

The Neuroscience of Coaching

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Introduction

Our conscious experience is so dense and multi-faceted that we puzzle how such complexity arises from a single source: the brain. This is not to say that the brain acts in isolation – as we shall see, brain function is influenced by its connection with the central nervous system (CNS), by multiple systems throughout the body, and by social and developmental factors. Recent developments in understanding the brain and nervous system's function and influence – in essence the expanding field of neuroscience – have promulgated a myriad of applications for behavioral-based professions, including coaching. Neuroscience is one of the fastest growing areas of research in science; its popularity is not dissimilar to the surge of interest in coaching. Thus, as neuroscience research continues to propagate alongside coaching, an obvious question emerges: “Can a synergism be forged between these fields in the future?”

It may not readily be apparent why neuroscience is relevant to coaching. Yet, like coaching, neuroscience is multi-leveled and multi-disciplinary. Investigations range from the specific, as when examining the signals that start and stop motor activities starting in a circuit of neurons (Jin and Costa, 2010), to systemic, as when recording activity in pain pathways arising from social rejection (Eisenberger *et al.*, 2003; Eisenberger and Lieberman, 2004). Such research has the potential to ratify (i.e., validate) widely-employed coaching practices and to inform empirically-supported future approaches. Because coaches are concerned with engaging clients to produce results, it behooves the coaching community to examine how neuroscience might impact current and future strategies within the coaching profession.

This chapter is intended to be a primer for coaches who wish to integrate fundamental aspects of neuroscience research and its applications into their practice. We provide examples that link neuroscience research to coaching processes. Section one introduces neuroscience research, describes the ways in which it is performed, and elaborates upon

potential mechanisms involved in coaching processes. Section two details the contributions of neuroscience in understanding human behavior and highlights those contributions that impact coaching. Section three suggests potential future collaborations between coaching and neuroscience.

Section One: Neuroscience and Understanding the Nervous System

As part of a general orientation, coaches claim to work with individuals as a whole, including their physical beings (Olalla, 2004; Whitworth *et al.*, 1998). Asking whether mind and body affect each other presupposes that they are separable. They are not (McEwen, 1998; Sapolsky, 2004; Segerstrom and Miller, 2004), although full understanding of the interaction between the brain and the body has yet to be elucidated. The brain is a major component of a system of nerves that extends throughout the entire body and is involved in our conscious experience and sense of self. Coaches who ignore the interrelatedness of brain–body–mind relationships are ignoring substantial research.

The brain governs behavior with both incredible complexity and elegant simplicity. There is a common fallacy that we use only 10 percent of our brains; however, even simple problem solving draws upon an array of interconnected systems throughout the cortex. The brain is functionally organized such that discrete areas are devoted to performing particular skill-types; broad examples of such organization include vision, touch, speaking, and movement. In addition, areas of greater refinement have been identified, for example cerebral specialization for error identification in planned goal-directed movements (Holroyd and Coles, 2002), or recognizing that your arm is your own (van den Bos and Jeannerod, 2002).

Anatomically, the various regions of the brain are intricately interconnected. One such example is the insular cortex, an area located deep within each hemisphere between the temporal and frontal lobes that plays a role in autonomic regulation, emotion, and cognition. The insular cortex connects with the amygdala, medial prefrontal cortex, anterior cingulate gyrus, frontal, parietal, and temporal cortical areas (Berntson *et al.*, 2011). Simply mapping these connections is an enormous task, let alone understanding how they relate to behavior. These types of cerebral organization are roughly consistent for all humans and analogous to other primates; this has important implications. For example, despite the varying contexts in which they might occur, fear responses result from activity in the same brain areas across species. That is, the ubiquity in the design of the brain and its relation to the body indicates that some level of standardization may be possible when designing behavioral treatments.

Exploring the links between wellness and performance – common background considerations in coaching – has revealed noteworthy relationships between physical and mental health (Walsh, 2011). For example, physical exercise relates robustly to physical health (Richardson *et al.*, 2004; Smart and Marwick, 2003), mental health, and cognitive ability (Pereira *et al.*, 2007; van Praag, 2009; Voss *et al.*, 2011) even when practiced later in life (Gates *et al.*, 2011; Kramer *et al.*, 2006). Physical self-care is the domain of many specialized coaches; its influence on mental processes is only beginning to be understood. Several branches of behavioral sciences are exploring these findings using combinations of neuroimaging, studies of brain lesions, clinical observations, and laboratory experiments. The findings are still preliminary, therefore coaches should not be compelled, as a result of these findings, to prescribe exercise as part of their practice; however, the potential application to coaching practice is profound.

Exercise-induced effects are but one of many possible underlying mechanisms relevant to coaches who want to gain a basic knowledge of how our central nervous system (CNS) processes information. Consider that neuroscience has aided understanding in coaching-relevant processes, including: the basis for motivation to reach a goal (Mizuno *et al.*, 2008); what mitigates stress responses when a threat is perceived (Arnsten, 2009; van den Bos *et al.*, 2009); and how change can be effectively adopted into long-term behavior (Bandura, 2004). These examples point to just three important elements that relate to successful coaching. Here, we suggest three levels of analysis at which the fundamentals of neuroscience may be understood:

- 1 Molecular and/or subcellular influences on behavior (e.g., hormones, neurotransmitters).
- 2 Intrapersonal – influences on the individual arising from the functional organization of the brain (e.g., emotion, motivation).
- 3 Interpersonal – behaviors that emerge as a result of interactions with the environment and, indeed, all complex human behavior (e.g., empathy, social interactions, culture).

Because of the wide variety of questions that neuroscientists attempt to answer, there are many different methods by which data can be gathered. We turn next to a brief summary of methodology, before returning to how neuroscience can facilitate coaching.

