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Mindfulness and the Neuroscience of Influence

Emily B. Falk

The concept of mindfulness as present-oriented awareness, coupled with flexibility in thinking and creating new categories (Langer, 1989), has been directly applied to problems ranging from conceptualizing and promoting creativity to reducing prejudice to improving health and longevity (Alexander, Langer, Newman, Chandler, & Davies, 1989; Langer, 1989, 2009; Langer, Bashner, & Chanowitz, 1985; Langer & Imber, 1980). From an academic standpoint, the basic tenets of mindlessness versus mindfulness recur throughout social psychology. These ideas form a theoretical basis for models explaining a range of human behaviors, whether directly referred to in these terms or not. Indeed, this conceptualization of mindfulness and Eastern-inspired forms of mindfulness have been highly influential in elucidating the overlap and connection between mind and body, and in promoting health and well-being.

Given the powerful effects of mindfulness on health, a growing body of literature has examined biological correlates of mindfulness practice. For example, neuroscientists have begun to uncover structural and functional correlates of Eastern-inspired forms of mindfulness in the brain. Although relatively little work has specifically examined the neural correlates of Langer's mindfulness (present-oriented awareness, coupled with flexibility in thinking and creating new categories), in the current chapter, I argue that doing so will shed light on important social neuroscience questions. First, extending current research beyond Eastern-inspired forms of mindfulness and related concepts such as mindfulness meditation to also understand the neural bases and effects of Langer's social-cognitive mindfulness can help clarify common and distinct mechanisms associated with each. Second, understanding these neural underpinnings may shed light on common and distinct pathways leading to the cognitive and health benefits of each form of mindfulness. Third, this type of work will facilitate more efficient

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connection to the existing social psychological literature. Finally, Langer's mindfulness as a dispositional trait is also likely a moderator of many commonly studied neurocognitive effects, and so its inclusion in social neuroscience investigations could shed light on a variety of neurocognitive processes. Thus, more work incorporating measures of dispositional mindfulness, as well as examining situations that promote state mindfulness, is likely to expand our understanding of the brain and its associated psychology beyond what has already been addressed by extant social-cognitive neuroscience research on mindfulness.

Given that most neuroscience research on mindfulness has focused on Eastern-inspired forms of mindfulness, in the current chapter I will provide a brief overview of social-cognitive neuroscience investigations of the neural correlates of this form of mindfulness. In addition, I will speculate about ways in which Langer's mindfulness (which is defined in more social-cognitive terms, as compared to Eastern forms of mindfulness and mindfulness meditation) might operate in similar or distinct ways from the forms of mindfulness studied in existing neuroimaging research. I will address the idea that trait mindfulness is likely to moderate many well-documented social-cognitive neuroscience findings. As one example to illustrate how this might be conceptualized, I will focus on Langer's social-cognitive mindfulness as a potential moderator of the neural bases of persuasion and social influence, as well as ways in which mindfulness may help explain certain brain-as-predictor relationships that are presently poorly understood. Questions include: In what ways might mindfulness moderate currently observed neural correlates of social influence? Can a mindfulness lens help explain why neural activity predicts variance in behavior change that is not currently explained by self-report?

Mindfulness and the Brain

A growing body of research explores the neural correlates of mindfulness meditation and other Eastern-inspired forms of mindfulness (Cahn & Polich, 2006; Treadway & Lazar, 2009). This growth parallels increased interest in scientific mechanisms that underlie the effects of Eastern forms of mindfulness intervention on health-relevant outcomes (Baer, 2006; Didonna, 2009). Many of these studies seek to understand the neural processes that take place during mindfulness meditation, as well as longer-term structural and functional consequences of such meditation.

Given that enriched experience fosters brain development across the lifespan, it is logical that mindfulness of a variety of forms should also alter the structure and function of the brain. In particular, it is now widely accepted that the brain is plastic, undergoing changes throughout life, according to experience (Maguire et al., 2000; Rosenzweig, Bennet, & Diamond, 1972). In her discussion of mindful aging, Langer (1989) notes that this capacity for development throughout the lifespan is often ignored; instead, Western society conceptualizes growing older in terms of inevitable decline. Consistent with Langer's view, a number of studies of mindfulness meditation and other Eastern-inspired forms of mindfulness also reinforce the conclusion that the mind, body, and brain are plastic.

