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CAN NEUROSCIENCE ADVANCE OUR UNDERSTANDING OF CORE QUESTIONS IN COMMUNICATION STUDIES? AN OVERVIEW OF COMMUNICATION NEUROSCIENCE

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Can neuroimaging methods offer any benefit to communication scholars? Although communication scholars draw on multiple, interdisciplinary methods, the field has not traditionally leveraged neuroimaging techniques (Cappella, 1996). By contrast, other social science disciplines have benefitted greatly from the use of neuroscience methodologies to test core theoretical questions (Adolphs, 2003; Cabeza & Nyberg, 2000a; Cacioppo, 2002; Cacioppo, Berntson, Sheridan, & McClintock, 2000; Lieberman, 2010; Loewenstein, Rick, & Cohen, 2008; Ochsner & Lieberman, 2001; Poldrack, 2008; Sanfey, Loewenstein, & Mcclure, 2006; Yarkoni, Poldrack, Van Essen, & Wager, 2010). The current chapter outlines a vision for how communication studies might leverage neuroimaging technologies moving forward. We begin by defining communication neuroscience as a subdiscipline and giving a brief overview of the most commonly employed neuroimaging methods. We follow this introduction with a discussion of the types of questions that neuroimaging is most equipped to answer and suggest areas for further exploration.

WHAT IS COMMUNICATION NEUROSCIENCE?

Communication neuroscience uses neuroimaging tools to understand social communication (e.g., interpersonal communication, media effects). Neuroimaging has aided cognitive and social psychologists in beginning to untangle and understand processes ranging from our ability to use language (Bookheimer, 2002) to the nature of stereotypes and prejudice (Amodio & Devine, 2006; Cunningham et al., 2004; Cunningham & Zelazo, 2007; Phelps, Cannistraci, & Cunningham, 2003; Phelps et al., 2000; Phelps & Thomas, 2003). Communication neuroscience provides a parallel opportunity for communication scholars interested in understanding health communication (Falk, 2010), political communication (Knutson, Wood, Spampinato, & Grafman, 2006; Westen, 2007), interpersonal and nonverbal communication (Todorov, Baron, & Oosterhof, 2008; Todorov, Gobbini, Evans, & Haxby, 2007; Willis & Todorov, 2006), and those interested in understanding media effects (Mathiak & Weber, 2006; Wagner, Dal Cin, Sargent, Kelley, & Heatherton, 2011; Weber, Ritterfeld, & Mathiak, 2006).

WHAT METHODS ARE AVAILABLE?[1,2]

Neuroimaging tools are becoming increasingly available and affordable. Currently, several methods exist that allow scientists to record neural activity, in real time, while participants are exposed to stimuli or perform specific tasks. Event-related potentials (ERPs), electroencephalography (EEG), functional near infrared spectroscopy (fNIRS), positron emission tomography (PET), and functional magnetic resonance imaging (fMRI) are some of the most common methods used. Each of these tools has relative advantages and disadvantages; for example, among the least invasive methods, EEG and ERPs allow extremely high temporal resolution (milliseconds), whereas fMRI provides better spatial resolution and whole brain

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[1]A complete discussion of available methods is beyond the scope of this chapter. Interested readers are referred to *Methods in Social Neuroscience* (Harmon-Jones & Beer, 2009).

[2]The focus of the current chapter is neuroimaging methods. However, other tools, including those used for psychophysiological measurement (see Cacioppo & Berntson, 1992; Lang, Potter, & Bolls, 2009; Potter & Bolls, 2011), and other biologically oriented tools (see Bailenson, Chapter 8, this volume; Johnson, Chapter 6, this volume) offer complementary advantages.

coverage. Functional near infrared spectroscopy (fNIRS) is an increasingly popular method due to its relatively lower cost and portability. fNIRS provides a means to test larger samples in more naturalistic environments, with relatively good spatial and temporal resolution; however, it is limited to examining processes that take place near the cortical surface. Detailed treatment of the methodological considerations arising from the use of neuroimaging methods are beyond the scope of this chapter; however, readers interested in a basic understanding of the process of conducting neuroscience research are referred to Harmon-Jones and Beer (2009). Researchers interested in more detailed treatment of the limitations of neuroimaging methods are referred to Aue, Lavelle, and Cacioppo (2009), Lane and Wager (2009), and Poldrack (2006). Collaborations between neuroscientists and communication scholars can provide an efficient and fruitful way to study theoretically substantive questions while maintaining high methodological standards.