Section Two: Studying Neuroscience and Observing Behavior

A large part of what we know about human behavior stems from observational studies of individuals with known brain injuries. Individuals who have suffered a damaging cerebellar incident (e.g., ischemia, thrombosis, lesion, ablation) can provide examples of impairment resulting from the loss of a specific functional area. However, bleeding, swelling, and infection produce non-discrete damage and sometimes tissue damage opposite a site of injury (Courville, 1942). Therefore an ability to generalize from a single case study is often limited. To protect against a limited ability to generalize from case studies, meta-analyses are often conducted that examine large sets of data to allow researchers to extrapolate the requirements for normal functioning in healthy brains (Berntson *et al.*, 2011).

Neuroscientists are also able to infer the underlying drivers of human behavior by observing changes in non-human organisms that result from experimental manipulation. Animal models range from simple organisms like fruit flies and yeast to more complex organisms such as rats and monkeys. In all cases animal models allow investigations and discoveries that would otherwise not be feasible on human participants, while still allowing generalization and comparison to human behavior.

Before the advent of imaging technology, efforts to determine the link between brain damage and behavioral changes were limited to postmortem confirmation. However, it is now possible to image the brain *in vivo* using technologies to record and reconstruct neural activity patterns *post hoc*. These reconstructions are therefore not indications of brain activity per se, but rather indirect measures or approximations constrained by the specifications of the equipment. Such limitations may, at first pass, hamper the ability to generalize these findings to behavior writ large. However, scientific design and the ability to replicate testing can somewhat alleviate concerns over technical limitations by requiring specific questions that address finite problems. Admittedly, the design of the

equipment described below may prevent participants from moving or talking freely; nonetheless, experiments may be conducted that allow participants to respond to pertinent questions. To fully understand measures of *in vivo* activity and how they can apply to coaching processes, we briefly review these technologies.

When neurons communicate they produce an electrical signal that moves along the membrane of an initiating neuron and is converted to a chemical signal that spans the space between two neurons to a receiving neuron. The junction between the initiating and receiving neurons is referred to as a synapse. These signals from neurons can be measured in volume from the surface of the skull. Using sensors placed upon the scalp, an electroencephalogram (EEG) can measure electrical activity in the brain. The EEG measurements typically represent a signal generated by larger sets of neurons related to a particular stimulus in the environment (known as an event related potential, or ERP). Since individual neurons fire regularly, it is difficult to isolate one neuron's response relative to the stimulus; however, the response of a population of neurons will produce an ERP that allows precise temporal measures related to cerebral activity. The electrical current flow within the brain that results from neural activity is similarly used in magnetoencephalography (MEG) scanners to provide precise estimates of when certain brain areas respond to a variety of stimuli. Thus, EEG and MEG studies are often used in investigating the timing of cerebral activation.

Greater spatial specificity related to cerebral activation is better obtained through positron emission tomography (PET). This method provides clear anatomical images with more detailed spatial precision but less temporally precise measures. This type of imaging does not provide direct measures of synaptic activity; instead researchers infer activity based on changes in metabolism in active areas. Positron emission tomography combines magnetic resonance imaging (MRI) and computed tomography (CT) scanning technology to measure blood flow via metabolic rates that are measured using radioactive deoxyglucose (or sugar) that is injected into the bloodstream shortly before performing the to-be-measured task. This radioactive material quickly decays and poses no serious risk while allowing researchers to measure which cells are active during the task by recording those that metabolize the deoxyglucose. When neural activity in a given cortical area demands an increase in metabolism, oxygen-rich blood, the source of energy, is supplied to that area and so, too, is the radioactive marker. Researchers can indirectly measure neural processing by recording the radioactivity in given brain regions.

In the example in Figure 6.1, researchers treated depressed patients with transcranial magnetic stimulation (TMS) to induce a weak electrical current in participants' mid-dorsal lateral frontal cortex. Paus *et al.* (2001) suggest that rehabilitating activity levels in the frontal cortex may be a means of treating depression. Positron emission tomography images taken following treatment show areas of decreased metabolism and other areas of increased metabolism in the patients' brains. Such a procedure enables researchers to directly engage with one area of cortex and then measure the subsequent changes in connected areas that result from the manipulations at a single treatment site.

Transcranial magnetic stimulation affects the natural changes in magnetic field properties in the brain that result from metabolism and is a non-invasive procedure that produces minimal discomfort. Transcranial magnetic stimulation equipment can be used to administer directed magnetic field disruptions to a selected brain region and may result in elevation or depression of neural activity, as illustrated in Figure 6.1. By rehabilitating activity levels in the frontal cortex using TMS, disorders such as depression can be treated (Paus *et al.*, 2001; but see also Paus and Barrett, 2004). Transcranial magnetic stimulation can also be used

