Individual, Relational, and Contextual Dynamics of Emotions

Can Brains Manage? The Brain, Emotion, and Cognition in Organizations
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CHAPTER 2

CAN BRAINS MANAGE? THE BRAIN, EMOTION, AND COGNITION IN ORGANIZATIONS

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ABSTRACT

In response to recent calls to better understand the brain's role in organizational behavior, we propose a series of theoretical tests to examine the question "can brains manage?" Our tests ask whether brains can manage without bodies and without extracranial resources, whether they can manage in social isolation, and whether brains are the ultimate controllers of emotional and cognitive aspects of organizational behavior. Our analysis shows that, to accomplish work-related tasks in organizations, the brain relies on and closely interfaces with the body, interpersonal and social dynamics, and cognitive and emotional processes that are distributed across persons and artifacts. The results of this "thought experiment" suggest that the brain is more appropriately conceived as a regulatory organ that integrates top-down (i.e., social, artifactual and environmental) and bottom-up (i.e., neural) influences on organizational behavior, rather than the sole cause of that behavior. Drawing on a socially situated perspective, our analysis develops a framework that connects brain, body and mind to social, cultural, and environmental forces, as significant components of complex emotional and cognitive organizational systems. We discuss the implications for the emerging field of

Individual, Relational, and Contextual Dynamics of Emotions
Research on Emotion in Organizations, Volume 14, 27–58

ISSN: 1746-9791/doi:10.1108/S1746-979120180000014009

organizational cognitive neuroscience and for conceptualizing the interaction between the brain, cognition and emotion in organizations.

Keywords: Brain; distributed cognition; emotions; embodied cognition; managerial and organizational cognition; organizational cognitive neuroscience; organizational behavior; socially situated cognition

In *That Hideous Strength* (1945/2012), C. S. Lewis describes how rogue members of a scientific institute preserve the disembodied head of a French scientist to keep alive the human brain within. Connected to the world by a series of tubes, pumps and gauges, the scientists remove the head from the corrupting influence of the body in order to develop a higher intellect cleansed of sentiment and emotion. With its brain swollen to superhuman proportions by stimulants, its creators envision that the technology behind the "Head" will allow power to be confined to a small number of knowledge-filled minds who will make decisions for all of humanity, freed from the restrictions of man's physical and social situations.

Recent technological developments in neuroscience, particularly advances in imaging and monitoring brain activity (e.g. fMRI, qEEG), have motivated organizational researchers to examine more closely the brain's actual and possible role in the management of work organizations (Ashkanasy, Becker, & Waldman, 2014; Balthazard, Waldman, Thatcher, & Hannah, 2012; Becker & Cropanzano, 2010; Becker, Cropanzano, & Sanfey, 2011; Beugre, 2009; Butler & Senior, 2007; Cropanzano & Becker, 2013; Healey & Hodgkinson, 2014; Hodgkinson & Healey, 2011; Laureiro-Martinez, 2014; Laureiro-Martinez, Brusoni, Canessa, & Zollo, 2015; Lee, Senior, & Butler, 2012a, 2012b; Lindebaum & Zundel, 2013; Powell, 2011; Powell & Puccinelli, 2012; Powell, Lovallo, & Fox, 2011; Reina, Peterson, & Waldman, 2015; Senior, Lee, & Butler, 2011; Volk & Kohler, 2012; Waldman, Balthazard, & Peterson, 2011b; Waldman, Ward, & Becker, 2017). The general thrust of much of this work is the idea that the human brain drives and controls organizational behavior. However, reflecting more critically, some scholars have cast doubt on this assumption, leading them to question whether the brain can really manage work-related processes (e.g. Lindebaum, Jordan, Zundel, & Wastell, 2015). These issues are a central concern for research on emotion in organizations, where assumptions concerning the interrelationship between brain, thinking and feeling shape many lines of inquiry, from studies of individual decision making to studies of group dynamics and organizational identity (Ashkanasy &

Ashton-James, 2007; Ashkanasy & Dorris, 2017; Ashkanasy, Humphrey, & Huy, 2017; Elfenbein, 2007; George, 2011).

In this chapter, we explore what we consider to be the central philosophical and theoretical aspects of the question "can brains manage?" To do so, we take inspiration from another idea that has inspired science and science fiction alike – Turing's (1950) test for a thinking machine – and propose a series of theoretical tests to explore whether or not brains can manage, focused on criteria for the effective management of work organizations.

Notwithstanding the ambiguity of the term "manage," it is tempting to follow Turing and devise a definitive test, operationalized in the form of a thought experiment. Along the lines envisaged in the aforementioned epigraph from C. S. Lewis, such a test might involve locating an isolated, disembodied brain in a vat and allowing it to communicate indirectly, perhaps via electronic means, with workers in order to orchestrate some basic work-related task. To pass the test, judges ignorant of the conditions must be unable to differentiate the resulting task outcomes from those produced by an authentic human manager.

Clearly, such a test would be absurd. However, the idea of manipulating the nervous system, and the brain in particular, to control human activities is no longer the preserve of science fiction. For instance, improving the performance of economic actors by stimulating or modifying the brain has been slated in several high-profile publications (e.g. Lawrence, Clark, Labuzetta, Sahakian, & Vyakarnum, 2008; Sanfey, Loewenstein, McClure, & Cohen, 2006). Given heightened interest in the brain, it seems timely to take seriously the question of whether or not brains can manage. The theoretical tests we propose for this purpose are designed to provide greater structure to the debate concerning the role of the brain in work organizations and the concomitant contribution of neuroscience to the analysis of organizational behavior. Our analysis encompasses a range of organizational activities, from coordination and communication, to decision making and emotion regulation.

The results of our assessments lead to the inescapable conclusion that any attempt to recreate, stimulate or understand the effective and complex management of organizations by solely zeroing-in on the brain, while ignoring extracranial factors, is bound to fail. Our central contention is that although the brain plays a driving role in organizational activity, this activity strongly interfaces with and relies on the body, situational factors, and affective and cognitive processes that are distributed across organizational agents and artifacts. Conceptualizing work organizations as cognitive-affective systems – i.e., systems that are both affective and cognitive in nature – we outline a socially situated framework that connects brain, body and mind to social, cultural, and environmental forces, as significant components of a more complex, adaptive organizational system (see also Healey & Hodgkinson, 2014, 2015).

Fig. 1 illustrates this socially situated framework, contrasting it with the intraindividual perspective on the brain's role in organizational behavior (cf. Becker & Cropanzano, 2010; Becker et al., 2011; Cropanzano & Becker, 2013;

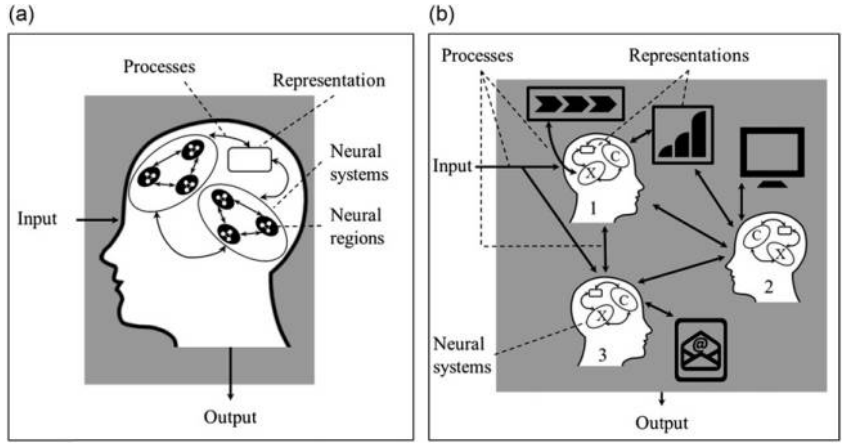

Fig. 1. The Brain's Role in Organizational Behavior According (a) to Intra-individual Cognition and (b) Socially Situated Cognition. *Source*: Healey and Hodgkinson (2015).

