

# The development and testing of an integrated neuroscience coaching framework for leadership



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**Orientation:** Applied neuroscience makes a unique contribution to the field of coaching and leadership development. It provides an integrated approach to enhancing coaching and leadership theory and practice, by incorporating new insights on human functioning.

**Research purpose:** The purpose of this study was to create an integrated neuroscience coaching framework and to test its impact on transformational leadership development.

**Motivation for the study:** While coaching and leadership development theory are well-researched within the management and behavioural sciences domains, current advances and research in neuroscience offer fresh perspectives on both fields.

**Research approach/design and method:** Initially, a theoretical coaching framework was developed. Interactive Qualitative Analysis (IQA) was applied, with two research groups participating: one group consisted of six leaders who took part in a coaching process to develop transformational leadership competencies, informed by the neuroscience integrated framework; the other consisted of three manager participants of coachee participants, who provided insights into observed leadership development. Data were collected and interpreted according to the IQA protocol.

**Main findings:** Applied neuroscience in coaching facilitates the development of homeostasis in the three operating neural networks, which results in the optimisation of neural functioning and congruence in terms of basic psychological needs.

**Practical/managerial implications:** Applying an integrated neuroscience framework to leadership coaching can enhance the development of transformational leadership behaviour. It thus provides an opportunity for incorporating neuroscience principles into coaching training and leadership development practices.

**Contribution/value-add:** This study contributes to the theory and practice of coaching and leadership development, by offering insights into new approaches and interventions within coaching, for enhancing transformational leadership behaviours.

**Keywords:** applied neuroscience; basic psychological needs; interpersonal neurobiology; leadership coaching; memory systems; operating neural networks; organisational neuroscience; organisational psychology; transformational change; transformational leadership.

## Introduction

### Orientation

Although the leadership development and coaching fields are witnessing increasing exposure to neuroscience, this process is still largely in its infancy (Butler et al., 2015). Research on the topics has remained limited, tending to adapt and evolve with the current context in which leaders have to operate.

Of late, the focus has been on the role of mental processes in explaining human behaviour and effectiveness, as a result of growing interest in examining the possible connections between human biology, and management and organisation studies (Butler, 2017). Hannah et al. (2013) term this a 'cognitive revolution', which has drawn increased attention to leaders' mental processes, thereby clarifying their behaviours and efficiency. To date, 'this revolution has been limited largely to conjecture of what occurs inside the "black box" of leaders' (Hannah et al., 2013), suggesting a similar revolution in methodology. As a result of the cognitive revolution in organisational and leadership studies, leaders' real thought processes to explain their conduct

and effectiveness, continue to garner attention (Fingelkurts et al., 2019).

Neuroscience explains how the brain functions and to some extent allows us to understand how leaders 'deploy' their brains, not only in terms of observable behaviours, but also by grasping the underlying mechanisms and actual wiring of the brain (Riddell, 2021). Neuroscience has recently developed to the point where the correspondence between the reductionist findings of the brain sciences and the holistic phenomenology of psychotherapy can be assessed (Ecker & Toomey, 2008). Research has demonstrated the effect of talking interventions not only on behavioural change, thinking patterns or feelings but also on neurochemical shifts, neural activity and even neuro-structural changes (Rossouw, 2013):

No theory of human functioning can be restricted to only a description of psychological processes; it must also be consonant with what we now know about biological structural brain development. (Schore, 2012, p. 1)

According to Siegel et al. (2021), interpersonal neurobiology and neuropsychology emerged to help integrate the evolving streams of neuroscience research with the existing bodies of knowledge in counselling, developmental psychology, cognitive and affective neuroscience, education, sociology and related disciplines. What distinguishes neuropsychotherapy is its focus on the neural networks underpinning human responses such as memory, sensations, emotions, ideas, behaviours and interactions (Rossouw, 2014). Enriched environments change the brain, and the essence of neural functioning is not chemical, but rather a network of connections (Rossouw, 2014). The goal of neuropsychotherapy is to encourage the growth of neurons and the integration of neural networks in an enriched environment (Arden, 2019; Cozolino, 2010; Rossouw, 2014).

Arguably, coaching may provide an enriched environment, facilitating neural change and neuroplasticity through the application of neuroscientific and neuropsychotherapeutic principles, interventions and approaches. The integrated coaching framework developed in the researchers' larger study, incorporates current neuroscience principles and neuropsychotherapy as a subfield of applied neuroscience, facilitating homeostasis within the operating neural networks. This article explores the development and testing of the integrated neuroscience coaching framework on the development of transformational leadership behaviour.

## Literature review

### Transformational leadership

Orejarena et al. (2019) view leadership in general as the synergy between diverse competences that contribute to influence the way in which we act towards, or think about, others, and as key to the survival of any organisation.

According to Dinh et al. (2014), transformational leadership has maintained its position as the most prominent leadership framework, as is evident from its lasting influence on both research and practice over 30 years. Transformational leadership, which is the most widely studied form of effective leadership (Waldman et al., 2011), is often referred to as charismatic and inspirational and as promoting change in social systems. The potential of transformational leadership to address issues that are relevant in the modern, changing and uncertain work environment, is the main reason for its positive influence (Lim & Ployhart, 2004). Transformational leadership is one of the most popular leadership models, judging by the number of articles produced on the topic, by a global cohort of scholars (Bush, 2018). Transformational leaders could be categorised as visionaries, futurists or catalysts for change – who adopt a proactive approach to management – with vision as the central construct (Bush, 2018; Hickman & Akdere, 2018; Mason et al., 2014; Murphy, 2005; Tichy & Ulrich, 1984).

According to Bass (1999), transformational leadership refers to the leader moving the follower beyond immediate self-interest, through idealised influence (charisma), inspiration, intellectual stimulation or individualised consideration. That elevates the follower's level of maturity and ideals, as well as his or her concerns about achievement, self-actualisation and the well-being of others, the organisation and society (Bass, 1999). Many meta-analyses and reviews have systematically documented the positive effects of transformational leadership (Benjamin & Flynn, 2006; Fingelkurts et al., 2019). Leaders wishing to transform their organisations must begin by transforming themselves, starting with their own mindsets (De Smet et al., 2018).

### Leadership coaching

Coaching has grown into a distinct field, having emerged from the sports arena in the 1960s, to be acknowledged as a separate discipline in the early 1980s (Passmore, 2016). Bachkirova et al. (2016) posit that coaching has evolved into an ever-maturing scholarly field of research. In organisational contexts, coaching is used to improve employee, team and organisational performance in numerous ways, helping with shortening the learning curve in a new position or organisation, succession planning, career planning and behavioural skills enhancement in leadership or management roles (Williams & Offley, 2005), the main purpose being to facilitate positive behavioural change. Coaching differentiates itself from counselling, consulting and therapy as an amalgamation of several helping, developmental and training techniques (Grover & Furnham, 2016). It is a relationship-based learning and development process, which unfolds in a structured manner (Passmore, 2021). The primary goal of coaching is to allow the individual to fulfil his or her professional and personal potential to enable him or her to perform optimally, unleash skills and find any blockages that might be obstructing this (Ghadiri et al., 2012; Kilburg, 1996). Joo (2005) describes leadership coaching as

typically involving an external professional (coach) and a current or aspiring leader (coachee), focusing on developing the coachee's self-awareness, creating sustained change and achieving personal success.