Structural changes associated with mindfulness

Studies of mindfulness meditation have examined the neural and behavioral consequences of mindfulness meditation in terms of both brain structure and function. For example, studies examining brain structure have demonstrated that long-term mindfulness meditation practice results in structural changes in cortical thickness (Lazar et al., 2005), as well as increased gray-matter concentration implicated in bodily perception (such as the anterior insula; Hölzel et al., 2008); thus, paralleling other strength-models (Muraven & Baumeister, 2000), it is possible that long-term mindfulness practice builds brain function as other forms of exercise build muscle. Experimental evidence also suggests that mindfulness practice can alter the structure of brain systems (effectively toning brain "muscles" to engage in relevant cognitive and affective processing). For example, participants who are randomly assigned to a mindfulness meditation intervention, compared to waitlist controls, show widespread structural changes across the brain (including changes in neural regions such as the posterior cingulate cortex, the temporo-parietal junction, and the cerebellum; Hölzel et al., 2011).

Functional changes associated with state mindfulness

Functional magnetic resonance imaging (fMRI) studies have also demonstrated differences in the brain activity observed: between meditators and nonmeditators; between those higher and lower in trait mindfulness; and between those assigned to mindfulness interventions versus controls. Participants randomly assigned to mindfulness-based stress reduction also demonstrate widespread increases in functional connectivity compared to control subjects (Kilpatrick et al., 2011). Finally, participants randomly assigned to a mindfulness meditation intervention evidence positive changes in immune function (Davidson et al., 2003). Consistent findings across these studies implicate neural systems involved in bodily perception, attention, and emotion regulation in mindfulness-related practice; however, the direction of effects across studies has not been consistent.

Studies comparing meditators and nonmeditators have demonstrated differences in neural regions associated with attentional control (e.g., dorsal anterior cingulate cortex [dACC]) and with perception of bodily states (e.g., anterior insula), though the direction of results has not been consistent across studies (Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007; Hölzel et al., 2007); on the one hand, meditation increases attentional control and hence should be reflected with increased neural activity in attentional processing regions. However, meditators also have become more skilled at achieving these results as they practice and hence may not require the same degree of activity in order to achieve parallel results (Treadway & Lazar, 2009). One recent study demonstrated increased activity in attention networks during mindfulness meditation compared to mindwandering in novice meditators, suggesting one pathway through which effects of mindfulness may initially take hold (Dickenson, Berkman, Arch, & Lieberman, 2013).

Studies comparing short-term mindfulness training to control conditions also suggest that mindfulness practitioners show better ability to regulate anticipatory anxiety and unpleasant emotions associated with pain (Gard et al., 2011; Zeidan et al., 2011).

Perhaps counterintuitively, this ability is associated with increased activity in neural regions associated with sensory perception, and decreased activity in lateral prefrontal emotion-regulation regions (Gard et al., 2011; Zeidan et al., 2011). It is possible that cultivation of present-minded awareness allows practitioners to dissociate sensation from evaluation. Participants who are assigned to mindfulness training also show functional changes in left-sided activation (previously implicated in positive affect), suggesting that the practice may alter this basic functioning (Davidson et al., 2003).

Complementing the experimental findings described, long-term practice of meditation is also associated with decreased prefrontal cortical activity during exposure to emotional images; whereas nonmeditators employing mindfulness techniques show decreased reactivity in neural regions implicated in affective processing (e.g., the amygdala), activity in experienced meditators employing mindfulness techniques suggests, instead, increase acceptance of current emotional states, and lack of neural changes in the face of affective stimuli (Taylor et al., 2011). This type of equanimity in the face of change is one characteristic that characterizes Eastern forms of mindfulness.

