Chapter 3

DISCOURSE AND COMMUNICATIVE PRAGMATICS

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To the linguist, language is a formal system defined by rules that allow us to compile an infinite number of messages from a finite system of symbolic elements. However, the everyday conception of language is the skill we use to coordinate our activities, to communicate with one another, and to share our thoughts and feelings. The study of discourse and communicative pragmatics relates more to this everyday notion of language, as it covers the component of meaning that goes beyond that derivable from knowledge of the words in a language and the rules of its grammar. Communicative pragmatics includes the way that nonverbal accompaniments to discourse shade its meaning; the use of figurative language to change and extend the meaning of words; and the capacity to negotiate social relationships by telling jokes, giving compliments, and conveying insults. Although communicative competence does indeed require knowledge of word meanings and of grammar, it also requires the ability to use background knowledge to infer unstated information and to understand how sequences of events relate to one another. Further, as the medium of social interaction, understanding discourse often involves making assumptions about speakers' motivations for speaking and the intended social consequence of their utterances.

The study of communicative pragmatics thus offers a rich arena for studying the interaction of language, cognition, affect, and social relationships (see the box of key references in this literature). Neuroimaging studies of communicative pragmatics have tended to address the extent to which the brain regions activated by these phenomena overlap with the language network, especially the importance of right hemisphere areas, how these areas overlap with the so-called mentalizing network, and how they overlap with brain areas involved in executive function. The terms "mentalizing" and "theory of mind" are often raised in discussions of sociocognitive capacities such as the ability to infer other people's beliefs, desires, goals, and intentions. While the neurocognitive underpinnings of these abilities are controversial, their importance for understanding discourse is not. Understanding the meaning of a speaker's utterance often requires the listener to appreciate their conversational goals. Likewise, executive function, that is, cognitive control processes such as inhibition, cognitive flexibility, and working memory, is also important.

With respect to cognitive development, the literature on discourse and communicative pragmatics is concerned with three interrelated issues, including the time course of children's ability to understand various pragmatic phenomena, their sensitivity to different sorts of cues to nonliteral meanings, and the cognitive abilities that allow them to recognize and interpret these sorts of utterances. Studies of how communicative pragmatics is affected by various kinds of brain injury or

https://doi.org/10.1037/0000307-003
APA Handbook of Neuropsychology: Volume 1. Neurobehavioral Disorders and Conditions: Accepted Science and Open Questions, Gregory G. Brown, Tricia Z. King, Kathleen Y. Haaland, and Bruce Crosson (Editors)

disease have tended to address the disparate reasons for impairment along with their neural correlates. Consequently, this literature has used patient studies to identify the neurocognitive underpinnings of executive function, emotional processing, and our understanding of social relationships to better specify the details of communicative pragmatics.

We begin with a section on established findings in the neuropsychology of discourse and pragmatics and follow with a short discussion of more controversial issues in the field. The section on existing knowledge in the field is divided into subsections that target a few well-investigated areas of pragmatics, including nonverbal communication, metaphors and idioms, jokes, and verbal irony. The section on controversies and further questions is divided into subsections on hemispheric specialization, embodiment, mentalizing, and executive function.

WHAT THE FIELD KNOWS

Discourse and pragmatics, although somewhat understudied, have received their fair share of attention from neuropsychologists—especially nonverbal communication and various figurative language phenomena. Here, we briefly review what has been learned regarding the ability to understand these phenomena, such as information about brain areas activated in neuroimaging studies of healthy adults, how these abilities manifest in typically and atypically developing children, how they change with healthy aging, and whether they are affected by neurological insult or disorders.