According to Passmore et al. (2013) coaching methodologies are highly diverse and heterogeneous. Vella et al. (2010) state that coaching scholars have developed and proposed models and frameworks for the coaching process for some time now, where these are empirically grounded, prescriptive and idealistic representations of the coaching process (Cushion et al., 2006). The establishment of coaching as a field has not necessarily resulted in the development of new models and frameworks, and the lack of empirically documented coaching models to provide theoretical groundwork for practice, is evident (Palmer & Whybrow, 2008).

Neuro-coaching has become of particular interest to coaches, judging from the numerous publications and training programmes, methods and techniques described in popular literature (Ghadiri et al., 2012). These authors confirm the importance of understanding the relevance for neuroleadership, and the impact thereof on leaders in organisations.

The prominent role of coaching in leadership, management and organisations has also drawn the attention of practitioners, prompting them to consider executive coaching as a central intervention of their human resource development practices (Ratiu & Baban, 2015). Unfortunately, this strong interest in coaching development has not fully translated into the academic context, creating a gap between theory and practice. Grover and Furnham (2016) concur that the consequence of this increased application is the demand for empirical data to clarify the process by which it operates, and its demonstrable efficacy in achieving pre-set goals. The disproportionate growth of practice, when compared to research, has created an urgent need for scientific inquiry into executive coaching (Passarelli, 2015). Fingelkurts et al. (2019) state that the rise in popularity of coaching as a principal method of human and organisational change brings with it many new opportunities and challenges for coaches and trainers alike, as well as for researchers in the field. Interest in coaching psychology and neuroscience has been steadily growing over the past 15 years (Dias et al., 2015). Notably, the two fields have not yet established consistent dialogues underpinned by experimental research. Shams (2015) corroborates this, stating that the influence of neuroscience on coaching is now receiving attention, as it addresses the biological basis of coaching intervention. With the link between neuroscience and coaching not yet firmly established, an interdisciplinary approach is recommended (Shams, 2015). Furthermore, no evidence could be found in the literature of research using the Interactive Qualitative Analysis (IQA) process, and facilitating it entirely via online platforms.

## Neuropsychotherapeutic framework

This study incorporated neuropsychotherapy as the foundation in developing an integrated neuroscience

coaching framework. According to Ward et al. (2017), 'neuropsychotherapy' has become synonymous with two distinct areas of application: the first pertains to individuals with a neurological condition (e.g. brain injury, stroke, dementia, or multiple sclerosis), and the second refers to the practise and understanding of psychotherapy in mainstream contexts. Walter et al. (2009) propose that neuropsychotherapy be viewed as a field of applied research aimed at (1) identifying neural mediators and functional targets of psychotherapeutic effects using neurotechnology, (2) determining new therapeutic routes using neurotechnology and (3) designing psychotherapeutic interventions using neuroscientific knowledge. According to Rossouw (2014), neuropsychotherapy is a comprehensive theoretical and holistic paradigm that integrates neuromolecular data with epigenetics on all levels, including the physiological, emotional, cognitive, behavioural, social and spiritual.

Neuropsychotherapy seeks to provide a framework to facilitate change and shift patterns of dysfunctional behaviour towards designs that improve the quality of life (Rossouw, 2014). As Grawe (2007) states, neuropsychotherapy should be regarded as a planned, structured endeavour, with neuroscientific foundations, which grant insight into the essence of well-being, thus providing guidelines for addressing dysfunction. According to Rossouw (2013), neuropsychotherapy is different from all other theoretical models, claiming a uniqueness in approach that no other model provides. What distinguishes neuropsychotherapy is its focus on neural networks that underpin human responses such as memory, sensations, emotions, ideas, behaviours and interactions (Rossouw, 2014).

Grawe (2007) developed a theoretical model for neuropsychotherapy and a meta-framework of neurobiologically informed psychotherapy based on the developments and findings of Seymour Epstein's 1999 framework, the Cognitive-Experiential Self-Theory (CEST) of personality (see Dahlitz, 2015; Rossouw, 2014). Other scholars have incorporated Grawe's work to expand the field of neuropsychotherapy (see Ghadiri et al., 2012). Dahlitz (2015) describes neuropsychotherapy as:

[A] neurobiologically informed framework for psychotherapy that conceptualises thought and behaviour as emerging from the influence of motivational schemata, developed to preserve or enhance basic psychological needs. Therapeutic processes start from the development of safe and enriched environments, to activate positive approach motivational schemata utilising a bottom-up neurological approach, and proceed from a top-down approach to facilitate long-term change in neural architecture. (p. 64)

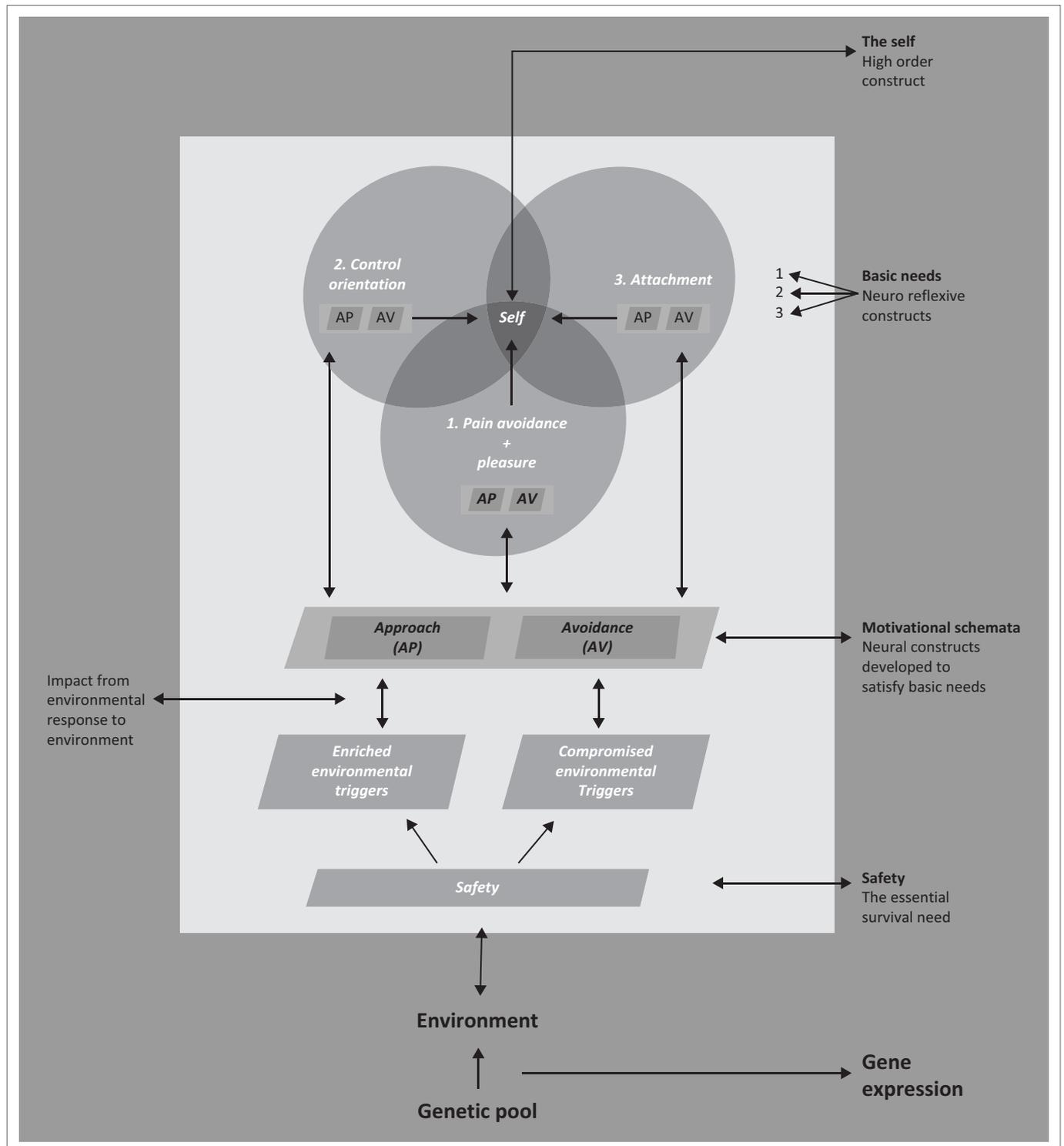
Figure 1 shows the integrated model of the base elements of the Theory of Neuropsychotherapy (Rossouw, 2014).