WHAT TYPES OF QUESTIONS CAN NEUROIMAGING METHODS INFORM?

Integration of neuroimaging methods with methods more commonly used in communication studies (e.g., surveys, content analysis, focus groups, experiments) can inform communication theory, provide practical insight about media effects, and aid neuroscientists in understanding the brain. As a starting point, a number of psychological processes have been characterized in terms of the neural activity that they elicit.[3] Of particular relevance to understanding social communication, neural systems involved in different types of emotional/affective processing, reasoning, attention, memory formation and retrieval, social cognition and perspective taking, and self-related processes, among others, have been mapped in the brain (Cabeza & Nyberg, 2000a, 2000b; Cacioppo, 2002; Cacioppo et al., 2000; Lieberman, 2010).

The ability to monitor and record neural activity throughout the brain opens the potential for communication scholars to test competing hypotheses. In particular, neuroimaging may be of use in distinguishing processes that appear to be similar on the surface but are actually supported by

[3]Studies that treat neural activity as a dependent variable (examining where a process takes place in the brain) are typically referred to as "Brain Mapping" studies. Although this type of research is highly useful and necessary, communication scholars are likely to benefit most from leveraging brain mapping that has already occurred to test specific hypotheses of interest.

distinct underlying mechanisms. For example, different neural mechanisms are recruited when ascribing beliefs to political candidates 5 weeks compared with 5 days prior to a presidential election despite equivalent self-reports (Falk, Spunt, & Lieberman, in press). Conversely, neuroimaging can also provide evidence for theories that suggest common underlying mechanisms for processes that appear distinct on the surface (Amodio, 2010a; Lieberman, 2010). For example, neural systems involved in processing the discomfort of physical pain overlap with the neural systems brought online when a person experiences social exclusion (Eisenberger, Lieberman, & Williams, 2003; Kross, Berman, Mischel, Smith, & Wager, 2011).

Finally, given that neuroimaging methods tap into processes that are introspectively opaque or otherwise difficult to capture through self-report (Morris, Ohman, & Dolan, 1998), neuroimaging may allow us to predict outcomes that are difficult to predict when relying on self-report alone (Falk, 2010; Falk, Berkman, Mann, Harrison, & Lieberman, 2010; Falk, Berkman, Whalen, & Lieberman, 2011). For example, neural signals in hypothesized regions of interest predict an additional ~20% of the variance in health behavior change following persuasive messages, above and beyond self-report measures such as attitudes, intentions, and self-efficacy (Falk et al., 2010, 2011).

QUESTIONS OF IMPORTANCE TO COMMUNICATION STUDIES

The following list of open questions is by no means exhaustive. Instead, it is meant to pique the interest of communication scholars and to suggest example ways in which neuroimaging methods might address relevant questions to our field.

Minority Portrayals in the Media. One of the earliest topics addressed by social neuroscientists using neuroimaging techniques concerned neural responses to outgroups (Phelps et al., 2000; Phelps & Thomas, 2003). Building on this early research, investigations of stereotyping, prejudice, and representation of explicit and implicit attitudes in the brain have proliferated (Amodio, 2008, 2010b; Amodio & Devine, 2006; Amodio, Harmon-Jones, & Devine, 2003; Amodio, Kubota, Harmon-Jones, & Devine, 2006; Cunningham, Espinet, Deyoung, & Zelazo, 2005; Cunningham et al., 2004; Cunningham, Raye, & Johnson, 2004; Cunningham & Zelazo, 2007; Cunningham, Zelazo, Packer, & Van Bavel, 2007; Richeson et al., 2003). Self-report data are notoriously inaccurate when referencing socially charged topics (because of self-presentation concerns, demand characteristics, etc.). In these situations, it is common to find discrepancy between implicit measures and explicit self-reports. For example, participants are loath to give responses that might reveal racial prejudice or animus. Given this type of concern, investigators interested in the influence of minority portrayals in the media may benefit by integrating neural measures into their repertoire/toolkit.

