety.

In summary, optimal psychological functioning depends on integrating and properly balancing these networks (Cozolino, 2017; Feldman Barrett & Satpute, 2013). Achterberg et al. (2023) confirmed the links between structural and functional features of the brain and behaviour. These mental networks organise self-referential information derived from long-term memory and current experiences. According to Arden (2019), the disorganisation or fragmentation between the networks contributes to mental challenges.

6.2.1.4 Sub-Theme 4: Neuroplasticity: The brain as a changing physical construct

Supporting quotes in text:

Interview quotes that capture this theme are set out below:

"Change requires an enriched environment and positive experiences."

> "Neuropsychotherapy (NP) provides a framework for applying neuroscience in organisations. NP implies change. NP offers a stand-alone method to comprehend and facilitate change and serves as a meta-theory that suggests baseline principles for other interventions."

Discussion:

There is a great deal of similarity between the descriptors in this theme and the evidence on neuroplasticity outlined in the literature. The expert interview results showed that a person can take advantage of the brain's natural neuroplasticity if they are held in a space of trust and security, as this enables an optimum level of arousal.

Due to the plasticity of the brain, where synapse connections are modified by experience, the network of neurons is continually changing (Grawe, 2007, p.8). One of Grawe's most significant findings was that enriched conversations (through psychotherapy) can change this neural brain activity (Draguns, 2007).

According to (Kandel, 2006), a secure, enriched environment facilitates the development of new neural patterns. Kandel proposed that psychotherapy works in part by "creating an environment in which people learn to change and that produces structural changes in the brain. Neuroscience provides direct evidence to measure such changes (Kandel, 2006, p 367).

Thus, leadership behaviour that activates secure environments will enhance the positive social interaction essential for healthy neural proliferation, contributing to strengthened relationships (attachment) and control and reducing stress.

A safe work relationship creates the ideal environment for facilitating neural proliferation, as the nervous system is essentially a social-centric system that thrives on interpersonal safety, acceptance, and security (Draguns, 2007).

The critical concept in neuroplasticity is repetition; the brain does not simply rewire overnight – changing behaviour and building new habits takes months to embed into neural pathways. As Kandel stated, "Synapses change with experience" (Kandel, 2006, p 466).

(6) ***6.2.1.5 Sub Theme 5: Memory systems*****(implicit and explicit)**

The supporting quotes in the text that support this theme are set out below:

> "We are all memory systems that are socially constructed."
>
> "our memories are conceptual models of how we see the world and predict the future - Developing self-awareness and self-regulation about behaviour and mental or conceptual models are key."

Discussion:

A focus on memory systems formed a widespread description of NP as a lens into leadership behaviour by the participant. These descriptions are synonymous with those described by Arden (2019), in which it is argued that the formation of implicit emotional memories lies at the heart of approach/avoidance motivational schemata; as such, implicit emotional memories constitute a primary target for personal change. Memories drive behaviour either (explicitly) or (implicitly).

Research has considered how the hippocampus encodes memory and produces an output that is eventually stabilised as long-term memory in other brain areas across the cortex (Dahlitz, 2015). The hippocampus has been extensively studied and verified as a critical component of memory formation but not the seat of memory storage (Ramachandran, Siegel, & Cozolino, 2016). Rossouw (2012a) suggests that the hippocampus is susceptible to the stress response (increased cortisol levels). In severe violation or emotional abuse cases, the hippocampus has been found to atrophy, inhibiting processes dependent on it, such as synaptogenesis. The critical role and sensitivities of the hippocampus become central to the formation of psychopathology, particularly in cases of early childhood abuse, neglect and trauma, and can be extended to understand and develop leadership behaviour in formal organisations.

The relevance to leadership behaviour is that it is pertinent for leaders and organisational scholars to understand how memory is formed on a neural level and what conditions might be necessary for change. Numerous behaviours can be helpful, including stress reduction, developing enriched conversations, and ensuring physical and psychological safety.

6.2.2 Theme 2: NP-informed core behaviours of NSBL

"What does Neuropsychotherapy look like in concrete leadership behaviour?"

The thematic analysis delivered two sub-themes;

(1) Sub-theme 1: Facilitating Enriched Environments
(2) Sub-theme 2: Activating Basic Psychological Needs through Core Leadership Behaviours.

6.2.2.1 Sub-theme 1: Facilitating Enriched Environments (EE).

This Sub-theme is about the leader developing personal resilience and self-regulation so that there is the personal capacity to build an enriched working environment where basic needs are fulfilled. The needs drive motivation and employee engagement in their work. Leaders model the way in which basic needs are met/violated.

The participant gave the following statements that exemplified the meaning of this sub-theme:

> "An enriched environment is a safe environment where basic needs are met."
>
> "The basis of leader development is about wellness as a leader and developing organisations that are resilient and adaptive to change."
>
> "Leaders that have a resilient mindset can build an enriched environment."
>
> "Taking a bottom-up approach is the starting point to build a sense of safety and facilitate an enriched environment."

Discussion and interpretation of the results

Enriched Environment (EE)

Similarly, the literature confirms that the brain functions best within an enriched environment (Rossouw & Rossouw, 2017). In an enriched environment, there are stimulating challenges and learning opportunities in relative safety. It arises from satisfying the individual's basic needs, i.e., by having a connection with others, having control over what they do and what they are working towards, and having the motivation to continue striving for their goals linked to the organisation's goals.

Neuroscientific research has shown that environmental enrichment, primarily used to study behavioural changes and neuroplasticity in the adult brain under normal and pathological conditions, significantly affects brain functioning. It has been observed that exposure to an enriched environment, even in adulthood, produces biochemical, morphological and functional changes in the adult brain under both normal and pathological conditions *(Kazlauckas et al., 2011, as cited in Rossouw & Rossouw, 2017).*

Building personal resilience

Supporting quotes in text:

> "I want leaders to function on an optimal level as a person. Resilience is about an adaptive self-organising system – and how it consistently behaves when basic needs are met or unmet. When needs are unmet, It creates this disorganisation within the self-organising system."
>
> "To develop the basic needs, a psychometric resilience assessment is conducted, which includes peer-reviewed research into the neuroscience of resilience."
>
> "Leaders must be self-aware and self-regulate within this self-organising system."

Similarly, the literature reviewed on this assessment mentioned by the participant is captured by Rossouw & Rossouw (2017, p. 173). The predictive 6-factor resilience scale assessment measures six key domains of resilience that make groups of skills that enhance people's resilience capacity. This includes:

"Vision (a sense of purpose and goals), Composure (having an internal awareness, managing stress and regulating emotions), Reasoning (problem-solving skills, being resourceful), Health (healthy nutrition, quality sleep and regular exercise, which in turn support brain health), Tenacity (being persistent, having realistic optimism, and bouncing back to regain motivation), and Collaboration (building strong support networks, communication skills, and making meaningful connections)."

According to Rossouw & Rossouw (2017), each of these domains interacts to build overall resilience levels and people's ability to advance despite adversity. A weakness in one domain can affect others; conversely, improving one can improve others. Similarly, several neuroscientific studies confirm the relevance of personal resilience (Kalisch, Müller, & Tüscher, 2015; Tabibnia & Radecki, 2018; van Wyk, Lipinska, Henry, Phillips, & Van der Walt, 2022).

The results of this sub-theme were consistent with the core behaviour of developing self-awareness and self-regulation as foundational components of NSBL (as per the literature reviewed and study findings in all three research chapters). Self-observation (or self-awareness) is crucial to leadership behaviour (Day & Antonakis, 2013; Hogan & Kaiser, 2005). The first step in developing self-awareness is to observe one's own behaviour and internal reactions in various contexts, as well as the impact on others. Self-awareness is how individuals understand themselves, including their emotions, motivations, and personal characteristics.

Lead by example: Mirroring of Leadership Behaviour.

Supporting quotes in text:

> "Leaders cultivate enriched or compromised environments at work – in an everyday manner."
>
> "The leader is mirrored in the culture– so it's about building relationships and conversations with employees as the leader and trusting them, as people mimic this behaviour."
>
> "We speak about basic human needs, but the way we try to fulfil those will differ from person to person and from culture to culture- the leader shows the way".

These sub-theme findings largely align with the basic principles of talking therapies to promote change in clients, as noted by Grawe (2007) and set out in Appendix E in Chapter Two. Similarly, Ramachandran, Siegel, & Cozolino (2016) captured these basic principles as (a) activation of the conversation partner's mirror neuron system by deliberately priming for positive mood states through gestures like eye contact, tone of voice and language, (b) promotion of safety (down-regulation of distress) through high levels of respect and acceptance, (c) enhancement of cortical blood flow, to enable good solutions to problems

(d) strengthening positive neural activation networks to enhance approach-patterns and reduce the risk of relapse into default neural protective or avoidance patterns and (e) encouraging healthy social relationships and interactions as the human brain is a social brain that thrives on social rewards like being included, accepted and complimented.

The results also appear consistent with prior neuroscientific research on leadership behaviour, the fMRI study "Examination of the neural substrates activated in memories of experiences with resonant and dissonant leaders" by (Boyatzis et al., 2012). Resonant leader-follower relationships impact the neural networks of followers through reciprocal positive emotions and a sense of collaboration. In contrast, dissonant leader-follower relationships lead to negative emotions and a sense of dissonance or disagreement.

Memories of resonant relationships activated mechanisms relating to positive affect, a broader attention field, and the social network, and memories of dissonant relationships with leaders activated neural mechanisms related to avoidance, low compassion, and narrowed attention). It is important to note that in this study, the neural response evidence relied on recalled memories only without real-time interaction. These findings support the notion that leaders influence and can have a lasting impact on their colleagues through their conversation and relationship styles.

Several studies have shown the impact of enriched environments using a talking therapy approach, including research by Furmark et al. (2002), Ledoux (2002), Grawe (2007), Marzenich et al., 1983, and Sporns (2013) and others cited in (Rossouw, 2014, p. 380). These studies indicated the effect on neural activation, chemical balance, neural firing, neural structure, and neural networks through talking therapies.

The relevance to leadership behaviour is that providing structured conversations (an enriched environment) facilitates new neural connections, shifts in neurochemical release, downregulation of the fear response and eventually, new neural connections. Ongoing exposure to this type of enriched environment facilitates effective neural changes (Henson & Rossouw, 2013). Incorporating the principles of facilitating an enriched environment into leadership behaviour in the work context in an informed manner may enable learning and change.

6.2.2.2 Sub-theme 2: Core behaviours to activate psychological needs fulfilment.

This sub-theme highlighted the importance of core behaviours and reflective questions that leaders can use to meet employees' basic psychological needs to enable adaptive, resilient workplace behaviours.

The participant gave the following statements that illustrated the meaning of this subtheme:

"The four basic needs are at the heart of human beings and leadership development."

> "To lead others well, one has to be mindful of their basic needs – taking their perspectives and asking pertinent questions."

> "Fulfilling one or more basic needs will also stimulate reward and alter the basic need for pleasure. For instance, being complimented for excellent work done will positively influence the basic self-esteem needs. It will also be a rewarding experience, increasing the employee's need for pleasure seeking. The same applies to attachment, orientation, and control – these can all stimulate reward and pleasure".

> "self-esteem is the outcome of the other three needs. Its a higher-order construct of " self" that emerges from the neural milieu of needs and motivational schemata."

Discussion

The participant described the basic needs and their application to leadership behaviour using NP as an interpretive framework. It was mentioned that physiological needs (e.g., water, air, sustenance, sleep, and shelter) are well understood. In contrast, psychological needs have eluded psychologists and organisational scholars.

The participant stipulated that adapting NP theory to leadership behaviour stresses that one of the essential leadership behaviours is to be mindful of basic psychological needs in the work context. These basic needs must be met by environmental conditions (the organisational context) for optimum psychological functioning.

Similarly, several authors argued that when the basic needs are not met or in balance, a person cannot be in harmony, and this will manifest itself in derailing behaviour and poor wellbeing, and it can even lead to psychological disorders (Epstein, 1994; Grawe, 2007; Mayer & Geldenhuys, 2019; Rossouw & Rossouw, 2017). These basic needs define who we are and motivate us. They also influence our interactions with one another (Epstein 1994).

The relevance to leadership behaviour is that leaders need to develop and intentionally deploy behaviours that support need fulfilment, leading to approach motivation and increased job engagement.

Neural foundations of basic needs

Basic needs have a neural foundation from birth that initiates behaviour like crying, sucking, and wiggling the body to meet those needs (Panksepp & Biven, 2012). These genetically governed behaviours are the beginning template of what will develop into much more personal and sophisticated motivational goals.

The first need that develops into an "approach" goal is the need for proximity of the primary attachment figure. As the infant experiences encounters with her mother, she develops a repertoire of behaviours to influence the mother to meet her needs. Neural activation patterns emerge that represent this and other goals and are strengthened with the help of oxytocin and dopamine. Both baby and mother are rewarded by oxytocin and dopamine release when in loving, mutually satisfying connectedness. The increasing strength and complexity of these neural patterns continue to form more easily activated circuits, eventually becoming very sophisticated and spontaneous (Rossouw, 2014).