According to Cozolino (2014), interpersonal neurobiology (IPNB), along with social neuroscience, affective neuroscience and sociophysiology, are among the emerging fields of study that are working to bridge the

gap between the social and biological sciences. The brain is a social organ, built by experience (as assumed by IPNB) and, at its core, it focuses on the neural systems that organise attachment, emotion, attunement and social communication. In addition to the many different social situations in which people find themselves, including the workplace, IPNB acknowledges the critical role relationships play in forming the human mind and

embodied brain across a person's lifespan. Interpersonal neurobiologists view the mind as an evolving mechanism that is continually adapting, directing and regulating energy and information flow through neurobiological and interpersonal processes (Siegel, 2020).

Variations in neural circuitry – be they inherited or acquired – may underlie important individual differences in thought,



Source: Rossouw, P.J. (2014). *Neuropsychotherapy: Theoretical underpinnings and clinical applications*. Mediros

**FIGURE 1:** Integrated model of the base elements of the theory of neuropsychotherapy.

feeling and action patterns (Seeley et al., 2007). As Lee et al. (2012) point out, a fundamental limitation in neuroimaging is the inability to infer complex social behaviour from observations of specific activated brain regions. Arden (2019) corroborates this, referring to the interplay of, and feedback loops within, the mind-brain-gene continuum and observing that mental aspects cannot be reduced to a neuron or a specific neural network. Neuroscience recognises that interactions between higher, more abstract analysis, and lower molecular levels are necessary to explain the complexities of human cognition and behaviour (Becker et al., 2011). Progress in neuroscience has illuminated the neural processes underlying behaviour, attitudes and motivations (Henson & Rossouw, 2013). Lindquist et al. (2012) use what they term a psychological constructionist approach, to suggest that networks in the brain interact to produce psychological events and behavioural phenomena, and that a particular network might be relevant to multiple phenomena that could span various aspects of emotion, cognition, and perception. Increasingly, neuroscience theory would suggest that complex behavioural phenomena, such as moral judgement or decision making, can best be considered using a network framework based on the interconnections between multiple brain regions (Arden, 2019). According to Siegel (2019), neural integration enables differentiated areas to communicate effectively with one another, supporting the coordination and balance of disparate areas to become part of a functional whole. That is most likely why neuronal integration is involved in regulation. Integrating and balancing these sub-systems or mental networks are thought to be critical for maintaining a coherent and adaptive mind and are major foci of therapy (Geldenhuys, 2020).

## Operating neural networks

To comprehend the neurological foundations of behaviour, Arden (2019) distinguishes three important self-organising mental operational networks: the salience network (SN), the default mode network (DMN) and the executive network (EN). According to Arden (2019), self-organising mental networks evolve from subordinate sensations, emotions, feelings and thoughts in the brain, functioning together to maintain a coherent sense of self. Siegel (2019) states that the optimal self-organisation of a complex system arises when its elements differentiate and then link. Integration is the foundation of mental health, and when a system is not optimising self-organisation, it is inclined towards either chaos or rigidity (Siegel, 2019). As Arden (2019) points out, mental networks organise self-referential information derived from long-term memory and current experience. This is important for understanding how behaviour is influenced by the structure of the neural networks in each individual brain and more so as regards how homeostatic balance can be restored. Because of the neural structures and connections formed in the brain over a long period of time, with certain stimuli, automatic responses and behaviour are favoured by the brain (Arden, 2019). As Grawe (2007) observes, a single neuron does not store or

encode any meaning, as meaning only arises from patterns of simultaneously activated neurons to inform behaviour.

## Salience network

According to Seeley (2019), SN refers to a suite of brain regions whose cortical hubs are the anterior cingulate and ventral anterior insular (AI) cortices. This network, which includes nodes in the amygdala, hypothalamus, ventral striatum, thalamus and specific brainstem nuclei, responds to diverse experimental tasks and conditions, suggesting a domain-general function (Seeley, 2019). The SN, in particular, plays a crucial role in cognition and emotion via the detection and attentional capture of goal-relevant stimuli, and the facilitation of access to appropriate cognitive resources across a wide range of cognitive tasks (Chen et al., 2016). According to Levy and Wagner (2011) and Chen et al. (2014), the AI and dorsal anterior cingulate cortex (dACC) nodes of the SN are among the most commonly activated regions in human neuroimaging studies, which points to the omnipresent involvement of this network in cognition (Chen et al., 2016). Crucially, the AI of the SN is thought to mediate the engagement of the EN and disengagement of the DMN, hence the dynamic interplay between externally and internally focused attention, and cognitive-affective processing (Uddin & Menon, 2010). Arden (2019) states that the SN is also called the feeling network (involving bodily sensations and the emergence of emotions), which provides mental operations that organise somatically derived information. In addition, the SN is supportive by determining what is in the individual's best interest on an emotional level, while the other two operational networks are mediated by robust SN activation.

## Default mode network

According to Szinte and Knapen (2020), the DMN is a brain network with associated activities spanning the frontal, parietal and temporal cortical lobes. Raichle (2015) specifies the areas of the DMN as roughly being divided into three major subdivisions: the ventral medial prefrontal cortex, the dorsal medial prefrontal cortex and the posterior cingulate cortex and adjacent precuneus plus the lateral parietal cortex. The DMN activates for high-level cognition activities and deactivates when participants are actively engaged in perceptual tasks. The DMN as a system is important for self-referential mental processes and multiple sensorimotor networks (Power et al., 2013). It is activated when the mind is not engaged in the current environment, but is rather in a state of rest (Menon, 2023). When individuals are engaged in internally focused tasks such as autobiographical memory retrieval, visualising the future, and conceptualising the perspectives of others, the default network is active, providing insight into these functions (Buckner et al., 2008). According to Arden (2019), the DMN is active during the retrieval of episodic memories, but not during the encoding of such memories, meaning that when individuals remember something that occurred the DMN is active, yet while experiencing the event the SN and/or

EN is active. The DMN regions appear to support a consistent and coherent synergy of sensory elements of the body, and internal experiences, which are core features for the experience of emotions that support a sense of self (Buckner & DiNicola, 2019). The latter may encompass three domains, namely: (1) self-awareness, (2) social awareness and (3) differentiated cognition and perception (Faustino, 2022).