Persuasion and Attitude Change. Preliminary work exploring the neural bases of persuasion suggests that, under many circumstances, neural systems involved in self-processes and social cognition are central to persuasion (Chua, Liberzon, Welsh, & Strecher, 2009; Falk, Berkman et al., 2010; Falk et al., 2011; Falk et al., 2010; cf. Klucharev, Smidts, & Fernandez, 2008). Additional research is needed to broaden our understanding of the boundary conditions on these effects and to link classic theories such as the Elaboration Likelihood Model (Petty & Cacioppo, 1986) and the Heuristic Systematic Model (Eagly & Chaiken, 2005) to observed neural activity in response to persuasive messages.

Behavior Change and Neural Focus Groups. In addition to brain mapping studies examining neural correlates of persuasion processes, recent work has also demonstrated that neural signals can predict variability in behavior change following exposure to persuasive messages that is not explained by self-report measures such as attitudes, intentions and self-efficacy (Falk, Berkman et al., 2010; Falk et al., 2011). In particular, our lab seeks to link neural responses in small groups of individuals (as with a traditional focus group) to the effects of media on a larger scale. This technique is known as "neural focus grouping." The broader concept of using neural activity to predict real-world outcomes is the "brain-as-predictor" approach to distinguish it from research on brain mapping (in which neural activity is treated as an outcome variable). Preliminary research suggests that neural signals that predict individual behavior change can also be used to predict population level media effects (Berns & Moore, in press; Falk, Berkman, & Lieberman, in press).

Automaticity and Control in Media Choice and Consumption. One important assumption in many theories of communication is that of an active audience. For example, the uses and gratifications perspective (Katz, Blumler, & Gurevitch, 1974) suggests that potential audience members make choices to satisfy individual preferences or needs. These preferences and needs thus shape potential media effects, but the motivations/needs/gratifications driving specific choices may be unconscious and difficult to capture through self-report. Neuroimaging is ideally positioned to aid in our understanding of the processes underlying media choice, consumption, and self-regulation with respect to choice and consumption (see Hare, Malmaud, & Rangel, 2011, for an example where neuroimaging informs similar processes in the context of food consumption). Of particular interest, neuroimaging research has characterized brain systems that tend to be involved in automatic, affective processes versus those that tend to be more involved in deliberative, cognitive reasoning (Satpute & Lieberman, 2006). Assessing the neural systems that are brought online when individuals make choices regarding the types of media to consume under different circumstances (e.g., under cognitive load vs. not under load; in the immediate vs. in the future) could provide insight about how and why we consume media, as well as the self-regulatory processes that direct our choices under different circumstances (Panek, 2011).

Affect Versus Cognition. The distinction between affective and cognitive processing parallels the distinction between automatic and controlled processes in many ways (Chaiken & Trope, 1999). Similarly, to the extent that neuroimaging has been able to characterize distinctions in affective versus cognitive processing in the human brain, this knowledge can aid in testing hypotheses about the balance of these processes in specific contexts (Satpute & Lieberman, 2006). Furthermore, to the extent that we are able to distinguish between different types of affective and cognitive processes (e.g., fear vs. anger vs. disgust; response inhibition vs. attention redirection), finer grained hypotheses can be tested. These distinctions may be especially relevant to questions in health communication and to questions of political communication and political action; for example, do neural processes underlying different negative emotions (e.g., fear, anger, disgust) predict support for conservative immigration policies? Does the same neural activity (or different neural activity) predict support for action against outgroups (e.g., by deputizing police, authorizing more violent action)? For example, prior work in this area has examined motivated reasoning when assessing the actions of political candidates (Westen, Blagov, Harenski, Kilts, & Hamann, 2006).