Laureiro-Martinez et al., 2015; Laureiro-Martinez, Brusoni, & Zollo, 2010; Waldman, Balthazard, & Peterson, 2011a; Waldman et al., 2011b). In the intraindividual perspective depicted in panel (a) of Figure 1, cognitive processes and representations occur within the brain. The information processing required to transform inputs into outputs occurs within and between selected neural systems in a given individual's brain, relying in turn on processes within specific anatomical regions and cellular processes within those regions. Hence, according to this perspective, drilling down into ever lower-level neural processes brings researchers closer to the fundamental workings of cognition.

In contrast, the socially situated perspective depicted in panel (b) of Fig. 1 posits that cognitive processes and representations are distributed across agents and organizational artifacts, exemplified by the routines, artifacts and communication technologies. According to this perspective, information processing occurs within and between neural systems but also in the interactions of those systems with the actions of other agents and material objects in the work environment that collectively constitute the overall organizational cognitive system. Hence, understanding the workings of cognition in organizations requires an appreciation of how the cognitive activity in question harnesses or makes use of the various components of the wider cognitive system, including but not limited to the brain's major functional systems. For illustrative purposes, the major functional systems depicted in panel (b) are Lieberman's (2007) reflexive (X) and reflective (C) systems, illustrating a situation in which an organization's

routines are regulating the reflexive system of agent 1, while agents 1 and 2 are harnessing (i.e. drawing on) representations externalized in artifacts.

The intra-individual perspective has characterized much emerging work in organizational neuroscience thus far. By emphasizing the activation of specific brain areas during certain tasks, this perspective has put forward a reductive, in some respects almost "neurological," approach to studying the brain in organizations. In contrast, a socially situated view of the brain's role in organizational behavior questions the long-term viability of the intraindividual perspective (Healey & Hodgkinson, 2014, 2015; see also, Butler, Lee, & Senior, 2017).

For scholars studying emotions in organizations, the value of a socially situated approach is twofold. First, by providing a theoretical framework that views organizational behavior as biologically founded *and* socially situated, it promises to build deeper connections between neuroscience and mainstream theories of emotion and cognition in organizations, without losing sight of the uniquely organizational nature of that behavior. Second, it promises to extend current understanding of the causes and consequences of emotions in organizations to reflect better the dynamic interplay of brain, mind and body with social and situational forces.

FOUR TESTS FOR THE BRAIN IN ORGANIZATIONS

Our tests for examining the focal question of whether brains can manage are fourfold. First, we examine whether brains can manage work organizations without bodies, reviewing evidence for the embodied nature of emotion and cognition in organizations. Second, we ask whether brains can manage without reliance on extracranial resources, given evidence for the many ways that organizational agents off-load cognitively and affectively demanding tasks to physical artifacts and technologies. Third, we examine whether brains can manage in isolation, taking into account the socially distributed nature of emotions and cognition in organizations. Fourth, we ask if it is accurate to assume that the brain is the ultimate controller of organizational activity, examining the role of top-down causal emergents in organizations; that is, higher-level factors such as norms, routines and structures that emerge from lower-level processes to influence behavior.

Can Brains Manage without Bodies?

Our first test concerns the question of whether brains can manage work organizations without bodies. C. S. Lewis's description of a brain sitting in a vat, linked to the world by means of artificial connections, implies that the rest of the body is merely a vessel for carrying a human's intellectual machinery. The

idea that human cognition is ultimately housed inside the brain is consistent with many information processing models popularized in experimental and social psychology from the 1950s onwards (Anderson, 1980; Miller, 1956). According to these models, people are like computing machines, where information processing takes place inside internal memory systems located within a (largely irrelevant) casing (for a review and critique, see Hodgkinson & Healey, 2008). Problem solving and decision making were often conceived similarly (Newell & Simon, 1972; Simon, 1979).

In stark contrast to this traditional view is the notion that cognition and emotions are embodied. Embodiment is a growing movement rooted in cognitive science, but rapidly spreading to social psychology and the wider social sciences (Anderson, 2003; Barsalou, 1999; Clark, 1997; Niedenthal, 2007; Semin & Cacioppo, 2008; Wilson, 2002). Although there are several variants of embodiment, they are united by converging evidence for the proposition that the body plays a central role in shaping the mind (Wilson, 2002). According to this view, human neural systems evolved primarily to serve perceptual and motor processes.

Researchers distinguish two ways in which cognitive-affective processes are embodied, namely on-line embodiment and off-line embodied grounding (Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Robbins & Aydede, 2009; Wilson, 2002). On-line embodiment refers to the way in which representation, computation and action depend on interactions between the sensorimotor systems of the brain and sense organs, limbs and the wider nervous system. In on-line embodiment, rather than being mere input and output devices (see Fig. 1(a)), bodily movements can cause mental states (Barsalou, 2008). One illustration of this phenomenon is that actions produce affect (Niedenthal, 2007). For instance, nodding the head generates positive affect (Wells & Petty, 1980), whereas pushing downwards with the arms, an action with negative associations, creates negative affect (Cacioppo, Priester, & Berntson, 1993).

Off-line embodiment, in contrast, affords an indirect role to the body (Lakoff & Johnson, 1999). Off-line embodiment holds that even abstract knowledge depends on activity in the sensorimotor systems (Barsalou, 1999, 2008). Research on off-line embodiment shows that merely thinking about an object or abstract concept (without physically interacting with it) involves activity in the brain's sensorimotor areas, often by mentally simulating or reenacting perceptual and motor states in order to prepare for action. For instance, thinking about a business meeting creates an embodied representation of that action that integrates various sensory modalities, for example how meetings look, bodily postures adopted in meetings, and feelings of boredom. Off-line embodiment holds that even higher-level representations and computations involved in activities such as reasoning are "grounded" (Barsalou, 2008) in whole-body systems that enable perception and action. These principles are evident in research on the embodied emotional mind (Niedenthal et al., 2005; Winkielman,

Niedenthal, & Oberman, 2008). This body of research integrates early views on embodied cognition, and proposes that sensorimotor, cognitive, and affective states – elicited following a stimulus – are captured and stored in association areas of the brain. When a person recovers this experience the original set of sensorimotor states (e.g. images, feelings) that initially occurred can be retrieved (Winkielman et al., 2008). This process is also named "embodied simulation"; former experience is replicated in the originally involved neural systems as if people were in the same scenario (Gallese, 2005). Illustrating bodily influences on mind, embodiment theories highlight the vital role of the autonomic nervous system. Recent research suggests that feedback from the autonomic nervous system contributes to embodied emotional experience (Craig, 2002); the autonomic nervous system interconnects with the brain to rapidly promote adaptive emotional changes and responses to various cues and tasks in the organizational environment (Massaro, 2018; Massaro, & Pecchia, 2016).