The DMN is active when we are ruminating and telling stories about ourselves and others, as well as fantasising about how events may develop (Arden, 2019). According to Buckner and DiNicola (2019), recent studies focusing on the DMN clearly show that the domain of default network involvement is broader than that of undirected cognition. The most recently appreciated understanding is that, rather than being a single monolithic network as previously thought, the DMN is more likely to be made up of many juxtaposed individual networks (Buckner & DiNicola, 2019). As a result of the discovery of the default network, researchers have a window onto the basic specialisation of brain processing networks – those that extract information from the external world versus those that generate representations that are partially or completely separate from the immediate external environment (Buckner & DiNicola, 2019). Arden (2019) points out that the fantasies generated by the DMN can boost or undermine self-esteem. Thus, through this network, new opportunities might arise when personal memories are shared with others in a secure environment, and fresh ideas are exchanged in a nurturing manner. Coaching interventions should take this into account, to ensure that a leader utilises his or her DMN for improving and sustaining his or her level of self-esteem.

### Executive network

According to Funahashi (2001), the EN refers to the function of a multioperational system, thought to be mediated by the prefrontal cortex. For Arden (2019), the dorsolateral prefrontal cortex (DLPFC) is the most evolutionarily advanced part of the brain, with myelination only fully occurring once individuals reach their mid-20s. Banks et al. (2007) state that the DLPFC stores short-term memory, meaning new information is registered here prior to becoming long-term memory. Executive function skills are a set of neurocognitive abilities that support the conscious, top-down control of thought, action, and emotion; they are required for deliberate reasoning, intentional action, emotion regulation, and complex social functioning and they enable self-regulated learning and adaptation to changing circumstances (Cozolino, 2010; Damond, 2013; Zelazo, 2015). These are typically measured behaviourally as three skills: inhibitory control, working memory and cognitive flexibility, as per Miyake et al. (2000, cited in Zelazo, 2020). For Arden (2019), working memory is more complex than simple short-term memory, as it provides a significant measure of executive control in terms of what information can be held in the mind. The DLPFC provides

the infrastructure to perform goal-directed behaviour for follow-through on tasks (Arden, 2019). Cognitive flexibility involves thinking about something in multiple ways, such as task switching or considering someone else's perspective on a situation, and inhibitory control (deliberately suppressing attention) (Zelazo, 2015).

Figure 2 shows the integrated neuroscience coaching framework developed by the researcher in this study. This framework was applied during the coaching process with the coachee participants.

Through the application of the integrated neuroscience coaching framework, homeostasis is arguably advanced to support the effective functioning of the three operating neural networks supporting transformational leadership behaviour. The effectiveness of these networks is further a function of the congruence of basic psychological needs, where motivational schemata determine approach or avoidance behaviour (Figure 1).

## Research design

### Research approach

In this study, IQA was used to determine and explore the lived experiences of the participants during the coaching process. Interactive Qualitative Analysis, which aims to give qualitative inquiry a systematic, rigorous and accountable framework, is deemed an appropriate design for investigating how social constructions of phenomena occur (Northcutt & McCoy, 2004). Through a variety of IQA protocols, participants are encouraged to develop, gather and analyse their own data as part of a social constructionist approach.

### Research strategy

Focus groups were used, followed by one-on-one semi-structured interviews. The themes (or affinities) that the focus groups created, informed the topic of the individual interviews, and the focus groups encouraged the simultaneous gathering and interpretation of data. The affinities created by the focus groups serve as the foundation for the interview protocol (Northcutt & McCoy, 2004). The results of the focus groups were verified through the interviews (Northcutt & McCoy, 2004). Each interview has a theoretical section, analogous to the theoretical coding activity of the focus group, in which the participants systematically analyse the relationship among affinities from their individual perspective (Northcutt & McCoy, 2004). There is a parallel structure between the IQA focus group and interview, whereas the interviews produce a richer, more robust picture of the phenomenon than the focus group alone (Northcutt & McCoy, 2004). Each interview was divided into a theoretical coding stage and an axial coding stage. During the theoretical coding, the interviewee answered questions grounded in his or her encounter and relationship with the affinities, for a detailed exploration of his or her individualised viewpoint.

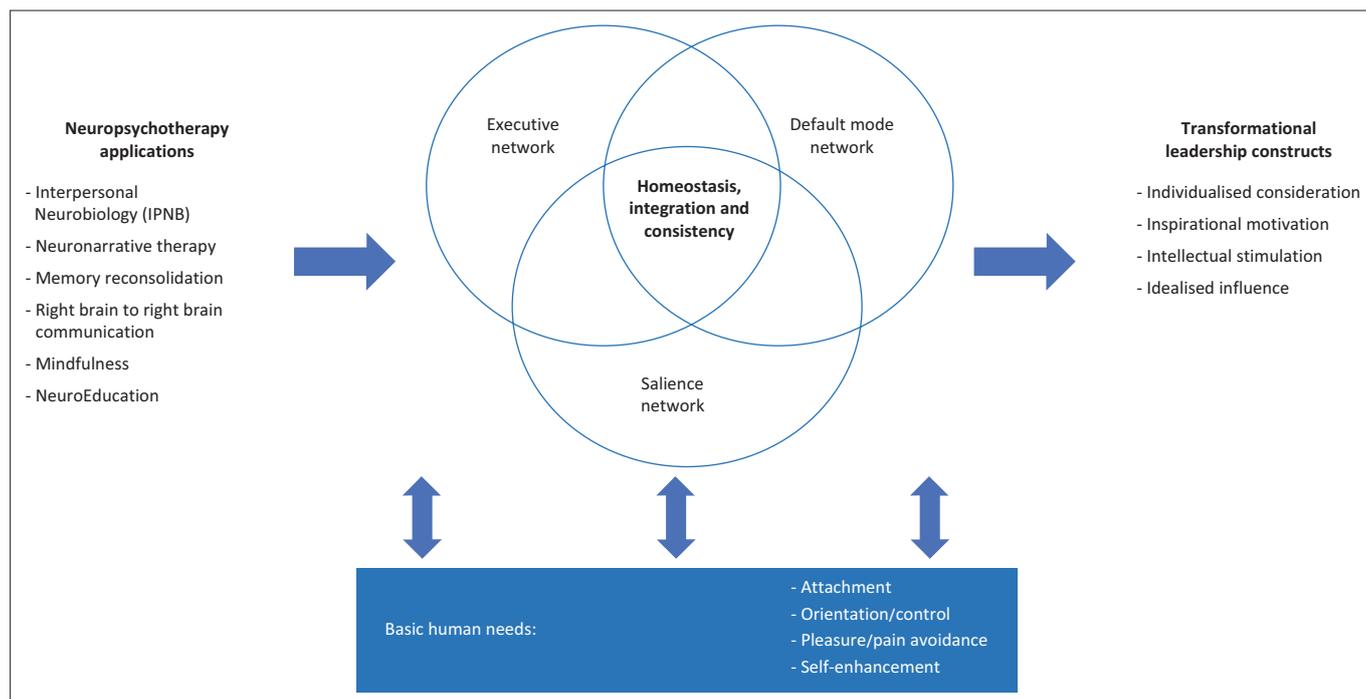


FIGURE 2: Integrated neuroscience framework for leadership coaching.

## Research setting

The research was conducted online with six industry-based team leaders who took part in six coaching sessions each. All hailed from different industries and organisations. Two focus groups were conducted, with five of the six coachee participants participating in the first and four taking part in semi-structured interviews. Three of the participants' managers participated in the second focus group, while one manager took part in the semi-structured interviews.

