Neuroscience

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Christopher N. Cascio
Chris Cascio is a doctoral student at the Annenberg School for Communication at the University of Pennsylvania. He is broadly interested in communication neuroscience, which combines methods from communication studies and social neuroscience. His research focuses on neurocognitive mechanisms associated with persuasive health messages delivered through mass media in order to better understand subsequent behavior.

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Emily Falk is an Assistant Professor of Communication at the University of Pennsylvania’s Annenberg School for Communication. Prof. Falk employs a variety of methods drawn from communication science, neuroscience, and psychology. Her work spans levels of analysis from individual behavior, to diffusion in groups and population-level media effects. In particular, Prof. Falk is interested in predicting behavior change following exposure to persuasive messages and in understanding what makes successful ideas spread (e.g., through social networks and through cultures).

Citation:
Abstract

Communication neuroscience is a subfield of communication studies that combines methods from social neuroscience and communications. Communication neuroscience encompasses studies that map neural systems associated with communication processes, as well as work that treats neural activity as a predictor, mediator, or moderator of communication processes and outcomes. For example, communication neuroscience aims to understand how direct and indirect messages delivered through mediated and interpersonal communication influence individuals, groups, and populations by examining the neural mechanisms associated with message processing and subsequent attitude and behavioral outcomes. This entry highlights the recent contributions communication neuroscience has made to the field of communication studies.
Main text:

Given the complex nature of research questions addressing communication processes and effects, it is no surprise that theoretical advances have arisen out of scholarship from multiple disciplines, including communication studies, health, political science, economics, marketing, biology, and psychology. Recently, this interdisciplinary approach has also expanded to include neural processes primarily examined with neuroimaging techniques, thus giving rise to a subfield: communication neuroscience. Communication neuroscience complements existing biological paradigms in communication studies by mapping neural mechanisms that are active during communication processes and treats neural activity as an outcome, predictor, mediator, or moderator of communication processes and outcomes (Falk, Cascio, & Coronel, in press). For example, communication neuroscience aims to understand how messages delivered via media and/or interpersonal communication influence individuals, groups, and populations by examining the neural mechanisms associated with message processing and subsequent behavioral outcomes (Falk, 2010).

The growth of communication neuroscience has been made possible by advances in methods for measuring and manipulating neural activity. Neuroimaging refers to broad set of techniques, such as functional magnetic resonance imaging (fMRI), magnetoencephalography, positron emission tomography, electroencephalography, functional near-infrared spectoscopy (fNIRS), transcranial magnetic stimulation (TMS), and transcranial direct-current stimulation. This entry focuses primarily on findings from fMRI studies as one of the most common methods currently used to study communication processes and effects. Furthermore, within different neuroimaging methodologies, there are also many different analytical approaches; for example, within fMRI analysis, one might report results from whole brain or region of interest (ROI)
analysis, brain mapping or brain-as-predictor paradigms, results from average activation in specific regions or their dynamic interplay with other regions assessed through functional connectivity analysis, to name just a few possibilities. Details concerning the wide range of neuroimaging techniques and analysis methods are beyond the scope of this review; however, further readings are suggested at the end of the entry.

Benefits and Limits of Neuroimaging

Importantly, as with any set of methodologies it is important to understand what information neuroimaging techniques provide and how can that information be used to advance communication theory and practice. One major advantage of neuroimaging methods is that they can provide insight into mental processes that occur in real time without the need for participant introspection and potentially circumventing certain social desirability biases (Lieberman, 2010). Neural measures can then be used as outcomes, direct predictors, mediators, or moderators of communication processes and effects. Modeling these neural processes can account for unique variance in behavior and provide insight into underlying mechanisms that are unaccounted for using self-report and other methods. It is important to note, however, that neuroimaging is not a replacement for other methods but rather should be used in conjunction with other methodologies in order to better understand phenomena important to communication scholars and provide a more holistic understanding of communication processes and effects. The aim of this entry is to highlight recent examples of communication neuroscience that illustrate the approach. Selected studies of message processing, social influence, idea retransmission, media violence, and processing political information serve to illustrate a range of possibilities within the communication neuroscience framework, leading into discussion of how these findings contribute to communication theory.
Message Processing

Within communication studies, neuroscience has been most used to date in the study of persuasive message processing and its links to behavior change. Building on past theories of behavior change, such as the Theory of Reasoned Action, Theory of Planned Behavior, Social Cognitive Theory, and the Health Belief Model, neuroimaging research attempts to explain variance that is not currently captured by variables in these theories. In addition, neuroimaging research aims to reveal which underlying cognitive and affective mechanisms independently or jointly produce persuasive outcomes, giving researchers access to processes of which individuals may not be consciously aware.