Both types of embodiment require that "the mind must be understood in the context of its relationship to a physical body that interacts with the world" (Wilson, 2002, p. 625). However, on-line embodiment challenges the causal primacy of the brain directly. Whereas a sizable body of basic evidence has accrued for on-line embodiment in the psychological sciences, there have been fewer direct tests of on-line embodiment in organizational research. However, there is a growing body of research that testifies to such effects.

Evidence of Embodiment in Organizational Behavior

Relevant lines of evidence concern the use of the body in communicating organizational ideas and in feeling and understanding organizational dynamics. Field studies show that entrepreneurs use hand and bodily gestures to communicate business ideas to potential investors, including metaphoric or "iconic" gestures that embody abstract concepts; for example, using upwards hand gestures to embody the technology development process or simulating a motion path to illustrate a business moving forward (Clarke & Cornelissen, 2011; Cornelissen & Clarke, 2010; Cornelissen, Clarke, & Cienki, 2012). In a similar manner, strategists used embodied metaphors to understand the strategic challenges facing their firms (Heracleous & Jacobs, 2008). For instance, strategy development is conceived and expressed as a physical journey communicated by the forward movement of the body. Gestures communicate perceptual-motor information about objects and activities, thereby allowing speakers to ground abstract concepts in physical experience when talking, thus improving listeners' understanding (Cook & Tanenhaus, 2009).

Basic research shows that, rather than being mere expressions of underlying thought, gestures play an active role in shaping mental states. For instance, gesturing while learning new ideas helps people retain knowledge, whereas impeding the ability to gesture hinders retention ability (Goldin-Meadow, 1999; Goldin-Meadow, Nusbaum, Kelly, & Wagner, 2001). Gesturing also shapes the

representation of tasks. For instance, when people use particular gestures to explain a problem, those gestures influence the way they approach that problem subsequently, suggesting that the way they mentally represent the task reflects the gestures they adopted (Beilock & Goldin-Meadow, 2010).

There is also increasing evidence that bodily gesturing is linked with emotion. Several studies have demonstrated that people tend to mimic the behavior of those around them. This includes postures of the body (Chartrand & Bargh, 1999), facial expressions (Dimberg, Thunberg, & Elmehed, 2000) and even tone of voice (Neumann & Strack, 2000). Moreover, merely thinking about emotional content elicits facial expressions (Cacioppo, Martzke, Petty, & Tassinary, 1988).

Further evidence that organizational behavior is embodied comes from research on the construction of organizational identity. This research shows that organizational identity – that which is central, distinctive and enduring about an organization (Albert & Whetten, 1985) – is understood through multimodal sensory experience. Harquail and King (2010, p. 1620) describe this process as an "interactive processes among mind, body, and organizational milieu." The process involves organizational members construing an organization's identity as a function of what they physically experience of that organization, rather than purely abstract conceptualization "in their heads" (Harquail & King, 2010, p. 1619). Harquail and King (2010) review numerous field studies to document how physical experiences including bodily kinesthetic (e.g. movement through work spaces), visual-spatial (e.g. images of the physical work environment), temporal-aural (e.g. the rhythms and pacing of workgroups), and emotional (e.g. emotional labor) experiences shape organizational identity.

Implications for Theorizing the Brain's Role in Organizations

Emerging evidence for embodiment in organizations suggests that it is unlikely that the brain can manage effectively without the body. Central activities such as understanding an organization's identity, emotional responding among employees, communicating business ideas and understanding power relations all make use of the whole-body sensory-motor systems involved in organizational action.

To illustrate further, consider the case of mirror neurons. Research into mirror neurons suggests that understanding social stimuli depends on the ability to simulate actions and feelings in our bodies (Keysers & Gazzola, 2009). Studies show that when an agent observes a significant other engaging in a goal-directed action (e.g. grasping an object) their motor cortex is activated, even when this activation does not translate into action on their own part (Rizzolatti & Craighero, 2004). Similar effects occur when understanding emotions: to understand others' pain agents simulate their own pain, via activation of a neural network corresponding to that feeling (Decety & Grezes, 2006).

Remarkably, however, inhibiting the motor movements involved in the bodily expression of emotion interferes with agents' ability to both experience emotion personally and to comprehend emotion experienced by others (Niedenthal, 2007). These findings illustrate that the ability to relate to others cannot be fully explained by confining attention to the activation of specific brain regions. Empathizing depends on bodily capabilities as well as brain processes.

For organizational cognitive neuroscience, the findings reviewed in this section suggest that it is inappropriate to divorce brain from body when seeking to understand more comprehensively cognition and emotions in organizations. As Clark (2008, p. 125) points out, bodily actions do not equate to the mere expressions of fully formed neural processes; rather, they are "part and parcel of a coupled neural-bodily unfolding that is itself usefully seen as an organismically extended process of thought." An embodied perspective requires a more recursive understanding of the relationship between brain, body and organizational action, where inference is not linear and unidirectional but multidirectional and multilevel (see Fig. 1(b)).

Can the Brain Manage without Extracranial Resources?

Initial forays into organizational neuroscience were predicated on the assumption that the cognitive processes that influence organizational behavior occur exclusively in the brain. By way of illustration, Becker et al. (2011, p. 934) suggest that peering into the "neural black box" will help researchers to "incorporate the cognitive machinery behind our thoughts and actions into organizational theory." Based on an intraindividual view of cognition in organizations (see Fig. 1(a)), they outline various ways in which a hierarchically reductive approach to organizational neuroscience might achieve this goal by "deconstruct[ing] individuals to discrete brain processes" (Becker et al., 2011, p. 936). For example, the focal point for phenomena such as fairness, justice and self-interest is the brain's emotion centers, specifically the amygdala and insula (see also Cropanzano, Massaro, & Becker, 2017; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). Similarly, Becker et al. (2011) posit that the ability of an organization to accept organizational change depends on the neural processes that produce implicit and explicit attitudes (see also Becker & Cropanzano, 2010).

In contrast to the intraindividual assumption that all cognition is just "in the head," in an extended or distributed cognitive system, "adaptive cognition involves perceptual–motor loops that pass through the environment" (Smith & Semin, 2007, p. 134). By way of illustration, rather than providing mere background, the physical environment provides resources integral to human performance, evident in the way people "offload" cognitively demanding tasks to

external objects; for example, they rely on cues gleaned from external objects (i.e. "affordances") to guide interactions with those objects (Norman, 1988).

Clark (1989) provides an evolutionary explanation for why information processing often relies on external structures, based on what he dubbed the "007 principle":

> In general, evolved creatures will neither store nor process information in costly ways when they can use the structure of the environment and their operations as a convenient stand-in for the information processing operations concerned. That is, know only as much as you need to know to get the job done.