Nonverbal Communication

When people converse in natural environments, only a portion of the information conveyed is carried by the language they use. Nonverbal cues executed by hand and arm movements, facial expressions, gaze shifts, and posture changes can provide meaningful information that contributes to a speaker's overall message. Cospeech gestures, or movements of the hand and arms that accompany speech, have received the bulk of researchers' attention. Iconic gestures, or gestures that bear some resemblance to the things they refer to, have been of special interest because they often add information that goes beyond that in the speech alone. For example, the message conveyed by a speaker who says, "I'm going for a workout" while simultaneously flexing their arms as if raising a barbell is different than if they alternate movements of their arms as if running. This difference in meaning reflects *speech–gesture integration*—our capacity to combine concepts evoked by speech with the imagistic concepts evoked by gestures. Research on this topic generally concerns the brain areas active in this process, the time course of their engagement, and the extent to which brain regions involved in processing gestures overlap with those in the language network.

Imaging studies of speech–gesture integration largely converge on the importance of two brain regions for this process, the inferior frontal gyrus and the posterior middle temporal gyrus, usually seen with a left-hemisphere bias (Dick et al., 2014; Straube et al., 2012; Willems et al., 2007). In addition, the posterior portion of the left superior temporal sulcus contributes to speech–gesture integration by adjusting the degree of direct multimodal coupling across visual and auditory cortices (Straube et al., 2018). Combined EEG–fMRI paradigms observing network-level changes as a function of the semantic relationship between speech and gesture further support the role of areas such as the posterior superior temporal sulcus, middle temporal gyrus, and inferior frontal gyrus by identifying relationships between behavioral measures of speech–gesture comprehension and subject-level fluctuations in the accompanying oscillatory dynamics (Drijvers et al., 2019; He et al., 2018). Beyond the frontotemporal language network, studies of speech–gesture integration also reveal the recruitment of extrastriate visual areas, sensorimotor cortex, and anterior cingulate cortex (Zhao et al., 2018).

Gestures become a fundamental part of a child's communicative repertoire very early in life and continue to serve a major function for communication, learning, and coordinating attention in social environments (Goldin-Meadow, 2007). Children generally show overlap in networks supporting dynamic speech and gesture processing with patterns seen in healthy adults—recruiting both inferior frontal and middle/posterior temporal areas, albeit with more bilateral engagement than evidenced in adults (Demir-Lira et al., 2018; Dick et al., 2012). Electrophysiological data indicate relatively adultlike sensitivity to the semantic relationship between speech and gesture in children by 7 years of age (Sekine et al., 2020), and children's speech–gesture comprehension ability correlates with the recruitment of sensory and motor cortices in discourse processing (Demir-Lira et al., 2018).

Sensitivity to cospeech gesture information declines in healthy aging (Cocks et al., 2011), although the literature on aging and multimodal discourse is sparse. While speech–gesture interactions in hippocampal amnesia appear to be relatively spared, Parkinson's disease has been associated with abnormalities in gesture production as well as impaired gesture comprehension (Hilverman et al., 2018; Humphries et al., 2016; Klooster et al., 2015). Additionally, both schizophrenia and autism spectrum disorder (ASD) have been associated with abnormal sensitivity to nonverbal cues. Schizophrenic patients, for example, overattribute communicative intent, interpreting grooming gestures and postural adjustments as conveying meaning (Bucci et al., 2008). By contrast, patients with ASD exhibit reduced sensitivity to cospeech gestures (Silverman et al., 2010).

Metaphors and Idioms

Statements such as "she's got a heart of gold" are not literally true but are used to convey the sentiment that she has a kind nature. Although figurative language is most obvious in literary contexts, linguists have shown that it is in fact a pervasive phenomenon in everyday discourse (Lakoff & Johnson, 1980). For example, the headline "GOP Scores Unexpected Gains in House, Poised to Hang on to Senate" includes the metaphoric expressions "scores" (using language from the domain of competitive sports to describe electoral outcomes), "poised" (employing language typically used to describe an animal's posture to denote preparedness for an upcoming event), and "hang on" (using language that typically describes a physical action to characterize the distribution of political power). Unlike homonymy, in which a word has multiple unrelated meanings, the literal and metaphoric uses of a word are typically related via an analogy between their two domains; for example, the metaphoric use of "scores" recruits an analogy between the source domain of sports and target domain of politics.

