The Role of Mentalizing in Communication Behaviors

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ABSTRACT

Communication is a fundamental ability of humans, and much of our daily energy is used in producing, sharing, receiving and understanding information and messages. As part of our capacities as information communicators and receivers, we often infer and evaluate the mental states of those people with whom we are interacting. Here we describe research from social psychology, communication, behavioral economics, and neuroscience that highlights the role of mentalizing in communication and decision-making more broadly. In this chapter, we give particular focus to the neuroscientific evidence, which shows that the mentalizing network, a set of cortical brain regions thought to preferentially process social information, are commonly activated by communicators and audiences, and facilitate successful information transfer between communicators and receivers. We close with future directions for research in psychology and neuroscience that further elucidates the role of mentalizing in communication and decision making.

Introduction

How does an idea move from one mind to another? Communication between people shapes our perceptions of the world and the behaviors we choose to enact. Our ability to navigate complex social relationships developed as our ancestors began forming larger and more complex groups (Dunbar, 1998). As modern humans, we have inherited remarkable social abilities, which allow us to effectively share knowledge, learn from others, and shape our behaviors around their experiences (Bandura, 1962). These communication skills, in part, rely on a process of mentalizing -- thinking about other people's mental states (Frith & Frith, 2003). Within the brain, a mentalizing network including regions such as the medial prefrontal cortex (mPFC), temporal-parietal junction (TPJ), posterior cingulate cortex (PCC), precuneus (PC), and posterior superior temporal sulcus (pSTS) (Frith & Frith, 2006; Mitchell, 2009; Saxe, Carey, & Kanwisher, 2004; Spunt & Lieberman, 2012; Van Overwalle, 2009), occupies greater relative space in humans compared to other species (Bradbury, 2005; Nimchinsky et al., 1999) and facilitates social communication, among other tasks (Cacioppo & Cacioppo, 2013).

Here we describe research that underscores the role of mentalizing in successful communication, drawing on research from interpersonal and mass communication, economic decision making, and social neuroscience. Specifically, these fields together highlight the critical role that mentalizing plays in guiding information sharing decisions, facilitating peer influence and behavior change, and promoting shared understanding across communicators and receivers.

Mentalizing in Communication

To understand how mentalizing is used during communication, we first describe its role in facilitating information sharing and message reception. Individuals often flow between acting as communicators and receivers of information over the course of an interaction, however these two roles can be described as distinct in how they take advantage of our ability to infer others' knowledge and intentions. In addition to exploring the process of mentalizing in these distinct roles, we also review how regions of the mentalizing network are recruited both when individuals take on the role of communicator and the role of receiver.

Communicators

"Know your audience." This advice highlights that considering the knowledge, thoughts or intentions of one's audience is crucial for effective communication. Constructing an effective message involves accurately representing others' minds, and this process can be very effortful and calculated (Frenzen & Nakamoto, 1993), or automatic and effortless -- shaping not only what we say, but how we say it (Berger, 2014). As an example, imagine you're approached in a park near your house by a stranger asking for directions, but they clearly do not speak your native language fluently. Immediately, you begin a process of inferring what knowledge this stranger has of the city, and how best to help them. How you choose to direct this stranger, and in what manner, will no doubt be based on your inferences (Kingsbury, 1968; Krauss & Fussell, 1991), and how helpful you are to this person will depend on how accurately you are able to represent their knowledge and goals. This interaction illustrates one way that mentalizing contributes to the ultimate success of social decision making and communication: supporting social inferences.

How is mentalizing utilized for generating and sharing information?

Our example in the park illustrates how mentalizing facilitates social inference and message production: initial impressions are used to represent what information a target might need for the goals we perceive them to have. These representations are not static however, and mentalizing makes it possible to continuously update knowledge about others and what information to share with them. Now imagine learning after your initial advice that the stranger in the park is, in fact, from the city. How might this new information shape your next instruction? Recipient design theory (Sacks, Schegloff & Jefferson, 1978) posits that mentalizing is used to guide communication both before an interaction, through initial impressions, and as feedback and new information about a target is incorporated into representations of their knowledge and mental state. In this section we use the recipient design theory as a framework to describe the role of mentalizing in message production and communication.

Beginning with initial impression formation, communicators use a variety of information sources to produce messages appropriate for the perceived needs of specific individuals. The physical location of a target and their perspective (Dumontheil, Küster, Apperly, & Blakemore, 2010; Keysar, Barr, Balin, & Brauner, 2000), target identity (Galati & Brennan, 2010), shared history or knowledge (Fussell & Krauss, 1992), and other factors shape message content. Experimental communication tasks, like the Tacit Communication Game (TCG) (De Ruiter et al., 2007), are one way that scientists have studied the effects of these information streams on message content and communicator decision making more broadly. In the Tacit Communication Game, communicators are asked to guide a partner, or receiver, to a hidden goal on a 3x3 grid using only vertical and horizontal movements. As part of their instructions, communicators are

given freedom to move in any direction, at any speed, and with as many moves as they would like, thus providing variability in communicative strategy. The identity of the receiver may be varied in the Tacit Communication Game, and it is this manipulation in which message tailoring can be experimentally controlled and investigated. For example, in one Tacit Communication Game study, adult communicators were made to believe that they were either guiding another adult or a child to their goal (Newman-Norfund, et al., 2009). This simple alteration dramatically changed the strategy that communicators used, such that instructive actions were deliberately slower and more repetitive near the target when communicators thought they were playing with a child. This study, and others like it, provide clear evidence that communicative decision making is affected by the inferences that communicators make about the knowledge and abilities of their intended audience.

The Tacit Communication Game has also helped to link the brain's mentalizing network to recipient design and message tailoring. Patients with damage to the vmPFC, a region often implicated in mentalizing (Atique, Erb, Gharabaghi, Grodd, & Anders, 2011; Schiller, Freeman, Mitchell, Uleman, & Phelps, 2009), show efforts to convey useful instructions to targets while playing the Tacit Communication Game, but fail to make communicative accommodations for children and adults, respectively (Stolk, D'Imperio, di Pellegrino, & Toni, 2015). Damage to this region seemed to impact communicators' ability to modify their instructions for different receivers. This lesion study, in conjunction with other correlational neuroimaging studies that associate the mentalizing network with message tailoring (Kuhlen, Bogler, Brennan, & Haynes, 2017; Noordzij et al., 2009; Vanlangendonck, Willems, & Hagoort, 2018), suggests that mentalizing is an important feature of recipient design and the process of message formation and delivery.