Humans change if these requirements are compromised or violated. Not only do behaviours and responses to others change, but the brain's network architecture also changes. This was captured by the following quote in the interview:

> "Meeting basic needs while avoiding threats is a driving force for all people at the neurological level".

This is consistent with the view of Grawe (2007), who claimed that these basic needs are profoundly ingrained in the foundation of the human nervous system, and similar to the effects of violation of physiological basic needs, violation of these psychological needs can lead to negative life events such as psychopathology.

This was captured by the following quote in the interview:

> "That is why we really emphasise organisation development, and our perspective is organisation development. It is about change. We not only want to understand behaviour, we also want to change behaviour. And the bottom line for that for us helpful is to use neuro-psychotherapy as a framework because neuro-psychotherapy actually applies change."

As per large-scale brain network theory, processes are interlinked (Cozolino 2017). Fulfilling one or more basic needs will also stimulate the reward network and alter the basic pleasure need. For instance, being complimented for excellent work done will positively influence the basic self-esteem needs. It will also be a rewarding experience, increasing the employee's need for pleasure seeking. The same applies to attachment, orientation, and control – these can all stimulate reward and pleasure (Rossouw & Rossouw, 2017).

The interview theme also underscores the intent of NP theory to explain how leaders influence employee motivation and engagement (Henson & Rossouw, 2013). At the neurological level, all individuals continuously monitor the environment for good vs. bad or pleasure vs. pain sensations. A functional relationship exists between perceiving the environment as good vs. bad and developing approach-avoidance motivational systems (Grawe, 2007). Approach motivations are developed when basic needs are met (Dahlitz 2015). Leaders who foster healthy relationships foster a secure environment and set the foundations for employees to take the initiative.

Understanding NP theory may assist leaders in recognising that they are continuously communicating unconsciously (especially with their facial expressions and tone of voice) a behavioural repertoire to convey a sense of openness and trust (or dissonance and distrust) through nonverbal means. In this way, they may signal to employees that the environment is secure, and they can risk thinking deeply without entering protective/avoidance mode.

To build an enriched environment, leaders can display behaviours that are aligned with basic psychological needs theory. This includes deep listening as one behaviour of being completely present with another individual (Henson & Rossouw, 2013). It contributes to an interpersonal environment that recognises and values the distinctiveness of the individual, which in turn contributes to the satisfaction of fundamental psychological needs *(safety, distress avoidance, control, and self-esteem* enhancement).

This enriched environment is conducive to developing new neural pathways, specifically those associated with approach motivation (proactivity) rather than avoidance. On a neurological level, as these new pathways are utilised, they are strengthened (wired), and the old pathways (avoidance) are gradually dissolved. This leads to both a modified neural substrate and altered behaviour. Similarly, attentive listening that focuses on an individual's value-based objectives and strengths boosts motivation and persistence.

The interview results also suggested how wellbeing and development are compromised when employees do not have the prospects to pursue need-related goals optimally at work. The participant proposed questions or prompts to guide the activation of basic psychological needs. This is set out in Table 6 alongside the core behaviours synthesised in the literature review.

Table 6 provides an updated caption of the quotes from the expert interview and the findings in the literature reviewed to articulate the concrete behaviours informed by NP theory (adapted from Ghadiri et al., 2013, p. 87 and Henson & Rossouw, 2013)

Table 6

Neuropsychotherapy as core concrete leadership behaviour. Basic psychological needs and core behaviours to meet these needs (adapted from Ghadiri et al., 2013, p. 87 and Henson & Rossouw, 2013)

Basic Psychological Needs	Core Behaviour that activates/supports needs	Research Findings:
1. Need for Attachment.	Cultivating inclusivity and collaborative working patterns by working in groups or teams Eliminate "fear" inducing behaviours through deep listening and supporting relationships to enhance trust, relatedness and cognitive power.	Concurs: Do people feel that they belong at work? Do they feel that they are heard and supported by their leaders? How might remote or hybrid work (how and where we work) violate basic psychological needs?
2. Need for Control and orientation.	Give responsibility and provide information on job goals and status. Alignment of life goals with realities of the organisational environment.	Concurs Do employees understand organisational challenges? Are job goals clear between the organisation and the employee? Are career expectations discussed, and do they feel they have a sense of coherence?
3. Need for pleasure maximisation and pain avoidance.	Building rewarding experiences at work (praise, formal recognition, free time) Enhance employees' status at work. Positive praise and individualised rewards	Concurs What is rewarded at work? What is reprimanded? Are employees provided with meaning and purpose in their work?
4. Need for self-enhancement.	Give constructive feedback and ensure employees feel respected at work. Cultivate experiences of success at work Developing competence and skills	Concurs and extends. Do workspaces enhance a sense of competence?

The behavioural examples given under this theme are also consistent with the original focus of NP on treatment, where the role of the therapist is critical to obtaining better therapeutic results and the establishment of a secure and positive therapeutic alliance if they can demonstrate personal qualities and behaviours such as empathy, respect, a non-judgemental attitude, genuine interest and engagement, pleasant tone of voice, appropriate body language, and communicate competency (Grawe, 2007, p. 411).

The neurobiological underpinnings of these core behaviours to activate basic needs first initiate the social engagement system (the DNW). When leaders inquire about their team members' opinions, emotions, and ideas, they demonstrate the value they place on these contributions (Ramachandran, Siegel, & Cozolino, 2016).

When a person responds, this motivates them and stimulates a higher level of thought (the CEN activation). These behaviours result in concrete changes in the neural networks, resulting in positive behavioural changes for employees.

One of the central premises of NP is that leaders must ensure that employees repeatedly encounter experiences that shift them from avoidance modes to approach modes of functioning that satisfy their basic psychological needs (Henson & Rossouw, 2013). Translating this to the neural level of functioning means that these experiences need to be sufficiently frequently and strongly activated so that corresponding neural connections can be firmly established.

Using a neuroscientific framework and language for mental experiences enables leaders to intentionally promote sufficient neural activation toward new firing patterns and thereby build new habits.

This was captured by the following quote in the interview:

"NP theory does not only provide an understanding of behaviour, it really implies you want to make a difference, you want to change people's behaviour, you want to change groups, you want to change organisations. It doesn't promote a specific school in psychology but focuses on the underlying essence of all human functioning while offering neuroscientific guidelines on how to shift from current functioning to higher levels of wellness".

The following section sets out the contributions, limitations and recommendations.

7. Contribution, limitations, and implications for future research

A solid case can be made for the argument that research is at its finest when the knowledge that has been learned can be put into practice. This professional practice report aimed to question how psychotherapy and neuroscience link up to practically enhance leadership behaviour. This was not an easy task.

7.1 Contribution

This qualitative descriptive case study contributed to closing the gaps in the literature about defining AONS and how NP can be used as a lens into NSBL. The results fit in with the conceptual framework and the literature review in Chapter Two. The researcher set out to define AONs and describe NP-informed leadership behaviour. The researcher formulated a working definition of AONS, found five foundational concepts that form part of neuro-education on NP as a lens into NSBL, and described the 4 basic needs with practical behavioural descriptors and reflective questions to operationalise NP theory in NSBL behaviour.

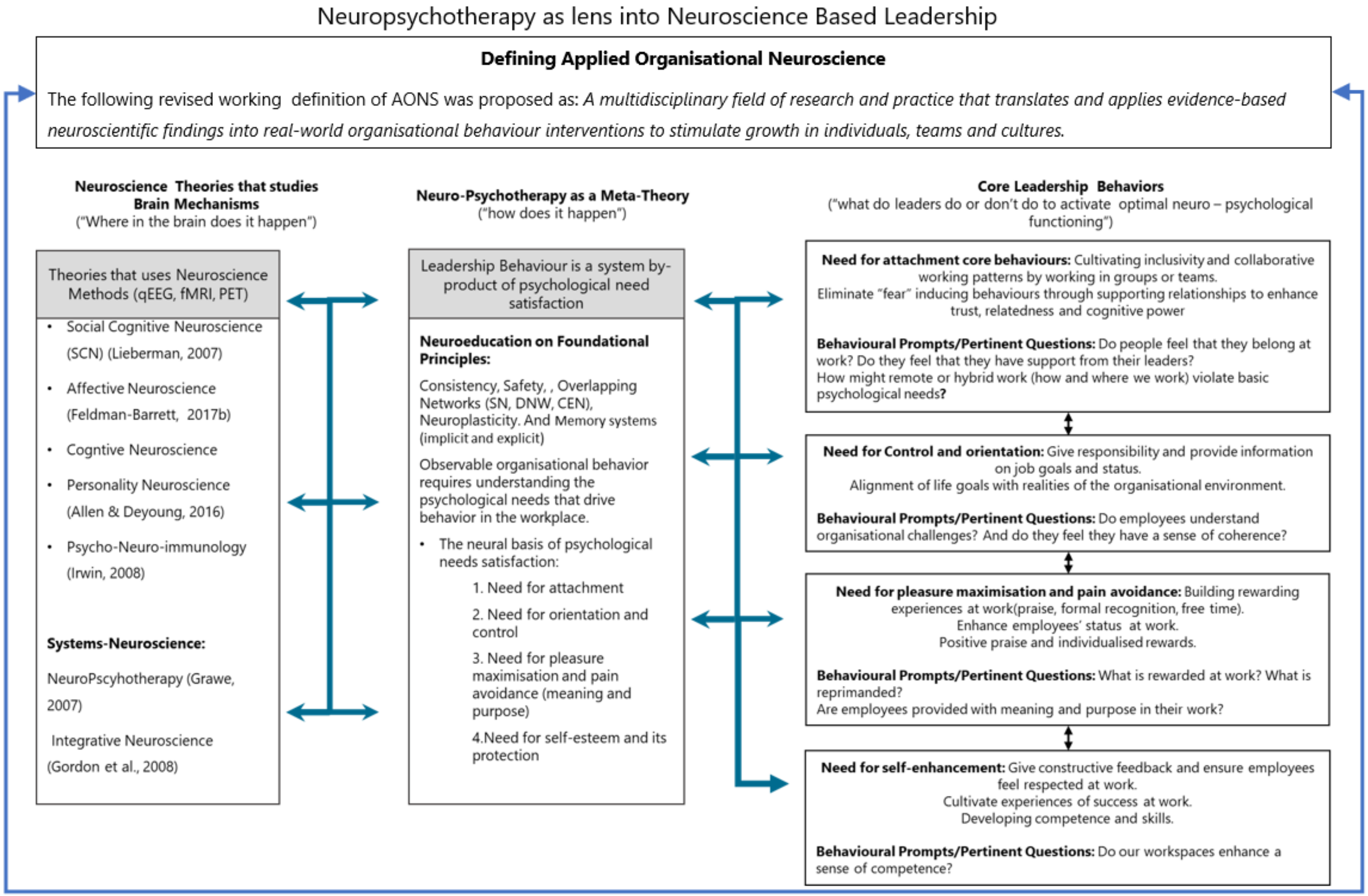
The literature and case study showed how organisational sciences could be integrated with NP theory to deliver new insights into organisational phenomena, like leadership behaviour. In the present study, the process of defining applied organisational neuroscience and describing the core behaviours of an NP-informed leadership behavioural repertoire was examined through an in-depth interview with an expert in the field. Qualitative descriptive data was obtained through open-ended questions.

Therefore, the AONS definition, Neuroeducation foundational concepts, and NP-informed behavioural anchors found in this study likely added a new understanding of an NP approach to NSBL behaviour in formal organisations. However, given the exploratory nature of this study, these findings are preliminary and need to be further validated.

The contribution made is captured in Figure 2 (The Interpretive Framework of how NP informs **NSBL).** The contribution of this research is theoretically and practically valuable, as organisational scholars can apply the framework to incorporate NP into leadership behaviour research and practices. Key Contributions are discussed next.

Figure 2

An Interpretive Framework of how NP informs NSBL



7.1.1 Defining Applied Organisational Neuroscience (AONS)

The following revised working definition of AONS was proposed as:

"A multidisciplinary field of research and practice that translates and applies evidence-based neuroscientific findings into real-world organisational behaviour interventions to stimulate growth in individuals, teams and cultures."

This definition provides a theoretical contribution and a baseline from which organisational scholars can gauge the neuroscientific foundations of organisational phenomena within a constantly changing landscape and a clear scope of practice.

This working definition also aligns with the need for organisational psychologists to deliver impactful research, which is defined by Hughes, Davis, Robinson, & McKay (2021, p. 340) as having "an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia". This is of utmost importance when we work on a cross-disciplinary basis.

7.1.2 NP as a Translational bridge and Meta-theory to enable an applied approach.

The literature reviewed (Becker, Cropanzano, & Sanfey, 2011) and the research findings showed no preferred framework for researching, studying or learning about AONS across organisational levels.

The interview quote below provides evidence of this lack of frameworks.

> "The challenge is "how to" translate neuroscience research findings into new organisational behaviour intervention techniques beyond an interpretive lens."

The research did offer NP as an interpretive framework for NSBL as a bridging tool between psychology and neuroscience. As mentioned in previous chapters, according to Neuropsychotherapy, behaviour is primarily a system by-product of needs satisfaction prioritisation (Grawe, 2007; Rossouw, 2014; Geldenhuys, 2022). Hence, understanding and developing observable leadership behaviour requires understanding the psychological needs and related neural processes that drive behaviour.