Clark suggests that humans' reliance on environmental structures for information processing occurs through a nonintentional, often automatic and emotionally salient process, whereby evolution economizes by exploiting the structure of the physical environment to aid information processing whenever it is possible to do so. In contrast, we suspect that (at least) some uses of the workplace environment to aid information processing involve a greater degree of deliberate design. Indeed, it is a common observation that many features of work organizations – from structures and routines to organizational identities – serve to help overcome the information processing limitations of individual agents (Cyert & March, 1963; March & Simon, 1993; Simon, 1947).

Evidence that Organizational Behavior Relies on Extracranial Resources

Hutchins's ethnographies of ship navigation (1991, 1995a) and aircraft flight (1995b) provide archetypal evidence of how cognition in organizations relies heavily on extracranial resources. Particularly noteworthy are Hutchins (1995b) observations of pilot and copilot attempting to land a commercial aircraft. During this activity, the two pilots in the cockpit must accurately know the aircraft's speed and weight in order to effectively adjust its wing flaps as it slows, to prevent it from destabilizing. To do so, they rely on various external representations, including physical displays of the aircraft's weight, airspeed indicators, and speed card booklets showing appropriate take-off speeds for various weights. In addition, verbal exchanges among the pilots enable them to cross check their understanding. For instance, a copilot will read out weights and speeds from a speed card, which the pilot controlling the aircraft will repeat verbally so that their colleague can check the values they are using to make critical decisions. Since the physical cockpit system is both representing current states and performing computations (e.g. speed/weight ratios), the information processing tasks facing the pilots involve interpreting and acting on a wealth of material symbols, and, we would add, interpersonal signals, rather than merely recalling the significance of those task-related cues from memory.

In related observations, Hutchins (1995a) describes how, when harbor pilots navigate a ship, the ship's position is represented using a combination of knowledge held "in the heads" of individuals and knowledge located in external devices such as charts and radar systems. As Hutchins (1995b, p. 282) notes, in

these activities the external physical devices do not enhance individuals' memory; rather, the ability to remember aircraft speed or know a ships spatial position is a property of a larger system that requires specific behaviors from individuals, behaviors shaped by the architecture and cognitive functions of the physical task environment rather than the architecture of the brain.

Related to Hutchins's accounts of distributed cognition, organizational researchers have amassed considerable evidence for the many ways in which organizational agents off-load representation, computation and even interpretation to extracranial resources (for reviews, see Hodgkinson & Healey, 2008; Hodgkinson & Sparrow, 2002). Research on organizational memory shows how organizational agents use various "storage bins" to retain and retrieve information (Walsh & Ungson, 1991). These include other individuals' memories and their artifacts (e.g. files, reports), culture (supraindividual resources such as language, symbols and stories), organizational processes and practices (e.g. routines and operating procedures; see also Cyert & March, 1963), structures (e.g. roles, hierarchy), and the physical ecology of the work environment (e.g. layout, office design). In addition, organizations have long used various electronic communication media to store, retrieve and transmit representations (Boland, Tenkasi, & Teeni, 1994).

As well as helping with the retrieval of representations, physical artifacts also shape interpretive and computational processes. For instance, spreadsheets, diagrams and graphical models act as boundary objects that represent work tasks and organizational processes, enabling users from different organizational groups to develop shared understandings and new interpretations (Boland & Tenkasi, 1995). In a related vein, studies of information technology at work demonstrate that the physical features of technologies such as software programs influence how users interpret and enact organizational routines, which in turn influences how agents interact with one another (Leonardi, 2011; Orlikowski, 1992, 2007). These studies suggest that physical artifacts play a more active role in organizational cognition, actively shaping representations and interpretations rather than merely storing and/or retrieving them.

Further evidence of the central role of extracranial artifacts in organizational cognition can be seen in the way organizations use language as a cognitive resource. For instance, a key function of organizations involves constructing categories and taxonomies to help agents make sense of their internal and external environments (Daft & Weick, 1984; Glushko, Maglio, Matlock, & Barsalou, 2008; Weick, 1995; Weick, 1979), from taxonomies for categorizing competitor firms (Hodgkinson & Johnson, 1994; Porac & Thomas, 1990, 1994) to taxonomies of performance criteria (Kaplan & Norton, 1993) and taxonomies for categorizing risky events (Kraus & Slovic, 1988). Interestingly, Shanahan (2008) proposed an integrative model that links language to emotion and the brain. Grounded in Pribram's integrated model of emotions and motivations (e.g. Tucker, Luu, & Pribram, 1995), Shanahan's framework offers an

explanation for how emotions may have contributed to the emergence and formation of symbols.

It may of course be tempting to assume that categories and taxonomies are manifestations of underlying individual information processing. To do so, however, is to miss their fuller influence as enablers and shapers of cognition and emotion. One such enabling function concerns how categorization systems off-load the cognitively and affectively demanding burden of generating and selecting action alternatives onto preestablished taxonomies. For instance, nuclear power plants categorize functional activities, systems and components according to the level of risk for the release of radioactive material and related accidents (IAEA, 2014). Once an event or component is categorized, operators can read off instructions from standard operation procedures to select appropriate courses of action. Such taxonomies not only aid in categorizing events, but also remove the need for demanding and time-consuming search, thereby lowering transaction costs (Glushko et al., 2008). In addition to such off-loading, categorization schemes influence mental states directly. For instance, Lipe and Salterio (2002) compared how decision makers evaluate organizations when performance criteria are organized into the categories of the balanced scorecard compared to situations in which those criteria are not categorized but merely listed. They found that categorization led evaluators to underweight low and high scores on criteria organized into common categories and thus form less extreme judgments than evaluators who viewed the criteria listed without such categories. These findings illustrate direct effects of categories on representation. Taken together, research on organizational categories shows that such linguistic artifacts are not merely the outputs of organizations' cognitive machinery; they are integral components of that machinery.

Implications for Theorizing the Brain's Role in Organizations

Strictly speaking, evidence showing that organizations frequently off-load the cognitive-affective functions of representation, computation and interpretation to extracranial technologies does not rule out the possibility that brains might be able to manage without such technologies. However, it does seem likely that any system that tried to do so would only be able to manage *far less effectively*, placing it at a serious disadvantage compared to a system that used language, structures, technologies and the like to support its activities. Not only is affect and cognition in organizations highly dependent on what Clark (1996) terms their "cognitive scaffolding," i.e. the extraindividual structures that support the mind, but variations in cognitive scaffolding go a long way toward explaining differences in the performance of organizations (see also Hodgkinson & Healey, 2011).

When the aforementioned evidence is considered, a key question becomes to what extent does cognition and affect in organizations – including the regulation of cognition and affect – occur *inside* actors' brains and how much is off-

loaded to extracranial technologies? This question matters because it is only when we understand the locus of our mental capacities that we can decide whether it is necessary to probe into the brain to study the cognitive machinery underpinning a given activity or whether such probing is likely to drill past that machinery and miss the place where cognition is actually occurring. Clearly, not all cognitive activity is off-loaded, all of the time, in all organizations. Indeed, the extent of off-loading depends on a number of factors, not least the nature of the cognitive activity in question and the availability of artifacts and technologies to substitute or augment computation and/or representation in an organization.