Recipient design does not end with communicators' initial impressions – the theory also contends that communicators incorporate feedback from their target over the course of their interactions and as new information is learned (Newman-Norlund et al., 2009). Indeed, people can be remarkably sensitive to their communication partners -- quickly changing course or doubling down at the slightest wince or smile, boo or cheer. Here also, mentalizing is involved in communication strategy revision (Bögels, Barr, Garrod, & Kessler, 2015). For example, communicators in the Tacit Communication Game show greater engagement of the TPJ when receiving feedback from their receiver, which in turn relates to changes in instruction (Bögels, 2015). Activation in the STS, rIPL and PCC is also associated with impression updating (Mende-Siedlecki, Cai, & Todorov, 2013), and the tracking of individual characteristics over time (Cloutier, Gabrieli, O'Young, & Ambady, 2011; Ma et al., 2012). Additionally, some of these same regions (STS, TPJ) are implicated in tracking relevant characteristics of other social agents during economic decision-making tasks (Behrens, Hunt, Woolrich, & Rushworth, 2008). This research provides evidence that people continuously incorporate feedback and new information into mental models of interacting partners in the context of active communication, in more basic forms of decision-making and behavior revision, and, importantly, activate regions of the brain's mentalizing system to guide decisions.

How does mentalizing lead to successful communication?

Mentalizing has an important role in providing a knowledge base for communicators to inform what information to share, but successful communication may hinge on whether a communicator can accurately represent the mental states of their audience (e.g., states of

knowledge or belief). In a classic series of studies (Fussell and Krauss 1989), participants provided written descriptions of several shapes for either themselves at a later time, their friend, or a complete stranger. Friends and participants themselves performed significantly better than strangers using these written descriptions, a result which the authors contend is driven by communicators using language that is informed by their and their friends' 'common-ground' (shared knowledge or beliefs (Clark & Murphy 1982)). Further, sharing an experience (even with an unknown target) provides enough common-ground for communicators to draw on when constructing more effective instruction (Traxler & Gernsbacher 1993), a result that is consistent with the idea that the success of mentalizing is increased by a better understanding of a social target, and that this in turn facilitates more successful communication.

Applied research also finds that the success of communication is related to mentalizing processes within individuals. For example, research on how individuals successfully propagate information indicates that brain activity in key parts of the mentalizing system, including the TPJ, dmPFC, precuneus, and ventral-dorsal striatum, is more engaged for content that individuals go on to positively endorse and enthusiastically share (Falk, Morelli, Welborn, Dambacher, & Lieberman, 2013). Additionally, product ads that more actively engage the TPJ and dmPFC were also associated with more use of social appeals when participants promoted the same product (O'Donnell, Falk & Lieberman, 2015).

Mentalizing also contributes to whether or not people share information with others in the first place. Indeed, neuroscience research shows that the spread of information may begin with simple social inferences (e.g. whether others will find information valuable or useful) on the part of individuals (Falk & Scholz, 2018). For example, one recent study found that when participants made decisions about sharing health news articles, activity in the TPJ, dmPFC and PCC

predicted their subsequent decisions to share the content (Baek et al., 2018). Further, those articles that elicited greater activity in the mentalizing network across participants also were shared more by a larger and separate population of news readers (Scholz et al., 2017) who may have also engaged in mentalizing as part of their communicative decision-making.

Finally, individual differences in the extent to which communicators recruit the TPJ (Falk et al., 2013) and mPFC (Dietvorst et al., 2009) track with their abilities as communicators and persuaders; salespeople who could acquire and maintain more profitable accounts also scored higher on a variety of mentalizing related skills like perspective taking, anticipating the needs of clients, detecting nonverbal cues, and shaping the course of the sales interactions (Dietvorst et al., 2009). These same high performing salespeople also showed greater activity in the mPFC during a mentalizing task compared to low performing salespeople. This 'salesperson effect' (Falk et al., 2013), or greater tendency for more effective communicators to engage areas of the mentalizing system, parallels research showing that individuals who engage in greater mentalizing also tend to express more socially adaptive behaviors like cooperating more (Krach, et al, 2009; Paal & Bereczkei, 2007, Ridinger & McBride, 2017), being more inclusive (Masten, Morelli, & Eisenberger, 2011), writing more persuasively to different audiences (Rubin & Rafoth, 1986), and more effectively negotiating (Galinksy, Maddux, Gilin & White, 2008).

The evidence, that mentalizing – and more specifically representing the mental states of communicative targets – facilitates communicative decisions and abilities, converges with a broader literature in neuroeconomics. This research has consistently found that individuals consider the mental states of others in order to guide their behavior, and that individuals with social deficits often perform poorly when making social decisions (Sally & Hill, 2006). Areas of the mentalizing network are frequently engaged when people play strategic games that require

them to understand and predict the behavior of another player before making a move. For example, regions of the TPJ and ACC are both actively engaged in predicting the behavior of other people in competitive card-games or tasks (Carter, Bowling, Reeck, & Huettel, 2012; Gallagher, Jack, Roepstorff, & Frith, 2002), the ventral and dorsal mPFC, the pSTS and PCC are all involved in tracking information about the beliefs of opponents in competitive tasks (Hampton, Bossaerts, & O'Doherty, 2008; Rilling, Sanfey, Aronson, Nystrom, & Cohen, 2004), and the mPFC is activated by considering how cooperative others are, as well as how cooperative one feels like being during such tasks (McCabe, Houser, Ryan, Smith, & Trouard, 2001). Complementing these findings, individuals with autism spectrum disorder, a population characterized by social deficits (Lombardo et al., 2007), not only fail to incorporate social inferences in economic decision making tasks (Sanfey, 2007), but also show reduced engagement of the rTPJ compared to control participants when making socially relevant inferences (Lombardo, et al., 2011).