7.1.3 Providing Neuro-Education on Foundational NP Concepts

NP does not endorse a particular school in psychology but focuses on numerous neural principles underlying the essence of all human functioning while extending neuroscientific recommendations to enable optimal functioning.

The interview quote below provides evidence of this educational focus:

"Educating organisational scholars on brain functioning and the basic needs model is key, and looking at the different types of experiential work that is done in organisational psychology, different models, different approaches, different techniques – to start evaluating it from a neuroscientific principle basis."

Understanding personal behavioural patterns and reactions is crucial for responding more effectively and/or modifying our surroundings to promote cognitive flexibility (Grawe, 2007; Ghadiri, Habermacher, & Peters, 2013; Geldenhuys, 2022).

7.1.4 Facilitating an Enriched Environment (EE)

The case-study demonstrated that a neuroscience-based leader needs to know the main drivers of human behaviour (the basic needs) and their origin in the human brain (e.g. large-scale brain network theory). A neuroscience-based leader needs to understand the basic principles of talking therapies to promote change and positive development in the workplace and develop personal resilience so that basic needs can be activated through positive example setting and promotion of safety. Finally, a neuroscience-based leader encourages healthy social relationships and interactions, knowing that the human brain is a social brain that thrives on social rewards like being included, accepted and complimented.

7.1.5 Core leadership behaviours that activate the basic psychological needs.

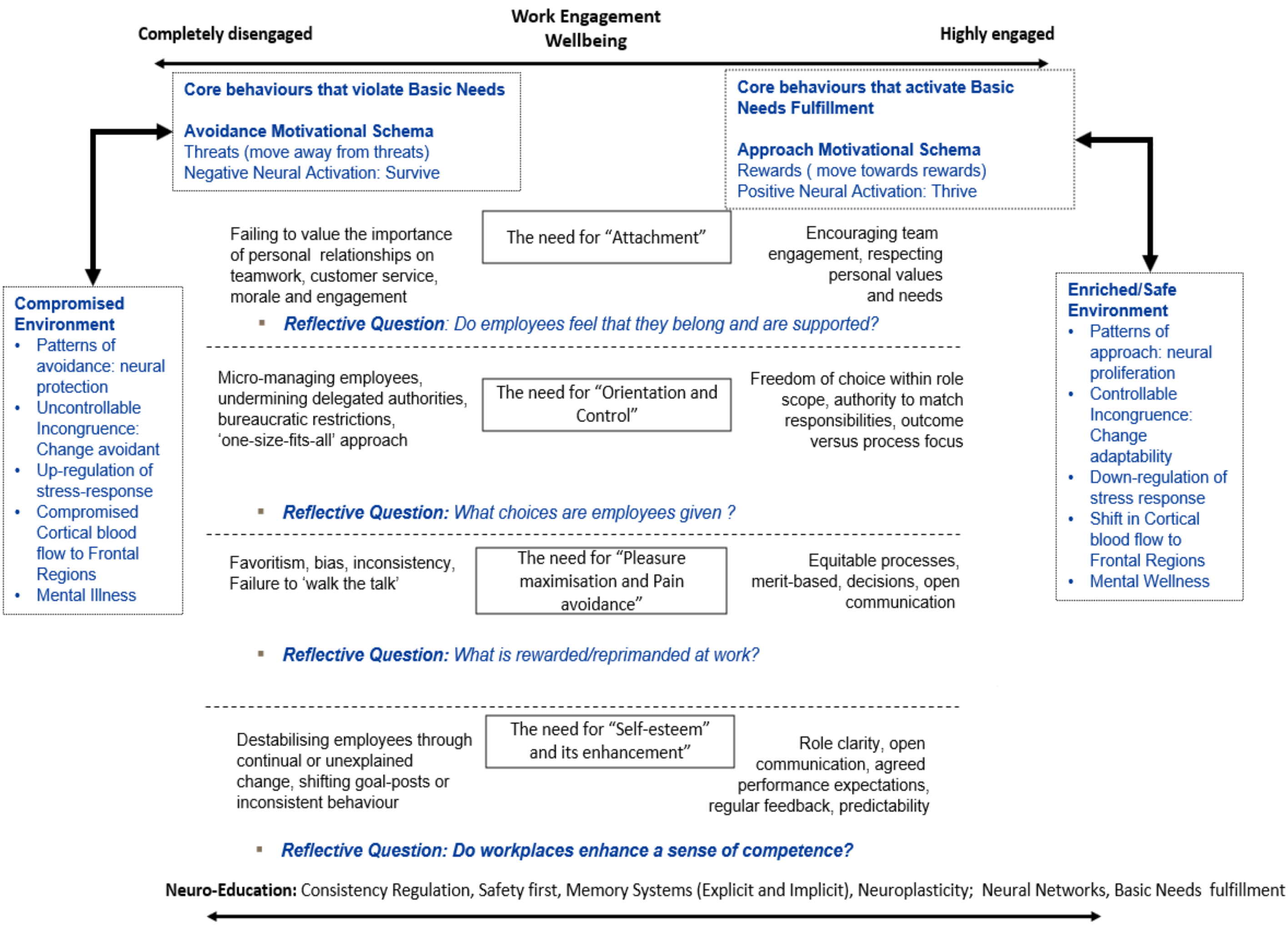
In line with the literature review, organisational leaders are well placed to model and build resilience in organisations because leadership enables meeting basic psychological needs and because a resilient workforce drives measurable benefits like engagement and productivity. This case study shed light on the neuroscientific underpinning of resilience in fulfilling basic psychological needs in the workplace.

This case study showed that these approaches (NP and Leadership behaviour) collectively provide a fuller explanation than they could deliver individually. According to Becker et al. (2011), integration provides content-rich and more robust theories.

This case study described foundational concepts about the brain that leaders should use in neuro-education and behavioural examples of how basic needs can be practically activated in the workplace. Building upon this, a NP-informed approach to NSBL means that leaders should fulfil the employee's needs with matching HR practices and Organisational Development tools. See Figure 3 for the practical application of NP-informed leadership behaviour.

Figure 3

A practical framework: The application of NP theory to leadership behaviour



The direct connection between the brain's form, function, and functioning and its ability to control all thoughts, feelings, and behaviours forms (consciously and unconsciously) the basis of neuroscience, neuropsychology and neuropsychotherapy. Neuropsychotherapy focuses on the neural structures and processes that shape perceptions and responses through memory, emotions, thoughts, and sensations expressed in decisions, behaviours, and interactions. Thus, the brain and behaviour are highly intertwined.

The result of this case study research sheds new light on the practical translation of neuropsychotherapy to leadership behaviour using a basic psychological needs model.

In summary, to assimilate a neuroscience perspective into psychological phenomena, organisational scholars should ensure that the science we practise is based on proper research (Healy and Hodgkinson, 2014), even though we are in a nascent emergent field. This case study attempted to contribute to "proper" research.

7.2 Limitations

An organisational consultant every so often does not have sufficient data to establish undisputably which solution to an organisational behaviour challenge is likely to be the most efficacious. As consulting psychologist Professor Rodney Lowman (2002, p. 90) rightly put it, "In the context of human systems and their complex, highly interactive nature, many different paths can lead to the same result."

Critique against Neuropsychotherapy is that it is just one model of describing human needs, motivation, behaviour and wellbeing (Habermacher, Ghadiri, & Peters, 2020). Articulating NSBL using NP is only one such path that illuminates how basic psychological needs violation or fulfilment impacts leadership behaviour in organisational settings.

An argument against NP is that it is too simplistic to do justice to the complexities of human behaviour and is limited in explaining the huge subjectivity in human wellbeing (Dweck, 2017). Also, Rossouw (2014, p. 1) states, "Neuropsychotherapy as an independent theoretical approach is no different from all other theoretical models. It attempts to provide a framework to understand the human condition: a framework to understand the pathogenesis of both wellness and pathology."

Like any research method, in-depth interviewing has its limitations and potential pitfalls. Firstly, the data generated by this method is limited and irrelevant to statistical inferences. Secondly, the limitation of this case study inquiry relates to the interview being conducted remotely using an online meeting platform. The quality of the interview experience was compromised by not being able to be fully present with the participant. The researcher's knowledge and insights into the complex field of Neuropsychotherapy theory constrained the interpretation of the data provided by the participant.

The literature on organisational neuroscience has not solidly grounded the concept of how the application between neuroscience and organisational sciences should be operationalised. One possible criticism of the conciliatory integration proposed in this case study is that its explanatory feat might be doubtful and premature in a highly complex field. This potential translatory reductionism represents a misuse of the methods of neuroscience.

At its core, Neuropsychotherapy provides insights into how functional disorders can be effectively and sustainably addressed and wellbeing achieved (Cozolino, 2017) through specific intervention techniques. Specific techniques include cognitive-behavioural strategies, mindfulness practices, trauma-informed therapy, and body-based interventions, all with a neuroscientific foundation (Ramachandran et al., 2016).

These techniques might be valuable in therapy but cannot fully support leadership behaviour development. These techniques must be adjusted, particularly in the context of organisational leadership, to be effective in enhancing leadership resilience or dealing effectively with daily challenges.

To operationalise NP theory as a leadership development framework, NP content should give simple but accurate depictions of human behaviour and guide others to enable better functioning of human beings and better health. NP is an exciting and evolving field that holds promise for advancing the understanding of mental health and wellbeing in the workplace. Education and proper training in NP processes are prerequisites to ethical conduct and doing "no harm".

7.3 Implications for future research

This chapter aimed to provide evidence to empower organisational scholars and leaders to use NP in their leadership behavioural repertoire. Although there are valid critiques and scrutiny of organisational neuroscience (Healey & Hodgkinson, 2014; Lindebaum & Zundel, 2013; Van Ommen & Van Deventer, 2016), there are important reasons to pursue a neuroscience lens into Leadership and organisational psychology phenomena.

The exploratory nature of this research generates several questions, such as how this research can be further operationalised. The working definition of AONS needs to be further studied. It could serve as a roadmap of applied neuroscience applications in the organisational behaviour context. AONS is an emerging field of research and practice. Organisational psychologists, consulting psychologists, organisational behaviour practitioners, and neuroscientists can further validate the field of AONS by embarking on a transdisciplinary research approach (Leavy, 2011). Transdisciplinary research is "an approach to social research that encompasses collaborative synergies between two or more disciplines with elevated levels of integration between the sets of knowledge" (Leavy, 2016, p. 9). Thus, AONS can become a legitimate and active field through a transdisciplinary merging of neurosciences, organisational behaviour, and psychology.

The chapter raised ethical questions about the fact that practitioners of NSBL have to learn about brain functioning or NP theory before deploying brain-based approaches in the work context. In addition, the number of organisational scholars and leader-managers who understand the AONS and NSBL approaches needs to be increased through training and development. There are not many AONS-informed organisations. Therefore, it is an area that holds much promise and risk for future research.

Psychology is about doing good, which requires relationships and collaboration between research and practice (Kwiatkowski, Duncan, & Shimmin, 2006; Kwiatkowski & Duncan, 2006). The challenge to prove scientist-practitioner acumen escalates when the field being studied is new and in the "theory-building" stage, such as the emerging field of applied organisational neuroscience. With AONS gaining popularity, a similar need has been established regarding the roles of researchers and practitioners within this new field of study and practice.

Organisational psychology also focuses on assessments. A recommendation is that basic needs and approach /avoidance motivations can be measured through psychometric instruments to assist in their development. For example, the Behavioural Inhibition and Activation Systems (BIS-BAS) Scale is a self-report questionnaire that Carver and White (1998) developed to assess individual differences in BIS/BAS. A Behavioural Approach System (BAS) is believed to regulate appetitive motives where the goal is to move toward something desired. A behavioural avoidance system (or behavioural inhibition system, BIS) regulates aversive motives aimed at moving away from something unpleasant.

Although it is alluring to integrate neuroscience with organisational science to enhance practice, the "how" of this assimilation is still steeped with questions. The challenge remains to build a body of knowledge on sound data (Dennis, 2018). This can add to the impetus in raising the visibility and validity of applying a neuroscientific lens to leadership behaviour. In sum, from the theoretical perspective, further studies should help to build a theory of NSBL using NP as an interpretive lens.

8. Chapter Summary

This descriptive qualitative case study examined "how" to translate NP theory into leadership behaviour within an applied organisational neuroscience setting. Some definitional issues were clarified, and a working definition of applied organisational neuroscience (AONS) was provided. In addition, **core** behavioural examples informed by basic psychological needs were provided, thereby paving the way for further research.

The contribution towards a model for conceptualising NSBL using NP theory is valuable to leaders and organisations to the extent that NSBL can contribute towards leadership growth and organisational sustainability. This chapter showed multiple definitions, methodological pathways, and relevant practice areas exist. The need for an applied organisational neuroscience approach to study human behaviour within the world of work (at the individual, group, organisational or inter-organisational level) requires further data-gathering and analysis.

As academic research is an ongoing process, new evidence or perspectives that challenge these studies' findings may emerge. Therefore, the conclusions made in this study are not definitive and open to revision.

In the following chapter, an overarching synthesis and critical review of the four portfolio elements of this study will be presented.