A key assumption of the socially situated view is that cognitive systems are rather agnostic about which of their components serve a given purpose (Clark, 2008). To illustrate how this assumption changes our view of the brain's role in organizations, consider the example of self-regulation. Self-regulation, i.e. the ability to control individual goals, desires, and feelings and steer them away from short-term personal gratification and toward long-term organization goals (cf. Lord, Diefendorff, Schmidt, & Hall, 2010) is among the most crucial functions of organizations (Blau, 1964; Etzioni, 1975; March & Simon, 1993). From the perspective of organizational neuroscience, self-regulation occurs in the brain in a top-down manner, where the brain's higher-level cortical systems regulate more "basic" emotional reactions in lower-level subcortical regions (Powell, 2011). However, basic research shows that self-regulation also occurs in subcortical areas such as the amygdala, where neurotransmitters such as dopamine and serotonin act as neuromodulators that variously inhibit or activate individuals' action orientation (Lewis & Todd, 2007). Hence, it appears that self-regulation can be both a top-down and bottom-up process.

However, self-regulation can also involve another kind of top-down process. Specifically, organizations often off-load self-regulation to social processes and structures (see Fig. 1(b)). For instance, self-regulation is a multiperson process, where interpersonal feedback, shared beliefs and group structures serve to regulate self-interest (Healey, Vuori, & Hodgkinson, 2015; Lord et al., 2010). Similarly, organizational routines are effective self-regulators, helping individuals to exercise self-command and restraining deviations from organizational goals (Postrel & Rumelt, 1992). Healey and Hodgkinson (2017) have also examined how organizational artifacts can serve vital purposes as regulators of emotion during the process of strategic adaptation.

Because organizations frequently off-load cognitively demanding functions such as self-regulation to extracranial components, it seems reasonable to conjecture that some forms of mental activity might strike a balance between harnessing subcortical neural processes to perform these functions *some of the time*, whereas in other situations the system may off-load these functions to extrapersonal components such as routines and social structures. Hence, the

socially situated view acknowledges that a wider range of (non-neural) components influence organizational behavior, which naturally draws attention to questions concerning the relative efficacy of different system components for serving a given cognitive-affective function.

Can Brains Manage in Social Isolation?

Most neuroscience research, even social neuroscience, focuses on how the individual brain determines or shapes an individual's behavior (Cacioppo & Berntson, 2005; Cacioppo et al., 2002). Although researchers have paid significant attention to how the brain processes social stimuli and have issued calls to integrate neural, cognitive and social levels of analysis (Decety & Ickes, 2011; Lieberman, 2007; Ochsner & Lieberman, 2001), partly due to experimental constraints, neuroscience and neuroimaging in particular has often studied how the brain creates representations in the absence of direct social interaction and online social influence. Early work in organizational neuroscience has followed suit (Balthazard et al., 2012; Hannah, Balthazard, Waldman, Jennings, & Thatcher, 2013; Laureiro-Martinez, 2014; Laureiro-Martinez et al., 2015).

Research on organizational cognition challenges this focus on the individual brain. Tsoukas's (1996) arguments are representative of the general view that no single individual mind can represent the complex problems facing an organization or know the full repertoire of responses needed to respond to those problems (Weick, 1979; Weick & Roberts, 1993; Weick, Sutcliffe, & Obstfeld, 2005). In consequence, he argues, organizations are best conceived as distributed knowledge systems without an overseeing mind. However, to say that representations are distributed across multiple brains does not pose a fatal challenge to the idea that individual brains can manage. Salomon (1993), for instance, argues, that there is no distribution without individuals' cognition; distributed cognition can thus be understood with reference to *interactions* among individual brains, where certain individuals may play a coordinating role, controlling information flows and the like (cf. Hutchins, 1995a). Similar considerations apply to the study of "hot cognition" in organizations (Healey & Hodgkinson, 2017).

Evidence that Cognition and Affect in Organizations Are Socially Distributed and Socially Situated

Another, more fatal, challenge to the brain's ability to manage without the social comes from research on situated cognition. In the context of organizations, Elsbach, Barr, and Hargadon (2005) reviewed various pieces of evidence showing how the sociodynamic context of organizations (i.e. "the nature of group interaction including the characteristics of group members and the specific processes of interaction," p. 425) directly influences momentary situated

cognition. Organizational examples abound of how on-line representations are socially situated, i.e. dependent on social processes for their nature and use. Chairing a meeting involves constructing a representation of the situation based on the features of the objects and persons present – including the latter's actions and perceived goals (Salomon, 1993). In strategy making, decision makers' representations of market opportunities are shaped by the political actions of significant others (Kaplan, 2008).

Similar evidence can be found concerning the experience of emotion in the workplace. Consider, for instance, the growing body of research on emotional contagion in the workplace; that is, the transfer of moods among people and the attendant impact of such transfer on work group dynamics and task performance (see, e.g. Barsade, 2002). Recent neuroscience research highlights how emotional contagion operates neurally; vicarious affective responses are contingent upon a number of situational and interpersonal factors – such as the quality of the interpersonal relationship between the person experiencing emotions and the others surrounding them and the perspective adopted during observation of the other (Singer & Lamm, 2009).

Perhaps the most famous account of how the sociodynamic context shapes representation and action comes from Weick and Roberts (1993). They analyzed how operatives landing planes on the flight deck of an aircraft carrier develop a collective mind that enables them to respond to ongoing events. To represent ongoing events individuals must monitor the actions of others and modify their representations dynamically in response to feedback from those actions. For instance, a pilot attempting to taxi on a flight deck at night watches the urgency with which the taxi director waves his wands to signal the plane's required movements. The pilot adjusts his understanding of his or her situation and his or her actions in accordance with those signals, enabling him/her to maneuver the aircraft into position. In situations such as these, it seems that representation and effective action would be impossible without the ongoing social process of what Weick and Roberts (1993) describe as "heedful interrelating" between individuals. According to this view "the collective mind is 'located' in the process of interrelating" (p. 365). When representation and action depend on processes occurring between individuals, the absence of social processes would seem to preclude the development of such collective representations. Crucially, those processes, inter alia, entail a rich interchange of bodily signals that must be variously encoded and decoded in real time. Hence, focusing on the individual brain promises to miss vital parts of the cognitive machinery in action, in this case (embodied) social elements.

Implications for Theorizing the Brain's Role in Organizations

Evidence that cognition and emotion in organizations relies on social processes suggests that in order to build a realistic view of the brain's role in organizational life researchers must locate it within the social processes taking place in a

given situational context. Recent work on embodied grounding provides important clues regarding how researchers can move in this direction. One useful framework is the social cognition model developed by Semin and Cacioppo (2008, 2009). This model focuses on how social action supports cognitive-affective activities that are more than the sum of their individual parts, drawing attention to how the interpersonal processes of synchronization, coordination and coregulation influence representation and action in dyads and groups. According to these authors:

> For action to be efficient and adaptive, it must be closely tuned to the relevant social environment. Adaptive social action is the emergent outcome of a dynamic process of moment-by-moment interaction between conspecifics. To adapt to a continuously changing environment, the organism must have a finely tuned mechanism in place that is responsive to the multifaceted and dynamic features of the physical and social environment. Whereas these features may apply generally to cognition and its functions, the unique feature of social cognition is that it is distributed across brains in a distinctive manner. (Semin & Cacioppo, 2008, pp. 121–122)

Semin and Cacioppo's model posits a central role for the human mirror neuron system, particularly as a means by which individuals synchronize their actions with one another. Of course, organizational neuroscience has already alluded to the importance of mirror neurons for interrelations among workers. For instance, Becker et al. (2011, p. 938) suggested that "workers automatically and often unconsciously imitate one another's behavior and feeling through the operation of the human mirror neuron system." However, in these discussions, the individual is the unit of analysis; the observed actions of others are inputs that the brain uses to output its own actions (see Fig. 1(a)). In contrast, in the social cognition model of Semin and Cacioppo, the unit of analysis is the social interaction or the activity (see Fig. 1(b)). From this perspective, in order to understand processes such as interpersonal synchronization it is necessary to take into account the iterative process by which the neural systems of individuals interact, through mutual monitoring and dynamic adaptation. Furthermore, it is necessary to take into account how the structural features of the environment and/or task influence the coregulatory processes that emerge from the activity in question. Healey et al. (2015) suggested that such reflexive (i.e. nonconscious) synchronizing of behavior could help explain how work-group members can coalign their actions regarding work tasks even while consciously disagreeing about those tasks.