Overall, research from social psychology, communication and neuroscience indicates that mentalizing impacts how people communicate and interact with others. This growing body of evidence suggests that neural pathways implicated in mentalizing can predict how successful a message is in reaching an audience (Scholz et al., 2017), and how successful individuals are in convincing others (Falk et al., 2013; Dietvorst et al, 2009). Such research falls into a broader area of science that finds mentalizing and the mentalizing network as necessary for decision making in social contexts.

Receivers

Reviewing how communicators use perspective taking to transmit ideas and persuade others considers only half of our story: listeners are at the other end of these exchanges. In this section, we explore evidence that information receivers also use their mentalizing skills to evaluate the content of messages and form preferences (Falk & Scholz, 2018). Again, findings from social psychology, economics, communication and neuroscience provide parallel insights, suggesting that mentalizing is a general process involved in successful social decision making across communicators and receivers.

How does mentalizing help to understand communicated information?

To understand information from other people, a receiver may need to consider the goals or intentions of the communicator. That is, the meaning of a gesture or comment can be affected by knowledge of the person (or entity) communicating it. Interactions can hinge on such an understanding (e.g. an inside joke or misread nod), and so the success of a message can rely not only on the message itself but on how a receiver understands the context inherent to mental states of the communicator.

The characteristics of a communicator can have a significant effect on how message receivers process and value information. These mediating factors, or source effects, are a topic of extensive research in social psychology and both basic and applied research in communication and consumer behavior (see Wilson & Sherrell, 1993 for review). Source effects like the credibility, expertise, trustworthiness (Sternthal, Phillips, & Dholakia, 1978; Heesacker, Petty & Cacioppo, 1984; Kumkale, et al, 2010; Kang & Herr, 2006), attractiveness (Chaiken, 1979; Pucket, Petty, Cacioppo, & Fisher, 1983), and ideological similarity of a communicator

(Woodside & Davenport, 1974; Silvia, 2005) all have long histories of positive effects on message processing and attitudes or behavior change. Evidence from neuroscience further indicates that mentalizing processes are involved in these source effects. For instance, objects associated with attractive or high expertise celebrities are not only valued more by observers but also elicit greater activation in the dmPFC (Klucharev, Smidts, & Fernández, 2008); high status individuals elicit greater activation in the dmPFC, PC, and rTPJ when others view their faces (Zerubavel, Bearman, Weber, & Ochsner, 2015); and source identity cues like group affiliation (Stallen, Smidts, & Sanfey, 2013), race (Cikara & Van Bavel, 2014; Ito & Bartholow, 2009) and even religion (Bruneau, Dufour, & Saxe, 2012) relate to activation in areas of the mentalizing network when information is evaluated by receivers.

Do receivers vary in their sensitivity to social information?

Many of our decisions, whether it's what news to read (Hermida, Fletcher, Korell, & Logan, 2012), food to eat (Zhang, Ye, Law, & Li, 2010), or even medical choices (Frost & Massagli, 2008), involve the consideration and incorporation of social feedback. Even with anonymous peers, mentalizing and social comparison still influence decision making (Cascio, O'Donnell, Bayer, Tinney, & Falk, 2015; Klucharev, Hytönen, Rijpkema, Smidts, & Fernández, 2009). Likewise, while individuals are generally attentive to deviations from group recommendations during decision making tasks, individuals' reactivity in the TPJ tracks with sensitivity to peer feedback, such that those individuals who show greater activation in the TPJ when viewing the opinions of a group are also more likely to update their opinions to fall in line with the group (Cascio, O'Donnell, et al., 2015). Interestingly, such results also vary with individuals' social network structure (O'Donnell, Bayer, Cascio & Falk, 2017), indicating that

one's social environment may also impact the neural processes that give rise to conformity. These findings and similar research (Welborn et al., 2016) suggests that individuals may be differentially influenced by normative messages during consumer decisions, and that such variability may be explained by both environmental and neurobiological factors like social network structure and mentalizing network sensitivity.

Mentalizing, Sharing, and Interactive Information Transfer

Multiple lines of evidence converge to show that mentalizing is an important process both for communicators choosing how and what to share, and for receivers determining whether or not information is persuasive. Although these lines of inquiry address mentalizing in these two communicative roles, they don't address the process of information transfer itself. Given that communication necessarily involves two or more agents interacting, studying these roles in isolation does not completely encompass the processes involved. In this next section we review research that indicates that the phenomenon of information transfer itself is supported by synchrony between people's mentalizing networks.

Inter-subject correlation (ISC), an analysis technique which measures the extent of shared neural processing between two or more individuals, has driven the understanding of the processes involved in information transfer and experience sharing. As part of this analysis method, either the spatial pattern of brain activity or (more commonly) the time-course of activation of two or more individuals' brains are compared for similarity as information is presented (Hasson, Nir, Levy, Fuhrmann, & Malach, 2004). The method is generally model free, which makes it particularly well suited for understanding how individuals similarly process and represent naturalistic stimuli (e.g. movies and written stories) or synchronize during realistic

interpersonal interactions. ISC research has revealed that neural coupling occurs in areas of the brain responsible for basic perception (Silbert, Honey, Simony, Poeppel, & Hasson, 2014), the value system (Zadbood, Chen, Leong, Norman, & Hasson, 2017), and that during face-to-face interactions areas of the mentalizing network (rTPJ) show increased similarity between partners (Tang et al., 2016).

How does neural synchrony facilitate communication?

As individuals interact, a complex process of mimicry and synchrony occurs in conversation topic and language use (Doré & Morris, 2018), prosodic cues (Lee et al., 2010), body position (Cappella, 1997) and even physiology (Mønster, Håkonsson, Eskildsen, & Wallot, 2016). Such coupling between individuals is thought to facilitate the transmission of information (Falk & Scholz, 2018), with the brains of two individuals sharing how information is represented both perceptually (Chen et al, 2017) and cognitively (Parkinson, Kleinbaum, & Wheatley, 2018). For example, in research by Stephens et al. (2010), speakers were instructed to tell a personal story while inside the MRI, and this story was then played to another listener while their brain was also scanned. Results from the study indicated that auditory processing areas, as well as the mPFC, dlPFC, striatum, precuneus and TPJ were all significantly coupled between speaker-listener pairs, and importantly, that the extent to which speaker-listener brain signal was coupled in these areas was predictive of how successfully the listener could recall the speaker's story. To establish that the coupling-comprehension relationship was not driven by low-level linguistic or auditory features, the authors also showed that the relationship did not hold when speakers told stories in a language that the listener did not comprehend.