These distinctions may also be useful in addressing debates surrounding aggression and the effects of media violence (Bartholow, Bushman, & Sestir, 2006; Denson, 2011; Eisenberger, Way, Taylor, Welch, & Lieberman, 2007; Mathiak & Weber, 2006; Weber, Ritterfeld, & Mathiak, 2006); for example, does neural sensitivity to threat cues in core affective processing regions predict aggressive behavior in experimental settings? To what extent can activity in cognitive control regions override such pre-potent impulses? Do these patterns of neural activity likewise predict aggression in the real world? Aggression researchers have proposed stimuli that act as inhibitory and disinhibitory cues to aggression and violence (Huesmann, 1986). Neuroimaging can help explain the balance among affective responding, cognitive control, and the relationships of each to aggressive behavior. Researchers have only begun applying neuroimaging research to this area, and there is considerably more to learn.

Understanding Emotions. Beyond distinguishing between affective and cognitive processes, the brain may also lend insight into the basic mechanisms underlying emotion (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, in press); in fact, affective neuroscience is an entire subdiscipline. In this domain, communication scholars have much to offer. In order to study affective processing mechanisms, neuroscientists need to effectively elicit powerful emotions in a laboratory environment. Finding appropriate stimuli can be a difficult task. In this area, communication scholars have much to contribute. We can develop stimuli that effectively elicit powerful emotions. Likewise, communication scholars have invested considerable effort in understanding these emotions, as well as why we seek out particular types of media and their corresponding emotional experiences (Bryant & Oliver, 2009; Katz, Blumler, & Gurevitch, 1973; Oliver & Bartsch, 2010). Investigation of media effects in the brain, with a focus on different types of emotional engagement and response, stands to inform our understanding of both the brain and human experience in relation to theories of communication.

Finally, there is strong evidence that labeling emotions (as necessary with many self-report measures) serves a regulatory purpose (Creswell, Way, Eisenberger, & Lieberman, 2007; Lieberman et al., 2007), and the experience of emotion is altered by introspection and verbal or written labeling. As with other biological response measures (e.g. Cacioppo & Berntson, 1992; Lang, Potter, & Bolls, 2009; Potter & Bolls, 2011), neuroimaging methods allow signal capture in the absence of self-report and can aid in our understanding of basic media effects with respect to emotion.

Priming Effects. Priming effects are likely to intersect with many of the concepts listed earlier (effects of emotion on political decision making, violence and aggression following exposure to violence in the media, multiple basic persuasion processes, basic emotional responses to media). Existing neuroimaging research takes advantage of priming techniques in experimental designs (Amodio, Harmon-Jones, Devine, & Curtin, 2004) as well as helping to further developing our understanding of how priming works and why (Moore et al., 2009).

Diffusion of Innovations. Social communication catalyzes the spread of values, attitudes, and behaviors. Current work in our lab explores the neural response to ideas that are destined to spread successfully (a meme effect), as well as neural activity predicting individual intentions to spread ideas and success in doing so (an idea salesperson effect). Current results emphasize three neural systems (involved in social thinking/perspective taking and self-related processes, and reward/valuation) that predict distinct components of these three effects (the meme effect, the intention effect, the salesperson effect); in particular, our results are consistent with the hypothesis that in the initial process of taking in information, people may consider the social currency of being the person who spreads a particular bit of information and plan for ways to successfully share the information with others accordingly. Being seen as the source of good ideas (regardless of whether the ideas are one's own) has always had great social value, and new media outlets have made this process even more visible and explicit. This line of research stands to inform our ability to construct more compelling, "stickier" messages and identify the mechanisms that lead individuals to be better messengers. Ultimately, this work may also help us understand how our ability to spread information relates to our social identity, builds social status, and strengthens our social ties, in addition to helping to uncover the basic mechanisms that lead to the diffusion of ideas and innovations.

Communication in a Global Society. The mass media have a global reach, with new technologies increasingly connecting individuals around the world. In the global media environment, and with increasing need for cross-cultural communication at the individual level (e.g., in business, through social media), questions of how people from different backgrounds process information become increasingly important. The nascent field of cultural neuroscience has provided baseline assessments of neural similarities and differences in basic cognitive processes across cultures (Chiao & Ambady, 2007; Kitayama & Park, 2010). In collaboration with cultural neuroscientists, communications scholars may find it useful to harness neuroimaging methods to address questions of how culture, and media exposure in particular, shapes neural systems and how similarities and differences in the functions adopted by different neural systems go on to influence the way that information is processed, synthesized, and interpreted, both within and across cultural boundaries.