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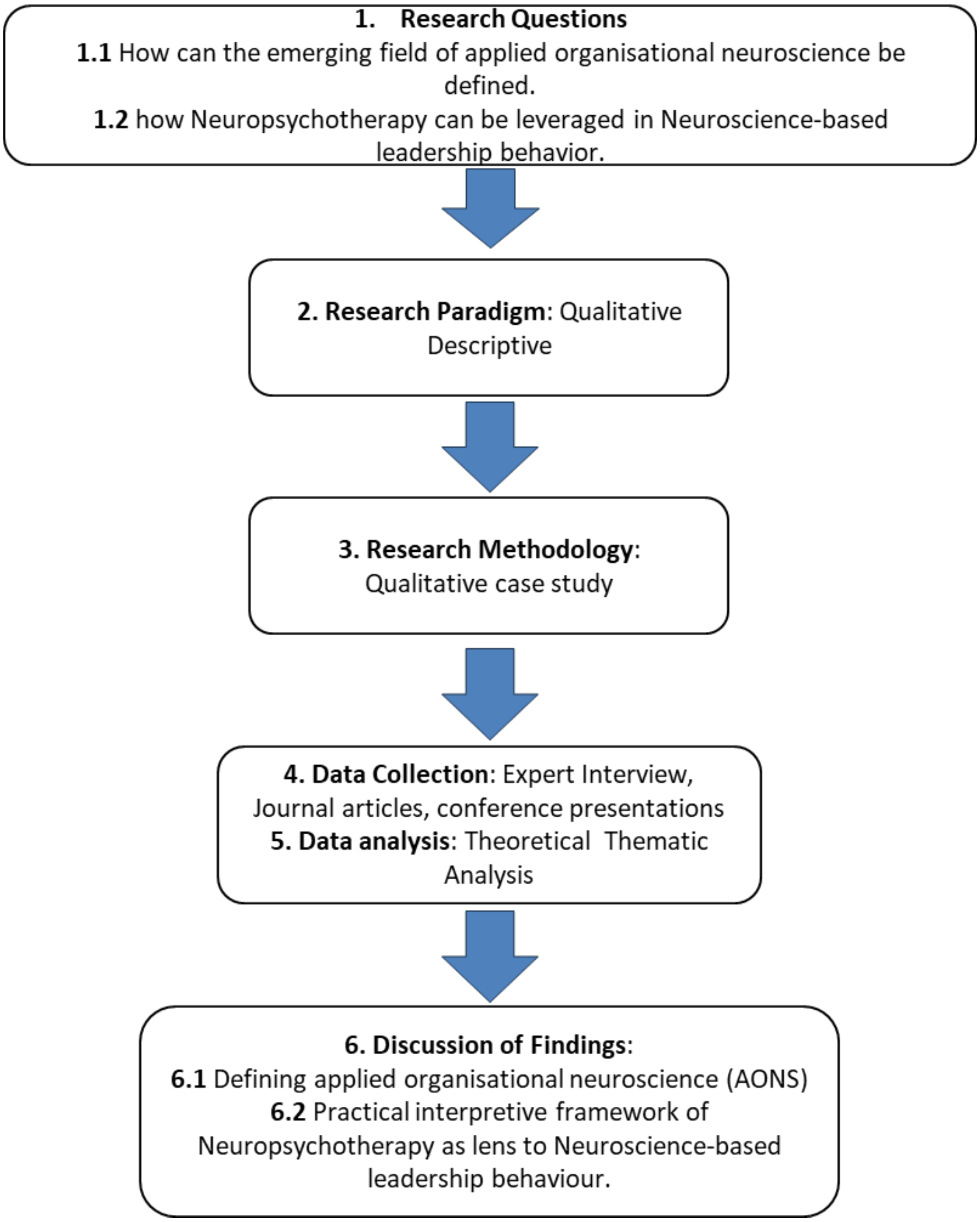
Appendices

Appendix A: Stages of the research design.



Appendix B: Consent form

"Letter of Consent for the Expert Interview (Psychological Perspectives)

I, ______________________________ (name and surname), agree voluntarily to take part in the EXPERT INTERVIEW project being conducted by Ingra du Buisson-Narsai (CCCU ID: DUB17159003) as part of the requirements for her pursuit of a PhD in Professional Practice. I agree to the following points:

1. I have read the Participant Information Sheet, and I understand the contents thereof. Any questions which I have asked have been answered to my satisfaction.
2. I understand that the information which I will supply is confidential and that it will be anonymised and will only be used in the findings of the research.
3. I understand that I do not have to answer all the questions which may be put to me.
4. I understand that the transcription will be reviewed by the researcher and her study supervisor so as to enhance the quality assurance of the research.
5. The information which I provide will be held securely until the research has been completed.
6. I understand that I am entitled to ask for a de-briefing session or a copy of the research at the end of the project.
7. I have been informed that I may withdraw from this study at any time.

Signed………………………… Date…………………………

Researcher commitment (Ingra du Buisson-Narsai):
I commit to treating all information garnered in this study with complete confidentiality.
A summation of the research outcomes will be what is reported."

Signature:  **Date:**

Ingra Du Buisson-Narsai
Student number: DUB17159003

Appendix C: Interview – Participant Information Sheet

This information sheet was adapted from a Delphi study (Singh, 2014)

1. Name of researcher Contact details	Ingra du Buisson-Narsai E-mails: ingra.narsai@gmail.com Ingra@neurocapital.co Cell: 082 612 2378
2. Title of the Research Project	Defining applied organisational neuroscience and its application to leadership behaviour development within the scope and practice of organisational psychology.
3. Purpose of the Study	To conduct qualitative exploratory research defining the field of applied organisational neuroscience with specific application to leadership behaviour development and within the scope of Organisational psychology.
4. Description of the Study	Academic research for a degree requires primary data from experts involved in the study of applied Organisational Neuroscience.
5. Duration of the study	3 to 5 months.
6. What will be your involvement, and how long will it take	Participating in a semi-structured expert interview. The time required is estimated to be approximately 60–90 minutes.
7. Why have you been asked to participate?	You have been asked to partake in this study due to your expertise in Organisational Neuroscience and its application to organisational behaviour and organisational psychology.
8. What will happen to the information which will be given for the study?	The interview will be recorded and then transcribed for THEMATIC content analysis. Following the successful; completion of the research, the interview transcripts will be shredded. This is within the standard data storage time limit of 5 years.
9. What will be done with the results of the study?	The interview content will be reported in the findings section of the project.
10. What are the possible disadvantages?	There are no costs to you associated with your involvement with this study. It is not envisaged that any negative consequences will accrue to you from your contributions to this research.
11. In what way will the study be beneficial, and to whom?	It is hoped that this study will provide a useful framework for how Neuroscience can be used as a lens to support the scope of leadership development from an Organisational psychology perspective.
12. Who has reviewed this study to ensure that it complies with all the requirements and ethical standards of the university?	The Ethics Committee of CCCU has approved this research proposal and granted permission for the research to commence.
13. Can permission be withdrawn having previously been granted?	Yes, you shall retain the right to have your contribution to the research withdrawn at any time.
14. Can you refuse to answer any questions?	Yes. The contributor can refuse to answer any question during the interview.

Appendix D: Research instrument:

Interview guide (questions directed to expert) Introduction and interview protocol

Researcher responsibilities:

1. Introduce the researcher and present the CCCU PhD fact sheet (Appendix B).
2. Describe research purpose and background.
3. Describe the outcome: "A small-scale research project report that provides insight into neuroscience-based leadership behaviour, AONS within contexts of organisational psychology."
4. Describe benefits of the study: "If the specific behaviours of neuroscience-based leadership can be clearly articulated, leadership development can be accelerated. This process will also add validation and legitimation to neuroscience-based leadership and AONS."
5. Describe confidentiality and format of the interview and that it will be recorded: "Interviews will be audiotaped and later transcribed. A semi-structured interview guide will be used to lead the interview. Due to the nature of the semi-structured interview (it allows flexibility and free-flowing conversation), the researcher anticipates further probing questions to be added to the list below during the interviews. The interview questions are designed around testing the propositions emanating from the literature review and the research questions themselves."
6. Sign the consent form (see Appendix B).

2. Interview questions

The following semi-structured questions will be used to guide the interviews:

1. Please tell us about your current role and responsibilities.
2. How long have you been exposed to neuroscience-based leadership and its application in organisation psychology?
3. What is your qualifications and experience in this field?
4. How do you use Neuroscience in Leadership development and in Organisational Development?
5. How would you describe organisational neuroscience within the context of organisational psychology?
6. Can you describe your preferred brain-based leadership thinking frameworks or models?
7. Can you describe underlying neuroscientific principles that apply to leadership behaviour?

8. Can you describe behaviours that describe brain-based leadership? These behaviours should be both practical and effective at different levels of organisational functioning.
9. What aspects of leadership behaviour are associated with brain-based processes? Primer: What is so important about the aspects you mentioned? Which of the aspects mentioned above should be prioritised?
10. Is there anything else you feel is valuable or important to add?

Closing

Placement of research journey: next steps and timeline.

Appendix E: Scope of practice

"Government Notice No. R. 993 of 16 September 2008: Department of Health: Health Professions Act, 1974: Regulations defining the Scope of the Profession of Psychology

The Minister of Health has, in terms of section 33(1) of the Health Professions Act 56 of 1974, as amended by Act No. 29 of 2007 and on the recommendation of the Health Professions Council of South Africa, made the regulations in the Schedule."

Schedule

"Definitions In these regulations, unless the context otherwise indicates, "**the Act**" shall mean the Health Professions Act, 1974 (Act No. 56 of 1974) as amended, and any expression to which a meaning has been assigned in the Act shall bear such meaning, and unless the context otherwise indicates –

"board" means the Professional Board of Psychology established in terms of section 15(1) of the Act;

"psychology" means the profession of a person registered under the Act as a psychologist, psychometrist, registered counsellor, or in any other category of registration as may be established by the board and

"section" means a section of the Act.

Scope of the profession

The following acts shall be deemed to be acts especially pertaining to the profession of psychology:–

(a) the evaluation of behaviour or mental processes or personality adjustments or adjustments of individuals or of groups of persons through the use or interpretation of any psychological test, questionnaire, instrument, apparatus, device or similar method for the determination of intellectual abilities, aptitude, interests, personality make-up or personality functioning, and the diagnosis or measurement of personality and emotional functions, neuropsychological disorders and mental functioning deficiencies according to a recognised scientific system for the classification of mental deficiencies;

(b) the use of any psychological method or practice aimed at aiding persons or groups of persons in the adjustment of personality, emotional or behavioural problems or at the promotion of positive personality change, growth and development, and the identification and evaluation of personality dynamics and personality functioning according to scientific psychological methods; I) the evaluation of emotional, behavioural and cognitive processes or adjustment of personality of individuals or groups of persons by the usage and interpretation of psychological questionnaires, tests, projections, or other techniques or any apparatus, whether of South African origin or imported, for the determination of intellectual abilities, aptitude, personality make-up, personality functioning, psychophysiological functioning or psychopathology;

(d) the exercising of control over prescribed psychological questionnaires or tests or prescribed techniques, apparatus or instruments for the determination of intellectual abilities, aptitude, personality make-up, personality functioning, psychophysiological functioning or psychopathology

(e) the development of and control over the development of psychological questionnaires, tests, techniques, apparatus or instruments for the determination of intellectual abilities, aptitude, personality make-up, personality functioning, psychophysiological functioning or psychopathology;

(f) the use of any psychological questionnaire, test, prescribed techniques, instrument, apparatus, device or similar method for the determination of intellectual abilities, aptitude, personality make-up, personality functioning, temperament, psychophysiological functioning, psycho-pathology or personnel career selection, and for this purpose, the board will publish a Board Notice listing the tests which are classified by the board for use by registered psychologists;

(g) the use of hypnotherapy;

(h) the use of any psychotherapeutic method, technique or procedure to rectify, relieve or change personality, emotional, behavioural or adjustment problems or mental deficiencies of individuals or groups of people; and

(i) the use of any psychological method or psychological counselling to prevent personality, emotional, cognitive, behavioural and adjustment problems or mental illnesses of individuals or groups of people.

Appendix F: Data Analysis Theoretical Coding

Theoretical Analysis (ThA)

Theoretical analysis is employed when the research has some predetermined categories (themes) to examine during the data analysis. In this situation, the researcher may use his/her pre-understandings when conducting the data analysis. Researchers might approach this analysis in two phases: In the first phase, after preparing the data (steps 1-4 below), one works on assigning the data units to the **predetermined themes derived from previous research** and theory and carries out the analyses as described in steps 5 through 13. Then, **in phase two**, return to the data and work with data units and patterns that did not seem to fit the pre-determined categories, again following steps 5-13. The themes derived from this analysis will likely not be found in previous research but may contribute to it.