One major issue in research on figurative language comprehension has been the extent to which the processing of metaphors and idioms differs from that of literal language. Electrophysiological studies show that, compared with literal uses of the same words, metaphors elicit enhanced responses on the N400 and P600/LPC event-related potential (ERP) components typically elicited by language (Bambini et al., 2016; Coulson & Van Petten, 2002; Lai et al., 2019). Such studies suggest that metaphoric language imposes demands that go somewhat beyond those of comparable literal language, even when controlled for psycholinguistic variables such as contextual predictability and imageability.

Neuroimaging studies likewise reveal that, relative to literal language, metaphors elicit greater activation in the language network, including the left hemisphere inferior frontal gyrus, insula, dorsolateral prefrontal cortex (BA9), lateral prefrontal cortex (BA6 and BA46), and inferior parietal lobule (BA 39; Rapp et al., 2012). The inferior frontal gyrus activations are considered especially important for figurative language comprehension due to the greater need for contextual integration than in literal language, as well as for selection between competing literal and nonliteral interpretations.

Because figurative language exists on a continuum of conventionality that seems to influence the salience of relevant analogical connections, another major concern in this literature is how the familiarity of metaphoric language affects its processing (Giora, 2003). Conventional metaphors are thought to have a preestablished meaning for a group of speakers and therefore may rely more on simple retrieval from semantic memory (for review of theories, see Holyoak & Stamenković, 2018). Likewise, idioms such as "I'm feeling under the weather" are opaque phrases with conventionalized meanings that often cannot be decoded from their literal readings. Novel metaphors, by contrast, require the listener to access semantic memory related to each of the relevant domains to compute the expression's meaning via analogical inference. Accordingly, while idioms activate a network of brain areas similar to those for metaphor, they also lead to activations in areas associated with retrieval, such as the precuneus (Rapp, 2019).

Metaphor comprehension begins with the development of general language comprehension but is constrained by the ability to understand an object as having more than one name, as well as by limitations in children's analogical reasoning ability and their background knowledge. Although figurative language is difficult for young children, evidence suggests that even 3-year-olds can understand metaphors appropriate to their vocabulary and world knowledge (Di Paola et al., 2020; Pouscoulous & Tomasello, 2020). Metaphor-comprehension ability develops rapidly from ages 8 to 11 years (Deckert et al., 2019; Pinto et al., 2018; Willinger et al., 2019), although the time course of development differs depending on the familiarity and salience of the metaphors. For example, children's comprehension of idioms nears adult-level competence around age 10 (Vulchanova et al., 2011), while the comprehension of novel metaphors continues to progress through adolescence (Carriedo et al., 2016). Deficits in metaphor comprehension are seen in children with ASD, as they are more likely to adopt a literal interpretation of metaphorical language (Kalandadze et al., 2019; Van Herwegen & Rundblad, 2018).

Metaphor comprehension is thought to worsen slightly with aging, with healthy older adults showing slower metaphor processing and, in some studies, lower quality explanations of metaphors (Bartczak, 2017; Newsome & Glucksberg, 2002). Moreover, deficits in metaphor comprehension have been reported in a wide array of clinical populations, including those with traumatic brain injury (Martin & McDonald, 2005), Parkinson's disease (Gutmann, 2009), amyotrophic lateral sclerosis (Bambini et al., 2016), depression (Rapp & Schmierer, 2010), and dementias (Rapp & Wild, 2011). Further, a number of patient groups, including those with frontal lobe lesions (Brownell et al., 1990; Cardillo et al., 2018), schizophrenia (Rapp, 2009), and ASD (Gold et al., 2010), present with selective deficits in metaphor-comprehension ability suggestive of a potential connection between neural function and this remarkable ability.