Another possibility that is consistent with Langer's description of mindfulness is that mindfulness intervention expands the practitioner's ability to flexibly interpret their position within context. For example, participants assigned to a mindfulness intervention condition differ from controls in how their brains come to represent the self (Farb et al., 2007): those who have practiced mindfulness-based stress reduction over the course of weeks show more dissociation between neural representations of the self across time (e.g., in terms of stable traits, which the authors refer to as "narrative focus"), and in the present moment (which the authors refer to as "experiential focus"), than novices. To the extent that individuals are able to see themselves from multiple other perspectives, we would expect to observe increased ability to think flexibly about a range of topics (potentially including pain).

Functional differences associated with trait mindfulness

A separate group of studies have examined neural responses to a range of tasks in nonmeditators according to levels of trait mindfulness—in other words, whereas the studies above examine differences associated with specific mindfulness-related activities (e.g., meditation), studies of trait mindfulness examine variability according to participants' self-reports of how they tend to approach the world and scenarios encountered. This early group of studies has focused primarily on the relationship between trait mindfulness and emotion regulation. Findings suggest that those higher in some forms of dispositional mindfulness (Brown & Ryan, 2003) may recruit prefrontal resources more easily during emotion regulation of different kinds, including affect labeling (Creswell, Way, Eisenberger, & Lieberman, 2007) and reappraisal (Modinos, Ormel, & Aleman, 2010). Levels of trait mindfulness also moderate responses to highly arousing images very early in the processing stream (Brown, Goodman, & Inzlicht, 2013).

Summary and extensions

In sum, reviews of the neural bases of Eastern-inspired forms of mindfulness suggest that mindfulness practices such as mindfulness meditation produce unique patterns of neural activation that "[appear] to promote long-term structural and functional changes in brain regions important for performing clinically relevant functions" (Treadway & Lazar, 2009), and that mindfulness meditation evokes substantially different patterns of activity from the brain at "rest" (Treadway & Lazar, 2009). In particular, consistent patterns across studies link mindfulness to structural and functional changes in brain regions associated with bodily perception and emotional processing. Results are consistent with the emphasis of mindfulness practitioners and researchers on mind–body connection, and may suggest mechanisms relevant to health effects of mindfulness.

Although not as thoroughly studied within the neuroscience community to this point, Langer's form of mindfulness shares common ideals with more Eastern-inspired forms of mindfulness-related meditation practices; however, they are conceptually distinct in several key ways (Langer, 1989). Both types of mindfulness have been associated with positive health effects and broader indices of well-being (Didonna, 2009; Langer, 1989). More Eastern forms of mindfulness, and mindfulness meditation in particular are conceptualized as being practiced effortfully. By contrast, Langer's mindfulness is conceptualized in terms of finding new ways of categorizing and viewing daily encounters in a way that Langer argues is not more effortful than the alternative (mindlessness). As such, results reviewed above pertaining to trait levels of mindfulness are likely to be most relevant to elucidating the neural correlates of Langer's form of mindfulness, and in understanding how it might moderate other social, cognitive and affective processes. For example, as reviewed, a small number of studies have demonstrated that trait mindfulness moderates brain responses to emotional stimuli during affect labeling and reappraisal tasks. Langer argues that mindfulness allows us to see the world from multiple points of view and, as such, might allow a wider range of labels and interpretations for any given experience, as well as, by definition, greater facility with reappraisal.

Although social neuroscience studies of mindfulness have focused most heavily on changes in attention and emotion regulation related to mindfulness, decades of social psychological research suggest that mindfulness also moderates many other basic social psychological processes. Thus, incorporation of measures of mindfulness into a wider range of social neuroscience investigations is likely to inform our understanding of both the brain and mindfulness. As one example of how this might be accomplished, I devote the remaining portion of this chapter to an exploration of one set of core concepts in social psychology (persuasion and social influence) and ways in which mindfulness might moderate the neural bases of these processes.