Per coachee, the online coaching sessions lasted 1–2 h over 6 months. The integrated neuroscience framework used in these sessions was based on current neuroscience principles and a systems perspective of neuropsychotherapy. This included incorporating concepts and methodologies such as IPNB, neuronarrative therapy principles, the application of memory reconciliation, right-brain communication, mindfulness and neuroeducation. Each coachee presented with unique requirements in respect of the application of the theories, principles and methodologies applied during the sessions: this, to support the creation of homeostasis and integration within the three main operating neural networks, and ultimately improve transformational leadership behavioural competencies. Thus, focusing on the concept of safety to create a collaborative connection and working alliance with clients is central to the neuropsychotherapy approach (Rossouw, 2014). This fundamental process began at the very first interaction with each coachee participant during the introductory meeting and remained a primary focus throughout the sessions. Creating a sense of physical and emotional safety downregulates any potential distress, and enhances the trust relationship through right-brain communication (Rossouw, 2014). From a basic psychological needs perspective, creating therapeutic attachment in

coaching is vital, and this was achieved in the coaching through social-brain connection. The early maturation of the right hemisphere is the locus of attachment formation and the gateway to affect regulation later in life (Schorre, 2022). Right-brain-to-right-brain connection with clients is thus fundamental to coaching.

The downregulation of stress chemicals (for effective coaching to take place) was established throughout each session to foster a sense of control – a basic psychological need (Grawe, 2007) – through person-centred, focused approaches. This bottom-up method of establishing safety differs from a top-down cognitive method, in that it involves the activation of a parasympathetic secure state and the downregulation of sympathetic over-arousal. This results in an increase in cortical blood flow to the left frontal cortex, for effective cognitive activation and the limiting of recursive patterned loops (Rossouw, 2014).

Such enhancement of emotional controls supported the process of shifting from avoidance schemata and narratives to approach-oriented action, when required. To strengthen hippocampal capacity and a shift in cortical blood flow to the frontal brain regions mindfulness was introduced, and was a theme throughout the coaching process. Ensuring that coachees were motivated and enthusiastic about the process and concomitant behavioural changes, supported the enhancement and strengthening of dopamine and serotonin release required for taking approach-oriented action, while downregulating stress chemicals.

The formation of implicit emotional memories lies at the heart of approach and avoidance schemata, and constitutes a primary target for therapeutic change (Dahlitz, 2015).

During the coaching, working with memory systems related to temporal contextualisation further reinforced approach behaviours, to strengthen new neural patterns for the facilitation of transformational leadership behaviour. Using neuronarrative methods supported such reinforcement of neural patterns in behaviour change through solution-oriented coaching approaches, and productive narrative creation. Neuroeducation – as and when appropriate during the coaching sessions – further facilitated and reinforced the ongoing activation of new neural pathways, shifting the unhelpful brain activation of prior pathological default patterns into new approach patterns. Neuroeducation extended to holistic discussions on healthy behaviours aimed at enhancing capacity, which include nutrition, stress management and sleep hygiene. These approaches led to the creation of congruence and homeostasis in the three main operating neural networks within the context of the basic psychological needs of each coachee.

### Entrée and establishing roles

Coachee participants opted to take part in the study voluntarily and were required to meet the criterion of being a leader of a team. The researcher acted as a facilitator of the focus group discussions and semi-structured interviews; she also guided the application of the IQA protocol throughout the data-collection processes. Once data-collection was complete, the researcher interpreted and analysed the data.

### Sampling methods

The coachee participants voluntarily responded to a request for research participants on the platform LinkedIn made by the researcher, who also acted in the role of coach during this study. Purposive sampling was used for the study. The study sample consisted of six coachee participants. A requirement of participation was that the coachee participants' direct manager also take part in the study. Only three managers could participate in the focus groups, and one in the interview. According to Robinson (2014), interview research that has an idiographic aim typically seeks a sample size that is sufficiently small for individual cases to have a locatable voice within the study, and for an intensive analysis of each case to be conducted. As the participants in an IQA study are selected to represent a constituency, they are seen as experts on the phenomenon in question, given their affiliation with a certain group (Northcutt & McCoy, 2004). Of the coachee participants, four were male and two were female; they hailed from South Africa, Ireland, Egypt and Portugal, with three speaking English as a first language, and three as a second language. The managers participating in the focus group and interviews were the direct managers of the coachee participants, and their participation was also voluntary. They were of the same nationality as the coachee participant they manage in the workplace, and spoke the same language as the coachee. All the manager participants were male. The age group for all participants ranged from 30 years to 60 years.

Table 1 indicates the biographical data for the participants in the study associated with the focus group and interview quotes in Table 2a, Table 2b and Table 3.

### Data-collection methods

In compliance with IQA guidelines, data were gathered in two stages (Northcutt & McCoy, 2004): firstly, two focus groups were conducted, followed by semi-structured interviews with the participants. The coachees were asked: 'How did the coaching impact you on a personal and leadership level?' The manager participants were asked: 'What changes have you noticed and observed in the person who attended the coaching process from a leadership behaviour perspective, as well as from a personal behaviour perspective?' The participants were asked to write their answers on content cards until capacity was reached, displaying one phrase or word per card. The themes or affinities created from this process served as input for the semi-structured interviews. Through this IQA protocol, the lived experience of the participants was recorded, as recommended by Northcutt and McCoy (2004).

### Data analysis

Through the processes of inductive and axial coding, from the content cards the participants created clusters of themes or affinities, which reflected the socially constructed meaning of each for the group, and to remove any possible vagueness or ambiguity associated with the meaning of the words or phrases (Northcutt & McCoy, 2004). The perceived relationships between affinities were explored and clarified in the focus groups, which interacted recursively through discussion. The links and directions of the affinity relationship tables between the themes were then determined, initially for each individual and subsequently for each group (Northcutt & McCoy, 2004). To identify the links that explained the most variance in the qualitative system, Pareto analysis was carried out (Northcutt & McCoy, 2004). An interrelationship diagram was created – a matrix encapsulating all the perceived relationships in the system and the output of the focus group hypothesising activity.

From here the researcher created a cluttered and uncluttered systems influence diagram (SID), which visually presents the entire social system of coachees' experiences of the coaching process, and the observed leadership outcomes which the managers' observed in the coachees. As a type of triangulation, each participant examined the focus group SID and contrasted it with his or her own interpretations during the interviews. The researcher transcribed and coded the data from the interviews as per the suggested IQA protocol, before analysing the text for axial codes, which are seen as 'specific examples of discourse that illustrate or allude to an affinity' (Northcutt & McCoy, 2004, p. 315). Through this analysis, themes were identified from the interviews, aligning with the outcomes from the focus group cards and subsequent affinities. The researcher interpreted and analysed the interviews to add depth and insight into the systems, which the participants created.

**TABLE 1:** Biographical data for the participants in the study.

| Participant                 | Gender | Job role                          | Industry                   | Country      |
|-----------------------------|--------|-----------------------------------|----------------------------|--------------|
| <b>Coachee participants</b> |        |                                   |                            |              |
| A                           | Male   | Operations Manager                | Supply Chain               | South Africa |
| B                           | Male   | Medical Team Lead                 | Pharmaceutical             | Egypt        |
| C                           | Female | Human Resources Business Partner  | Medical Clinics            | South Africa |
| D                           | Male   | Technical Team Lead               | Engineering                | Ireland      |
| E                           | Female | Senior Manager                    | Remote Working Consultancy | Ireland      |
| F                           | Male   | Finance Manager                   | Automotive                 | Portugal     |
| <b>Manager participants</b> |        |                                   |                            |              |
| X                           | Male   | General Manager                   | Remote Working Consultancy | Ireland      |
| Y                           | Male   | Human Resource Operations Manager | Medical Clinics            | South Africa |
| Z                           | Male   | Senior Manager                    | Pharmaceutical             | Egypt        |