Neuroimaging research examining persuasive messages has begun by investigating difference in neural processing during exposure to persuasive health messages in relation to subsequent behavior change. For example, during persuasive message exposure, individual differences in neural activity within the brain’s medial prefrontal cortex (MPFC) predicted 23% of the variance in behavior one week later, above and beyond self-reported attitudes and intentions (Falk, Berkman, Mann, Harrison, & Lieberman, 2010). This study demonstrates how neuroimaging data can predict unique variance in behavior that is currently not captured using other methods. From a theoretical perspective, the MPFC is a region commonly associated with self-processing, and the authors suggest that persuasive messages may be successful, at least in part when message content is incorporated into one’s self-concept (Falk et al., 2010). In a follow-up study examining the relationship between MPFC activity during anti-smoking advertisements and smoking behavior, researchers found that increased activity in the MPFC was associated with reductions in smoking one month after the neuroimaging appointment (Falk, Berkman, Whalen, & Lieberman, 2011). Furthermore, research examining specific sub-regions of the
MPFC, those involved in self-processing and valuation, during anti-smoking messages found that increased activity in the MPFC was associated with reductions in smoking behaviors (Cooper, Tompson, O'Donnell, & Falk, in press). In addition, the ability of MPFC activity to predict behavior change was specific to MPFC activity during message exposure, not individual differences in one’s ability to recruit the MPFC during a more general self-related processing task (Cooper et al., in press). Building on these results, recent data have also used psychological techniques to manipulate neural activity within MPFC; in a study of physical activity behavior change, researchers used self-affirmation to increase activity within MPFC and observed that increases in MPFC activity were related to greater behavior change in the subsequent month (Falk et al., 2015).

Finally, activity in the MPFC during health message exposure in a sample population has been shown to predict population level media effects. In one study, smokers were shown three different quit line help campaigns (ten messages in total) during an fMRI session and were asked to self-report how effective they felt each campaign was. Increased MPFC activity during message exposure predicted the volume of population level calls to the quit line with greater accuracy than self-reported message evaluations (Berkman, Lieberman, & Falk, 2012). In addition, a second study examined neural activity in self-related processing regions during exposure to anti-smoking messages in 50 smokers. The team used this neural activity to predict population-level click through rates from an anti-smoking email campaign (Falk, O’Donnell, et al., 2014). Overall, these studies highlight the role of self-related processing and valuation in persuasive message processing in ways that have not been emphasized by prior theory.

Social Influence
Social influence can alter attitudes and behaviors under a variety of circumstances. For example, social norms are modeled during interpersonal communication, in advertisements, public service announcements, television shows, and on social network sites. Individuals are often unaware, however, of the extent to which social information influences their behavior. Thus, gaining a better understanding of the mechanisms that drive social influence may reveal new theoretical insights that extend beyond a participant’s conscious knowledge. Converging evidence suggests that brain systems associated with valuation and conflict detection are core drivers of conformity (Cascio, Scholz, & Falk, in press; Izuma, 2013).

*Sensitivity to conflict and social threats.* Initial studies on conformity find that increased activity in the dorsal anterior cingulate (dACC), a region implicated in conflict detection, and the anterior insula (AI), a region often implicated in negative arousal, is associated with updating one’s behavior in response to information that one’s opinion is misaligned with the group. In order to test whether conflict detection is a core component of social influence, processing researchers examined whether conformity would take place when conflict detection regions were interrupted (Klucharev, Munneke, Smidts, & Fernández, 2011). Using TMS, a technique that can stimulate the brain in order to increase or decrease activity in particular regions, researchers were able to downregulate (reduce) activity in a region of cortex that includes the dACC during a social influence task, resulting in significantly less conformity (Klucharev et al., 2011). Overall, these studies are consistent with the idea that perceiving opinions that differ from one’s own elicits a conflict signal, and associated arousal, which in turn motivates individuals to update their behavior to align with the group (even if more research is needed to establish a causal order between environmental distress, neural conflict signals, and behavior change). Additional research also suggests that individual differences in neural sensitivity to exclusion within
conflict-sensitive regions predict susceptibility to influence (Falk, Cascio, et al., 2014); those who are more sensitive to negative social experiences may conform in order to maintain group harmony. This is consistent with the idea that conformity and compliance serve to maintain group harmony.

**Sensitivity to social rewards and value.** Although conflict detection systems seem to play a crucial role in conformity, evidence suggests that reward or valuation systems, including the ventral striatum (VS) and ventral medial prefrontal cortex (VMPFC) also play an integral role in updating one’s behavior to align with group opinions. For example, in one study of conformity, agreeing with expert opinions of music was correlated with reward processing (Campbell-Meiklejohn, Bach, Roepstorff, Dolan, & Frith, 2010). Reward activity has also been linked to conforming to indirect social norms. For example, a study examining the social norms conveyed by price found that VMPFC activity positively correlated with the price of the wine, despite having participants taste the same wine on each trial (Plassmann, O’Doherty, Shiv, & Rangel, 2008)—in other words, the social cue (price) influenced perceived reward associated with consuming the wine. Overall, these studies suggest that individuals internalize the value others place on stimulus, whether direct or indirect. Having such sensitivity to social threats and rewards, which in turn motivates attitude and behavior change, may reinforce social connections with others.