Jokes

Besides being a joyful form of social interaction, jokes reveal how language comprehension relies upon listeners drawing inferences from background knowledge (see Coulson, 2015, for a review). For example, in "she read so much about the harmful effects of smoking she decided to give up the reading," the listener initially constructs a cognitive model of a smoker who is frightened about the negative health consequences of her habit. This is despite the fact that the joke never refers to the "she" as a smoker and never directly mentions how the content of the literature influenced her emotional state. Such inferences derive from frames or schemas activated by the words in the sentence. The inference that she plans to give up smoking is explicitly contradicted by the punchline "reading," which triggers a process of frame shifting in which the listener retrieves a new frame to reinterpret information active in working memory.

Humorous materials elicit activation in nearly every major area of the brain, including inferior and superior frontal gyri, ventromedial prefrontal cortex, middle temporal areas, frontal and temporal poles, and motor cortex (Jääskeläinen et al., 2016; Vrticka et al., 2013). Electrophysiological studies suggest jokes elicit an early response in the medial frontal cortex followed by a later response in the temporoparietal junction (Shibata et al., 2017). Frontal and parietal lobe regions important for conflict detection and resolution, such as superior and inferior frontal gyri and temporoparietal cortex, are thought to be involved in the detection of contextual congruity that triggers the interpretive shift needed to get the joke (Samson et al., 2009; Vrticka et al., 2013).

Nascent forms of humor appreciation begin relatively early in life (McGhee, 1979), and verbal humor emerges around age 4, at approximately the same age children begin to understand other types of nonliteral language (Semrud-Clikeman & Glass, 2010; Pexman & Glenwright, 2007). Paralinguistic cues contribute to the comprehension of humor early in life, and joke comprehension is better when the recognition of discourse incongruities is facilitated by the presence of visual representations of the discourse content (e.g., in cartoons). Children with cognitive impairment, including those with Williams syndrome and Prader-Willi syndrome, experience difficulty identifying humorous content from language alone (Bruno et al., 1987; Sullivan et al., 2003). Interestingly, gestures may support humor comprehension in children with cognitive impairment over other types of visual prompts such as pictures (Degabriele & Walsh, 2010).

Beyond the ability to identify whether discourse is meant to be humorous, the elicitation of an affective reaction is a separate feature of joke comprehension. Affective appreciation recruits cortical and subcortical structures involved in reward processing, such as the ventromedial prefrontal cortex, ventral tegmentum, ventral striatum, nucleus accumbens, and amygdala (Goel & Dolan, 2001; Mobbs et al., 2003; Watson et al., 2007). Activity in insular and superior temporal regions has also been shown to scale with subjective ratings of experienced humor (Hutcherson et al., 2005). Further, whereas the ability to identify jokes has been reported to decline with age (e.g., Mak & Carpenter, 2007), affective responses are more robust to changes associated with healthy aging (Shammi & Stuss, 2003; Uekermann et al., 2006), consistent with at least a partial dissociation between the cognitive and affective components of joke comprehension.

As for many other phenomena in communicative pragmatics, a major issue of research has been whether the ability to understand jokes is systematically related to executive function or mentalizing ability. Success on joke-comprehension tasks is positively related to working memory capacity, and joke-comprehension deficits are observed in those whose working memory has been compromised by healthy aging or frontal lobe lesions (Shammi & Stuss, 1999, 2003). Likewise, success on joke-comprehension tasks is associated with other executive functions of set shifting and information updating (Shammi & Stuss, 2003; Hull et al., 2008). Finally, abilities associated with mentalizing play an important, albeit underspecified, role in appreciating humorous content that requires listeners to reason about mental states (Bischetti et al., 2019).