**TABLE 2a:** Affinities for focus group 1.

| Affinities                    | Definition  | Interview comments  |
|-------------------------------|---|---|
| 1. Behavioural change         | Those elements that influenced transformation. These areas are internal processes and experiences, as a result of the coaching which resulted in behavioural change.                        | <p>'I think since the beginning of the coaching the transformation that happens by the way, I'm leading the way as a leader from a team. So, for me, transformation here means my evolution.' (Participant A)</p> <p>'I'm thinking of it like a tree. That awareness is like a tree that you are aware of the exact moment you are here, and what it's connected to.' (Participant B)</p> <p>'It helped me a lot to support my team and correct my procedures, so going through this coaching process was a relief for m[e].' (Participant B)</p> <p>'Be able to change it; that you are aware of where you can change.' (Participant A)</p>  |
| 2. Conscious action           | The new behaviours or actions taken and applied, which lead to changes in behaviour or in outcomes within the self, and which are then extended to the team.                                | <p>'Because we are aware of how we can change our brain processes, we have more control over our behaviour and ourselves as a leader.' (Participant A)</p> <p>'If you do not have self-control, I can get very excited.' (Participant B)</p> <p>'I didn't have that self-control, I just wanted to expose the team to all these exciting things, and not taking the time to get to know the people. There has to be a strategy.' (Participant A)</p> <p>'As a result of the coaching, I made a conscious effort to first understand how and why I react the way I do in certain situations, which then led to changes in my behaviour and actions as I worked on consciously applying what I learnt, to my behaviour.' (Participant B)</p> <p>'Continuous development comes from first taking conscious action to improve and develop.' (Participant D)</p>   |
| 3. Continuous development     | The process of learning within the self, as well as in the team members reporting to the participants.  | <p>'We need to teach as well, sharing information for trust and confidence.' (Participant A)</p> <p>'Continuous development comes from first taking conscious action to improve and develop.' (Participant D)</p> <p>'Continuous development leads to improved leadership characteristics; good leaders know they need to always be learning, it's an ongoing process.' (Participant A)</p>   |
| 4. Leadership characteristics | The demonstrated outcome of the change and transformational process through the application of learnings and actions within the organisation and team.<br><br>Displaying leadership skills. | <p>'I found empowering is like planting, we are planting skills and perspectives; it is a slow process.' (Participant B)</p> <p>'We think of the environment and create an environment where people feel safe and secure enough to ask any question and get the help they need from their team members or myself or anyone else in the team.' (Participant E)</p> <p>'I think I've used the phrase 'fears, frustrations, wants and aspirations'. And it's just trying to find out all that information from people and ... understanding them, and then trying to match that to the job and giving them the joy or the motivation or ... to derive happiness from their day-to-day work.' (Participant A)</p> <p>'I feel it's important that, as leaders, we need to guide, and not in a sense of control, but more in a sense of inner care, in a caring way.' (Participant D)</p> <p>'I think that what the process of coaching showed me, and we talked before the process [about] trust and confidence as well, but that [I] as a leader can show some vulnerability to the team, and it's not a sign of weakness.' (Participant A)</p> |
| 5. Personal impact            | Areas of personal leadership influence in the organisation and teams.   | <p>'You know that you can help them and that can be really impactful.' (Participant A)</p> <p>'The personal impact of the coaching leads to improved leadership characteristics, in my experience.' (Participant A)</p> <p>'... if you empower people through trust and support and guidance, and allow them to own things, as they get more self-confidence.' (Participant C)</p>  |

**TABLE 2b:** Affinities for focus group 2.

| Affinities                | Definition   | Focus group comments   |
|---------------------------|--|--|
| 1. Leadership qualities   | Demonstrating leadership skills, behaviours, and characteristics.                    | <p>'Political savvy resulted in applying strategies to handle tough situations.' (Participant Y)</p> <p>'[B]ecame more flexible, comfortable with uncertainty.' (Participant X)</p>  |
| 2. Emotional intelligence | Ability to understand emotions and that of others, and to react appropriately.       | <p>'Certainly, a more mindful approach. We are not just responding immediately, I wouldn't say cautious, but a more controlled approach, before we respond.' (Participant X)</p> <p>'Slow down and [show] consideration for others.' (Participant Z)</p>   |
| 3. Social interactions    | Being able to comfortably interact with others in the work environment and socially. | <p>'Standing her ground, saying 'This is the value I bring', more self-assurance.' (Participant Y)</p> <p>'I certainly noticed a higher level of comfort in those settings ... Saw her stepping up and standing in front, being more comfortable with what she provides in a business context. I noticed this specifically.' (Participant Y)</p> <p>'Self-awareness, [I've] seen the difference over time in [participant]. Asking, "Is that the appropriate action right now?"' (Participant X)</p> |

## Ethical considerations

Ethical clearance to conduct this study was obtained from the University of South Africa, Department of Industrial and Organisational Psychology Ethics Review Committee

(Ref. no. 2021\_CEMS/IOP\_023) prior to recruiting volunteers. Informed consent was obtained from all participants and participation was voluntary. The researcher explained confidentiality and anonymity of the participants, who could

**TABLE 3:** Behavioural changes.

| Behavioural construct      | Interview comments   |
|----------------------------|--|
| Letting go of control      | 'So, the control feeling that I had, or the responsibility of [taking] control of everything from a behavioural change perspective, if I had to use an example, it helps me understand that I didn't need to, and I didn't need to have that type of control.' (Participant A)<br>'Now when I get to situations where I understand that I don't need to be in full control, but I need to be able to give input or guidance, then I can and I'm comfortable with it.' (Participant B)      |
| Social and self-confidence | 'I am more self-confident in myself and in my leadership.' (Participant B)<br>'Standing her ground, saying "This is the value I bring," more self-assurance.' (Participant X)  |
| Emotional self-regulation  | 'I work in intensive and, often, the emotions are high, and I take the moment to breathe [as] being the moment [to] understand, or do this differently.' (Participant B)<br>'I try to consider my body language when I talk. What is the word? Mindful interaction. I keep this in mind when talking to other people. My tone of voice, and all that.' (Participant D)   |
| Perspective taking         | 'This kind of day is very hard, and all the team feels stress. Recently, I [found] out ... I [found a] way ... to remove this load from my team, by just my reactions to this situation.' (Participant B)<br>'You need to, I guess ... "read" ... understand the person and provide the right type of support for that situation.' (Participant C)   |
| Stress management          | 'The biggest control over my personal impact is probably my stress level. I've definitely learnt that over the last year. I've learnt to not be stressed. You know, it's not always possible, but I've learnt.' (Participant A)<br>'Not feeling stressed or lost, but with [a] curious mindset.' (Participant B)<br>'Every time I keep calm and I don't feel stressed, my behaviour in such situations [becomes] more aware and focused on how to go through this moment.' (Participant B) |

withdraw at any time from the study without explanation or fear of penalty. The IQA protocol allows for all data to be generated and analysed by the participants themselves, through the focus groups and interview protocols described (Northcutt & McCoy, 2004). The IQA protocols supported integrity, trustworthiness and rigour of the data, through the comparison of the focus group SIDs with the interview data, adding further depth to the findings.

## Results

### Findings regarding the affinities

The affinities the participants created through the IQA process, are displayed in Table 2a and Table 2b. The comments from coachee participants from the focus groups and interviews conducted in Table 2a, Table 2b and Table 3, are recorded from A–E and that of the manager participants X–Z.

The findings indicate the complex and dynamic nature of the relationship between leadership and behavioural change. It also highlights that behavioural change is incredibly unique for each individual, even though various similarities were found in the content cards and comments made during the interviews. Behavioural Change, together with Internal Subconscious Development as primary drivers in the system, facilitate Conscious Action, a secondary driver.