Can the Brain Control Organizational Activities?

Much early discussion in organizational neuroscience posits the brain as the controller-in-chief of organizational behavior. For instance, the brain is assumed to control leader behavior (Balthazard et al., 2012; Waldman et al., 2011a, 2011b), decision making (Laureiro-Martinez, 2014; Laureiro-Martinez

et al., 2015), and entrepreneurial orientation (Lawrence et al., 2008). Illustrative of this view, Laureiro-Martínez et al. (2015, p. 5) argued in the context of strategic decisions that "the dorsolateral prefrontal cortex (DLPFC) and frontopolar cortex (FPC) are responsible for top down control over attention." However, the question of whether brains control organizations or whether organizations control brains is open to debate.

Evidence for Organizational Influences on the Brain

As we established in the preceding sections, when one looks at the various ways that organizational agents off-load various cognitive-affective functions to extracranial technologies, group processes, and social structures it seems clear that not all organizational processes are determined by neural processes. For instance, given the various ways in which organizations regulate the self, it would seem inaccurate to say that neural processes alone determine self-regulation in organizations, or even that they are *a* primary cause, or even that they are a *more or less influential* determinant than other components in the wider organizational system.

To characterize more accurately the brain's role in socially situated organizational cognitive systems, Healey and Hodgkinson (2014, 2015) developed a framework that posits how organizational behavior operates under the "dual control" (Polanyi, 1968) of lower-level forces (that is, by including the neurophysiological processes of the brain) and higher-level forces (e.g. social processes, technologies and organizational structures and routines). According to this framework, it is the "neuro-physiological complexity" (Bhaskar, 1978, p. 15) of individuals that enables them to initiate actions in a purposeful way, monitor their performance and act back upon and transform their physical states and actions (see also Bandura, 1986). Individual mental states are said to emerge from interactions among the brain's functional systems (which recruit inputs from neural processes distributed across the brain), the body (including the perhipheral nervous system), and external inputs (i.e. from other individuals, and from the physical environment). Although mental states and actions emerge from interactions among these components, because emergence depends on those interactions, attempting to reduce behavior to any single component is to omit part of the causal system. Put simply, human activity is an "irreducibly bio-social product" (Bhaskar, 1998, p. 411).

In this view, higher-order psychological states emerge out of neurophysiological processes, whereupon psychological states recursively shape subsequent neurophysiological activity. For example, goals, discrete emotions, needs and perceptions are mental events that emerge from activity in particular brain systems. Once developed, those higher-level mental events subsequently interact and shape how the brain behaves. As we have seen, social agents use mirror neurons to monitor one another's behavior and emotions (Keysers & Gazzola, 2009; Rizzolatti & Craighero, 2004). However, it is perceptions (i.e. attitudes,

stereotypes) and actions (e.g. communicating with and prompting from those being monitored) that decide when such monitoring takes place, continues, and stops. Scholars describe this as a process in which mental states *supervene* on brain states (Murphy & Brown, 2007). The process of *mental emergence* is mirrored by the process of *behavioral emergence*. Behavior is emergent in the sense that it results uniquely from interactions between the whole organism and the external physical and social environment.

The Nobel Prize winning neuropsychologist Roger Sperry (1988) contrasted this form of emergent determinism with the micro-determinism of the then standard neuroscience model. For Sperry, microcontrol from the brain operates concurrently with downward control from higher-level causal forces. Campbell's (1974, 1990) related writings on downward causation go further. He emphasizes how, in all natural systems, the higher-level properties of the system determine at least in part the organization and operation of its lower level constituents. Similarly, in *social* systems, once aggregate processes emerge from lower level mechanisms they become causal forces with (at least) the same legitimacy and causal power as lower level factors (see also Bhaskar, 1998).

Due to the predominance of this microdeterministic view of the brain as the ultimate causal force behind organizational behavior, management researchers have not yet prioritized tests of the top-down influence of organizations on the brain. However, recent studies have demonstrated the general influence of social structures on the operation of neural circuits.

In one such study, Spitzer, Fischbacher, Herrnberger, Gron, and Fehr (2007) used fMRI to examine how the brain reacts to violations of social norms when playing interactive games for monetary rewards. Comparing individuals in situations where violations of social norms could be punished to individuals in situations where violations could not be punished, they found that activation of a distinct neural network (involving the lateral orbitofrontal cortex and right dorsolateral prefrontal cortex) was highly predictive of the degree of compliance with norms. Moreover, comparing responses in social (i.e. playing against another person) versus nonsocial (i.e. playing against a computer) conditions, they observed that this network was distinct to social situations. Their findings suggest not only that social norms influence brain states but also that dealing with social norms recruits distinct neural systems.

In a related study, Zink et al. (2008) used fMRI to analyze neural responses to information concerning social hierarchy among individuals playing an interactive game for monetary reward. They found that viewing a superior player in the social hierarchy compared to an inferior player resulted in increased activity in regions associated with emotional processing (i.e. the thalamus and the amygdala) and regions associated with recognizing the goals of others (i.e. the medial prefrontal cortex). These responses were distinct to social (compared to non-social) and hierarchical (compared to monetary) situations, suggesting that the influence of social hierarchy on the brain is unique.

Implications for Theorizing the Brain's role in Organizations

The studies by Spitzer et al. (2007) and Zink et al. (2008) indicate that brain states are at least partly dependent on sociostructural features of the situation. Moreover, by showing that the brain is seen better as a *mediator* of the influence of social norms and social status on behavior, they lend support to the socially situated view of organizational cognitive systems depicted in Fig. 1(b), where information is transmitted and transformed via flows and loops that pass through the brain's systems and through extracranial circuits in the environment (Clark, 2008; Semin & Cacioppo, 2008).

The findings of this body of work are particularly instructive for organizational neuroscience when viewed from the perspectives of dual control and emergent (co)determinism. Specifically, they suggest that although neural structures and processes may be homogenous across individuals (Becker et al., 2011), heterogeneity in organizational norms and structures creates considerable variation in behavior precisely because such structures and processes exert distinctive influences on neural systems. Since work organizations constitute complex networks of norms and social cues, the emergence of a gamut of higher-level social processes and structures that influence neural processes ensures that, as with other social systems, "the system as a whole gains a broader causal repertoire" (Murphy & Brown, 2007, p. 89).