Step-By-Step Analysis:

Neuropsychotherapy theory as an interpretive lens into neuroscience-based leadership behaviour (NSBL)

	Data Analysis Procedure	**notes**
1.	Read, review, and familiarize yourself with the data collected from each participant (interviews, journals, field notes, records and documents). Re-read the documents and highlight intuitively any sentences, phrases, or paragraphs that appear to be meaningful. Keep in mind the **predetermined categories (themes)** related to the theory and research question posed and remain open to any new patterns and themes related to the research question that have emerged from the data analysis. During this process, the researcher immerses himself/herself in each participant's data. **Research Question: "**How can NP theory inform leadership behaviour in formal organisations?"	**Data:** 1. Expert interview 2. Journal Articles x 4 3.Conference presentations **Predetermined themes:** from Grawe 2007
2.	For each participant, review the highlighted data and **use your research question** to decide if the highlighted data are related to your question. Some information in the transcript may be interesting but not related to your question.	One Participant ✔
3.	Eliminate all highlighted data that are not related to your question; however, start a separate file to store unrelated data. You may want to come back and reevaluate these data in the future.	✔
4.	Take each item of data and code or give a descriptor for the data. The descriptor or name will often be a characteristic word from within the data.	✔
5.	Cluster the items of data that are related or connected in some way and start to develop patterns.	✔
6.	Patterns that are related to a preexisting theme are placed together with any other patterns that correspond with the theme, along with direct quotes taken from the data (transcribed interviews, field notes, documents, etc.) to elucidate the pattern.	✔
7.	Any patterns that do not relate to preexisting themes should be kept in a separate file for future evaluation of the meanings as they relate to the overall topic. Repeat steps 1-7 for all participants.	✔

8.	Take all the patterns and look for the emergence of overarching themes. This process involves combining and clustering the related patterns into the preexisting themes.	✔
9.	After all the data have been analyzed, arrange the themes to correspond with the supporting patterns. The patterns are used to elucidate the themes.	✔
10.	Now, **revisit the patterns** that did not fit the preexisting categories and remain open to any new patterns and themes that are related to the research topic and have emerged from the data analysis.	Neuro-education Personal Resilience
11.	For each theme, the researcher needs to write a detailed analysis describing the scope and substance of each theme.	✔
12.	Each pattern should be described and elucidated by supporting quotes from the data.	✔
13.	Finally, the themes are synthesized together to form a composite synthesis of the question under inquiry.	✔

Reference: Percy, W. H., Kostere, K., & Kostere, S. (2015). Generic qualitative research in psychology. *Qualitative Report*, *20*(2), 76–85. https://doi.org/10.46743/2160-3715/2015.2097

Chapter Six: Reflective account

"From its inception in the early 18th century (as an amalgam of philosophy, neurology, and physiology), psychology has always been in a bit of an identity crisis, trying to be both a social and a natural science. Psychologists attempt to bridge the social and natural worlds using the conceptual tools of their time. Throughout our history, the link between the social (mind and behaviour) and the natural (brain) has felt less like a solid footbridge and more like a tightrope requiring lightness of foot and a really strong safety net" (Feldman Barrett, 2009, p. 326).

1. Introduction

This thesis aimed to conceptualise neuroscience-based leadership behaviour and articulate the core behaviours of neuroscience-based leadership in formal organisations. Richer explanations and insights emerged through this P5-7 exploratory research process, and a preliminary theoretical framework for neuroscience-based leadership behaviour was offered. This chapter offers a collective overview of the research journey, showing new knowledge in neuroscience-based leadership (NSBL) behaviour. This final chapter also offers the research limitations, methodological challenges and recommendations for future practice and research.

2. Background: Not building theories on false information

The researcher's interest in neuroscience-based leadership originated in the world of work, where clients demand parsimonious but science-driven models and theories that can enhance change, wellbeing and growth.

Differentiating "fact from fiction" has been a perplexing challenge in the NSBL field and this research journey. A standard criticism of the research on the intersection between leadership and neuroscience is that it is a producer and perpetuator of neuro non-sense or even myths (Ashkanasy, Becker, & Waldman, 2014).

Neuroscience, or the application of its findings in formal organisations, is an emerging field in industrial psychology and, therefore, susceptible to false claims. These false claims or "neuromyths" (a frequently used neuroscience colloquialism) may well, directly and incidentally, inflict more harm to the psychological wellbeing of a client than when no advice is offered (Lilienfeld, Lynn, Ruscio, & Beyerstein, 2010). On the contrary, false observations of neuroscience research can promote the study of NSBL, as these neuromyths captivate the interest of stakeholders and inspire them to think about how the brain works (Feiler & Stabio, 2018).

According to Feiler and Stabio (2018), neuromyths stem from challenges in the interpretation and communication of neuroscience rather than the soundness of the science itself. Such interpretive challenges are not unique to NSBL practice. However, they are also extensively covered in educational neuroscience and prevalent in all translational or applied sciences that engage multiple disciplines (Furnham, 2004).

It is vital to dispel the prevalence of neuromyths, as their endorsement is unethical and can potentially harm the people, professionals and others like clients receiving professional services (Papadatou-Pastou, Haliou, & Vlachos, 2017; Morris, Du Buisson-Narsai, Jardine, & Van Lill, 2021). This prevalence of myths in Organisational Neuroscience was also presented as a white paper by the researcher and colleagues to guide the practice of applied neuroscience by work psychologists (Morris, Du Buisson-Narsai, Jardine, & Van Lill, 2021). The framework by Furnham (2004) was used to display how psychological practice (including the practice of NSBL) falls into the trap of endorsing myths through a seven-stage successive process (as set out in Figure 1).

Stage 1 – *Discovery*: A myth might have origins in an initial discovery at an academic institution.

Stage 2 – Oversimplification: Somebody might read the paper and provide others with an oversimplification of its findings. Due to people's selective memory, they might choose to preserve and perpetuate only one specific thing about the article. Through repetition, this one piece of evidence might take hold as fact, notwithstanding the context in which it was said.

Stage 3 – Popularisation: An influential individual might promote the oversimplification of a complex issue among psychological professionals and laypeople.

Stage 4 – Craze: As excitement about the idea spreads, it is widely adopted as a state-of-the-art practice in AONS.

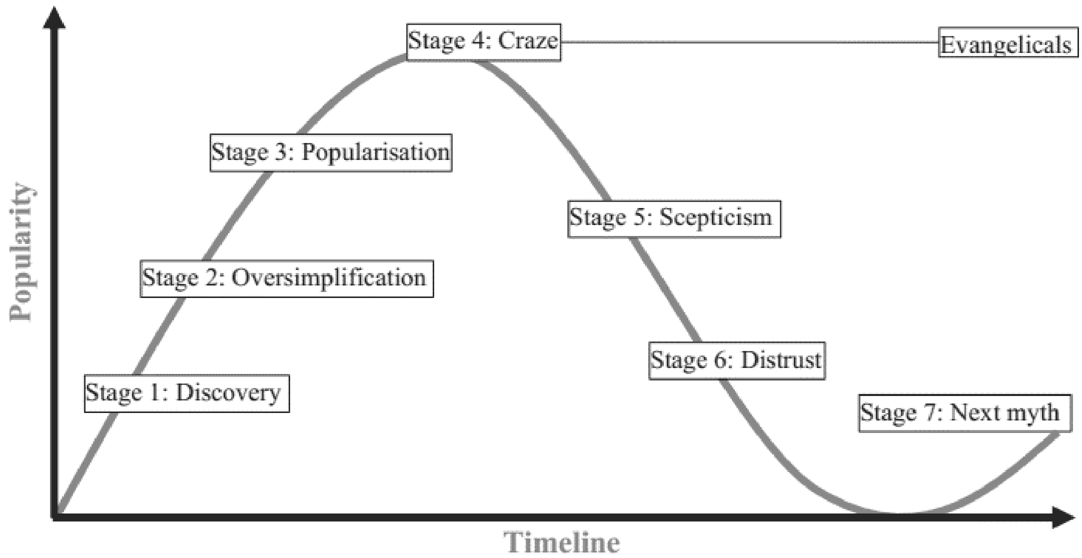
Stage 5 – Scepticism: Some scholars are willing to challenge prevailing and emerging myths. However, practitioners might initially be defensive about the counter-findings.

Stage 6 – Distrust: The media gets hold of a myth and publically denounces the merit of the finding. A complete distrust of a particular finding, perhaps even its related scope of practice, might develop due to the misleading idea. Even though a thorough understanding of the original claim in all its complexity might have yielded some interesting insights, the idea is now completely abandoned.

Stage 7 – Next myth: As practitioners' distrust of a myth eventually increases due to a lack of evidence, charismatic individuals might start gravitating toward another (Furnham, 2004).

Figure 1

A myth's lifecycle (Furnham, 2004, p. 3)



The prevalence of myths stresses the importance of psychological professionals critically consuming neuroscience research findings by adopting the necessary analytical skills. Some psychologists and laypeople might so wildly hold a myth that they remain devoted followers, notwithstanding the heightened evidence against a myth. This false belief can damage the professional's career reputation.

2.1 Implications for the study of neuroscience-based leadership

Neuroscience-based leadership (NSBL) within the context of applied organisational neuroscience (AONS) might be susceptible to numerous myths and misconceptions as a result of the following causes:

- Cause *1*. NSBL and AONS are emerging fields, and practitioners might hastily search for definitive explanations about the links between brain function and human behaviour.
- Cause 2. Practitioners who use NSBL and AONS might think too reductionistic about human behaviour rather than comprehend the topic's complexity.
- Cause 3. AONS might become a fad, making it hard to distinguish fact from fiction.

One of the aims of this thesis was to present legitimate neuroscience research and its application to leadership behaviour to alleviate these myths and misconceptions. It is worth noting that NSBL and AONS are vulnerable to myths due to their emergent nature,

Next, a reflection on how the current study contributed to validating the field of NSBL through evidenced-based research is discussed.

3. Revisiting the research problem and research questions

The problem in NSBL research is similar to the challenges in Krasikova, Green and Lebreton's (2013) study on destructive leadership. Three problems were stated as intrinsic to the literature on destructive leadership. These are: (1) the lack of a unified working definition to clarify the concept of NSBL, (2) a variety of components; and (3) the absence of a unified framework.

This thesis aimed to contribute to resolving these three challenges in NSBL by taking advice from Grant (2005, p. 7), who proposed that “a solution can be found by borrowing from related fields or where construct-specific literature is limited; then the best current knowledge can be drawn from the established literature in related fields”.

This thesis drew on established literature in applied educational neuroscience (Feiler & Stabio, 2018) to enable the translation of theory adaptation in applied organisational neuroscience. Given this context, this thesis aimed to contribute to the scientific translation, integration and application of the neuroscientific underpinnings of human behaviour in the context of leadership behaviour in formal organisations.

At the start of this research journey, three overarching research questions were set in Chapter One: What is a working definition of NSBL? What are the foundational neuroscientific concepts that underpin NSBL behaviour? What keywords or phrases describe the core behaviours that differentiate NSBL from other approaches to leadership? These broad questions were then actioned through four distinct pieces of research, each with additional specific research questions.

These overarching and specific questions were discussed in the research undertaken in four chapters: literature review (Chapter Two), small-scale research project (Chapter Three), applied research project (Chapter Four), and case study (Chapter Five). A professional personal learning journey also underpinned the research project.

Details of professional involvements are set out in Appendix A.

In Chapter Three, neuroscience self-report diagnostics provided underpinning brain functioning concepts and specific constructs that can gauge brain capacities like collective creativity, focused attention, and short-term memory, to name a few. This chapter was used as a “sorting and learning tool” to see what happens in organisational settings.

Chapter Four provided leadership behaviour dimensions from behavioural theory, focusing on the self, relations, tasks, and change. Insights from NSB theories were reported via the literature and the views of experienced professionals.

Chapter Five gave insights on applied neuroscience and theory adaption methods to ethically apply neuroscience in organisational settings.

Chapter Six of the research journey presents a graphic picture of how constructs interconnect. This integrative conceptual framework consolidates the information from the literature review and the research results of the thesis.

The various chapters adequately answered the research questions, resulting in a preliminary theoretical framework of NSBL.

4. Contribution to scholarship and practice

This section reviews the contribution of this thesis to scholarship (theory) and practice. Strauss and Corbin (1998, p. 15) described theory as “a set of well-developed concepts related through statements which constitute an integrated framework that can be used to explain phenomena”.