Beyond temporal synchrony, successful information transfer also evokes patterns of brain activity across speakers and listeners that are highly spatially similar (Zadbood et al., 2017). In

one study, speakers described scenes from two television shows to listeners. Speakers and listeners showed significant spatial correlation in the precuneus, PCC and mPFC, and the amount of speaker-listener pattern correlation in these regions was predictive of successful memory of the spoken information by listeners. Together with the results of Stephens et al., (2010), these results suggest that socially-mediated information transfer depends on the coupling of neural signal over space and time in brain regions responsible not only for perception, but also higher order brain areas including the precuneus, mPFC, dmPFC, TPJ.

How do the brains of audiences synchronize to messages?

Neural synchrony also occurs between larger groups of individuals, and not just in cases of direct interpersonal communication. As audiences interact with messages, the extent to which a message is successful is also associated with the extent to which the neural signal between individuals in the group follow a similar pattern (Hasson, Nir, Levy, Fuhrmann, & Malach, 2004; Schmälzle, Häcker, Honey, & Hasson, 2015). In these investigations, stimulus driven activity in the visual and auditory cortices are often correlated, but higher order regions of the mentalizing network, such as the STS, mPFC and TPJ are also correlated between observers. For example, Schmälzle et al. (2015) found that correlated activity in the TPJ and mPFC in response to political speeches was associated with the speeches being evaluated as stronger rather than weaker, suggesting that successful speeches result in shared processing of social information in the minds of listeners.

Overall these lines of research highlight the importance of understanding how individuals and groups interact as they engage in shared processing of information. This area of research still has much to explore, but has already started to reveal the importance of mentalizing for understanding socially-mediated communication.

Future Directions

Beyond building an initial basic science model of the neuroscience of successful communication, it is also important to identify contextual factors that influence or moderate the effects of mentalizing on information sharing and persuasion. Two such contextual factors, inter-group bias and mediating technology, are particularly relevant to practitioners and researchers focusing on modern social life, and may be fruitful topics for researchers in this area to explore.

Communication Breakdown: Mentalizing and Intergroup Bias

Social conflict is common across the globe, and understanding how group biases impact communication is of great importance for improving discourse between groups and promoting social understanding. A broad literature in social psychology and neuroscience indicates that group identity affects decision making (Bodenhausen, 1988; Bruneau & Saxe, 2010; Cikara, Botvinick, & Fiske, 2011) and social perception (Van Bavel, Packer, & Cunningham, 2011). Such effects are so salient, in fact, that even arbitrary, experimentally constructed, groups can powerfully shape responses to in- and out-group members (Brewer, 1979; Judd & Park, 1988; Taijfel, 1970; Van Bavel, Packer, & Cunningham, 2008). Mentalizing is also affected by group bias -- people are more conservative in their attribution of mental capacities when observing the faces of out-group members (Hackel, Looser, & Van Bavel, 2014), and even show reduced empathic response in the mentalizing and pain networks during exposure to the pain or suffering of out-group members (Cikara, Bruneau, & Saxe, 2011).

One informative direction for this research area could be in exploring how mentalizing, or a lack of mentalizing, toward out-group members can lead to reduced civility and fairness in communication (Galinksy & Moskowitz, 2000), as inferences about a target seem to have a dramatic impact on how a communicator shapes the content of a message (Noordzij et al., 2009). A question worthy of greater attention is whether failed communication between members of opposing groups results from a lack of perspective taking, or engagement in inaccurate perspective taking based on false stereotypes. Further, only a handful of neuroimaging studies have asked how communicators update their inferences about targets from their in- versus out-group (Bögels et al., 2015; Freeman, Schiller, Rule, & Ambady, 2010). Contributions in this area could help explain how stereotypes or false assumptions may be corrected when people engage in conversation. Such work could build our scientific understanding of how people shape their statements when confronting others they staunchly disagree with.

Mediated Mentalizing: How Distance Shapes Communication.

A growing proportion of social interactions occur in a manner that is mediated by technology, making it especially important for researchers to understand how technologies affect communication. People sometimes find it difficult to interpret the meaning or intention of emails or texts, and empirical evidence indicates that people are more likely to misjudge the intentions of others over computer-mediated, versus face-to-face, communications (Kato & Akahori, 2005). Technologically-mediated communication by its nature reduces the amount of contextual information, like eye-gaze or gesture, available to a recipient (Sproull & Kiesler, 1986). This is important because such secondary communicative information can improve interpersonal understanding (Kiesler, Siegel, & McGuire, 1984) and cooperation (Tang et al., 2016). Recent

fNIRS neuroimaging studies suggest that the positive effects of secondary communicative information may be related to greater mentalizing in response to richer information, in that activation in the mentalizing network -- especially the TPJ -- is greater when individuals interact face-to-face as compared to when they are separated by physical barriers (Jahng, Kralik, Hwang, & Jeong, 2017; Tang et al., 2016).

An important feature of online communication is that it can be spatially, temporally and socially distant -- depending on the platform, other individuals may not be in immediate proximity, may communicate asynchronously, and may or may not be perceived as immediate social entities (Norman, Tjomsland, & Huegel, 2016). In the brain, the dmPFC, a region in the mentalizing network, is more active when individuals evaluate information that is perceived as more psychologically distant (Baetens, Ma, Steen, & Van Overwalle, 2014). Combining this finding with the noted role of mentalizing in communication reveals a set of interesting questions. Namely, future research may ask whether online communications with different affordances differ as a function of how they affect mentalizing and activation in the mentalizing network. Evidence already suggests that psychological distance and modality do impact cognitive processes, like how communicative information is attended to and remembered (Amit, Algom, & Trope, 2009; Amit, et al., 2019), and how content is assessed and valued (Henderson, Wakslak, Fujita, & Rohrbach, 2011). Similar research could help to disambiguate whether spatial, temporal or hypothetical distance have similar or independent effects on mentalizing as well. For instance, would a communication medium like text messaging have varying effects on an individual's ability to infer the mental state of their partner or fall into neural synchrony if the time between sending and receiving messages was shortened, thus reducing temporal distance while maintaining spatial distance? Although it is difficult to manipulate some of these factors

within the constraints of fMRI (e.g. spatial distance), methods such as fNIRS and EEG may offer more flexibility for naturalistic assessment (Vettel et al., 2019). Additionally, this research has the exciting potential to catalyze cross-discipline collaboration, further linking communication and neuroscience with related fields like linguistics and computer science.