Mindfulness as a Moderator of the Neural Bases of Social Influence: An Exploration of Broader Incorporation of Mindfulness in Social Neuroscience

Neural correlates of persuasion and social influence

In contrast to the decades of research that have characterized psychological and physiological mechanisms of persuasion and other forms of social influence (Allport, 1935; Chaiken, Liberman, & Eagly, 1989; Eagly & Chaiken, 2005; Hovland, 1949; Hovland, Janis, & Kelley, 1953; Petty & Brinol, 2012; Petty & Cacioppo, 1986a, 1986b), neuroimaging work examining the brain's representation of these processes is in a relative state of infancy (Falk & Lieberman, 2013; Falk, Way, & Jasinska, 2012; Lieberman, 2010). As such, there is still much to uncover. Researchers interested in understanding persuasion and social influence have looked to the brain in order to answer questions that have been challenging to answer using self-reports and direct behavioral observation alone, and to identify common and distinct mechanisms of a range of persuasion and broader influence processes. Given that mindfulness clearly moderates individual's responses to potential sources of social influence (Langer, Blank, & Chanowitz, 1978; Santos, Leve, & Pratkanis, 1994), examining the conditions under which mindfulness moderates neural responses to social inputs, and in what ways, is likely to shed light on both mechanisms of influence and on basic neuroscientific questions about the social brain.

Much of the recent neuroimaging work on social influence has focused on the ventral striatum and ventromedial prefrontal cortex (VMPFC; Falk, Way, & Jasinska, 2012), which are key components of the brain's reward system (Haber & Knutson, 2010; Knutson, Adams, Fong, & Hommer, 2001; Knutson & Cooper, 2005; McClure, York, & Montague, 2004). Across several studies, activity within these putative reward structures, during exposure to social information, is associated with participants conforming to the opinion of others. For example, in one early study of the neural bases of influence effects (Klucharev, Hytonen, Rijpkema, Smidts, & Fernandez, 2009), neural activity was recorded using fMRI, while male participants were presented with female faces and asked to rate the faces according to attractiveness. Directly following their own rating of the faces, participants were subsequently presented with the ratings of peers. Following the scanner session, participants rerated the faces. Discrepancy between the participants' initial ratings and the "peer" ratings led to subsequent conformity on average (changing one's opinion in the second rating session to be consistent with the group). In the brain, decreased activity in the ventral striatum was associated with discrepancy between one's own opinion and the opinion of the group. This "discrepancy signal" was specific to social influence—the neural signal was greater when the reference group ratings were said to be provided by other people, as compared to when the reference group ratings were said to be generated by a computer. In addition to tracking social value of stimuli during initial exposure to the opinions of others (Klucharev et al., 2009), activity in the brain's reward system also appears to be positively associated with ratings of others, when they are higher, compared to lower, than participant's initial ratings (Zaki, Schirmer, & Mitchell, 2011).

A parallel study by Campbell-Meiklejohn, Bach, Roepstorff, Dolan, and Frith (2010) examined the converse effect. In this study, participants made ratings of music, which were sometimes concordant and sometimes discordant with information provided about the ratings of "musical experts." Results from this study indicated that participants showed increased activity in the ventral striatum when their own opinions about music were consistent with the opinions of two "expert raters" (Campbell-Meiklejohn et al., 2010). This activity overlapped with activity in response to being given monetary rewards in response to their ratings. This provides evidence first for modulation of the reward system by social, in addition to nonsocial, rewards. Second, this overlapping neural activity between monetary and social rewards may suggest that being consistent with experts produces a reward signal in the brain. The authors speculate that this reward may come from the feeling that concordance with expert ratings suggests that one has good musical taste, or taste that is socially valued.

Follow-up work by Campbell-Meiklejohn and colleagues (2012) pharmacologically manipulated levels of dopamine in the brain by administering the dopamine reuptake inhibitor, methylphenidate (also known as Ritalin), in order to examine its effects on conformity. The researchers found that the Ritalin group showed more exaggerated conformity effects as compared to a placebo control group (Campbell-Meiklejohn et al., 2012). Although neural effects were not assessed in this study, these data are consistent with the hypothesis that dopamine signaling in the striatum sensitizes individuals to the opinions of group members, and associated social rewards of conformity (Falk, Way, et al., 2012).