Attention and Switch Tasking; Multitasking and Information Synthesis. In an increasingly complex media environment, how is attention directed and captured? Concern abounds that youth raised in the current media environment will be unable to focus on scholarship and meaningful social relationships and will become less civically engaged. It is widely speculated that today's youth will rely more and more heavily on multitasking/switch-tasking, and that this pattern will have detrimental effects on learning and information synthesis. Significant bodies of literature exist addressing the neural systems involved in attention capture, direction and focus, as well as neural systems implicated in information synthesis and learning (Cabeza & Nyberg, 2000a). Current evidence suggests detrimental effects of switch-tasking on learning and information synthesis (Foerde, Knowlton, & Poldrack, 2006; Foerde, Poldrack, & Knowlton, 2007). It is possible that these effects are universal and represent significant cause for concern moving forward. The brain is extremely adaptable, however, and there is some possibility that rising generations will develop ways of processing information to conform to the surrounding environment. Longitudinal studies combining neural measures with behavioral performance measures stand to inform our understanding of multitasking, how people interact with the new media environment, and how the brain adapts to capitalize on environmental and situational constraints and opportunities.

Distinctions Between Reality and the World Portrayed by the Media. Cultivation theory (Gerbner, Gross, Morgan, & Signorielli, 1994) suggests that our attitudes and beliefs about the world are influenced by the world as portrayed by the media. The proposed process is cumulative across time, and the psychological mechanisms underlying this evolution are likely to elude self-report (e.g., to what extent are popular media portrayals of the world encoded in the same way as "real" events?). As noted by Cappella (1996): "One place to start is with the assumption of a brain specialized to process physical reality, not mediated information. As media evolve technologically, answering queries about their possible effects requires an understanding of the mental processes and structures that constrain audience responses. Part of understanding how texts work, then, is understanding the media that hold them and the neural structures that must respond to them" (p. 6). Neuroimaging could be used to examine whether similar or distinct neural systems are recruited when individuals encode story lines attributed to soap operas versus the news media versus information from a trusted friend or family member. It may also be of interest to compare the neural systems recruited in each of these cases to the neural systems recruited when processing storylines attributed to reality television shows. Neural signals present during encoding in each of these conditions might also predict the extent to which beliefs about the world change to conform to the world as portrayed by the media.

Presence. A related set of questions concerns presence, or the "psychological state in which virtual objects are experienced as actual objects in either sensory or nonsensory ways" (Lee, 2004). In summarizing the literature on presence, Lee (2004) argues for a unified term encompassing telepresence, virtual presence, mediated presence, co-presence, and presence. Neuroimaging can be of use in addressing the theoretical question of defining subsets of presence. In particular, neuroimaging can tell us which experiences the brain codes as similar and to what extent the brain differentiates them.[4]

[4]While distinguishing among physical presence, social presence, and self presence, Lee (2004) argues that "technology-specific differentiation of presence (telepresence vs. virtual presence) is meaningless, because presence, by definition, is not about characteristics of the technology—it is a psychological construct dealing with the perceptual process of technology-generated stimuli" (p. 30). As such, under this typology, video conferencing, seeing a person on television, and seeing a photographic image of someone are all categorized as para-authentic social experiences.

As a starting point, we might compare neural responses to known others over virtual connections (e.g., a conversation with a friend over a mobile phone, social networking site, instant messaging, or teleconferencing) versus live interactions with the same individuals (as in face-to-face interaction). Neuroimaging was used to resolve a similar early debate in cognitive psychology concerning the role of visual simulation in mental imagery. Specifically, does mental imagery rely on depictive representations or purely propositional representations? By demonstrating that mental imagery relies on similar neural systems to actual primary visual perception, Kosslyn and others were able to make a more convincing argument for depictive representations in mental imagery (Behrmann, Kosslyn, & Jeannerod, 1995; Kosslyn, Thompson, & Ganis, 2006). A parallel argument could be made in determining the extent to which virtual communication is processed similarly to face-to-face interaction.