Conclusion

The complexity and effectiveness of human communication is perhaps one key ingredient to our success as a species. Human communication is strongly facilitated by our ability to accurately infer what information should be shared with others and how to interpret information that is shared with us. The mentalizing system is implicated in a broad set of behaviors related to communication and decision-making, and this network is engaged when we both automatically and effortfully represent the mental states of our communicative partners. When acting as communicators, the mentalizing system facilitates our ability to infer the mental states of our audience in order to tailor how and what we say, and when acting as receivers, the system is engaged in relation to our attempts to understand messages and the intentions behind them. Neural synchrony between communicators and receivers also facilitates the flow of information between them. Environmental and situational factors impact the association between the mentalizing system and communicative decision-making, and it is these factors where some of the greatest promise for this area of research can be found. By linking issues in communication to neurobiological correlates, we will be able to better understand how the world we make and the world we live in impact our ability to share and connect with others at the most basic level.

Works Cited

Amit, E., Algom, D., & Trope, Y. (2009). Distance-dependent processing of pictures and words. *Journal of Experimental Psychology: General*, *138*(3), 400.

Amit, E., Rim, S., Halbeisen, G., Priva, U. C., Stephan, E., & Trope, Y. (2019). Distance-dependent memory for pictures and words. *Journal of Memory and Language*, *105*, 119-130.

Atique, B., Erb, M., Gharabaghi, A., Grodd, W., & Anders, S. (2011). Task-specific activity and connectivity within the mentalizing network during emotion and intention mentalizing. *NeuroImage*, *55*(4), 1899–1911.

Baetens, K., Ma, N., Steen, J., & Van Overwalle, F. (2014). Involvement of the mentalizing network in social and non-social high construal. *Social Cognitive and Affective Neuroscience*, *9*(6), 817–824.

Bandura, A. (1962). Social learning through imitation, 211–274.

Behrens, T. E. J., Hunt, L. T., Woolrich, M. W., & Rushworth, M. F. S. (2008). Associative learning of social value. *Nature*, *456*(7219), 245–249.

Berger, J. (2014). Word of mouth and interpersonal communication: A review and directions for future research. *Journal of Consumer Psychology: The Official Journal of the Society for Consumer Psychology*, *24*(4), 586–607.

Bodenhausen, G. V. (1988). Stereotypic biases in social decision making and memory: testing process models of stereotype use. *Journal of Personality and Social Psychology*, *55*(5), 726–737.

Bögels, S., Barr, D. J., Garrod, S., & Kessler, K. (2015). Conversational Interaction in the Scanner: Mentalizing during Language Processing as Revealed by MEG. *Cerebral Cortex , 25*(9), 3219–3234.

Bradbury, J. (2005). Molecular insights into human brain evolution. *PLoS Biology, 3*(3), e50.

Brewer, M. B. (1979). In-group bias in the minimal intergroup situation: A cognitive-motivational analysis. *Psychological Bulletin*, *86*(2), 307.

Bruneau, E. G., Dufour, N., & Saxe, R. (2012). Social cognition in members of conflict groups: behavioural and neural responses in Arabs, Israelis and South Americans to each other's misfortunes. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *367*(1589), 717–730.

Bruneau, E. G., & Saxe, R. (2010). Attitudes towards the outgroup are predicted by activity in the precuneus in Arabs and Israelis. *NeuroImage*, *52*(4), 1704–1711.

Cacioppo, J. T., & Cacioppo, S. (2013). Social Neuroscience. *Perspectives on Psychological Science: A Journal of the Association for Psychological Science*, *8*(6), 667–669.

Cappella, J. N. (1997). Behavioral and judged coordination in adult informal social interactions: Vocal and kinesic indicators. *Journal of Personality and Social Psychology*, *72*(1), 119.

Carter, R. M., Bowling, D. L., Reeck, C., & Huettel, S. A. (2012). A distinct role of the temporal-parietal junction in predicting socially guided decisions. *Science, 337*(6090), 109–111.

Cascio, C. N., Carp, J., O'Donnell, M. B., Tinney, F. J., Jr, Bingham, C. R., Shope, J. T., Ouimet, M. C., Pradhan, A. K., Simons-Morton, B. G., Falk, E. B. (2015). Buffering social influence: neural correlates of response inhibition predict driving safety in the presence of a peer. *Journal of Cognitive Neuroscience, 27*(1), 83–95.

Cascio, C. N., O'Donnell, M. B., Bayer, J., Tinney, F. J., & Falk, E. B. (2015). Neural Correlates of Susceptibility to Group Opinions in Online Word-of-Mouth Recommendations. *JMR, Journal of Marketing Research*, *52*(4), 559–575.

Chaiken, S. (1979). Communicator physical attractiveness and persuasion. *Journal of Personality and social Psychology*, *37*(8), 1387.

Chen, J., Leong, Y. C., Honey, C. J., Yong, C. H., Norman, K. A., & Hasson, U. (2017). Shared memories reveal shared structure in neural activity across individuals. *Nature Neuroscience*, *20*(1), 115–125.

Cikara, M., Botvinick, M. M., & Fiske, S. T. (2011). Us versus them: social identity shapes neural responses to intergroup competition and harm. *Psychological Science*, *22*(3), 306–313.

Cikara, M., Bruneau, E. G., & Saxe, R. R. (2011). Us and Them: Intergroup Failures of Empathy. *Current Directions in Psychological Science*, *20*(3), 149–153.

Cikara, M., & Van Bavel, J. J. (2014). The Neuroscience of Intergroup Relations: An Integrative Review. *Perspectives on Psychological Science: A Journal of the Association for Psychological Science*, *9*(3), 245–274.