Finally, just as activity in the brain's reward system is moderated by directly provided social cues (e.g., the preferences or ratings of others), activity within the reward system is also moderated by indirect signals of social value (in effect "social placebos") and can be modulated by the mere presence of others. One clear demonstration of this effect comes from a study in which participants were asked to taste and rate wines that were priced at different levels. Although the actual wine fed to participants was held constant, participants believed that the wines they were tasting were different. They rated the more expensive wines as tasting better and showed increased activity within the brain's reward system (in the VMPFC) while drinking wines that they believed to be more expensive (Plassmann, O'Doherty, Shiv, & Rangel, 2008). Receptivity to peer influence in adolescence also appears to be tied to the brain's reward system (Casey, Getz, & Galvan, 2008; Steinberg, 2008), and the VS in particular (Chein, Albert, O'Brien, Uckert, & Steinberg, 2010). The mere presence of peers increases adolescents' susceptibility to risk taking and is associated with heightened sensitivity within the VS (Chein et al., 2010). In addition, during adolescence, the brain's emotional system develops more quickly than the brain's cognitive control system, which results in an imbalance of the strength of emotional signals in relation to the brain's capacity to exert cognitive control and regulate such emotions (Casey et al., 2008; Chein et al., 2010; Steinberg, 2008).

One way of viewing this body of research suggests reason for pessimism—the mindless use of an "expensive = good" heuristic (Cialdini, 2009) may trick us, and cost us money, and the presence of peers may lead to risky behavior in adolescence. Levels of activity within the VS are associated with risky behavior in the presence of peers in teens, and VMPFC are associated with participants willingness to pay for items (Plassmann, O'Doherty, & Rangel, 2007), as well as purchase decisions (Knutson, Rick, Wimmer, Prelec, & Loewenstein, 2007). Furthermore, encoding of value signals in these brain regions appears to occur outside of our conscious awareness and in cases where we aren't consciously evaluating (Tusche, Bode, & Haynes, 2010).

These data may also suggest a silver lining, however. As Langer has noted, mindfulness training may increase the ability of the VMPFC to focus selectively on cues that maximize happiness. The brain's reward system, and VMPFC in particular, encodes and integrates many different value signals (e.g., healthiness and taste, in addition to social value, when choosing foods; Hare, Camerer, & Rangel, 2009; Hare,

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Malmaud, & Rangel, 2011). The VMPFC gives different weight to attributes according to one's motivational goals (Hare et al., 2009, 2011). Given that the VMPFC responds to many different possible forms of value, the mindful consumer might actively choose to focus on some attributes over others to maximize happiness. As such, the VMPFC may be a fruitful target for studies examining effects of mindfulness interventions on happiness. Likewise, the mindful teen might be in a better position to conceptualize many ways of being "cool."

In sum, in multiple separate studies, activity in the reward system appears to be modulated by social feedback. Neural activity within the reward system appears to increase when one is in line with a valued reference group, and to decrease when one is out of line. Across different paradigms, activity within the brain's reward system covaried with the fit between participants' opinions and the opinions of others. These data are consistent with the idea that the social reward of fitting in promotes conformity (Cialdini & Goldstein, 2004).

Potential moderation by mindfulness

How might these findings be moderated by mindfulness? We might expect that more mindful people, or people in a more mindful state, might evidence different responses to persuasion and other forms of social influence effects than those who are less mindful. First, it is well documented that, although mindfulness can open us to the views of others, it can also reduce mindless susceptibility to social influence. As noted by Langer (1989): "Once we become mindfully aware of views other than our own, we start to realize that there are as many different views as there are different observers" (p. 68). She further suggests that by seeing the multiple possible viewpoints that one might take on, we gain more choice with respect to how we respond.

Thus, instead of mindlessly changing her opinion of music based on the views of an expert, an expert rating might prompt a more mindful consumer to consider the different aspects of a song that the expert would have considered to arrive at the displayed rating. This, in turn, might be associated with greater neural activity in perspective taking and executive control regions of the brain. By contrast, in a situation where others rate a face or a piece of music differently than we have, instead of viewing the discrepancy as a threat, we may be prompted to consider other possible ways of viewing the stimulus, which, in addition to neural systems associated with perspective taking, might also be associated with more extensive processing in sensory regions of the brain (mindfulness is likely to change the way we physically see, hear, etc.), as well as within the reward system (mindfully processing stimuli is likely to be rewarding).