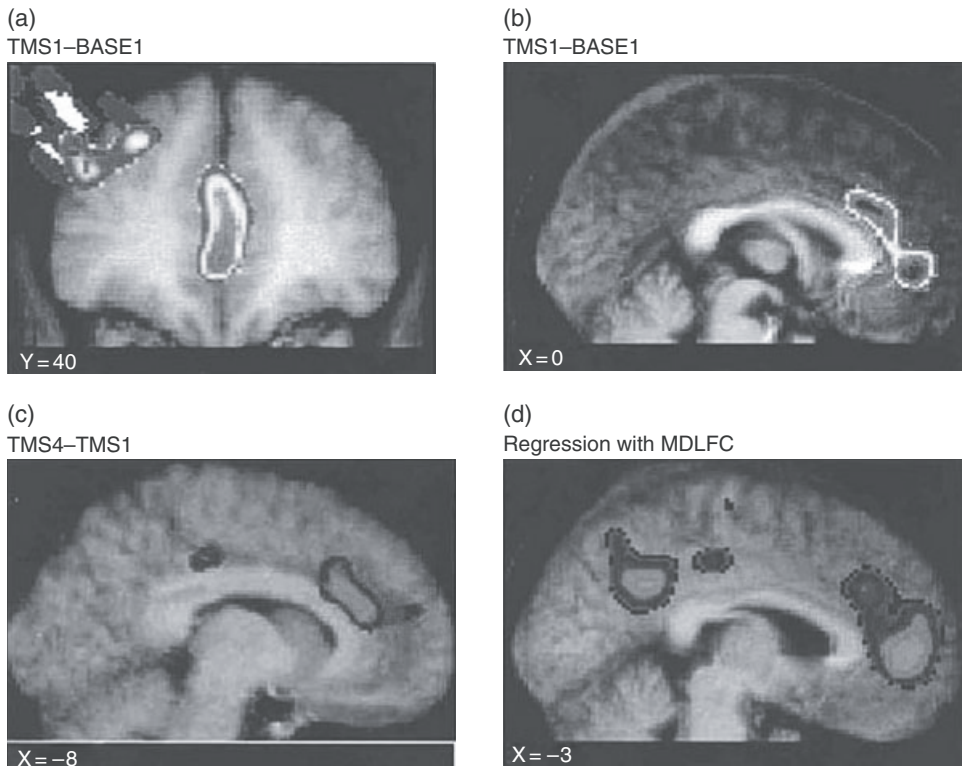


Figure 6.1 Examples of PET measured changes in metabolism following clinical TMS treatment. Participants with depression were treated with TMS stimulation to the mid-dorsal lateral frontal cortex (placement of TMS coil shown in top left of (a); target of stimulation in crosshairs). Following treatment with TMS, metabolic rates in the brain were measured using PET imaging. Areas of decreased metabolism (i.e. inhibited activity) were seen at the stimulation site and several distal sites (a–b). Areas of increased metabolism (c) and correlated increases in blood flow also resulted (d) (adapted from Paus *et al.*, 2001).

to temporarily disrupt behavior in a focused brain area by inhibiting neural activity without causing permanent damage. This ability has led many to describe its effects as a virtual lesion, which, as discussed above, can reveal contributions of specific brain areas to behavior.

Studies using functional magnetic resonance imaging (fMRI) also record the flow rates of oxygenated blood (i.e., hemoglobin). When hemoglobin is deoxygenated, the magnetic property of the hemoglobin changes and produces a signal that can be detected by the MRI scanner. Thus, greater neural activity in the brain during a cognitive task produces a change in the magnetic field in that brain region. Figure 6.2 compares examples of fMRI recordings during creative and uncreative thinking (Howard-Jones *et al.*, 2005). In both cases, activity shared in both creative and uncreative thinking is not shown. Images such as these enable researchers to “see” inside a functioning brain and to determine which cortical areas are necessary for a variety of cognitive tasks.

While each current technique has its limitations, these approaches are not easily dismissed. Both PET and fMRI measurement have become increasingly useful in recent years, as their ability to record more rapid time-sensitive readings with greater accuracy has progressed. Bennett and Miller (2010) report that while the “reliability of fMRI may not be high relative

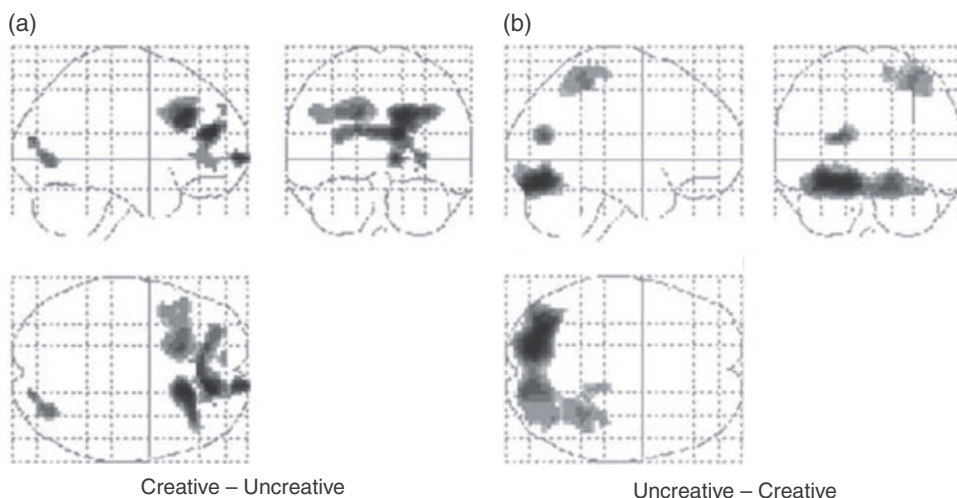


Figure 6.2 Examples of fMRI recordings during creative and uncreative thinking. (a) Activation patterns recorded during creative thought which are achieved by “subtracting out” activity that also occurs during uncreative thinking; areas of shared activity are not represented. (b) Activity patterns during uncreative thought which are achieved by subtracting out activity that also occurs during creative thought; areas of shared activity are not displayed (adapted from Howard-Jones *et al.*, 2005). Note that creative thinking uses frontal areas (used in problem solving) while uncreative thinking uses areas that process visual information.

to other scientific measures ... it is presently the best tool available for *in vivo* investigation of brain function” (p. 150). To account for these challenges, Logothetis (2008) suggests a “multimodal approach is more necessary than ever for the study of brain’s function and dysfunction ... [including] further improvements to MRI technology and its combination with other non-invasive techniques that directly assess the brain’s electrical activity” (p. 877).

Indeed, several researchers have begun employing more than one approach in their studies to minimize equipment-specific limitations and to bolster the robustness of their findings (see Figure 6.1). For example, certain researchers are using multiple tools to capture brain activity with the temporal specificity of MEG and the spatial specificity of fMRI (Sawyer, 2011). Taken together these approaches reveal that there are multiple avenues of exploration available to neuroscientists to study behavior as it occurs. Unsurprisingly, with so many tools at its disposal neuroscience research has grown rapidly in recent years.