Verbal Irony

Verbal irony includes a wide range of utterances whose literal content contrasts with the speaker's intended message. These sorts of utterances are sometimes directed at the overall situation (e.g., making complimentary remarks regarding the weather during a thunderstorm or a blizzard) or at a person (e.g., issuing a compliment regarding driving skills to someone who has just demonstrated that they are an inattentive driver). Neuroimaging studies of verbal irony comprehension reveal activations in the same set of areas implicated in metaphor comprehension (see Rapp et al., 2012), as well as brain areas associated with so-called theory-of-mind tasks, such as the left and right hemisphere temporoparietal junction, medial prefrontal cortex, and precuneus (Eviatar & Just, 2006; Shibata et al., 2010; Spotorno et al., 2013; Uchiyama et al., 2006; Wakusawa et al., 2007).

The ability to understand verbal irony undergoes a rather protracted developmental trajectory in which children must first learn to distinguish between literal and nonliteral meanings and later learn to discriminate between lies, mistakes, and sarcastic utterances (Andrews et al., 1986). While children begin to understand discourse irony around the age of 6, they often do not fully comprehend ironic utterances until they reach 12 years of age (Creusere, 1999). Understanding verbal irony requires first recognizing that a speaker does not believe what they are saying as well as recognizing that the speaker's intention is to be critical—or to offer a compliment (Pexman & Glenwright, 2007). Evidence suggests that children initially learn each of these subcomponents independently, as they can appreciate the speaker's attitude without fully grasping the meaning of the ironic utterance (Creusere, 1999). Thus, children initially learn to distinguish between irony and white lies (Winner & Leekam, 1991), then learn to recognize teasing (Pexman et al., 2005), and finally, develop the capacity to understand ironic utterances.

Studies of how the comprehension of verbal irony is affected by various neurological conditions have addressed the disparate reasons for impairment in understanding these sorts of pragmatic phenomena. In turn, this literature has used patient studies to address the brain regions important for the detection of contextual congruity, executive functions, theory of mind, and social and emotional processing. Deficits in irony comprehension have been associated with traumatic brain injury in children and adults (Dennis et al., 2001), ASD (Kalandadze et al., 2018), and attention-deficit/hyperactivity disorder (ADHD; Caillies et al., 2014).

Damage to the right hemisphere has long been associated with deficits interpreting pragmatic language phenomena (Wilson et al., 2018), many of which are important for the comprehension of discourse irony. For example, patients with right hemisphere damage (RHD) have been shown to have difficulties utilizing paralinguistic cues that might indicate the presence of verbal irony—such as the speaker's mood or tone of voice (Brownell et al., 1992; McDonald & Pearce, 1996; Tompkins & Mateer, 1985). RHD patients exhibit difficulty using an understanding of the relationship between conversational participants to infer the presence of sarcasm (Cheang & Pell, 2006; Kaplan et al., 1990). As in children, RHD patients have been shown to have difficulty distinguishing sarcasm from lies and other sorts of counterfactual utterances (Champagne et al., 2003; Kaplan et al., 1990; McDonald, 1999, 2000; McDonald & Pearce, 1996; Tompkins & Mateer, 1985; Winner et al., 1998).

RHD, of course, is not a homogeneous condition, and the incidence of pragmatic language comprehension deficits is approximately 50% (Benton & Bryan, 1996; Champagne-Lavau & Joanette, 2009). Indeed, pragmatic language deficits are associated with lesions specifically in the frontal lobe (Champagne-Lavau & Joanette, 2009; Papagno et al., 2006; Shamay-Tsoory et al., 2005). Difficulty understanding discourse irony is thought to be related to the direct versus indirect nature of the communication, as well as whether understanding requires inferences about the speaker's beliefs or about their intentions (Dennis et al., 2001).