This concept is also consistent with literature in the emotion regulation literature suggesting that emotions can be up- or downregulated in a top-down fashion (Ochsner et al., 2009). In the context of social influence, mindfulness might not systematically change the ratings that individuals make (e.g., in the music study described above, more and less mindful people might each change their opinion following expert ratings), but might do so for very different reasons (heuristically expert → authority → change, versus expert → prompts consideration of different stimulus features → person finds beauty where they hadn't heard it previously).

The differing mechanisms that lead to social influence in mindful and mindless participants could be evident in examining neural activity in a way that is not evident based on observing the outcome of the second rating, or even in the number of reasons generated (NB: elaboration, as captured in the classic Elaboration Likelihood Model of persuasion, and mindfulness are not synonyms, and may be represented quite differently in the brain). For example, arguments may be processed centrally with a relatively high degree of elaboration without being mindful, and mindful processing does not necessarily require more effort than mindless thought (Langer, 1989). High degrees of elaboration can engage more mindful critiques of arguments, however, effortful processing can also call to mind knowledge acquired under other circumstances that need not apply in the current circumstance, and/or overlearned beliefs may serve as starting points for seemingly logical arguments that constrain the way a thinker views the current situation. In other words, it is possible to engage in high degrees of elaboration without mindfulness. Likewise, it is possible to process cues mindfully and peripherally (Langer, 1992). To the extent that arguments are considered within the framework of ideas that were acquired under one context, without full consideration of the current context, these so-called premature cognitive commitments may still limit the degree to which incoming information can be fully leveraged. Within the brain, we might expect that increased mindfulness would be associated with greater connectivity across networks that link sensory input, memory, and generation of novel concepts, or in systems associated with abstract thought.

Thus, in addition to considering central versus peripheral processing in furthering our understanding of the neural bases of persuasion and the neural precursors of behavior change, it will also likely prove useful to consider mindfulness. Research examining trait mindfulness as a moderator of currently documented effects will be of interest in defining the boundary conditions of the effects observed. Furthermore, in considering these results and their potential moderation by mindfulness, it is important to keep in mind that no brain region operates in isolation, just as no psychological process operates outside of a social context. Thus, the involvement of any neural system in the process of making an attitudinal evaluation is actually a product of the interaction of multiple brain systems, which in turn is operating within a social context.

Acknowledging this complexity, Wil Cunningham and colleagues have suggested that incoming stimuli are initially registered in relatively fast-operating, affective processing regions, including the brain's reward system, but are subsequently iteratively reprocessed between such affective processing regions and higher level executive control systems (Cunningham & Zelazo, 2007; Cunningham, Zelazo, Packer, & Van Bavel, 2007). In parallel with the Elaboration Likelihood Model, they suggest that the degree of iterative reprocessing depends on contextual factors, internal motivation, and social cues. The results of this iterative reprocessing are stimulus evaluation and goal-directed action. Mindfulness is likely to affect this process in at least two ways. First, increased mindfulness may increase connection and processing of incoming stimuli between affective processing regions and the executive control system. Second, mindful consideration of different aspects of the incoming stimulus is likely to alter the weight given to different aspects of the stimulus.

As currently conceptualized in investigations of the neural bases of social influence, neural activity in the ventral striatum is thought to index a discrepancy signal wherein agreement with others is more rewarding than not agreeing. Subsequent viewing of stimuli that others value is also conceptualized as more rewarding than viewing stimuli that others don't value. However, participants who are more mindful might spontaneously have more ways of conceptualizing beauty or quality, due to their increased tendency to actively construct distinctions and see novel distinctions in the ordinary (Langer, 1992). They might show more facility in simultaneously maintaining their initial preference rating, while seeing the merits of the peers supposed ratings (Langer, 1989). Hence, more mindful participants might not view initial discrepancy between the participant and peer ratings as prompting a need to conform, but might instead prompt participants to consider what might be beautiful in the face of another and/or what might be viewed as strange or undesirable (in effect making more categories of attractive and unattractive). Participants processing the social cues in a more mindless fashion, by contrast, might have more difficulty simultaneously representing positive evaluations of both their own view and a seemingly contrasting view. Neural evidence for such effects might parallel the results suggesting that mindfulness alters neural representations of the self across time (Farb et al., 2007), such that individuals higher in trait mindfulness, or those exposed to a mindfulness intervention, might show both more discrepancy in representations of the self across time, and less of a discrepancy signal to information contradicting their own view, and might show less discrepancy within the reward system when confronted with potentially contrasting views to their own.