We turn now to the application of neuroscience findings to coaching processes by reviewing findings at the three levels and how each can impact coaching. A quick caveat: coaching discussions include abstract concepts such as social awareness, empathy, and creativity. These abstract concepts are difficult, though not impossible, to examine in a laboratory setting. And while exactly how the brain gives rise to these more complex faculties is not yet fully understood (Brothers, 2001; Siegel, 2010), significant progress has been made. The lack of clarity stems in part from the fact that abstract concepts such as empathy and fear emerge from interactions between multiple brain areas (Preston *et al.*, 2007; Zahn *et al.*, 2009). Still another factor that will be familiar to coaches is that many abstract concepts are difficult to define operationally. Ask yourself what consciousness entails and you’ll soon find yourself in good company, as this is a current dilemma for many neuroscientists. Thus, although still preliminary, evidence is mounting to suggest that even the more complex mental processes can be investigated using modern equipment.

Molecular and subcellular influences

Although studying behavior at a microscopic level may initially seem to simplify experimentation, these pursuits require extraordinary precision and highly-detailed paradigms. For example, studying how neurons communicate takes great care. Synaptic transmission – the result of chemical reactions within the cell and between neurons – can be influenced in their development and function from the release of neurotransmitters (Greengard, 2001), can be influenced by other chemical influences such as endocannabinoids (Alger, 2002), as well as the components of the neuronal membrane (Zamponi *et al.*, 2010), past connections between cells and more. Each of these components can influence the activity of single cells and circuits of many neurons related to the behavior we see in an individual. As just one example, a defect in the way a protein is synthesized in the structure involved in generating the synapse in neurons has recently been found to contribute to epilepsy (Zamponi *et al.*, 2010).

At the molecular level, investigators employ a number of state-of-the-art technologies and methodologies. These may include the analysis of a cell's DNA and the localization of specific molecules within cells using specific antibodies, cell-body staining, using radioactive markers to monitor deoxyglucose uptake in neurons during metabolism, or using genetic color markers that dye certain proteins in order to trace neuronal connections throughout the brain. While these methods are beyond the scope of this chapter, they contribute to understanding of the connectivity and function and are often the first step neuroscientists employ in understanding behavior at the next level of analysis.

An awareness of the interrelatedness of neural connections and their influences could benefit coaches who desire to understand the mechanisms that underlie behavioral strategies they may wish to employ with clients. As an example, gonadotropin releasing hormone (GnRH) stimulates the pituitary to secrete luteinizing hormone, which in turn induces ovulation in females and spermatogenesis in males. Neurons that stimulate GnRH production are heavily represented in the hypothalamus (a gateway to the limbic system), the autonomic nervous system (responsible for, among other things, both stress and relaxation responses), and the endocrine system. Thus, the production and availability of just one hormone can have far-reaching implications for a number of behaviors.

The majority of applications to coaching at the molecular level are, for now, beyond our reach, though they may still provide the foundation to the intrapersonal and interpersonal level of analysis relevant to coaches. A few examples provide some points of reference. Van den Bos and colleagues (2009) have noted differences between men and women in how cortisol reactivity relates to performance. Many coaches are also familiar with the behavioral indicators of attention deficit hyperactivity disorder (ADHD), an area of concerted investigatory focus in neuroscience. Although there remains a great deal to be learned about this disorder, having an awareness of the underlying mechanisms may provide coaches with a better understanding of approaches they can use to mediate a client's emotional response or to help them battle feelings of being overwhelmed.

Intrapersonal influences: Mediating individual behaviors

Research in psychology in the mid-twentieth century explored myriad behavioral topics related to individual behavior, including perception, memory, reasoning, language, problem-solving, and decision making; as technology improved, neuroscience-influenced questions began to follow. The rapid expansion rate of investigation has engendered considerable

understanding of behavior, both developmentally (Hua and Smith, 2004) and with regard to adults (Johnson and Taylor, 2006). Among the array of coaching-related topics investigated by neuroscience researchers are creativity (Limb and Braun, 2008), problem solving (Kounios, *et al.*, 2006), and the effects of optimism (Schacter and Addis, 2007). In all cases these findings have led to a greater understanding of how the environment and behavior reciprocally influence the individual – the topic of our next section.

At first pass, coaching might be described as a process to facilitate the learning (and remembering) of new behaviors. In the brain, memory is in part influenced by activity in the hippocampus (Davachi and Wagner, 2002). Recalling memories is subject to a variety of influences and can be improved by allowing elaboration in relation to closely-valued concepts and autobiographical details (Tambini *et al.*, 2010). Learning is also benefited by aerobic exercise (Ratey and Hagerman, 2008), sleep patterns (Tambini *et al.*, 2010), distributed practice (Litman and Davachi, 2008), and even taking tests (Roediger and Karpicke, 2006), and is conversely inhibited by distraction (Arnsten, 1998, 2009). Learning is too broad to be included in the scope of this chapter, and is instead presented in more detail in Chapter 11. Coaches can benefit greatly from researching and applying empirically substantiated learning methods in their practice.

Coaching requires more than providing an environment in which the client remembers and develops action goals, it also requires acknowledging feelings as a crucial component in facilitating change behaviors. Indeed, recent trends in neuroscience place emotion at the center of coaching issues (Camille *et al.*, 2004; Davidson *et al.*, 2000; Izard, 2010; Jaremka *et al.*, 2010). Emotional self-regulation – considered central to maturational development (Posner and Rothbart, 2009) – positively relates to effective socialization (Rand *et al.*, 2009), achievement (Blair and Diamond, 2008; Pekrun *et al.*, 2002), productivity in adults (O'Connor *et al.*, 2010), and avoidance of psychopathology (Schoore, 2006). Evidence is amassing to suggest that emotion reciprocally influences cognition; emotions do not corrupt rational decision making – they are necessary to it (Bechara, 2004; Bliss-Moreau and Barrett, 2009). Part of the coach's job, then, is to create an environment in which clients integrate their emotional experience to generate cogent decision making.