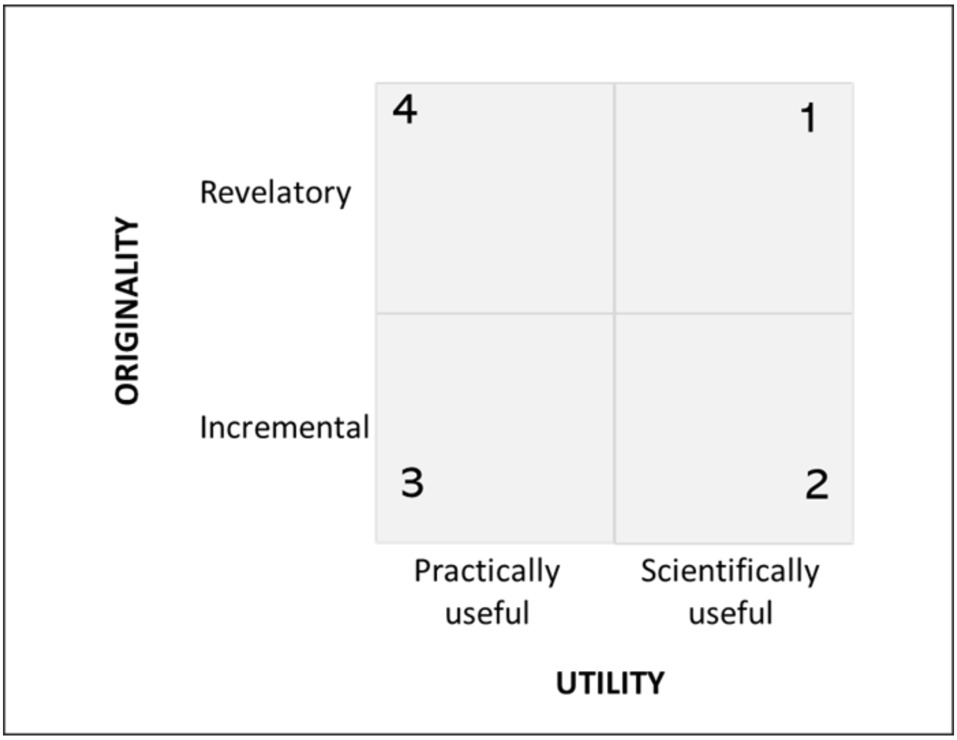
This aligns with the theory that has evolved in this research. Core behaviours have been defined, and neuroscientific conceptual underpinnings of a neuroscience approach to leadership development have been articulated.

According to Corley & Gioia (2011, p. 15), “Theory development promotes the expansion of knowledge and aims to move the discipline’s thinking forward, offering new relationships and examining the practical implementations of these connections”. According to these authors, a theory is the development of a perspective and the design of a mental model of the phenomenon to be understood.

The theoretical contribution is evaluated on two criteria – the originality of the contribution and the utility of the contribution. Originality may be small and incremental, or it may be revelatory. In terms of utility or usefulness, it may be practically valuable or scientifically useful. This is displayed in Figure 2 on the next page.

Figure 2

Theoretical contribution criteria (Corley & Gioia, 2011, p. 15)



The researcher's view of the theoretical contribution criteria shown in Figure 2 is that this research lies in the middle between incremental and revelatory. While NSBL is not entirely new, the revelatory component is the descriptors of what NSBL behaviours look like and the integration of neuroscientific concepts with the meta-model of leadership behaviour.

The shift is towards revelatory as the neuroscientific descriptors have been arrived at by consensus-seeking through a Delphi panel based on the current knowledge of experienced professionals in the NSBL field. Thus, the research does not sit firmly in the revelatory block.

The research is scientifically useful, as neuroscientific concepts, definitions and behavioural descriptors have been specified. An illustration of such scientific usefulness is the working definition of NSBL, the description of the neuroscientific concepts that underpin leadership behaviour, and a synthesis of the neuroscientific explanation of leadership behaviours to articulate a behavioural framework of NSBL.

The research is also practically useful as organisational psychologists, leadership coaches, and even leader-managers can apply the theory in a practical, hands-on manner in how they work with the development of leadership behaviour.

The neuroscientific theories studied can explain the underpinning biology behind human behaviour, resulting in leader-managers being more receptive to cultivating new behaviours in themselves and those they manage and lead. To conclude, the core behaviours and descriptors set out in this research can be cultivated and learned.

5. Theoretical framework development of neuroscience-based leadership (NSBL)

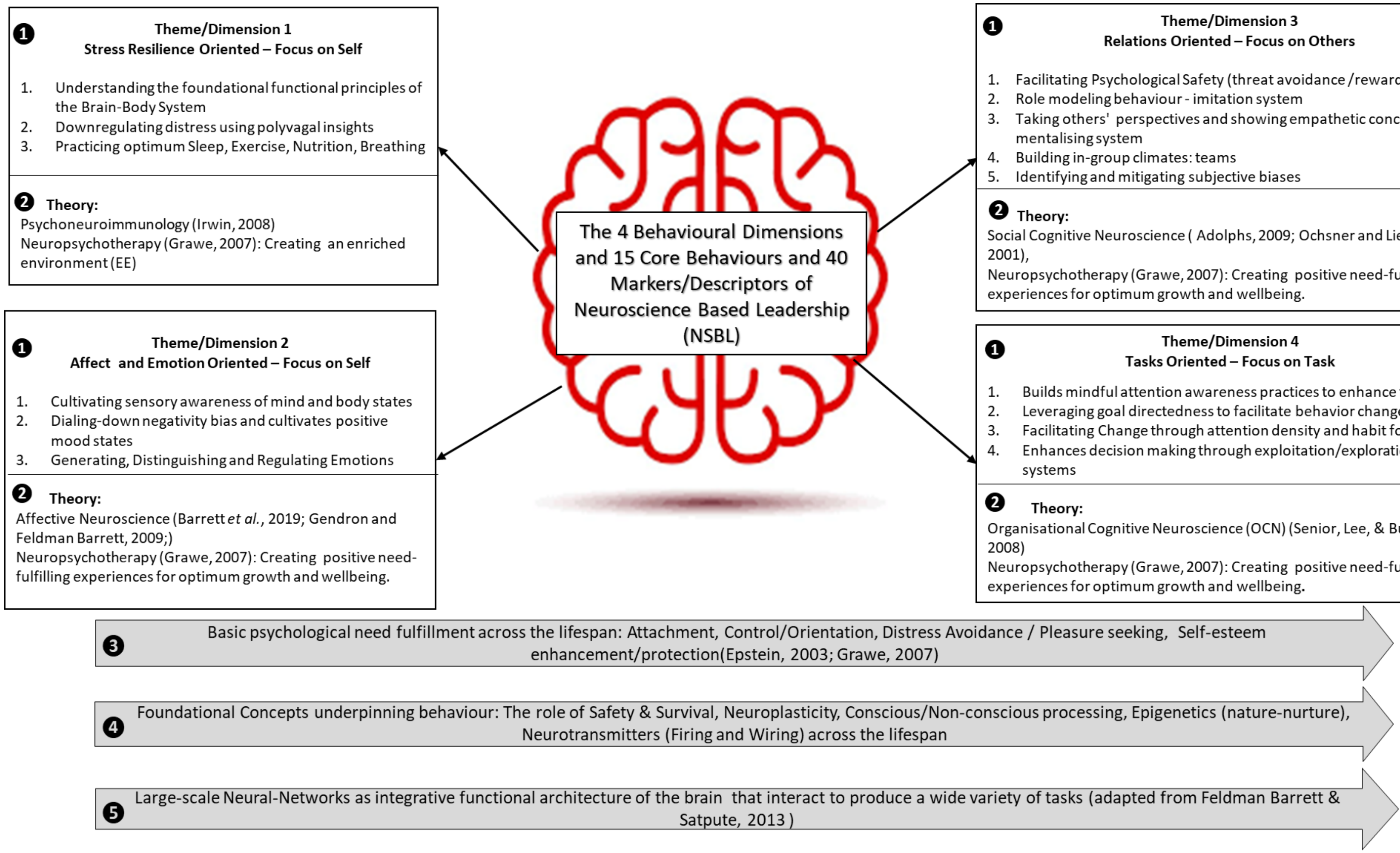
The challenge in twenty-first-century psychology remains the lack of a unified framework of mind-brain and behaviour–brain correspondence. Feldman Barrett (2009, p. 1) stated, “psychology is not and has never been a unified discipline with a single approach to science. Instead, it encompasses many different topics, methods, assumptions, and much diversity in its level of interest toward and treatment of the brain.”

This exploratory study used a qualitative approach. Hence, the findings are preliminary; hopefully, new evidence or perspectives that challenge the study’s findings may emerge. Whilst the aim of this study was by no means to attempt to provide a unified framework of the mind-brain and behaviour response, a contribution was made towards conceptualising NSBL.

As suggested by the results of this thesis, a theoretical framework of NSBL is proposed in Figure 3 and preceded by a working definition of NSBL derived from the applied research project in Chapter Four.

Figure 3

The graphical conceptual framework contains the theoretical content of neuroscience-based leadership (NSBL) behaviour as reported in this study.



5.1 Definition of NSBL

The synthesised definition, inclusive of the literature review (theories plus concepts) and the Delphi study of NSBL (Chapter Four), is offered by the writer as follows:

> *Neuroscience-based leadership (NSBL) is a neuroscientifically informed framework that conceptualises leadership behaviour as the enhancing of basic psychological needs, as well as influencing and facilitating individual and collective efforts to accomplish shared objectives through cultivating stress resilience-oriented, affect and emotional-oriented, relations-oriented, and task-oriented core behaviours.*

The seven elements of the NSBL theoretical framework are discussed below, with insights from research evidence across the entire submission. This conceptual framework is offered for understanding the scope of applied NSBL behaviour.

The conceptual framework in Figure 3 is a graphical representation of the literature and research results. It illustrates the four dimensions or themes of NSBL behaviour, as outlined in the following section. It also articulates the interplay between the leadership behaviour domains and the vital neuroscientific theories that inform human functioning.

5.2 The four dimensions of NSBL behaviour

The quadrant of four NSBL dimensions and the 15 core behaviours are derived from the Delphi study in Chapter Four. The four domains, behaviours and descriptors of NSBL are derived from the study outcomes (in the applied research project). The domain model of leadership (Behrendt, Matz, & Göritz, 2017; Hogan and Kaiser, 2005; Yukl, 2012) reviewed in the literature review (Chapter Two) and applied research project (Chapter Four) was used as a framework to integrate the themes from the Delphi study with leadership behaviour.

The four key themes or dimensions of the core behaviours of NSBL reviewed in Chapter Four have been captured in this framework, providing an integrated perspective on the study's results.

5.2.1 Dimension / Theme 1: Stress resilience-oriented

Theme 1 considers stress resilience as an NSBL dimension with underpinning core behaviours at the level of the individual (focus on self). The three supporting behavioural descriptors of the stress resilience-oriented dimension / theme are set out in Chapter Four, Figure 11.

5.2.1.1 Underpinning neuroscientific theory

The field of psychoneuroimmunology investigates interactions between psychological and behavioural states, the brain, and the immune system (Irwin, 2008). Research in psychoneuroimmunology has provided evidence of the effects of stress at many levels of the neuro-immune network, with significant implications for both physical and mental health.

Psychoneuroimmunology combines the study of multiple systems to reveal how behaviours like sleep, diet, mood, mindfulness, emotional state, and health are interrelated (Bower, Kuhlman, Haydon, Boyle, & Radin, 2019). The key focus is the immunological mechanisms that underlie these interrelated behaviours.

5.2.2 Dimension / Theme 2: Affect and Emotion-oriented.

Theme 2 outlines the affect and emotion-oriented dimension of NSBL with underpinning core behaviours at the level of the individual (focus on self). The supporting three behavioural descriptors of the affect and emotion-oriented dimension / theme are set out in Chapter Four, Figure 13.

5.2.2.1 Underpinning neuroscientific theory

Affective neuroscience. This is a complex field and, at present, riven by paradigmatic division around the definition of the nature of emotions – the classical/essentialism theory of emotions vs the theory of constructed emotions (Gendron & Feldman Barrett, 2009; Lindquist & Feldman Barrett, 2012).

5.2.3 Dimension/Theme 3: Relationship-oriented

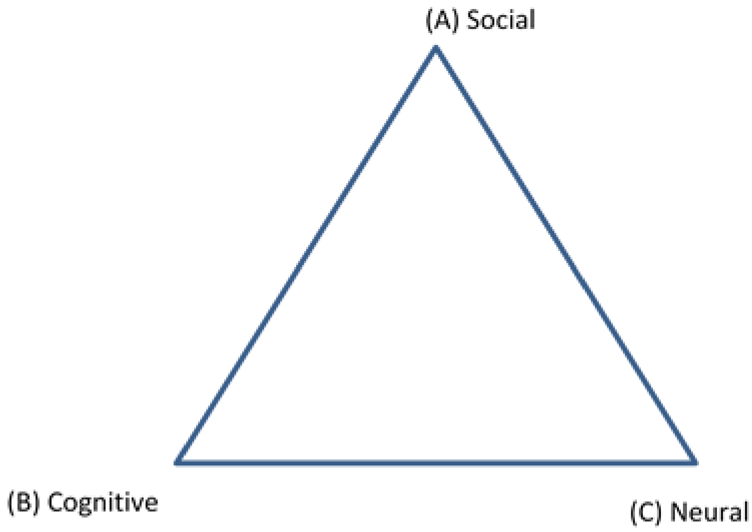
Theme 3 includes the relationship-oriented dimension of NSBL with underpinning core behaviours at the interpersonal and group level (focus on others). The supporting five behavioural descriptors of the relationship-oriented dimension/theme are set out in Chapter Four, Figure 14.

5.2.3.1 Underpinning neuroscientific theory

Social cognitive neuroscience theory, as pioneered by Ochsner and Lieberman (2001, p. 720), proposes three levels of analysis by a prism (Figure 4) with the intention to capture that social cognitive neuroscience entails “studying phenomena at many levels of analysis to learn how and when brain systems are used to mediate motivated human behaviour”.