Finally, the idea that one key pathway to social influence is through the brain's reward system also suggests a potential route to leverage influence to actively recreate such rewards in situations when we might not otherwise experience reward. Indeed, a number of forms of meditation, and other religious activities, appear to achieve salutatory effects, perhaps by reducing negative affect or increasing social support. In the first section, I reviewed evidence suggesting that mindfulness meditation reduces unpleasantness and anxiety associated with pain and is also associated with decreased activity in lateral prefrontal brain regions that have been implicated in cognitive control and emotion regulation (Gard et al., 2011; Zeidan et al., 2011). Interestingly, in a separate line of work, Christian participants with strong beliefs in the power of intercessory prayer evidenced decreased activity in medial and lateral prefrontal executive control brain regions when they believed that messages were delivered by individuals with charismatic abilities, compared to the same statements delivered by individuals not labeled as having such powers (Schjoedt, Stodkilde-Jorgensen, Geertz, Lund, & Roepstorff, 2011). As Langer (1989, 2009) argues, placebos are very powerful in part due to the power of the mind–body relationship, and this may also apply to active intervention by prayer and other forms of mind focus. Although many of us require outside influence to spur our bodies into responding (e.g., through the use of placebo medicines or through strong belief in intercessory prayer), it is likely possible to activate parallel brain mechanisms without such stimuli, and hence achieve similar results. Just as placebos can help the mind/body heal itself, attention to certain forms of external cues can also alter our pleasure and corresponding neural activity in response to experiences (Langer, 2009).

Mindfulness and brain–behavior relationships

The neuroscience studies reviewed above manipulate psychological processes as independent variables and treat neural activity as a dependent variable. These "brain-mapping" studies are useful in exploring the neural mechanism that are associated with psychological processes of interest (e.g., mindfulness, social influence), and can help identify psychological phenomena that share common versus distinct underlying neural mechanisms. A growing body of literature, however, has also begun to harness what we have learned from such brain-mapping studies in social and cognitive neuroscience and neuroeconomics to predict outcomes outside of the lab. In particular, we can use our knowledge of the brain in order to choose neural regions a priori that are hypothesized to predict outcomes outside of the neuroimaging lab. In this type of brain-as-predictor model, neural activity during basic laboratory tasks is used to predict real-world outcomes longitudinally outside of the laboratory (Berkman & Falk, 2013).

Employing this type of brain-as-predictor approach can help us test competing theories and can help us link what we have learned about the brain in the controlled laboratory environment to more complex real-world behaviors. However, in many cases, neural activity predicts behavior change above and beyond self-report measures (Falk, 2010). In other words, these studies might suggest that the brain contains information that is implicitly registered but is not accessed by conscious self-report. For example, neural activity in VMPFC, in response to public-health-service announcements, has been used to predict individual health-behavior change over the course of weeks (Falk, Berkman, Mann, Harrison, & Lieberman, 2010) or months (Falk, Berkman, Whalen, & Lieberman, 2011), above and beyond what is explained by participants' reports of their attitudes toward the health behaviors, their intentions with respect to the behaviors, their confidence in their ability to change, and their ability to relate to the ads. Likewise, neural activity in VMPFC has also been used to predict population-level behavior change in response to persuasive messages (Falk, Berkman, & Lieberman, 2012) and other socially relevant stimuli (Berns & Moore, 2012), above and beyond participants' self-reports.