Emotional and cognitive processes, while interdependent, are at least partially segregated in the brain (Critchley, 2005). Self-reflections relative to emotional states have been shown to occur separately in the brain from reflections on self-conceptualization (Lieberman, 2007). Conscious cognitive strategies may thus be used to regulate emotional responses that would otherwise reduce cognitive capacity and make falling into implicit patterns more likely (Mak *et al.*, 2009; Ochsner and Gross, 2005, 2008). Strategies to determinatively select emotional states that are conducive to decision making can arise from helping an individual name an experienced emotion (Lieberman *et al.*, 2007) and from reappraising emotion – in other words, to reassess assumptions that associate tears with sadness rather than joy (McRae *et al.*, 2010).

Becoming aware of automatic patterns and deciding to regulate our emotions requires metacognition, or the ability to observe our own thoughts, feelings, and behaviors. A popular technique for this is mindfulness training. Using an approach that taught participants mindfulness meditation, Farb and colleagues (2007) found participants were able to dissociate between self-evaluative measures that are momentary (present) and those that are persistent (ongoing). In doing so participants differentially engaged frontal cortical resources and effectively changed the way they thought about an issue (Farb *et al.*, 2007). Similar training also influenced how participants' experience of sadness is expressed in the brain (Farb *et al.*, 2010). Such changes may occur in response to physical changes

in brain structures associated with attention and emotional integration that have been recorded following mindfulness training (Hölzel *et al.*, 2011).

Present-based focus (through mindfulness) may be a critical component of changing how clients process an event and find viable alternatives by suggesting that clients re-frame how they think about an issue. Directed attentional control is required to guide our thinking patterns when we are tempted to focus only on an emotion-arousing event (Hedden and Gabrieli, 2006). Though evidence is just emerging, mindfulness training appears to be a solid candidate for an empirically validated coaching skill that benefits attention (Lutz *et al.*, 2008; Tang *et al.*, 2007), measures of general well-being (Brown and Ryan, 2003), and memory and emotional experience (Jha *et al.*, 2010).

Clients often seek coaching to create change in their lives. However, there is a gap between recognizing the need for change and choosing what must be done. In such cases, coaches would benefit from understanding how to inspire creative thinking in order to provide unusual or unexpected solutions. Recent work on creativity has revealed that the frontal cortex plays a pivotal role in creative thinking (Heilman *et al.*, 2003). Heightened frontal cortical activity has been recorded in activities such as divergent creativity tasks in music (Gibson *et al.*, 2009) improvisation for jazz musicians (Limb and Braun, 2008) and storytelling (Howard-Jones *et al.*, 2005). These are just a few examples of important skills used in solution finding.

Electroencephalogram (EEG) measures reveal a distinct pattern of electrical activity in the brain known as alpha wave activity during the creative process (Fink *et al.*, 2008). That is, creative thinking is activity-level dependent (Heilman *et al.*, 2003) and requires investment from a great many cortical structures. Indeed, one of the hallmarks of creative thinking is a vastly distributed activation pattern (i.e., creativity is not a strictly right hemisphere task – Sawyer, 2011). Importantly, training can help participants produce creative thinking (Fink *et al.*, 2008), suggesting that creative thinking can be instigated under certain circumstances. While the components necessary for creative thought are only just being identified, coaches may already be able to draw from these discoveries. Creative thinking occurs when the perception of threats are mitigated (Berns, 2010); it often does not result from “thinking about a problem” but instead stems from insights that occur when distracted (Kounios *et al.*, 2008).

Maintaining a positive mindset – at least while solution finding – may be what keeps individuals open to possibility. When positive and negative experiences occur at a ratio of three to one, problem-solving abilities improve (Frederickson, 2009). Similar findings have surfaced in work with couples and relationship enhancement (Gottman, 1994), business team dynamics (Losada and Heaphy, 2004), and psychotherapy success (Schwartz *et al.*, 2002). The possibility that positive behavior influences the brain is suggested by research showing resilient individuals (those who resist succumbing to setbacks or challenges) show distinct physiological and psychological profiles (Frederickson, 2001, 2009). Waugh and colleagues (2008) show corresponding evidence in brain-scanning work, concluding that neural activation patterns correlated with resilience (i.e., ability to recover following setback).

Mindset and expectation can affect the body in many ways, including our next topic – the negative. Negative behavioral strategies such as emotional suppression have been linked with the physical side effects of increased blood pressure and heart rate. However, there are mental artifacts as well. There are important reasons why a coach should identify instances when a client attends to the negative. For example, focusing on the negative increases the salience of negative stimuli (Barrett *et al.*, 2007) that are then remembered more often than positive stimuli (Ray *et al.*, 2005). Fixating on the negative may also limit social

and self-awareness, relationship management, and self-regulation (Beauregard, 2007). Thus, a negative mindset can lead to a familiar downward spiral that actively inhibits a client's capacity to help themselves and, over protracted periods of time, may contribute to depression.

When circumstances are perceived as sufficiently negative, a threat response may be triggered in the amygdala (a component of the limbic system and important for emotional regulation). The strength of amygdala activation depends, in part, on the level of threat appraisal and results in activation of the sympathetic nervous system's fight or flight response. Amygdala activation produces the subjective experience of a strong emotional surge that inhibits frontal cortical areas while increasing self-protecting behaviors (Arnsten, 1998, 2009). The inhibition of frontal cortical areas limits creativity and meta-thinking, and encourages fixating upon more proximal and immediate details of the task at hand (Phelps, 2006) that can significantly hamper decision making (Feinstein *et al.*, 2011; Mui *et al.*, 2008), emotional memory encoding (Murty *et al.*, 2010), and social status evaluation (Borsook and McDonald, 2010; Zink *et al.*, 2008). Accordingly, old habits that may exacerbate the situation are more likely acted upon while analytical capabilities are sacrificed – a familiar profile to many coaches.