Figure 4

The prism of social cognitive neuroscience (Ochsner & Lieberman, 2001, p. 720)



As social cognitive neuroscience employs neuroscience and cognitive psychology to study social behaviour, it effects social behaviour in organisational settings. Consequently, Butler and Senior (2007) and Lee and Chamberlain (2007) expanded SCN to organisational contexts.

According to these authors, organisations are social settings, and findings from social cognitive neuroscience are important to NSBL, providing knowledge related to the neural basis of social and interpersonal relations. The premise is that human behaviour in organisations can be better understood by understanding their neural foundations. This foundational premise has been the foundation of this thesis.

5.2.4 Dimension/Theme 4: Task-oriented

Theme 4 is associated with the task-oriented dimension of NSBL with underpinning core behaviours at the organisational level (focus "in" and "on" the business). The supporting four behavioural descriptors of the task-oriented dimension/theme are set out in Chapter Four, Figure 15.

5.2.4.1 Underpinning neuroscientific theory

Organisational cognitive neuroscience (also known as OCN) is the cognitive neuroscientific study of organisational behaviour. It uses fMRI and electroencephalogram (EEG) technology. OCN focuses on social processes within the workplace at the individual, team and organisational levels. According to Butler and Senior (2007), leadership cannot be studied only from a social-cognitive neuroscientific stance; it must be studied in an OCN environment.

5.3 Neuroscience theories (direct and applied)

The evidence base for this research comes mainly from social cognitive and affective neuroscience (Ochsner & Lieberman, 2001; Lieberman, 2007; Feldman Barrett, Adolphs, Marsella, Martinez, & Pollak, 2019). However, each leadership behaviour domain is associated with the most relevant theoretical field of study in neuroscience **(see point 2, "Theory" in Figure 3).** Neuropsychotherapy theory (NP) underpins all the NSBL behavioural dimensions as a meta-theory. It is relevant to leadership behaviour because becoming aware of approach or avoidance patterns allows the leader to reframe goals that drive approach behaviour towards higher levels of personal functioning and fulfilment. One of the critical aspects of neuropsychotherapy is its emphasis on building a safe and supportive environment and ensuring the fulfilment of psychological needs (Grawe, 2007). Similarly, leadership is about helping team members regulate their emotional states and build strong relationships, positively impacting the brain's ability to adapt, rewire, and problem-solve (Henson and Rossouw, 2013; Geldenhuys, 2022).

5.4 Brain-based self-report diagnostics

The three brain-based self-report diagnostics reviewed measure (1) brain performance drivers across a neural axis of physiological, emotional, social, and cognitive domains (Van der Walt, 2017); (2) real-time brain capacities (across the thinking, feeling, emotion and self-regulation domains as set out in the "MyBrain Solutions Leadership Assessment" (Gordon, Barnett, Cooper, Tran, & Williams, 2008), and (3) Archetypes of neuropsychological states via the NeuroSurge diagnostic (Weinberg, 2009. This was researched in Chapter Three. These diagnostics all provide insights into brain-based leadership, albeit using different constructs that help inform the scope of NSBL.

The arrows at the bottom of **Figure 3 (points 3, 4, 5)** show that visible core behaviours are influenced dynamically through the lifespan by intermingling with psychological needs, environments, contexts and individual differences in brain networks (Alexander, Aragón, Bookwala, et al., 2021).

5.5 The basic psychological needs (Point 3 in NSBL Conceptual Framework in Figure 3)

❸ Basic psychological need fulfillment across the lifespan: Attachment, Control/Orientation, Distress Avoidance / Pleasure seeking, Self-esteem enhancement/protection(Epstein, 2003; Grawe, 2007)

According to neuropsychotherapy, human behaviour is a system by-product of need-satisfaction prioritisation (Epstein, 2003; Rossouw, 2014). Thus, understanding and developing observable leadership behaviour requires understanding the psychological needs that drive behaviour in the workplace. This topic was covered in Chapters Two, Four and Five of the study. As a recapture of this, as an evolutionary adjustment, human functions have developed to optimally use the environment to allow for the reproduction, development and growth of the species (Grawe, 2007). The four basic psychological needs are present among all humans and are closely related to each other. The satisfaction of one need will influence the other needs. The violation or enduring non-fulfilment of these needs leads to impairments in mental health and wellbeing at work and in life over the life-span.

5.6 Underpinning neuroscientific concepts (Point 4 in NSBL Conceptual Framework)

❹ Foundational Concepts underpinning behaviour: The role of Safety & Survival, Neuroplasticity, Conscious/Non-conscious processing, Epigenetics (nature-nurture), Neurotransmitters (Firing and Wiring) across the lifespan

These neural underpinnings of behaviour were captured as concepts to allow easier translation to human behaviour. This was reviewed in Chapter Two's literature and the expert interviews conducted with neuroscientists (set out in Chapter Three). Finally, a consensus was gained on these underpinning concepts within the Delphi study in Chapter Four. According to key themes, there was a significant overlap between the research and the literature, which is set out in Figure 5.

Figure 5

Underpinning neuroscientific concepts that inform NSBL behaviour.

Theme	Description	Overlap between Findings and literature
Safety	Specialised survival networks avoid danger and minimise pain.	Yes
Overlapping Networks	Multiple interconnected neurons constitute overlapping networks (e.g., the default network, the central executive network, the salient/control network)	Yes
Reflexive vs reflective	Incoming information is processed fast via reflexive networks or, if a mismatch occurs, more slowly via reflective networks. *(Attention deployment is conscious vs less conscious)*	Yes
Neurotransmitters	All information transfer in the brain consists of electrochemical processes (firing and wiring).	Yes
Epigenetics	Inherited genetic thresholds modulate neural functions	Yes
Neuroplasticity	Adaptive needs are met through Neural plasticity	Yes
Interconnected Brain Body System	The whole brain and body are a highly interconnected system functionally as well as anatomically	Yes

The only theme that was reported differently by the Delphi panel members (Chapter Four) was reflective / reflexive as opposed to conscious / less-conscious processing, as per the results of the small-scale research project in Chapter Three. This reflects the current disagreements in the neuroscience literature between the classical conceptualisation of the brain as a dual system of interaction between the reflexive / implicit (System 1) and the reflective / rational (System 2) (Epstein, 1994; Grawe, 2007; Kahneman, 2011), versus the predictive processing theory which postulates that the brain uses predictive and correction modelling to create all mental representations (Feldman Barrett, 2017; Hutchinson & Feldman Barrett, 2019). The quote by Daniel Kahneman captures the essence of these different terminologies used:

> "Odd as it may seem, I am my remembering self, and the experiencing self, who does my living, is like a stranger to me" (Kahneman, 2011).

5.7 Large-scale neural networks (Point 5 in the NSBL Conceptual Framework)

❺ Large-scale Neural-Networks as integrative functional architecture of the brain that interact to produce a wide variety of tasks (adapted from Feldman Barrett & Satpute, 2013)

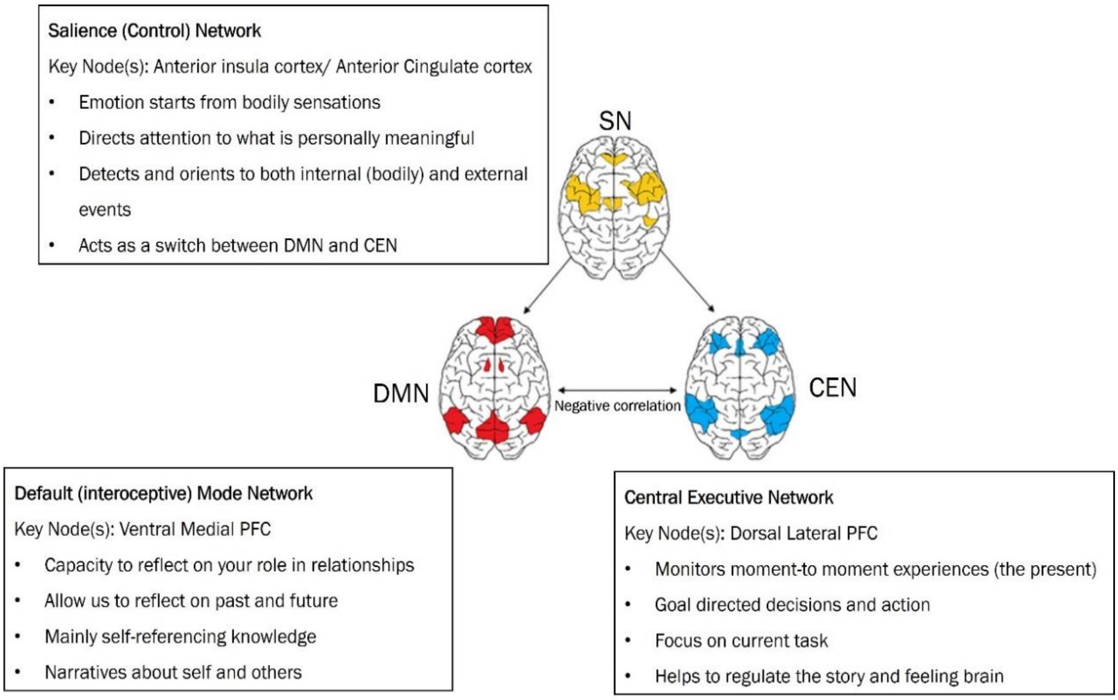
The insights from large-scale network theory are that these dynamic overlapping brain networks are a collection of interconnected brain areas that interact to perform restricted functions. Specific networks act as controllers or task switchers that coordinate, direct and synchronise the participation of other brain networks. On the other hand, other brain networks enable sensory or motor information flow and participate in the conscious execution of tasks. The research showed that these "performing of functions" or "enabling" by networks are highly dependent on the social environment, specifically enriched environments (EE) as per (Furmark et al. (2002), Ledoux (2002), Grawe (2007), Marzenich et al., 1983, Sporns (2011) and others cited in (Rossouw, 2014, p. 380). These studies indicated the effect on neural activation, chemical balance, neural firing, neural structure, and neural networks through "talking therapies".

The relevance to leadership behaviour is that providing structured conversations (an enriched environment) facilitates new neural connections, shifts in neurochemical release, downregulation of the fear or stress response and eventually, new neural connections. Ongoing exposure (consistency) to this type of enriched environment facilitates effective neural changes (Henson & Rossouw, 2013) and new behavioural habits. Incorporating the principles of facilitating an enriched environment into leadership behaviour in the work context in an informed manner may enable learning and positive change.

The large-scale brain networks and their functions are set out in Figure 6 in the descriptive form. This was reviewed in Chapters Two, Three, Four and Five.

Figure 6

Large-scale networks of the brain (adapted from Arden, 2019; Bressler & Menon, 2010)



Note: The DNW is also referred to as the "story" brain, the SN is referred to as the "feeling" brain and the CEN as the "chief executive" of the brain (Arden, 2019).

The practical implication of neural network theory for leaders is that networks underlie all thoughts, feelings, or behaviour. The process of pruning and establishing neural activation patterns depends on repeated behavioural patterns. These patterns can be strengthened, unlearned or substituted with a different one. Interaction with the environment changes these patterns. Leaders influence the organisational environment through leading by example.

5.8 Organisational context

The NSBL theoretical framework is contextualised within the boundary of a formal organisation and as part of a complex adaptive system. As the Royal Society stated: *"A neuroscience perspective recognises that each person constitutes an intricate system operating at neural, cognitive, and social levels, with multiple interactions taking place between processes and levels. Neuroscience is a key component of this system. It is, therefore, a key contributor to enriching explanations of human thought and behaviour"* (Royal Society, 2011, p. 8).

6. The methodological challenges in conceptualising NSBL from an applied neuroscience perspective

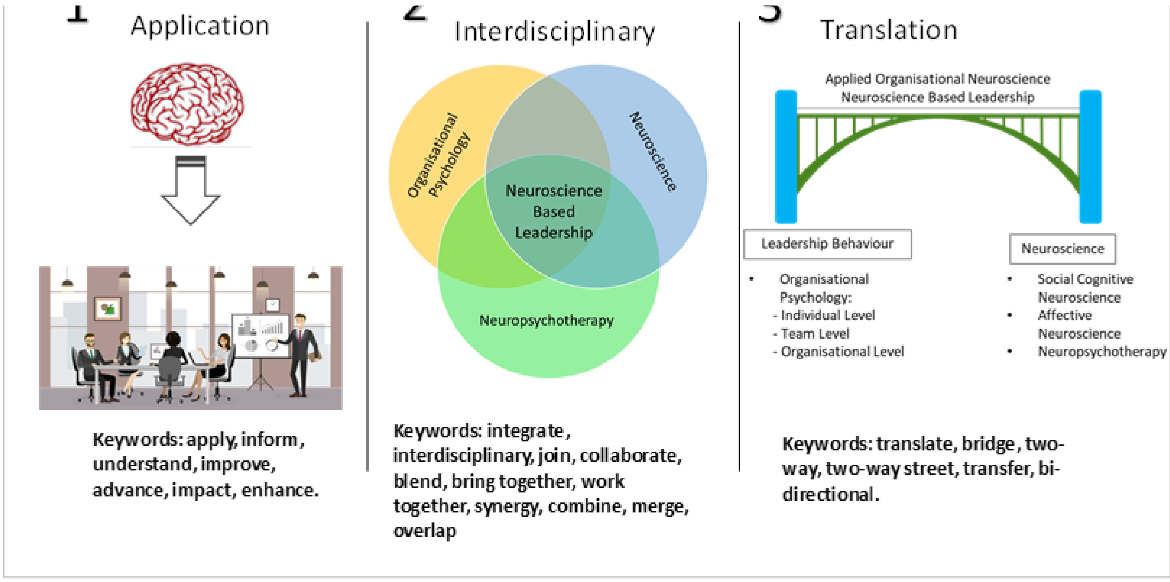
Conceptualising NSBL in this thesis required working in a cross-disciplinary manner, which required many perspectives and areas of expertise – a challenging endeavour. This thesis deployed a qualitative interpretive approach to obtain feedback from experienced practitioners in the field of NSBL. Thus, it was an applied approach. Both direct and applied neuroscience research studies were used to validate these expert opinions against current literature.