ACCEPTED SCIENCE

- Beyond the canonical language network in the cortex, figurative language comprehension recruits frontal lobe regions such as the medial prefrontal cortex and superior frontal gyrus that are known to be important for social reasoning and executive functions.
- Middle childhood (ages 8–11 years) sees a dramatic shift in the ability to appreciate nonverbal discourse cues and nonliteral meanings in language.
- By 12 years of age, children show evidence of adultlike comprehension abilities for pragmatic phenomena such as speech–gesture integration, metaphors and idioms, jokes, and verbal irony.
- Discourse and communicative pragmatics recruit a broad range of cognitive functions and consequently are compromised by a broad array of neurological disorders, including schizophrenia, autism spectrum disorder, dementias, and frontal lobe lesions.

QUESTIONS AND CONTROVERSIES

Although neuropsychologists have made substantial progress in the study of discourse and communicative pragmatics, there remain many areas ripe for investigation. Next, we discuss a few topics that have sparked some lively discussions in the literature. These include hemispheric specialization, embodiment, mentalizing, and executive functions.

Hemispheric Specialization

Perhaps the longest running controversy in this area concerns the importance of hemispheric specialization for pragmatic language competence. Given the known significance of the left cerebral hemisphere for core aspects of language production and comprehension, neuropsychologists seized on the import of the nondominant right hemisphere for its extralinguistic aspects. This division of labor in which the left hemisphere specializes in processing purely linguistic information whereas the right hemisphere is dedicated to paralinguistic information was buttressed by reports that patients with RHD present with difficulty understanding jokes, metaphors, sarcastic statements, and other pragmatic phenomena (for review, see Wilson et al., 2018). However, recent research suggests a more nuanced view of the importance of hemispheric specialization that differs across various pragmatic phenomena.

Figurative language such as metaphors, jokes, and verbal irony all involve a divergence from literal meaning but otherwise might be expected to recruit a diverse set of neurocognitive resources. For example, whereas metaphors are frequently used to extend word meanings to new domains, joke comprehension poses inferential demands that require listeners to retrieve and connect information from semantic memory. Thus, we might expect hemispheric differences to be more relevant for the complex operations of understanding jokes than for the lexical task of understanding metaphors.

Indeed, whereas early studies suggested right hemisphere lesions were associated with deficits in metaphor comprehension, subsequent work points to a more robust association between metaphor-comprehension deficits and left hemisphere lesions (Cardillo et al., 2018). Moreover, RHD can lead to impairments in the comprehension of literal and nonliteral language alike (Ianni et al., 2014). Neuroimaging studies in healthy adults show that although more than 30% of the activation loci are in the right hemisphere, the majority of brain areas activated in metaphor comprehension are in the left hemisphere. EEG studies also indicate that, while the right hemisphere is involved in metaphor comprehension, it does not dominate the processing (Coulson & Van Petten, 2002, 2007).

The importance of right hemisphere integrity for joke comprehension is better supported by the patient data, and studies of healthy adults suggest the importance of the left hemisphere for puns and the right hemisphere for narrative jokes. Bilateral and right hemisphere lesions to the frontal cortex have been associated with deficits in the comprehension of narrative-format jokes, while patients with lesion profiles involving left frontal or more posterior bilateral damage display preserved joke comprehension (Shammi & Stuss, 1999). Neuroimaging studies of joke comprehension show left lateralized activity in the inferior frontal gyrus for humor involving multiple word meanings, such as puns, but bilateral temporal lobe activations for narrative-format jokes (Goel & Dolan, 2001). Similarly, EEG recordings in conjunction with the hemifield priming paradigm suggest an important role for the left hemisphere in the comprehension of puns (Coulson & Severens, 2007) and for the right hemisphere in the comprehension of narrative jokes (Coulson & Williams, 2005).

The apparent lateralization of joke comprehension abilities may originate in subtle hemispheric differences in the organization of semantic memory, with the activation of causal and relational features better represented in the right hemisphere temporal lobe (Coulson & Wu, 2005). Moreover, variation in the cognitive and neural signatures of joke comprehension as a function of variance in callosal integrity suggests the importance of hemispheric interaction for these processes (Brown et al., 2005; Coulson and Lovett, 2004).