Participants overall reported that they experienced fewer 'autopilot' reactions than before, as substantiated by supporting quotes from the interviews (see Table 3):

'So taking conscious action and, in my mind, it's almost [as] if I had to picture it, [as] if I had to try and find words for it, [it] is when you've gone through this behavioural change, you've realised how making decisions differently can have different, better outcomes potentially. I'm understanding that I [have] the ability to make decisions with [a] better perspective. [Taking] conscious action and being more aware of your surroundings because of the clarity. You now have [a] renewed or ... improved perspective.' (Participant B, Male, 30 years old)

Phrases and words such as 'mindfulness', 'taking a pause and/or breath', 'early [mental] preparation', 'reflection' and

'[being] conscious of behaviour' were mentioned throughout the interviews and focus groups contributing to various behavioural changes of which some are reflected in Table 3. These practices and actions specifically slow down the nervous system, which supports a perception of safety, bringing focused attention to the moment in order to allow the individual to make thoughtful and considered decisions. The findings suggest that becoming aware of current leadership behaviour in order to adjust or take different actions, was inherent in the lived reality of the coachee participants and their managers that is taking conscious action, which a secondary driver in the system. The SN in particular guides the brain's 'decision' about where to pay attention, and promotes a focus on what is most important in the current environment. The findings suggest that the participants had learnt to engage differently with their environment, by consciously paying attention to being aware of the moment, the 'here and now'. Throughout the coaching process, as inferred by the researcher based on coaching experience, participants demonstrated and articulated excitement, as well as a desire to act positively and constructively, committing to create improved outcomes and results within their teams, their organisation, and at a personal level. Approach-oriented behaviour is consistent with the left hemisphere, which further supports the inhibition of any overactivity in the amygdala, creating a sense and perception of safety, reduced anxiety, an expectation of reward and positive memories (Arden, 2019; Pillay, 2011). These neural changes may have contributed to the two pivots in the system, Continuous Development and Leadership Actions. Participants were able to focus on these approach-oriented actions, expecting positive outcomes. Such actions as a result, influence the necessary behavioural changes for Transformational Leadership and Leadership Characteristics, the primary outcomes in the system and subsequent Personal Impact, the secondary outcome.

From the interviews with coachee and manager participants, themes were identified, indicating the specific changes in behaviour that transpired (see Table 3). These themes are further explored in the discussion below.

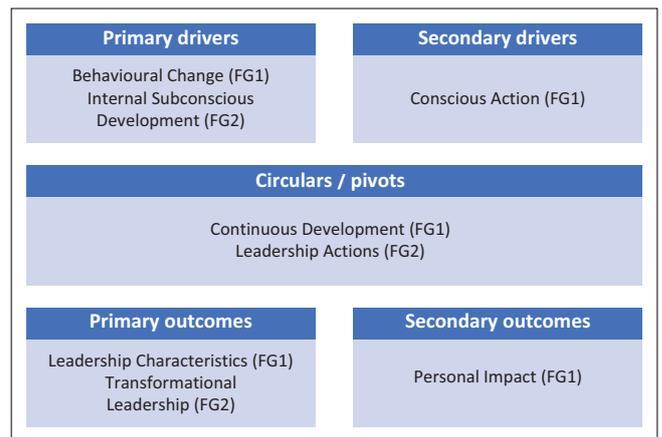
## Discussion

The purpose of this article was to report on the development of an integrated neuroscience coaching framework, and to further test the impact of such a framework on the development of transformational leadership behaviour. The framework was created based on current neuroscience and neuropsychotherapeutic principles. Limited literature and research are available on the impact neuroscience coaching has on leadership development, and in particular transformational leadership. As a result, other studies of this nature for consideration and comparison, were not found.

It is postulated, based on the findings of this study, that the integrated framework supported the coachees in the development and enhancement of transformational leadership behaviour, where the three operating neural networks were balanced, as influenced by the specific basic psychological needs of each coachee. The framework aims to create congruency or consistency between an individual's perception of reality and his/her beliefs, expectations, and goals. Incongruence will cause inconsistency within the mental system, and result in psychopathology (Dahlitz, 2015; Grawe, 2007). Approach and avoidance schemata show that the interpretation of basic needs, and motivation for their fulfilment, are driven individually, based on the entire history of the experiences to which each individual has been exposed (Ghadiri et al., 2012).

Establishing motivational priming (i.e. goal-directed behaviour or approach schemata) during coaching is a key element for a controllable incongruent learning state (Grawe, 2007). The formation of implicit emotional memories lies at the heart of approach/avoidance motivational schemata, and is a primary target in behavioural change interventions (Dahlitz, 2015). As a result of memory systems, leaders develop autonomic and default patterns of behaviour which may derail transformational leadership behaviours.

The terms 'top-down' and 'bottom-up emotion generation' refer to the brain's dual-route pathways that facilitate the activation of emotions (LeDoux, 1994). Bottom-up emotion activation is mediated by the amygdala-hippocampal network (rapid pathway and subconscious cognition), whereas top-down emotion activation is driven by the prefrontal cortex networks (slow, through conscious thought) (Faustino, 2022). The release of dopamine through goal-oriented excitement in the reward and SN helps with embracing reality and avoiding pain, contributing to a more fruitful neurochemical environment for learning and adopting change. The neuroscience principles applied in the coaching process facilitated approach-oriented behavioural change, a primary driver identified by Focus Group 1 (see Figure 3). This behavioural change presented in constructs such as a reduced need for control, reduced stress, perspective taking, self-efficacy, self- and social confidence, trust in their teams, positive



**FIGURE 3:** Summary of two focus groups' drivers, pivots and outcomes.

mood states, enhanced self-regulation and improved resilience, as identified through the interviews and focus groups. An improvement in these constructs contributes to the leader's overall demonstration of transformational leadership behaviour and personal impact.

Such approach behaviours are enhanced by the healthy activation of the EN, known for its higher-order functioning, which involves relying on the ability of the SN to choose where to place appropriate focus. Decision making is compromised when overactivation of the DMN takes place, which leads to a decline in cognitive functioning (Rossouw, 2014), and the selection of flexible approaches and the use of coping methods as an alternative (Arden, 2019). Should the DMN be excessively activated together with the SN this may lead to negative rumination, hampering leaders' ability to be effective in their daily operations and decision making, and further exerting an impact on positive self-regard, and self-esteem perceptions. When the leader experiences stressful or challenging situations, the function of the EN is further diminished, as blood flow is primarily in the areas supporting the biological requirements of dealing with perceived threat situations. Once primitive survival systems are activated by threatening environments, survival responses take priority in the neural patterns (Rossouw, 2014). Incongruence in the basic psychological needs, which contributes to a stress state, was thus addressed to further tone down the HPA axis creating emotional dysregulation – an axis linked to anxiety and overactive amygdala functioning. Pillay (2011) points out that it implies that leaders who are, for example, unable to form secure attachments, have a greater cortisol response to stressful situations. When a controllable congruence of basic needs is perceived, individuals may respond adaptively and employ an adaptive personal strategy to support their actions (Grawe, 2007). Coachees learnt how to engage the EN during times of stress, and improve emotional regulation through the healthy activation of the SN, thus activating the parasympathetic nervous system. While in a state of EN functioning, coachees were able to improve their perspective taking regarding the self and others, as well as their environment, leading to improved decision making and assessment of situations through self-regulated reflection,

instead of default and autonomic actions. Such mastery of stress reactions may stimulate reward circuits, and thus be saved as a learning memory for future activation (Ghadiri et al., 2012). From the findings it is postulated that the enhancement of SN functioning, which controls the selective activation of DMN versus EN, supported improved optimal switching between these networks. When one psychological basic human need is being positively strengthened, all other needs are affected in the pursuit of congruence, according to Grawe (2007). The findings suggest that becoming aware of current leadership behaviour in order to adjust or take different actions, was inherent in the lived reality of the participants and their managers. Focus Group 1 identified this process as Conscious Action. The pivots in the system, namely Continuous Development and Leadership Actions further indicate enhanced SN functioning, where the participants choose approach-oriented actions (see Figure 3).