Clark, H. H., & Carlson, T. B. (1982). Hearers and Speech Acts. *Language*, *58*(2), 332–373.

Cloutier, J., Gabrieli, J. D. E., O'Young, D., & Ambady, N. (2011). An fMRI study of violations of social expectations: When people are not who we expect them to be. *NeuroImage*, *57*(2), 583–588.

De Ruiter, J. P., Noordzij, M., Newman-Norlund, S., Hagoort, P., & Toni, I. (2007). On the origin of intentions. *Attention & Performance XXII*, 593–610.

Dietvorst, R. C., Verbeke, W. J., Bagozzi, R. P., Yoon, C., Smits, M., & Van Der Lugt, A. (2009). A sales force–specific theory-of-mind scale: Tests of its validity by classical methods and functional magnetic resonance imaging. *Journal of Marketing Research, 46*(5), 653-668.

Doré, B. P., & Morris, R. R. (2018). Linguistic Synchrony Predicts the Immediate and Lasting Impact of Text-Based Emotional Support. *Psychological Science, 29*(10), 1716–1723.

Dumontheil, I., Küster, O., Apperly, I. A., & Blakemore, S.-J. (2010). Taking perspective into account in a communicative task. *NeuroImage, 52*(4), 1574–1583.

Dunbar, R. I. (1998). The social brain hypothesis. *Brain: A Journal of Neurology*, *9*(10), 178–190.

Falk, E. B., Morelli, S. A., Welborn, B. L., Dambacher, K., & Lieberman, M. D. (2013). Creating buzz: the neural correlates of effective message propagation. *Psychological Science*, *24*(7), 1234–1242.

Falk, E., & Scholz, C. (2018). Persuasion, Influence, and Value: Perspectives from Communication and Social Neuroscience. *Annual Review of Psychology*, *69*, 329–356.

Freeman, J. B., Schiller, D., Rule, N. O., & Ambady, N. (2010). The neural origins of superficial and individuated judgments about ingroup and outgroup members. *Human Brain Mapping*, *31*(1), 150–159.

Frenzen, J., & Nakamoto, K. (1993). Structure, Cooperation, and the Flow of Market Information. *The Journal of Consumer Research*, *20*(3), 360–375.

Frith, C. D., & Frith, U. (2006). The neural basis of mentalizing. *Neuron*, *50*(4), 531–534.

Frith, U., & Frith, C. D. (2003). Development and neurophysiology of mentalizing. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *358*(1431), 459–473.

Frost, J. H., & Massagli, M. P. (2008). Social uses of personal health information within PatientsLikeMe, an online patient community: what can happen when patients have access to one another's data. *Journal of Medical Internet Research*, *10*(3), e15.

Fussell, S. R., & Krauss, R. M. (1992). Coordination of knowledge in communication: effects of speakers' assumptions about what others know. *Journal of Personality and Social Psychology*, *62*(3), 378–391.

Galati, A., & Brennan, S. E. (2010). Attenuating information in spoken communication: For the speaker, or for the addressee? *Journal of Memory and Language*, *62*(1), 35–51.

Galinsky, A. D., & Moskowitz, G. B. (2000). Perspective-taking: decreasing stereotype expression, stereotype accessibility, and in-group favoritism. *Journal of personality and social psychology*, *78*(4), 708.

Gallagher, H. L., Jack, A. I., Roepstorff, A., & Frith, C. D. (2002). Imaging the intentional stance in a competitive game. *NeuroImage*, *16*(3 Pt 1), 814–821.

Gallese, V., & Goldman, A. (1998). Mirror neurons and the simulation theory of mind-reading. *Trends in cognitive sciences*, *2*(12), 493-501.

Hackel, L. M., Looser, C. E., & Van Bavel, J. J. (2014). Group membership alters the threshold for mind perception: The role of social identity, collective identification, and intergroup threat. *Journal of Experimental Social Psychology*, *52*, 15–23.

Hampton, A. N., Bossaerts, P., & O'Doherty, J. P. (2008). Neural correlates of mentalizing-related computations during strategic interactions in humans. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(18), 6741–6746.

Henderson, M. D., Wakslak, C. J., Fujita, K., & Rohrbach, J. (2011). Construal level theory and spatial distance. *Social Psychology*, *42*(3), 165-173

Hasson, U., Nir, Y., Levy, I., Fuhrmann, G., & Malach, R. (2004). Intersubject synchronization of cortical activity during natural vision. *Science, 303*(5664), 1634–1640.

Hermida, A., Fletcher, F., Korell, D., & Logan, D. (2012). SHARE, LIKE, RECOMMEND. *Journalism Studies*, *13*(5-6), 815–824.

Ito, T. A., & Bartholow, B. D. (2009). The neural correlates of race. *Trends in Cognitive Sciences*, *13*(12), 524–531.

Jahng, J., Kralik, J. D., Hwang, D.-U., & Jeong, J. (2017). Neural dynamics of two players when using nonverbal cues to gauge intentions to cooperate during the Prisoner's Dilemma Game. *NeuroImage*, *157*, 263–274.

Judd, C. M., & Park, B. (1988). Out-group homogeneity: Judgments of variability at the individual and group levels. *Journal of Personality and Social Psychology*, *54*(5), 778.

Kang, Y.-S., & Herr, P. M. (2006). Beauty and the Beholder: Toward an Integrative Model of Communication Source Effects. *The Journal of Consumer Research*, *33*(1), 123–130.

Kato, Y., & Akahori, K. (2005) Analysis of judgment of partners' emotions during e-mail and face-to-face communication, *Journal of Science education in Japan 29*(5), 354-365.

Keysar, B., Barr, D. J., Balin, J. A., & Brauner, J. S. (2000). Taking perspective in conversation: the role of mutual knowledge in comprehension. *Psychological Science*, *11*(1), 32–38.

Kiesler, S., Siegel, J., & McGuire, T. W. (1984). Social psychological aspects of computer-mediated communication. *The American Psychologist*. Retrieved from http://psycnet.apa.org/record/1985-27678-001?casa_token=qx7q_6sto90AAAAA:Kugom-T2X-rVGijd9o1apc8n3CzOLO6VilvN7NxSksk52-t_ukX4IQiwh8oxoruyG3ZZ6s0Vv0Uz-4uBmdGWBds

Kingsbury, D. (1968). *Manipulating the amount of information obtained from a person giving directions*. Harvard University.