We might then move to investigation of interactions between the medium of experience and the players involved (in what ways is interacting with a partner, friend, family member, acquaintance, or stranger similar or different [from a brain perspective] depending on an in-person vs. virtual context). A combination of higher resolution imaging modalities (e.g., fMRI) with imaging modalities that allow for more naturalistic environments (such as EEG and fNIRS) may be best suited to address such questions because all interactions in the fMRI environment are in some ways virtual (given the constraints of the method and scanner space). Similarly, we might explore the extent to which parasocial relationships between media consumers and media personalities, between individuals in virtual environments (e.g., avatar-based interactions), and experience in the real world are represented similarly or differentially in the brain.

It might also be of interest to compare the brain's representation of parasocial relationships to real-world relationships. Given that media personalities can feel like close friends (e.g., Princess Diana, favorite characters on fictional shows), a natural question might be the extent to which the neural systems recruited when observing and considering the actions of media characters are similar or distinct from the neural systems recruited when observing and considering the actions of friends, acquaintances, and the self in the real world (to what extent does the brain treat these figures as it treats real friends? to what extent does it flag parasocial relationships as different?).

We might hypothesize different consequences of overlapping neural representations of fictional and real social ties; for example, neuroimaging research has demonstrated that (a) physical pain and social exclusion/rejection share common neural underpinnings (Eisenberger, Jarcho, Lieberman, & Naliboff, 2006; Eisenberger & Lieberman, 2004; Eisenberger et al., 2003), (b) empathy for the pain of others is also partly represented in these circuits (Masten, Eisenberger, & Borofsky, 2009; Masten, Eisenberger, Pfeifer, & Dapretto, 2010; Masten, Morelli, & Eisenberger, 2011). Do we represent the social pain of virtual characters' losses in the same way that we represent our own social pain and that of those closest to us?

Finally, research in social neuroscience demonstrates that thinking about personal attributes of close others and thinking about the self recruit overlapping neural regions, whereas thinking about more distant others and those who are different from us recruit distinct neural regions from self-related processing.[5] These lines of research have not explicitly considered the role of real versus mediated relationships within this framework, nor has the possibility of multiple selves (as is possible to create in virtual environments, e.g., through avatars) been considered in this context. It may be of interest to study neural representations of the self in virtual worlds as compared to the self in the real world. Individual differences in the neural representations of the self in mediated contexts (e.g., through avatars) might also predict individual differences in behavior change following interventions employing these technologies (Fox & Bailenson, 2010). Finally, just as with any social psychological phenomenon, we might hypothesize variables that would moderate these relationships (including transportation, engagement with a television series, perception of events on television as being more closely aligned with reality, and culture).

CLOSING THOUGHTS

The list of questions and areas for exploration suggested in this chapter is by no means exhaustive. Instead, this list is meant to provide example starting points for future research, to spur brainstorming, and to highlight areas of potential fruitful collaboration between communication scholars and neuroscientists. Taking a step back, as we consider what the neuroscience literature has to offer our theory and practice, and as we consider incorporating neuroimaging methods into our own work, the same principles that guide sound behavioral research apply. We must be cautious in our use of causal language; a combination of sound experimental design and incorporation of neuroimaging measures into longitudinal studies will facilitate better evaluation and use of the predictive capacity of neuroscience methods. In many cases, we still need to clarify the neural

[5]Interestingly, this finding is moderated by culture. Those raised in more collectivist (East Asian) societies tend to show even greater increased overlap between self and close others as compared with those raised in individualist (Western/American) society. It is possible that the relationship between viewers and characters also varies by culture.

mechanisms associated with observed effects (in a brain mapping step) before we will be able to develop predictive models to explain variance that is not currently explained by other measures (i.e., self-report and implicit measures). A separate step is also needed if we want to connect neural responses at the individual level to behavior responses at the population level (see *neural focus groups*). Longitudinal studies will also help to bridge the gap between the relatively foreign neuroscience laboratory environment and real-world experience. The communication neuroscience framework emphasizes interdisciplinary collaboration in an effort to maximize theoretical relevance, innovation, and practical application. Communication scholars and neuroscientists alike will benefit by taking advantage of the expertise that each has to offer.

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