If lower-level neural processes are not the "primal causes of behavior" (Becker et al., 2011, p. 934) in organizations, we might well ask what role they do play. The answer, according to a socially situated view, is that the brain and its mechanisms are but one factor, albeit a directing one, responsible for orchestrating complex mental activity. Although brain activity per se is never sufficient for the existence of a given mental state (given the emergent nature of mind), that activity is a vital part of the machinery that implements cognition. As Clark (2008, p. 122) states:

> […] it is indeed the biological brain (or perhaps some of its subsystems) that is in the driver's seat. That is to say, it is indeed some neurally based process of recruitment that […] turns out to be so pointedly unbiased regarding the use of inner versus outer circuits, storage, and operations. But once such an organization is in place, it is the flow and transformation of information in (what is often) an extended, distributed system that provides the machinery of ongoing thought and reason.

Viewed thus, the limitations of neurocentricism (the assumption that emotion and cognition occur solely in structures and processes of the individual brain) as a foundation for organizational neuroscience become clear. By zeroing in on the brain, we lose sight not only of the other components contributing to the system (e.g. bodily, artifactual, social) but also of how those components combine in the execution of skilled tasks.

Building on these insights and the principles of dual-control and emergent (co)determinism, we suggest that it would be more informative for organizational researchers to ask how brains draw upon or *harness* higher-level

components (e.g. bodily actions and states, social processes, external technologies, and organizational processes and structures) in the execution of particular organizational activities. From this viewpoint, the brain is a central regulatory organ (Cacioppo, Berntson, & Decety, 2012), traffic facilitator (van Dijk, Kerkhofs, van Rooij, & Haselager, 2008), or driving component for the recruitment of cognitive-affective resources for action (Clark, 2008), which needs a gamut of higher level components to accomplish the many and varied tasks that organizations face. Focusing on how the brain harnesses extracranial (i.e. bodily, material, social and technological) resources to coordinate organizational behavior (rather than how it determines that behavior) acknowledges that a wider range of (non-neural) components influence action, draws attention to the relative efficacy of different system components for serving a given mental function, and replaces a linear view of causation with a nonlinear view based on whole-part relations (for details, see Healey & Hodgkinson, 2014, 2015).

Organizational scholars will recognize that a socially situated view of cognition characterizes organizations as "systems within systems," i.e. brain systems embedded within bodily systems embedded within interpersonal systems embedded with organizational systems (Beer, 1981; Katz & Kahn, 1978). As Hackman (2003) argued in the context of multilevel analyses of organizations, the system or subsystem that warrants closest attention depends on which system or subsystem is closest to the behavior to be explained. Fig. 1(a) shows that an intraindividual view of cognition locates neural processes close to the cognitive system's outputs (i.e. organizational behaviors). This conception of organizational activity legitimates a reductive, microdeterministic approach to organizational neuroscience (Becker & Cropanzano, 2010; Becker et al., 2011) where particular neural structures, and even structures within neurons, are relatively proximal causes of organizational behavior. Hence, the cellular level of analysis becomes a legitimate focus for organizational analysis.

In contrast, from a socially situated perspective it seems unnecessary to go beyond the level of distinguishing the broad functional systems of the brain to explain adaptive action in organizations. The general nature and characteristics of neural systems (e.g. the reflexive and reflective systems depicted in Fig. 1(b)) are important, since they set boundary conditions for the wider cognitive-affective system and are "in the driver's seat" for action taking. But, when seeking to understand organizational cognition, emotion, and behavior it is more appropriate to focus on how those high-level systems accomplish information processing and representation in conjunction with other agents and artifacts than to drill down into their lower-level (i.e. neuronal and intracellular) processes.

DIRECTIONS FOR FUTURE RESEARCH

Investigating Brain–body Relations in Organizations

Our analysis of brain–body relations highlighted ways in which embodiment and neuroscience are converging (Garbarini & Adenzato, 2004). To date, however, few if any studies have incorporated neuroscientific measures alongside behavioral measures to examine how organizational cognition uses the body *and* the brain (on the importance of using behavioral measures with neuroscience methods, see Laureiro-Martinez, 2018; Massaro, 2018). However, our analysis suggests that organizational neuroscientists should prioritize studies of how the brain uses the body, and how the body uses the brain, to enact cognition and emotion in organizations.

Research on emotion in the brain is instructive in this regard (Damasio, 1994, 1999; LeDoux, 1998). This research consistently emphasizes brain–body connections, whereby the prefrontal cortex processes signals via the amygdala regarding the body's homeostatic state (e.g. body temperature, heart rate, hormonal changes). This bodily feedback process constrains ongoing interactions with the environment. Educational researchers have begun to explore the implications of these ideas for learning (Immordino-Yang & Damasio, 2007). One such implication concerns the development of principles for the design of learning environments that pay heed to the various ways in which emotion enables and constrains the development and transfer of knowledge.

In related vein, organizational researchers might find this approach informative for examining the types of organizational processes, structures and work designs that constitute an effective organizational learning environment (Argote & Miron-Spektor, 2011; Vince, 2001). Hodgkinson and Healey (2011) adopted a similar approach in the context of strategic management. Building on the idea of distinct (i.e. dual) neural and cognitive systems, they examined the types of "cognitive architectures" (i.e. decision-aiding technologies, debiasing procedures, and change management techniques) that support emotional processes required for cognitive adaptation (see also Healey & Hodgkinson, 2017; Hodgkinson, Wright, & Anderson, 2015).

Identifying Cognitive and Emotional "Scaffolding" in Organizations

Our analysis illustrates that brains need a wide variety of extracranial resources to regulate, coordinate and inspire organizational behavior, from physical artifacts to communication technologies to group processes to routines and structures. Our analysis suggests that understanding the brain's major functional systems and their interactions with extracranial factors is necessary for a more detailed understanding of the purposes organizations serve. Put differently, it is

important to ask what must organizations be like in order for the brain to function *and* what must the brain be like for organizations to function (Healey & Hodgkinson, 2014).

A promising way for research to proceed in this regard is to bring organizational neuroscience into line with research on the architecture of choice in behavioral science (Thaler & Sunstein, 2003, 2008). The core idea in this line of research is that "a choice architect has the responsibility for organizing the context in which people make decisions" (Thaler, Sunstein, & Balz, 2012, p. 428). Where this approach differs from established theories of organizational behavior such as sociotechnical systems theory (e.g. Trist, Higgin, Murray, & Pollock, 1963) is that it makes explicit assumptions about the cognitive-affective neural systems with which incentives and structures ("nudges") interact to produce desirable behaviors. In fact, writers have begun to explore how leaders might use neuroscience to become more effective "decision architects" (Beshears & Gino, 2015; Rosenzweig, 2014). However, it would seem that an organizational neuroscience that focused on brain−body-environment interrelations would add significantly to these endeavors (but for a discussion of the dangers of misapplying neuroscience in this context, see Healey & Hodgkinson, 2014; Lindebaum, 2013).