According to Caneppele, Serra, Pinochet, & Ramos Ribeiro (2022), neuroscientific tools should support traditional research techniques due to the ethical challenges of neuroscientific methods.

Feiler and Stabio (2018) provided some foundational pillars in the applied field of educational neuroscience, which was extended to this study on NSBL. According to these authors, three core themes characterise the foundational pillars for applied neuroscience: application, interdisciplinary collaboration, and translation of technical language. This thesis was informed by all three of these themes, as illustrated in Figure 7, with specific examples of peer-reviewed articles to conceptualise NSBL behaviour.

Figure 7

Visual depictions of themes in the domain of NSBL (adapted from Feiler & Stabio, 2018)



Notes to Figure 7:

1. The application of neuroscience discoveries to leadership behaviour in formal organisations.
2. Interdisciplinary collaboration of organisational psychology, neuroscience, and Neuropsychotherapy.
3. A bridge that translates technical languages and jargon between organisational psychology, leadership and neuroscience.

Next, these three themes depicted in Figure 7 are expanded.

6.1 Application

These studies focus on applying research findings about the brain to NSBL or using neuroscience to inform and direct new perspectives on leadership development. Research titles and mission statements within this theme include terms like: "advance, apply, enhance, improve, inform, and understand" (Feiler and Stabio, 2018, p. 18). An example of such a study in the literature is Geldenhuys (2020, p. 1), which focuses on "valuing and adapting appreciative inquiry to enhance wellbeing using a neuropsychotherapeutic framework".

6.2 An interdisciplinary collaboration

The interdisciplinary or even multidisciplinary collaboration theme focuses on the whole, being more significant than the sum of parts. Feiler and Stabio (2018, p. 19) state that critical terms within this theme include "integrate, interdisciplinary, join, collaborate, blend, bring together, work together, synergy, combine, merge, and overlap". As shown in Figure 7, the Venn diagram is a figurative representation of interdisciplinary collaboration. This collaboration is essential for the field to advance, with contributions from social cognitive neuroscience, organisational psychology, and leadership behaviour in this research on NSBL.

Examples of such studies in NSBL are (a) "A neurological and ideological perspective of ethical leadership" – qEEG (Waldman, Wang, Hannah, & Balthazard, 2017); and (b) "Examination of the neural substrates activated in memories of experiences with resonant and dissonant leaders" – fMRI (Boyatzis et al., 2012).

6.3 A translator of languages

Applied Neuroscience is also associated with being a translator of languages, thought paradigms, and methods that have historically belonged to different disciplines. Research studies along this theme rely on the premise that the fields of neuroscience and leadership behaviour are distinct but that AONS "can help translate the languages used between the fields as a professional interpreter" (Feiler and Stabio, 2018, p. 20). Examples of such studies in NSBL are: (a) mirror neurons and group sub-climates – modelling others; and (b) cultivating change plasticity (Dahl, Wilson-Mendenhall, & Davidson, 2020).

To conclude, these three themes can contribute to moving the study of leadership behaviour nearer to theoretical integration. However, this is still a primary challenge for research and practice in NSBL – knowing what research methods are best suited for this integration in applied organisational neuroscience.

The research approach was mainly a qualitative interpretive and descriptive analysis of expert opinions in NSBL in formal organisations. According to Klenke (2008), qualitative interpretive research can be performed within a pragmatic paradigm. Pragmatism is associated with action and practical knowledge and is aligned with a critical aim of this research to describe what NSB leaders do within the individual, team and organisational levels of functioning.

7. Methodological challenges in building an integrative conceptualisation of NSBL

The researcher was guided by the article of Kotchoubey et al. (2016) on "Methodological problems on the way to Integrative Human Neuroscience" to reflect on the methodological challenges of the thesis.

The arguments raised by these authors include the following challenges:

(1)The challenge of "a *mosaic of neuroscience lenses*" – Neuroscience consists of a mosaic of sub-disciplines that are not well integrated into a coherent system. These stretch from psychics, biology, psychiatry and psychology, sociology, economics and anthropology. It has many hybrid fields as well, e.g., neurophysics and neurochemistry. Each sub-branch of Neuroscience has its own concepts, techniques, methodologies, paradigms, models and theories and operates in different contexts (Kotchoubey et al., 2016). Overcoming the "multiple lenses" challenge: This was done by using social cognitive neuroscience and neuropsychotherapy as neuroscientific theory and applying that to leadership behaviour theory.

(2) The challenge of "*Data does not equate to understanding*" – Sciences are typically divided between "hard" and "soft" sciences. In the "hard" science of neuroscience, the plurality is further complicated by the fact that data does not equate to understanding, and more data will not solve the dilemma. Noise factors in data must also be contended with; different methods result in different "pictures" of the brain. Also, generalising results in animal studies is not without criticism (Kotchoubey et al., 2016).

The "soft" part of neuroscience has challenges, such as resolving the science's duality and reconciling its phenomenological and behavioural sides. For example, psychological constructs like trust, fairness, and inclusion are not easy to define or operationalise neurobiologically. Another challenge is defining constructs in a nested system or articulating the relationships between constructs (Kotchoubey et al., 2016). In the neurosciences, it has become acceptable that network conceptions of brain functions should supplement the localisation of brain functioning. According to (Kotchoubey et al., 2016), similar network conceptions should be adopted in psychology so as to develop a systemic perspective of this new field.

Overcoming the "*Data does not equate to understanding*" challenge in this thesis: A challenge explicitly raised in this thesis is that as an organisational psychologist, it is vital to understand the risk factors in dealing with neuroscientific theory in a reductionistic or un-reflective pluralistic manner (i.e., lazy eclectic work and thinking). This equates to interpreting psychometric scores without understanding the psychometric theory or the properties of instruments. The challenge is that my work in applied organisational neuroscience must not only be that of an evidence-based practitioner ("data does not equate to understanding") but, more importantly, become a reflective practitioner. Hence, there is a need to continuously critique and adapt preferred interventions by integrating new neuroscience-related knowledge into those interventions.

This is in line with the recommendations made by Geldenhuys (2022), who suggested that a systems theory lens is required to understand the dynamic patterns and relationships of applied organisational neuroscience. This means adopting multiple lenses and finding valid touch-points – a perplexing proposition in a new multidisciplinary field. This thesis aimed to deliver something without vague statements about leadership behaviour.

(3) The challenge of "*Ethical risks*" and limitations are mostly summarised under the term Neuroethics. It covers ethical issues of neuroscience research, such as safety requirements, small research samples, lack of replication studies, privacy issues, and the danger of manipulation (Kotchoubey et al., 2016). Overcoming the "ethical risk" challenge: When using neuroscience to study leadership behaviour, these ethical risks and limitations are also relevant. Ethical concerns are escalated when direct neuroscience methods (like imaging studies) are used to research behaviour (Lindebaum, 2016; Lindebaum & Zundel, 2013).

The ethical risks were also managed by considering the findings of meta-studies rather than once-off correlational studies in the literature reviewed. Neuromyths or baseless beliefs were also debunked by using this evidenced base approach.

8. Possible limitations of the study and implications for future research

The NSBL theoretical framework reveals considerable complexity around the topic of neuroscience-based leadership behaviour. This research was primarily a descriptive account, as the small-scale research project involved interviewing neuroscientists, and the applied research project involved seeking consensus from experienced professionals.

The professional practice case study entailed an open-ended qualitative interview with a leading academic in the field. This descriptive nature of the research leads to numerous questions that the researcher could not address within the present study. The conceptual relevance of the framework hinges on the practitioner's knowledge of applied organisational neuroscience in the leadership behaviour domain. Thus, the operational aspects of the framework need to be further explored.

More research is needed in neuroscience-based leadership behaviour from the perspective of leadership, social cognitive neuroscience and neuropsychotherapy theories to expand the knowledge about NSBL. In addition, the touch-points between these theories can be explored to add to the "touch-point validity" (Fisher, 2006).

The basic psychological needs that drive leadership behaviour (Ghadiri, Habermacher, & Peters, 2013) were reported in this research. However, none of the research questions covered how these needs play out at individual, team and organisational levels. Further research on the topic can offer integrative value to the connection between basic psychological needs and demonstrated leadership behaviour.

The Delphi study (Chapter Four) was positively focused by design. The researcher was deliberately looking for those behavioural descriptors that facilitate desired leadership behaviour per the leadership definition used by Yukl (2012). However, leadership behaviour is not only positive. Future studies could look at those leadership behaviours that hinder desired outcomes.

This study did not include the perspectives of leaders who follow a neuroscience-based approach to leadership. Future research could incorporate these perspectives as they may provide valuable interpretations of NSBL and add further depth to the study.

Further qualitative studies could be conducted that examine one of the behavioural dimensions in much greater detail, exploring all the facets and implications of the behaviour. For example, the leadership core behaviour of creating shared goals or mitigating unconscious bias could be explored in depth. Each of the core behaviours can be an avenue for theoretical and practical inquiry.

Leadership behavioural theory claims that leadership is viewed as a behavioural response that can be learned. It is the view of the researcher that the behaviours set out in this research can be cultivated and learned. The neuroscientific lens explains (albeit to a limited extent) the biology behind human behaviour, which can result in leader-managers being more receptive to enhancing NSBL behaviours in themselves and in those they manage and lead. This framework can be used as a workable mental map for the understanding and qualitative interpretation of NSBL.

According to Feiler and Stabio (2018), falsifications about the impact of neuroscience stem from the wrong interpretation of neuroscience research results rather than the legitimacy of the science itself. These authors further recommend that the number of psychologists and practitioners using a neuroscientific lens in their practices should be increased, and emphasis should be given to debunking neuromyths. This recommendation is extended to this study - exploring more neuroscientific topics relevant to organisational psychology should be encouraged.

9. Chapter Summary

This final chapter offered a reflective account of the research journey. This study provided insight into neuroscience-based leadership at work, clarifying the concepts, behavioural descriptors, and underpinning psychological needs of neuroscience-based leadership.

These findings were connected to the current literature on NSBL and consequently constructed into an interpretive conceptual framework for NSBL. This conceptual framework could potentially increase the likelihood of this approach to leadership being deployed in the workplace.

This thesis showed that neuroscience provides a complementary lens for leadership behaviour research by enabling researchers to interpret and describe human behaviour at the neurophysiological level. May it serve as a meaningful framework for future identification, analysis and possibly integration of the neuroscientific conceptual descriptions of leadership behaviour in formal organisations.

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Appendices

Appendix A: Publications during the research learning journey

1. In 2018, presented at Society for Industrial and Organisational Psychology of South Africa (SIOPSA) 2018 conference a Master Tutorial. Title: "Using Neuroscience as Lens in Coaching and Consulting: Promises and Pitfalls." The aim was to explore the opportunities and challenges for coaching and consulting psychologists in assisting organisations to build brain-fit collaborations that result in adaptive, resilient organisations.
2. In 2019, published working paper on "Busting myths in coaching: The implications for and value of coaching psychology" in *Scientia et Praxis*, Volume 1 (Issue 1): A white paper published by the Academy of the SIOPSA on 27 August 2019. The aim of this white paper was to bust myths in coaching psychology.
3. In 2020, co-authored a working paper, published by SIOPSA: Morris, A., Du Buisson-Narsai, I., Jardine, R. and Van Lill, X. (2021). *Busting neuro-myth-conceptions in applied organisational neuroscience*. SIOPSA Working Paper. Centurion: Society for Industrial and Organisational Psychology of South Africa (SIOPSA). Retrieved from https://www.siopsa.org.za/wp-content/uploads/2021/10/2021-SIOPSA-_-Working-paper-_-Busting-neuro-myth-conceptions.pdf.
4. In 2021, presented at the 2021 SIOPSA conference in panel discussion format on the abstract titled "Defining the field of organisational neuroscience and its application to and implications for organisational psychology". The aim was to contribute to the debate in defining applied organisational neuroscience and its integration with organisational psychology through a synthesis of findings from formal academic research, lead body publications, and consulting practices / conceptualisations in formal organisations.
5. During 2020 to 2022, conducting research on the prevalence of neuro-myth-conceptions and the implications for industrial psychology in South Africa. This was a cross-sectional study aimed at getting an impression of industrial psychologists' knowledge of prevalent neuro misconceptions and myths at one point in time. The study involved a convenience sample (N = 98).