As we have said, amygdala activation arises in response to perceived threats. Coaches may deal predominantly with those stemming from social threats. Researchers have identified what may be considered to be five key areas in which social threats are perceived: social status related to dominance hierarchies (Chiao *et al.*, 2004; Zink *et al.*, 2008); autonomy, or self-governance of the individual (Leotti *et al.*, 2010; Rodin, 1986); belonging or alienation from social groups (Baumeister and Leary, 1995; Baumeister *et al.*, 2002); fairness estimates (Tabibnia *et al.*, 2008); and uncertainty related to decision making and producing errors in judgment (Heilman *et al.*, 2010). Thus, an important consideration for clients emerges: situational evaluations may promote threat assessments and shut down cognitive ability related to solution finding. Indeed, the type of thinking that coaches encourage for their clients might require regulating fear responses – especially fear of public ridicule, failure, and uncertainty (Berns, 2010). In some cases, coaches must keep clients from “thinking too much” in order to continue to promote productive creativity.

Taken together, the above-detailed neural activation patterns provide coaches with good reason to remain aware of – and in some cases increase – the client's awareness of his or her emotional state while offering strategies for self-management. Mediating emotional extremes is necessary to maintaining the cognitive capacity to identify options in coaching. For example, the client's naming of an emotion (affective labeling) interrupts activity in the amygdala and promotes right ventrolateral prefrontal cortical activity and results in a calming effect (Lieberman *et al.*, 2007). Thus, talking about feelings in the present may implicitly calm a client, while talking about narrative details may freeze them (recall the similar effects of mindfulness training).

Coaches are familiar with the common route of solution finding to decision making that leads to action. But is one path better than another? And, should coaches be at liberty to prescribe it? Consider that the positive outlooks discussed earlier can be learned and therefore do not need to be imposed upon a client. One strategy for improving outlook is keeping a daily gratitude journal, which has been shown to protect against depression and to help individuals identify components of their lives that they enjoy (Emmons and McCullogh, 2003). Accordingly, coaches may encourage clients to be self-directed while also indicating options that incorporate the coach's input into decision making.

However, coaches must be aware that providing too many options may also be problematic as the client pursues his or her goals. Making choices involves conscious processes influenced by the pre-frontal cortex (PFC; Gold and Shadlen, 2007). When tired or otherwise depleted, we literally may not have the energy to interrupt an established pattern (Gailliot *et al.*, 2007). Even when well rested, too many choices will negatively affect decision making (Halford *et al.*, 2005; Shiffrin and Nosofsky, 1994) by, for example, dividing attentional resources (Einstein *et al.*, 2003; Kensinger *et al.*, 2003). As a result of overwhelming choice, implicit habitual responses are more likely to be selected rather than potentially adaptive behaviors. Some researchers have suggested that considering only two options is the ideal circumstance for making a decision (Schwartz, 2004). Others suggest that having and following explicit procedures in making decisions can help regulate the emotional arousal that interferes with decision making (Seo *et al.*, 2010). Here, the coach's influence in helping the client design such systems becomes apparent.

Not only can emotional state influence a client's view of himself or herself, it also colors their perception of others. Moreover, creativity, optimism, and confidence, may well impact interpersonal relationships and the workplace (Peterson *et al.*, 2008). Helping clients understand their peers can produce several benefits within organizations.

We turn next to social relationships because while it is clear that there are many internal influences on an individual, recent findings in social neuroscience have revealed important interactions between the social environment and the individual as well.

Interpersonal influences: Complex social interactions and dynamics

Cozolino (2006) argues: "The individual neuron or a single human brain does not exist in nature," referring instead to social interactions as "our natural habitat" (p. 11). Indeed, many professionals, including coaches, are interested in behaviors that arise from social interactions and their potential to influence brain structure (Siegel, 1999). Neuroscience research has begun to elucidate the underpinnings of relationship management, social awareness and how we view others (Amodio and Frith, 2006; Lieberman, 2007; Mitchell *et al.*, 2006).

An undeniably large part of our social skill set is learned during maturation. Child-caregiver attachment styles shape how an individual will later relate to their social sphere (Ainsworth *et al.*, 1978; Bowlby, 1951, 1969, 1973, 1980). Siegel (1999) suggests that adult relationships both reflect and heal childhood attachment deficits. Using imaging studies, Schore (2001) has reviewed the caregiver's influence on infant limbic system development (the amygdala and more), suggesting that parenting styles influence how a child self-regulates, copes with stress, and relates to others, and whether they are susceptible to mental disorder. Life experiences will influence how a client sees their social world, but is this immutable?

Despite such established patterns, coaches may explore using brain-based approaches with clients to influence how they perceive others. Coaches may have heard of one of the more vaunted discoveries from neuroscience: mirror neurons (Gallese *et al.*, 1996). This discovery is both new and far-reaching so it calls for careful consideration. Mirror neuron studies cite activation patterns in specialized subsets of neurons involved in both the generation and observation of action (Gallese *et al.*, 1996; Iacoboni *et al.*, 2005). Rather than being a specialized type of neuron, mirror neuron activity is linked to populations of neurons that respond to actions of another (Dinstein *et al.*, 2008). Mirror neurons point to a common specialized circuitry that is tuned to respond to activities that are self-generated as well as those generated by others. This has been substantiated with common activity patterns found

in the frontal cortex during self-evaluative judgments and evaluations of others (Mitchell *et al.*, 2005). The idea of shared neural circuits suggests to some that it may be possible to influence how a person sees others by coaching the individual on how they see themselves.

Indeed, some researchers have even gone so far as to claim mirror neurons may be a source for empathy (Carr *et al.*, 2003; Iacoboni, 2009). Mirror neuron activity associated with empathic response is sensitive to perceived similarities to others and previous observation of fairness (Singer and Lamm, 2009). Further, engaging in positive social interactions reciprocally promote pro-social behaviors (Rand *et al.*, 2009). How social interactions are influenced by mirror neurons is only beginning to be investigated (Montgomery and Haxby, 2008), but the mere presence of socially-based behavioral primers underscores the importance of the social environment and its link to understanding ourselves.