Klucharev, V., Hytönen, K., Rijpkema, M., Smidts, A., & Fernández, G. (2009). Reinforcement learning signal predicts social conformity. *Neuron, 61*(1), 140–151.

Klucharev, V., Smidts, A., & Fernández, G. (2008). Brain mechanisms of persuasion: how "expert power" modulates memory and attitudes. *Social Cognitive and Affective Neuroscience, 3*(4), 353–366.

Krach, S., Blümel, I., Marjoram, D., Lataster, T., Krabbendam, L., Weber, J., van Os, J., Kircher, T. (2009). Are women better mindreaders? Sex differences in neural correlates of mentalizing detected with functional MRI. *BMC Neuroscience, 10,* 9.

Krauss, R.M. & Fussell, S.R. (1991). Perspective-taking in communication: Representations of others' knowledge in reference. *Social Cognition, 9*(1), 2–24.

Kuhlen, A. K., Bogler, C., Brennan, S. E., & Haynes, J.-D. (2017). Brains in dialogue: decoding neural preparation of speaking to a conversational partner. *Social Cognitive and Affective Neuroscience, 12*(6), 871–880.

Kumkale, G. T., Albarracin, D., & Seignourel, P. J. (2010). The effects of source credibility in the presence or absence of prior attitudes: Implications for the design of persuasive communication campaigns. *Journal of applied social psychology, 40*(6), 1325-1356.

Lombardo, M. V., Barnes, J. L., Wheelwright, S. J., & Baron-Cohen, S. (2007). Self-referential cognition and empathy in autism. *PloS one, 2*(9), e883.

Lombardo, M. V., Chakrabarti, B., Bullmore, E. T., Baron-Cohen, S., & MRC AIMS Consortium. (2011). Specialization of right temporo-parietal junction for mentalizing and its relation to social impairments in autism. *Neuroimage, 56*(3), 1832-1838.

Lee, C.-C., Black, M., Katsamanis, A., Lammert, A. C., Baucom, B. R., Christensen, A., Georgiou, P. G., Narayanan, S. S. (2010). Quantification of prosodic entrainment in affective spontaneous

spoken interactions of married couples. In *Eleventh Annual Conference of the International Speech Communication Association*. isca-speech.org. Retrieved from http://www.isca-speech.org/archive/interspeech_2010/i10_0793.html

Masten, C. L., Morelli, S. A., & Eisenberger, N. I. (2011). An fMRI investigation of empathy for "social pain" and subsequent prosocial behavior. *NeuroImage*, *55*(1), 381–388.

McCabe, K., Houser, D., Ryan, L., Smith, V., & Trouard, T. (2001). A functional imaging study of cooperation in two-person reciprocal exchange. *Proceedings of the National Academy of Sciences of the United States of America*, *98*(20), 11832–11835.

Mende-Siedlecki, P., Cai, Y., & Todorov, A. (2013). The neural dynamics of updating person impressions. *Social Cognitive and Affective Neuroscience*, *8*(6), 623–631.

Mitchell, J. P. (2009). Inferences about mental states. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *364*(1521), 1309–1316.

Mønster, D., Håkonsson, D. D., Eskildsen, J. K., & Wallot, S. (2016). Physiological evidence of interpersonal dynamics in a cooperative production task. *Physiology & Behavior*, *156*, 24–34.

Newman-Norlund, S. E., Noordzij, M. L., Newman-Norlund, R. D., Volman, I. A. C., Ruiter, J. P. de, Hagoort, P., & Toni, I. (2009). Recipient design in tacit communication. *Cognition*, *111*(1), 46–54.

Nimchinsky, E. A., Gilissen, E., Allman, J. M., Perl, D. P., Erwin, J. M., & Hof, P. R. (1999). A neuronal morphologic type unique to humans and great apes. *Proceedings of the National Academy of Sciences of the United States of America*, *96*(9), 5268–5273.

Noordzij, M. L., Newman-Norlund, S. E., de Ruiter, J. P., Hagoort, P., Levinson, S. C., & Toni, I. (2009). Brain mechanisms underlying human communication. *Frontiers in Human Neuroscience*, *3*, 14.

Norman, E., Tjomsland, H. E., & Huegel, D. (2016). The Distance between Us: Using Construal Level Theory to Understand Interpersonal Distance in a Digital Age. *Frontiers in Digital Humanities*, *3*, 5.

O'Donnell, M. B., Bayer, J. B., Cascio, C. N., & Falk, E. B. (2017). Neural bases of recommendations differ according to social network structure. *Social Cognitive and Affective Neuroscience*, *12*(1), 61–69.

O'Donnell, M. B., Falk, E. B., & Lieberman, M. D. (2015). Social in, social out: How the brain responds to social language with more social language. *Communication Monographs*, *82*(1), 31–63.

Paal, T., & Bereczkei, T. (2007). Adult theory of mind, cooperation, Machiavellianism: The effect of mindreading on social relations. *Personality and Individual Differences*, *43*(3), 541–551.

Parkinson, C., Kleinbaum, A. M., & Wheatley, T. (2018). Similar neural responses predict friendship. *Nature Communications*, *9*(1), 332.

Petty, R. E., Cacioppo, J. T., & Heesacker, M. (1984). Central and peripheral routes to persuasion: Application to counseling. Social perception in clinical and counseling psychology, 2, 59-60.

Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In Communication and persuasion (pp. 1-24). Springer, New York, NY.

Ridinger, G., & McBride, M. (2017). Theory-of-mind Ability and Cooperation. Retrieved from http://economics.ucr.edu/seminars_colloquia/2017-18/economic_theory/McBride%20paper%20for%201%2031%2018%20seminar.pdf

Rilling, J. K., Sanfey, A. G., Aronson, J. A., Nystrom, L. E., & Cohen, J. D. (2004). The neural correlates of theory of mind within interpersonal interactions. *NeuroImage*, *22*(4), 1694–1703.

Rubin, D. L., & Rafoth, B. A. (1986). Social cognitive ability as a predictor of the quality of expository and persuasive writing among college freshmen. Research in the Teaching of English, 9-21.