Emphasizing the Social Brain in Organizations

A key conclusion from our tests concerns the brain's reliance on cognitive-affective processes that are distributed across organizational agents. As we saw, models such as the social cognition model of Semin and Cacioppo (2008, 2009) emphasize the interpersonal nature of the types of prevalent organizational behaviors, such as synchronization, coordination and entrainment. Recent technological developments suggest that it is now possible for researchers to observe such interpersonal synchrony in action by scanning the brains of multiple actors engaged in a wide variety of social activities (Spiegelhalder, Ohlendorf, & Regen, 2014), including those in the workplace (Waldman, Wang, & Fenters, 2016; Waldman et al., 2017).

Suitably harnessed, these methods will open the doors for researchers to examine the interindividual synchronization of neural, cognitive and affective functioning (Semin & Cacioppo, 2008, 2009). This approach could prove valuable for examining the physiological mediators of various interpersonal phenomenon in organizations, from consensus formation and the nature of conflict to the development of shared cognition and emotional contagion (for further discussion of these possibilities, see Healey et al., 2015).

Studying Organizational Influences on the Brain

The legitimacy of higher-level causal emergents in organizational systems suggests that, together with focusing on how the brain causes behavior in organizations, scholars should also, if not, indeed, mostly, ask how organizations influence the brain. One potentially fruitful line of inquiry is to examine the role of organizational routines and systems in variously suppressing and harnessing the neural motivational systems concerning self-interest and impulsiveness (Healey & Hodgkinson, 2014, 2015; Hodgkinson & Healey, 2011; Postrel & Rumelt, 1992). Neuroscientists have already begun to identify the neural substrates of impulsiveness using economic games (McClure, Laibson, Loewenstein, & Cohen, 2004). Organizational neuroscience might provide a richer understanding of impulse control by looking at the neural substrates of self-interest and self-regulation during organizational tasks.

Our analysis suggests that to explain why some organizations are more effective than others in regulating and harnessing impulses, we need to understand how the neural processes of self-interest and impulsiveness *mediate* the effects of organizations' distinctive social, artifactual and cultural features on the expression of impulsive behavior. From this perspective, the machinery of motivated activity and emotion regulation involves the transmission of information from external artifacts (e.g. norms, routines, social cues) to intrapersonal neural systems and executive cognitive control systems, and onward to the restrained or indulgent actions of agents (see Fig. 1(b)). Viewed thus, the architecture of work organizations is configured so that impulse control and emotion regulation are off-loaded to extrapersonal processes and structures (e.g. norms, routines, hierarchies).

One way to explain complex cases such as the corporate corruption scandals at Enron, Lehman Brothers and Barclays is to posit that the underlying neurology of the key individuals involved was instrumental to their unfolding. Consistent with this idea, some studies point to abnormalities in cortical and subcortical brain structures among psychopathic individuals (Muller et al., 2003). From this evidence, it would take only a small leap to explain corporate dysfunction and psychopathy by reference to neurological differences (Babiak & Hare, 2006). However, this neurocentric approach ignores the role that higher-level boundary constraints – specifically organizational culture, group norms, corporate rules, and routines – play variously as triggers, facilitators, suppressors, and regulators of moral cognition (Hannah, Avolio, & May, 2011; Wang & Murnighan, 2011). From a socially situated perspective, higher-level artifacts and processes influence the social signals that the neural systems use, in concert with bodily and other resources, to convert them into motivational states and ultimately actions. This top-down perspective leads naturally to questions of a rather different nature, not least questions concerning the extent to which and in what ways certain types of

social norms and routines are more or less effective in regulating destructive impulses, and what processes and practices might help to foster moral judgments and emotions that benefit the long-term interests of workplace collectives.

CONCLUDING REMARKS

In this chapter we have marshaled evidence that, although the brain is vital to the management of work organizations, its influence cannot be isolated meaningfully from the wider sociomaterial and organizational context in which human agency is inextricably embedded. We see immense potential for neuroscience to deepen understanding of cognition and emotion in organizations. To realize this potential, however, organizational neuroscience needs to connect more meaningfully with the wider management field and embrace a less deterministic and objectivist ontological foundation. From a critical realist perspective (Bhaskar, 1989, 2008; Healey & Hodgkinson, 2014, 2015; Hodgkinson & Starkey, 2011), organizational neuroscience brings an essential framework that has largely been downplayed in organizational research (cf. Becker et al., 2011), enabling researchers to explicate biological level generative mechanisms that inform organizational design efforts (Hodgkinson & Starkey, 2011, 2012).

Consider, for example, the case of sociotechnical systems design (e.g. Trist et al., 1963). Recently, Davis, Leach, and Clegg (2011) called for a broadening of sociotechnical systems theory, to incorporate the entire work system including the design of the physical environment, as well as processes, job roles, and technologies. In so doing, they advocated a broadening of the types of outcome measures incorporated in evaluation studies of sociotechnical design interventions, including the use of physiological data (i.e. heart rate, skin conductance and blood pressure). An obvious next step in furthering this agenda is to incorporate neuroscientific measures, thus enabling a more complete examination of the interplay of neural and bodily processes and social and physical systems, along the lines depicted in Fig. 1(b).

By way of a second illustration, consider the multilevel framework of team cognition advanced recently by Healey et al. (2015). Healey and colleagues draw on evidence in social cognitive neuroscience to posit a role for reflexive (i.e. nonconscious and affectively charged) cognitive processes in shared cognition. They discuss how reflexive processes can be "primed" by extracranial stimuli that reside within the wider social and physical environment (Bargh & Chartrand, 1999; Latham & Locke, 2012). Their analysis is consistent with embodiment and engages directly with multilevel issues regarding interactions between neural systems and the work environment. The design implications of their analysis range from issues of team training to the management of group-level emotion-regulation processes.

As a third illustration, our arguments are highly compatible with Ashkanasy and colleagues' well-known multilevel framework for the analysis of emotions in the workplace (Ashkanasy, 2003; Ashkanasy & Ashton-James, 2005; Ashkanasy & Dorris, 2017). This framework spans five levels of analysis, namely (1) within-person (including affective events, neurobiology, and cognitive processes), (2) between-persons (individual differences), (3) interpersonal relationships (dyads), (4) groups, and (5) the organization as a whole (policies and culture/climate). It isolates the distinct explanatory power of each level of analysis, but also argues for work that furthers understanding of "the interrelatedness of emotional variables across all levels of the analysis," and the "myriad of interconnections" among them. This framework links employees' mood states and emotions to the effects physical settings in a manner that accords with our calls for closer integration of neuroscience and sociotechnical systems theory. The present chapter has laid the foundations required to advance this vision a little further.

Returning to our opening vignette, it is clear that much of the growing debate on neuroscience in management and organization studies has been no less imaginative than C. S. Lewis's narrative, yielding provocative Orwellian scenarios depicting how neuroscience interventions will eventually replace organizational structures (Powell & Puccinelli, 2012). In parallel, the bulk of empirical research to date that has appeared under the umbrella of organizational neuroscience (Waldman & Balthazard, 2015; Waldman et al., 2017) has overlooked almost entirely the organizational context. In short, organizational neuroscience has to date moved too far in the direction of neurology at the expense of what should be its primary organizational focus. Our fundamental hope is that, by emphasizing how cognition and emotion in organizations reflect the dynamic interplay of mind and body with social and situational forces, this chapter will further motivate organizational researchers to redress this fundamental imbalance.

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