Embodiment

According to conceptual metaphor theory, physical experience gives rise to metaphoric mappings that structure our conceptual knowledge (Lakoff & Johnson, 1980). For example, phrases such as "things are looking up" and "down in the dumps" originate from the conceptual metaphor *up is good*, which maps valence onto a vertical axis with good things at the top and bad things at the bottom. It has been proposed that these metaphoric mappings emerge from experiential correlations between, for example, the positive experience of getting picked up by a parent and the negative experience of falling down. Embodied metaphor theory has emerged as a lively topic in the literature because it aligns with the more general proposal of *embodied cognition*, that is, the suggestion that conceptual knowledge about, for example, apples recruits sensorimotor regions active in experience with apples (Lakoff, 2014).

As noted earlier, models of embodied meaning suggest that brain systems for perceptual and motoric processing play a role in understanding language. According to this theory, brain systems involved in experiencing the referents of concrete concepts are activated when we initially learn a concept and then get partially reactivated when we use that concept. Embodied metaphor theory suggests that perceptual and motor regions are recruited to understand metaphors that map concrete concepts onto abstract ones (Jamrozik et al., 2016). Tests of these models have largely involved investigating whether metaphors activate brain regions involved in experience with their source domains (Lacey et al., 2012). For example, early investigations explored whether verbs describing actions performed with the body activate the sensorimotor cortex in a somatotopic fashion.

Results of such studies have been mixed, as some investigators report motor activation for both literal and metaphoric uses of verbs such as “grasp” (Boulenger et al., 2009, 2012), while others find motor activation for literal but not metaphoric language (Aziz-Zadeh et al., 2006; Raposo et al., 2009). Electrophysiological studies also support more direct involvement of embodied perceptual representations in the comprehension of literal language than of metaphors (Bardolph & Coulson, 2014; Teuscher et al., 2008). Winkielman and colleagues (2018) suggested embodied simulation using somatosensory and motor cortex is not obligatory but rather recruited to different degrees as a function of context and goals. Similarly, the neural career of metaphor theory suggests that embodied simulation occurs more readily for novel metaphoric language than for highly conventionalized metaphoric expressions (Desai et al., 2011).

Mentalizing

As noted earlier, neuroimaging studies of pragmatic phenomena frequently report activations in brain areas associated with mentalizing. The implication of these activations is somewhat unclear, however, given disputes regarding the extent of the mentalizing network itself. While early characterizations of brain areas involved in so-called theory-of-mind tasks included the medial prefrontal cortex, bilateral temporoparietal junction, posterior superior temporal sulcus, the posterior cingulate, and precuneus (Frith & Frith, 2006), later meta-analyses suggested the network was limited to the medial prefrontal cortex and bilateral posterior temporoparietal junction (Schurz et al., 2014; Van Overwalle & Baetens, 2009). Moreover, an area of active dispute is the precise relevance of activations in the medial prefrontal cortex associated with the comprehension of verbal irony (Filik et al., 2019), as some researchers suggest medial prefrontal cortex activation is a fairly ubiquitous characteristic of nonliteral language comprehension (Rapp et al., 2012), whereas others have argued medial prefrontal cortex activation is specific to discourse irony (Bohrn et al., 2012).

Mentalizing typically involves some form of high-level expectations about perceived behavior. Notably, this can affect the magnitude and distribution of sensory and motoric engagement with others—a process reflected in interactions between executive function, mentalizing, and action–observation networks (Chambon et al., 2017; Jacquet et al., 2016). In particular, temporoparietal and dorsal prefrontal cortices can modulate the recruitment of action-monitoring regions (e.g., the posterior superior temporal sulcus) during inferential processing depending on factors such as perceived communicative intent and the congruity between semantic and biomechanical properties of observed behavior (Trujillo et al., 2020).