Sally, D., & Hill, E. (2006). The development of interpersonal strategy: Autism, theory-of-mind, cooperation and fairness. *Journal of economic psychology*, *27*(1), 73-97.

Sanfey, A. G. (2007). Social decision-making: insights from game theory and neuroscience. *Science, 318*(5850), 598-602.

Sacks, H., Schegloff, E. A., & Jefferson, G. (1978). A simplest systematics for the organization of turn taking for conversation. In *Studies in the organization of conversational interaction* (pp. 7–55).

Saxe, R., Carey, S., & Kanwisher, N. (2004). Understanding other minds: linking developmental psychology and functional neuroimaging. *Annual Review of Psychology, 55*, 87–124.

Schiller, D., Freeman, J. B., Mitchell, J. P., Uleman, J. S., & Phelps, E. A. (2009). A neural mechanism of first impressions. *Nature Neuroscience*, *12*(4), 508–514.

Schmälzle, R., Häcker, F. E. K., Honey, C. J., & Hasson, U. (2015). Engaged listeners: shared neural processing of powerful political speeches. *Social Cognitive and Affective Neuroscience*, *10*(8), 1137–1143.

Scholz, C., Baek, E. C., O'Donnell, M. B., Kim, H. S., Cappella, J. N., & Falk, E. B. (2017). A neural model of valuation and information virality. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(11), 2881–2886.

Silbert, L. J., Honey, C. J., Simony, E., Poeppel, D., & Hasson, U. (2014). Coupled neural systems underlie the production and comprehension of naturalistic narrative speech. *Proceedings of the National Academy of Sciences of the United States of America*, *111*(43), E4687–E4696.

Silvia, P. J. (2005). Deflecting Reactance: The Role of Similarity in Increasing Compliance and Reducing Resistance. *Basic and Applied Social Psychology*, *27*(3), 277–284.

Sproull, L., & Kiesler, S. (1986). Reducing Social Context Cues: Electronic Mail in Organizational Communication. *Management Science*, *32*(11), 1492–1512.

Spunt, R. P., & Lieberman, M. D. (2012). An integrative model of the neural systems supporting the comprehension of observed emotional behavior. *NeuroImage*, *59*(3), 3050–3059.

Stallen, M., Smidts, A., & Sanfey, A. G. (2013). Peer influence: neural mechanisms underlying in-group conformity. *Frontiers in Human Neuroscience*, *7*, 50.

Sternthal, B., Phillips, L. W., & Dholakia, R. (1978). The persuasive effect of scarce credibility: a situational analysis. *Public Opinion Quarterly, 42*(3), 285-314.

Stephens, G. J., Silbert, L. J., & Hasson, U. (2010). Speaker–listener neural coupling underlies successful communication. *Proceedings of the National Academy of Sciences, 107*(32), 14425-14430.

Stolk, A., D'Imperio, D., di Pellegrino, G., & Toni, I. (2015). Altered communicative decisions following ventromedial prefrontal lesions. *Current Biology: CB*, *25*(11), 1469–1474.

Taijfel, H. (1970). Experiments in intergroup discrimination. *Scientific American, 223*(5), 96–102.

Tang, H., Mai, X., Wang, S., Zhu, C., Krueger, F., & Liu, C. (2016). Interpersonal brain synchronization in the right temporo-parietal junction during face-to-face economic exchange. *Social Cognitive and Affective Neuroscience*, *11*(1), 23–32.

Traxler, M. J., & Gernsbacher, M. A. (1993). Improving written communication through perspective-taking. *Language and Cognitive Processes, 8*(3), 311-334.

Van Bavel, J. J., Packer, D. J., & Cunningham, W. A. (2008). The neural substrates of in-group bias: a functional magnetic resonance imaging investigation. *Psychological Science, 19*(11), 1131–1139.

Van Bavel, J. J., Packer, D. J., & Cunningham, W. A. (2011). Modulation of the fusiform face area following minimal exposure to motivationally relevant faces: evidence of in-group enhancement (not out-group disregard). *Journal of Cognitive Neuroscience*, *23*(11), 3343–3354.

Vanlangendonck, F., Willems, R. M., & Hagoort, P. (2018). Taking common ground into account: Specifying the role of the mentalizing network in communicative language production. *PloS One*, *13*(10), e0202943.

Van Overwalle, F. (2009). Social cognition and the brain: a meta-analysis. *Human Brain Mapping*, *30*(3), 829–858.

Vettel, J. M., Lauharatanahirun, N., Wasylyshyn, N., Roy, H., Fernandez, R., Cooper, N., … Garcia, J. O. (2019). Translating Driving Research from Simulation to Interstate Driving with Realistic Traffic and Passenger Interactions. In *Advances in Human Factors in Simulation and Modeling* (pp. 126–138). Springer International Publishing.

Welborn, B. L., Lieberman, M. D., Goldenberg, D., Fuligni, A. J., Galván, A., & Telzer, E. H. (2016). Neural mechanisms of social influence in adolescence. *Social Cognitive and Affective Neuroscience*, *11*(1), 100–109.

Wilson, E. J., & Sherrell, D. L. (1993). Source effects in communication and persuasion research: A meta-analysis of effect size. *Journal of the Academy of Marketing Science*, *21*(2), 101.

Woodside, A. G., & Davenport Jr, J. W. (1974). The effect of salesman similarity and expertise on consumer purchasing behavior. *Journal of Marketing Research, 11*(2), 198-202.

Zadbood, A., Chen, J., Leong, Y. C., Norman, K. A., & Hasson, U. (2017). How We Transmit Memories to Other Brains: Constructing Shared Neural Representations Via Communication. *Cerebral Cortex , 27*(10), 4988–5000.

Zerubavel, N., Bearman, P. S., Weber, J., & Ochsner, K. N. (2015). Neural mechanisms tracking popularity in real-world social networks. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(49), 15072–15077.

Zhang, Z., Ye, Q., Law, R., & Li, Y. (2010). The impact of e-word-of-mouth on the online popularity of restaurants: A comparison of consumer reviews and editor reviews. *International Journal of Hospitality Management, 29*(4), 694–700.