Letting go of control was a theme which most participants raised, and this was observed by the manager participants in Focus Group 2 (see Table 1, Table 2a and Table 2b). According to Grawe (2007), the need for control is a basic psychological need which stems from fear, and a desire for certainty in the environment. Incongruent perceptions activate the need for control (Grawe, 2007). The avoidant motivational schema hypothesises holds that the participants' SN, and the procedural and affective components of experiences encoded in their implicit memory system, might be dysregulated, avoided or suppressed (Arden, 2019). This indicates that they are potentially, through neuroception, deciding that the environment is not safe, therefore possibly avoiding approach schemata which could be supportive of their team members and other stakeholders. The construct of self-efficacy beliefs (Rotter, 1966, as cited in Grawe, 2007) corresponds to this basic conviction related to control. The construct of self-efficacy is antecedent for transformational leadership. Sun et al. (2017) established that the most steadfast predictor of transformational leadership was leaders' self-efficacy. Trait mindfulness, as in repeatedly bringing awareness to the moment and thus slowing down the autonomic nervous system, predicted positive affect; leaders' positive affect, in turn, predicted leadership self-efficacy (Carleton et al., 2018). By harmonising the threat response, ignited by the need for control, participants experienced a safety state which allowed for reflection and awareness of their current actions. This provided an opportunity to consider alternative actions which might enhance outcomes in that environment. Grawe (2007) refers to this as a positive experience which grants clarity and sees an improvement in wellbeing and satisfaction with an individual's need for control, further resulting in a reduction of distress.

Transformational leadership is inherently a socially oriented approach with a strong focus on followers. Navigating the social world effectively requires a thorough integration between the left and right hemispheres, and between the cortical and subcortical systems (Dahlitz, 2015). The

framework supports such integration through the applied approaches, seeking congruence between basic psychological needs, and specific attachment needs which support healthy social functioning. Secure attachment leads to the creation of pro-social behaviours, and allows individuals to engage positively with others in the organisation, including peers and direct teams. Building trust in the organisation and teams is a further outcome of optimal attachment need satisfaction. An increase in social confidence, self-confidence, self-efficacy, and team functioning were reported by Focus Group 1 as Personal Impact, and Focus Group 2 (the manager group) as Social Interactions (see Figure 3).

Emotional Intelligence was highlighted as a primary outcome by Focus Group 2. They described a heightened level of emotional intelligence among the participants reporting to them, specifically when dealing with others by employing a mindful approach (see Table 3). The findings suggest that participants have learnt to engage differently with their environment, by consciously focusing on being aware of the moment, the 'here and now', as repeatedly expressed by one participant throughout the study. Emotional intelligence is an overarching leadership construct which influences various transformational leadership behaviours (Barbuto & Burbach, 2006). Self-regulation, as described above by the activation of the EN and deactivation of the DMN, may contribute to this affinity as a primary outcome.

The findings suggest that the various characteristics of transformational leadership development can be enhanced with the application of neuroscience and neuropsychological principles through coaching. In line with the literature, establishing homeostasis and congruence in the operating networks and basic needs creates a neurological state which supports behavioural change within an individualised context.

Furthermore, IQA can be used when doing online research, specifically to determine the success of coaching interventions.

## Implications

The findings suggest that the application of the neuroscience coaching framework created an enriched and safe environment in which the participants experienced enhanced functioning of the three operating networks, and increased congruence of their basic psychological needs.

Neuroscience offers coaching insights into the functioning of the brain, to facilitate change in a more directed and intentional manner, resulting in the achievement of desired outcomes. New models and frameworks for coaching, which incorporate neuroscience and neuropsychological principles, could be developed alongside other disciplines to inform coaching practice. Coaches will therefore benefit from understanding neuroscience principles as a means of facilitating and enhancing their coaching practice. Besides the impact neuroscience coaching has on leadership

development, the knowledge and understanding of neuroscience principles learnt through the coaching process itself, may further translate into the enhancement of the leader's impact on his/her teams and peers within the wider organisational context. The concepts and principles derived from neuroscience are further applicable to the wider context of the organisation, and would be useful to consider for interventions related to change management initiatives, organisational development and learning and development activities.

Leadership coaching can also be successfully conducted online.

### Limitations and recommendations

Literature and research studies specifically related to neuroscience in the coaching context, were limited. Literature related to applied neuroscience from a neuropsychological perspective was available, and greatly informed this study. Language was a limitation in the study, especially in the focus groups and during the interviews. English was the second language of some of the participants and that had an impact on the flow of discussions and the meaning attributed to concepts during the focus groups. The fact that the study was conducted with six participants may be deemed a limitation, given that the findings are not generalisable to other populations. Similarly, the number of managers who subsequently attended the focus group and interview was small (three and one, respectively), and that may be deemed a limitation. Apart from the limitations of the empirical study, the research provides opportunities and possibilities in a rapidly developing field that will greatly benefit from future empirical research, and subsequent application within the business and coaching contexts.

The integrated framework developed in this study, provides a new dimension for coaches, where knowledge of neuroscience and neuropsychology provides insight, and may illuminate areas of coaching which might never before have been incorporated in the general or mainstream training of coaches. The concepts of neuroscience and neuropsychology seem far removed from the business world. Coaches can use this framework to engage in neuro-education, bringing concepts that may have positive, constructive and productive impact on leaders, to their attention. Neuroscience provides a foundation of rigorous scientific evidence to support coaches in this regard. Coaches can benefit greatly from the insights and principles that neuroscience offer, in seeking to better comprehend the mechanisms underpinning the behaviour and development of their clients. Coaches will further enhance their skillset, expand their own coaching approaches, and develop new competencies through the application of the integrated framework.

### Conclusion

The study reported on here, explored the impact of an integrated neuroscience coaching model on transformational

leadership behaviour, through the lived experiences of the coachees and manager participants. Leadership, in essence, is an expression of the self, and neuroscience allows working at this level with leaders to enhance leadership behaviours. The findings support the rapid and profound impact which applying neuroscience principles within a neuropsychological context may have on leadership behaviours and learning. Facilitating improved integration of the three operating neural networks within the individual dynamics of basic psychological needs promoting leadership development through the coaching process. The framework described in this study opens up opportunities for further research in applied neuroscience and coaching.

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### Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

### Authors' contributions

L.K. conducted the research as part of the requirements for the completion of a PhD in Industrial and Organisational Psychology and wrote the first draft of the article. D.J.G. supervised the study and contributed to the writing and review of the article prior to submission.

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### Data availability

The data that support the findings of this study are available from the corresponding author, L.K. upon reasonable request.

### Disclaimer

The views and opinions expressed in this article are those of the authors and are the product of professional research. It does not necessarily reflect the official policy or position of any affiliated institution, funder, agency or that of the publisher. The authors are responsible for this article's results, findings and content.

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