Thus, one logical question is whether the information encoded in the brain is inaccessible to self-report because it cannot be consciously accessed, or whether, instead, the information is not captured by self-reports due to mindlessness. It has long been recognized that many important psychological processes occur outside of conscious awareness, and that conscious introspection can alter or disrupt these processes (Dijksterhuis, 2004; Nisbett & Wilson, 1977). However, Langer (1989) suggested that some of the processes that we conceptualize as subconscious might be made conscious if we attended to our own thoughts more clearly. She argues that just as placebos can alter the relationship between brain and body, so too we might alter these processes without the need for a pill. It stands to reason, then, that if it is possible to exert top-down control over the body by being more in touch with the mind, one might also be better in touch with the mind by attending more to the body; as practitioners of nearly all forms of mindfulness suggest, the dissociation between mind and body creates a false dichotomy that may have negative consequences when it comes to understanding ourselves and the antecedents of well-being. Of course, it is also likely that some of the discrepancy between variance in behavioral outcomes that is predicted by the brain, and not by self-report, will be resolved by measuring other self-report constructs that have not yet been explored, and by examining moderators of influence processes. For example, in addition to using mindfulness as a tool to improve our ability to forecast our actions, mindfulness is likely to moderate the strength of the relationship between neural activity and behaviors that follow.

Summary and Conclusion

In this chapter, I have reviewed evidence for systematic changes in brain structure and function brought on by diverse forms of experience, including the active practice of mindfulness meditation, as well as trait mindfulness. Although the neural correlates of Eastern forms of mindfulness and mindfulness meditation have been more extensively explored than more social-cognitive forms of mindfulness, such as Langer's mindfulness, we now know that lived experience alters the brain throughout life. Hence, mindfulness or mindlessness, too, should affect the brain accordingly. The current literature on mindfulness meditation falls into three categories: studies of long-time meditators compared to novices, studies comparing those who have undergone a relatively brief mindfulness training intervention (on the order of days or weeks) compared to a control group, and studies examining dispositional mindfulness. Across studies, neural systems associated with attention, perception of bodily awareness, and emotion regulation differ between those higher and lower in mindfulness. This is true of short-term functional variation within specific networks as well as differences in structure.

Findings from studies of dispositional mindfulness are likely to provide the best starting point for forming hypotheses about how social-cognitive mindfulness is likely to moderate brain function in contexts beyond those currently studied. Mindfulness is likely to moderate a much wider range of processes than have been currently explored or documented in the social neuroscience literature. The incorporation of trait and state levels of mindfulness within neuroscientific investigations stands to benefit both our understanding of the clinical social psychological phenomena under study and our understanding of brain function.

As one example of how mindfulness might be more deeply integrated into social neuroscience inquiry, I reviewed selected examples of neuroimaging findings pertaining to the neural bases of social influence and speculated about how mindfulness might moderate underlying neural function within this context. In particular, a growing body of studies suggest that the brain's reward system is sensitive to a wide range of social cues, including whether our opinions conform to the opinions of others. Researchers have suggested that the social rewards of conformity may have had evolutionary benefits in terms of group cohesion and protection of individuals within the group (Cialdini & Goldstein, 2004; Lieberman & Eisenberger, 2009). However, several factors contribute to any given overall evaluation of the value of a stimulus, which are integrated within the VMPFC (Hare et al., 2009, 2011). Increased mindfulness might lead to increased control over the weighting of these different value signals, expansion of the list of attributes that are seen as desirable, and increased happiness through focus on social cues as one of many possible ways of computing value.

Likewise, increased mindfulness may facilitate parallel effects to forms of placebic influence exerted by sugar pills or certain religious rituals or beliefs. Mindfulness meditation increases attention to bodily states and increases present-oriented awareness. Correspondingly, mindfulness is associated with increased activity in neural systems associated with sensory awareness and with decreased activity in cognitive control regions. These findings may suggest that mindfulness practice decreases active engagement of cognitive control, or simply that less effort is required to achieve parallel results. In either case, increased mindfulness may allow individuals to simulate social influence effects within their own minds and bodies to achieve positive results.

Further study that simultaneously examines neural function during experiences of influence, including connectivity between regions, as well as changes in structure in response to changes in mindfulness may be especially helpful in uncovering links between state and trait levels of mindfulness, and the ways that we are mindfully or mindlessly open to cues from those around us. In turn, this form of investigation stands to increase not only our understanding of mindfulness and of influence but also our ability to integrate diverse forms of measurement to predict behavioral outcomes.

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