Our capacity for theory of mind, or the ability to surmise what others are thinking, may also be influenced by mirror neurons (Gallese and Goldman, 1998; Lombardo *et al.* 2009; Vogeley *et al.*, 2001). Pro-social behaviors such as altruism and empathy are contingent upon the capacity for theory of mind (Batson, 1987) and can trigger the release of oxytocin, a hormone associated with bonding (Mitchell *et al.*, 2006). Bonding can in turn positively influence self-evaluations of well-being and measures of trust (Kosfeld *et al.*, 2005). When we perceive ourselves as similar to others, we are more likely to feel good about their good fortune (Mobbs *et al.*, 2009) and to act with compassion toward them (Decety and Batson, 2007; Decety and Ickes, 2009). Interestingly, displays of compassion from leaders in the workplace have been shown to promote healthy workplace environments (Boyatzis *et al.*, 2006).

On the other hand, fear responses can promote projectionist and antagonistic behaviors; that is, a me-against-them perspective. Amygdala activation is negatively associated with altruistic behavior (Marsh *et al.*, 2007; Marsh and Blair, 2008) as well as the ability to accurately interpret the fear response of others (Marsh *et al.*, 2007; Marsh and Blair, 2008). Managing negative response toward others is particularly important in organizations (Gibson and Callister, 2010). A lack of structure for resolving issues can contribute to an emotional contagion, whereas explicit problem-solving strategies can reduce this (Johnson, 2008). This supports the legitimacy and efficacy of a coach's role in devising and using conscious procedures for decision making.

Because not every social interaction ends well, coaches must be prepared to deal with the after effects in coaching sessions. Consider our earlier cited source of amygdala activation: social rejection. There is good reason to regard rejection as threat – the social pain of rejection registers in the same brain areas as physical pain (Eisenberger and Lieberman, 2004; Eisenberger *et al.*, 2003). Acetaminophen can even relieve social pain (DeWall *et al.*, 2010). Paradoxically, mildly negative social interactions reduce pain sensitivity (Borsook and MacDonald, 2010). Such findings challenge the assumption that social pain is imagined and add significant weight to the importance of giving clients the appropriate space and resources they need to deal with these types of pain.

Social behaviors are complex, and their interpretation can vary due to individual differences (Grabner *et al.*, 2006) and emotional states (Arnsten, 1998); however, it is also important to recognize culture's influence on social behavior (Kitayama *et al.*, 2003). Cultural differences may have profound effects in our personal expression, as when interpreting emotional display on the face (Masuda *et al.*, 2004). Culture's influence may also be imperceptible, as when recent eye-gaze studies found basic differences in how Chinese and American participants focused on a complex image (Chua *et al.*, 2005). These kinds of findings have led to the inception of a new field of cultural neuroscience that suggests

culturally mediated brain activity (Chiao *et al.*, 2010; Kitayama and Thompson, 2010). As we know, culture is variable and because the environment can have such a profound effect on the brain, coaches must add this to the list of influencing factors.

In our final section we discuss three main questions that coaches are presented with and how neuroscience is being applied in each case: how to manage approach-avoidance; mitigating factors in adopting change behavior; and how to inspire and maintain motivation when dealing with clients. These three issues are raised in an effort to point to possible synergisms between coaches and neuroscientists. We point to an overarching theme of coaches understanding what is required to help individuals move from relationships of projection, or distance, to relationships of engagement – from egocentric to collaborative and cooperative.

Section Three: Applications and Future Directions

Rock and Page (2009) have argued that coaching emerged from the type of crossover that occurs when disciplines meet. A similar emergence occurred when neuroscience arose from its cross-disciplinary beginnings. As in neuroscience, coaches must resist confusing common concepts or shared terminology. Coaching is additionally faced with the challenge of building an evidence base to validate it as a field. These needs are occurring at the very moment that neuroscience is developing new techniques for studying coaching-related issues. The coincident timing points toward a potential synergism that may help establish coaching as a neuroscience-backed discipline. However, in order for that to happen, the direction and goals of coaching as a discipline must be clarified.

Neuroscience findings are only beginning to be integrated into coaching applications (Rock and Page, 2009; Street, 2010). As yet, there is little research that directly addresses the neural underpinnings of coaching *per se*, perhaps because the questions have remained too broad to be scientifically investigated. Questions such as: “Does coaching affect a client’s brain?” are often where conversations begin, but such a question is unanswerable because of its lack of scientific focus – it cannot properly be tested. Answering more testable questions like: “Does approach X diminish amygdala-based fear-response more than approach Z?” remains a long way off because we do not have competing theories to pit against each other. This lack of generative models is perhaps the biggest limit to scientific progress in the coaching industry. While there are several frameworks available for how to coach from a given perspective, we do not know of any models that currently generate research-related questions as a result of their explanatory power or theoretical stance. Until coaching can establish a base of questions that can be empirically tested, the gap between coaching and neuroscience will persist. The onus of responsibility rests with coaches to operationalize and parameterize key concepts for the field such that they can be subjected to scientific inquiry.

Yet, despite these shortfalls, there are still coaching issues that can be addressed here. The three levels of analysis in neuroscience described above might be a suitable framework for asking coaching questions. First, and largely undiscovered, are those questions that arise around the unseen factors (chemical, hormonal, perhaps unconscious) that produce changes in behavior. Second, questions related to a client-focused approach might ask how environmental control, subjective reappraisal and emotional triggers can promote or discourage positive thinking, resilience, and creative solution finding. Third, questions can be asked pertaining to how to assist clients to be more receptive to social cues or to promote collaborative and engaging social environments and what effects such training might have (Logan *et al.*, 2008).