**Retransmission**

The research above focuses on neural activity associated with being influenced. This section directs attention to the equally important question of neural processes associated with sharing or retransmitting ideas to others. Such word-of-mouth recommendations are found during face-to-face interpersonal communication and throughout the current media environment.
Although neuroimaging research in this area is relatively new, consistent findings are already beginning to emerge among studies that have examined communicators who effectively influence others. Specifically, these studies find increased activation in the temporoparietal junction (TPJ) to be associated with being a good ‘idea salesperson’ (Dietvorst et al., 2009; Falk, Morelli, Welborn, Dambacher, & Lieberman, 2013); TPJ is a region commonly associated with perspective taking and considering the intentions of others, termed mentalizing. In one fMRI investigation, researchers examined neural activity during exposure to television show ideas that participants later described to others. Results from this study demonstrated that participants who displayed greater activity in the bilateral TPJ during initial exposure to the ideas later showed greater success in effectively persuading others to have the same opinions during the retransmission part of the task. The authors concluded that those who successfully propagate their opinions to others may be engaging in greater perspective taking or mentalizing during initial idea encoding (Falk et al., 2013).

In addition, research examining the effectiveness of a salesperson’s ability to take their customers’ perspectives found that increased activity in the bilateral TPJ and MPFC was associated with an increased likelihood of mentalizing about customers’ cognitive states, which was also correlated with increased sales performance (Dietvorst et al., 2009). This study in particular is important for two reasons. First, it supports the idea that successful retransmission of ideas and information to others can be attributed in part to one’s ability to take the perspective of others. Second, it provides an example of how to effectively integrate self-report methodology with neuroimaging to better understand a real-world phenomenon.

Finally, research has also examined the intersection of social influence and retransmission-- how the opinions of others can influence our own recommendations. In one
study (Cascio, O’Donnell, Bayer, Tinney, & Falk, in press), convergent with neural correlates of conformity to social influence on one’s own preferences, greater activity in valuation regions was associated with a greater likelihood to conform to peer opinions when making recommendations to others. Convergent with neural correlates of retransmission, individual differences in right TPJ activity predicted participants’ likelihood to use social information to update their recommendations (Cascio, O’Donnell, et al., in press). Overall, these studies suggest that increased mentalizing is associated with more effective propagation as well as susceptibility to social influence in recommendation contexts.

Media Violence

One of the most widely studied areas of media effects research is media violence. Studies examining media violence exposure have found evidence for both short and long-term links to aggression. However, despite empirical evidence, some scholars contend that the link between violent media exposure and aggression is not straightforward. Neuroimaging may be uniquely positioned to inform this discussion. For example, neuroimaging methods can be used to examine the underlying processes that take place at the time of violent media exposure, thus helping to determine whether violent media alters mechanisms that contribute to future aggressive behaviors. Current neuroimaging research on video game play has found that exposure to violent relative to non-violent video game play is associated with increased activity in the dACC, a region associated with conflict detection, as well as decreased activity in the amygdala and rostral ACC, regions implicated in emotional salience and regulation (Weber, Ritterfeld, & Mathiak, 2006). Further neuroimaging research examining violent video games found that exposure to violent video games is correlated with decreased activity in cognitive control regions during a response inhibition task (Hummer et al., 2010). Although these studies
cannot directly speak to changes in aggressive behavior due to violent media exposure, together they both suggest that viewing violent media is associated with changes in emotional regulation and cognitive control. In addition, these data are consistent with a desensitization account of media violence effects, though substantially more work is needed to link this activity to relevant affective, cognitive, and behavioral outcomes.

Political Information Processing

Vast amounts of money are spent on political campaigns, and one important question is whether exposure to different issue positions by political candidates shapes voter behavior, even if voters don’t remember specific facts. Current research explored this question by examining whether voters who cannot remember candidate issue positions can still vote intelligently. More specifically, researchers examined voting behaviors of healthy adults and amnesic patients with hippocampal damage (Coronel et al., 2012). Hippocampal damage renders amnesic patients unable to remember details regarding facts like issue position, but does not affect their ability to experience and form emotional memories. Participants were exposed to experimentally manipulated candidate issue positions, where one candidate’s positions were manipulated to be congruent with the participants’ political beliefs, a second candidate was created to be incongruent, and a third irrelevant. Findings indicated that amnesic patients consistently voted for congruent candidates and against incongruent candidates, despite not being able to remember issue positions. These data confirm the theoretical claim that voters can implicitly tally affective information, which in turn influences voter behavior, even if the voter cannot remember specific issue positions (Coronel et al., 2012). Although this is not a traditional neuroimaging study, this alternative neuroscience method represents a unique approach to advancing communication theory that would not be possible using other methods.
Conclusion

The current review highlighted examples of findings in communication neuroscience and discussed how empirical findings can be used to help advance research questions within communication studies. Building on past traditions of utilizing biological measurement in communication studies, neuroscience methods including neuroimaging are beginning to make contributions to our understanding of media effects research and have potential to contribute to a wide range of questions in interpersonal and mass communication research more broadly.

Overall, using multiple methods, such as self-report, behavioral observation, psychophysiology, and neuroimaging, will ultimately lead to greater understanding of interpersonal communication and media effects and processes.

SEE ALSO: Attitude; Behavior; Biology; Cognitive science; Information processing and cognition; Persuasion and social influence; Psychology
References


Further Readings