Approach-avoidance: As discussed earlier, mindset can greatly influence an individual's perceptions. Individuals assigned to coaching, especially following poor performance review may be tuned to a negative assessment of the experience (Baumeister *et al.*, 2001); for some, just the word "feedback" may set off neural alarms (Kluger and DeNisi, 1996). Establishing a meaningful relationship might therefore be predicated on first working on the client-coach relationship and the prescribed issue later. This example, while facile, serves to illustrate that coaches must be aware while they are coaching of how the client views others, themselves, *and* the coach.

There is good reason for coaches to be attending to the literature in this area. For example, using TMS to selectively inhibit regions of the brain, van Rijn and colleagues (2005) have revealed dissociation between detecting approach emotions (happiness, anger) and avoidance emotions (sadness, fear). While still preliminary, the advent of differential emotional detection systems may have a significant impact on how coaches develop a relationship with their clients. The importance of this distinction is highlighted by Boyatzis and colleagues' (2010) recent finding that positive and encouraging remarks from coaches prepared clients to be more open and ready for change compared with negative or neutral comments.

Rock's (2008) SCARF model, based upon assessing amygdala response to threats of Status, Certainty, Autonomy, Relatedness, and Fairness, is an example of an attempt to develop a framework to help coaches promote healthy relationships. Recent studies suggest that using this framework facilitates organizational cohesion (e.g., Martin-Kniep, 2010; Street, 2010). Similar models are sorely needed that apply to coach/client dynamics and to client-centered assessment.

Change: Change is not a simple, one-step process. To change, clients must become aware of what needs to be changed; however, change-related issues are often indicated by discontent, hope, worry, expectation or fear; that is, by emotions. While we have highlighted above a number of findings that indicate the importance of emotional valence in change management, a cohesive theory is yet to be developed. There may be types of change programs that are more responsive to positive emotional valence than to negative. For example, smokers show greater success when quitting is framed in terms of gains rather than losses (Toll *et al.*, 2007). Similar queries around other change behaviors remain to be investigated; yet there are clues that such investigations would be worthwhile.

Programs to encourage lasting change can be drawn from neuroscience research. For example, because the resources required for working memory are limited and easily disrupted (Halford *et al.*, 2005), being able to automate behaviors, or make them habitual, bestows advantages – at least when we want that behavior to propagate or to be selected in high-stress situations. However, the lack of competing theories limits coaches in developing an actual template for such programs.

Motivation and reward: Motivation is influenced by and dependent upon emotion (Yerkes and Dodson, 1908). With too little emotion clients are uninterested, unengaged, and unmotivated. Similarly, too much investment makes us so "frazzled" that our capacity to solve problems is greatly reduced (Arnsten, 1998; Mather *et al.*, 2006). Coaches may need to help clients engage, but not be overwhelmed in solution finding and decision making.

Gollwitzer and Bargh (1996) suggest making desired goals more salient, and their achievement more likely, by implementing "if-then" planning. Describing specific actions, taking contingencies into account, and asking for accountability are common practices in

encouraging goal achievement (Gollwitzer and Bargh, 1996), though such approaches are limited by marginal success, qualifiers (Gollwitzer *et al.*, 2009) and frequent outliers (Powers *et al.*, 2005, 2011).

Because selected change behaviors can be related to a number of motivational factors, coaches might benefit from learning to identify the basis of reward for a desired change (e.g., social, physiological), and from looking at the timing of when reward is given. Although there are a number of reward circuits in the brain, each relies on its ability to associate reward with behavior. One future avenue for coaches may lie in increasing the salience not only of rewards but also the consequence of refusing to change, depending on the nature of the to-be changed behavior (see Toll *et al.*, 2007).

Conclusion

Research in coaching of any kind is still in its early stages, so the small number of applications of neuroscience to coaching is hardly surprising. Neuroscience may come to provide an empirical foundation for coaching and mentoring but the matter is complicated because coaching tends to be framed in high-level abstractions and cognitive processes that are difficult to operationalize. Yet techniques from neuroscience research are already becoming an integral part of inquiry in all the disciplines from which coaching draws its theoretical and empirical nurturance. For these reasons, coaching-specific questions will help to provide much needed direction to the profession as a whole. As coaching is operationalized and data are gathered, meta-analyses will soon follow, leading to a better understanding of the questions that specifically relate to or can be elucidated by, neuroscience.

Knowledge about brain function will have considerable value for coaches. We have reviewed several behaviors that can be influenced by coaches. Yet the potential power of brain-based explanations comes with a caveat. Neuroscience findings are commonly portrayed in print, broadcast, and electronic media as definitive explanations for why we behave as we do, and often with conflated elaborations. For example, recent reports in the media cited that watching the television show *Spongebob Squarepants* caused braindamage (Liete, 2011; *Spongebob Study*, 2011). However, the Lillard and Peterson cited report (2011) in fact claimed only a short-term decrease in executive function (e.g., working memory, self control) after watching a segment of the show. Many of the attention-grabbing sound bites about the brain may in fact be inaccurate or downright wrong. As professionals, it is our responsibility to seek out the source before determining if current findings apply to coaching. Such a responsibility only further highlights the need for the coaching profession to be asking its own questions ensuring the validity and applicability of results.

It is our hope that readers are not discouraged at this point. After reading this litany of factors that often complicate issues rather than resolving them this would not be surprising. However, this complexity is precisely what we, the authors, would choose to celebrate about neuroscience, or indeed science in general. Neuroscience cannot and will not provide all the answers about human behavior. In many cases it may just provide us with more questions. As with all scientific and intellectual pursuits, the preponderance and patterns of questions will indicate not only what is understood, but also how much more is left to discover. Neuroscience is an approach for exploring the neural basis of thinking. It can help coaches and clients think about thinking. Its pursuit will generate more questions each time one is answered, but this is, as coaches know, the real value. The real power after all, lies in the questions.

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