Further, neuroimaging studies of multiple interacting partners have demonstrated bidirectional neural coupling between partners, where signal correlations in multiple levels of the cortical hierarchy predict how well they understand each other (Stephens et al., 2010). Although the relationship between embodied coordination and high-level mental alignment remains uncertain, the activation of brain areas such as the medial prefrontal cortex and the temporoparietal junction in action monitoring and imitative control highlights the need for a more well-specified account of mentalizing (Wang & Hamilton, 2012), one that would hopefully explain the curious but well-replicated correlations between sociocommunicative faculties and nonsocial perceptual skills such as biological motion processing (e.g., Miller & Saygin, 2013).

Executive Function

Disputes over the utility of the construct of mentalizing spill over into the third major issue in research on communicative pragmatics—executive function—as some researchers have questioned whether the constructs of mentalizing and theory of mind can be reduced to aspects of executive function (Byom & Turkstra, 2017; McDonald et al., 2014). For example, the emergence of adultlike narrative comprehension skills generally coincides with the development of the abstract reasoning abilities needed to navigate complex social contexts and interactions. Developmental psychologists have hypothesized a major transitional period around 4 or 5 years, when social reasoning skills allow the child to be aware of potentially diverging beliefs about a shared environment or situation. However, the emergence of these early mentalizing abilities coincides with the development of the prefrontal cortex that may subserve inhibitory control needed to maintain such conflicting representations in working memory (Luciana & Nelson, 1998; Perner & Lang, 1999).

A great deal of research concerns how executive function contributes to the interpretation of discourse, including the overlap in the neural substrate of executive function and discourse interpretation and whether communicative deficits can be understood as being caused by underlying deficits in executive function. For example, patients with frontal lobe damage frequently exhibit deficits in executive function as well as nonliteral language comprehension, raising the issue of whether these facts are causally connected. Further, figurative language comprehension deficits in both Alzheimer's disease and Parkinson's disease have been linked to executive function (Monetta & Pell, 2007; Papagno et al., 2003). Likewise, in schizophrenic patients, overly literal interpretation of metaphors occurs chiefly for novel metaphors that rely most heavily on executive functions (Rapp et al., 2018). As disruptions of the dopaminergic system occur in schizophrenia, Alzheimer's disease, and Parkinson's disease, it points to a common cause for deficits in executive function and figurative language comprehension (McNamara & Durso, 2018). However, extant models lack the specificity to convincingly connect empirical predictions regarding working memory, set shifting, and inhibitory control to mechanistic accounts of discourse processing.

QUESTIONS AND CONTROVERSIES SUMMARY

- How do the neural underpinnings of communicative pragmatics change over the course of the lifespan?
- How are sensorimotor processing mechanisms recruited in the production and comprehension of discourse?
- What neuropsychological mechanisms mediate the interaction of semantic memory and the generation of affect in discourse?
- Can the concept of mentalizing skills required for discourse comprehension be recharacterized so that they map cleanly onto neurobiological constructs?
- How does variability in executive function in health and disease affect the comprehension of figurative language such as metaphor, jokes, and irony?

CONCLUSION

When learning a new language, people can spend a tremendous amount of time committing thousands of new words to memory. While this knowledge may help you order a burger, and even ask whether it is possible to get a gluten-free bun, no amount of vocabulary memorization and grammar drills will help you interpret your waiter's snarky reply. In such a case, you might do better to ignore their verbal utterance and instead draw inferences from the way they roll their eyes. This type of nonliteral meaning appreciation recruits cultural as well as linguistic knowledge and requires experience actually using the language to interact with the people who speak it.

From a cognitive perspective, understanding discourse involves a dynamic interplay between the literal meaning of an utterance and various features of the context. In face-to-face conversations, for example, speakers use both verbal and nonverbal cues to signal their intentions and motivations for speaking. When speakers joke or make ironic remarks, understanding what they mean depends less on prior expectations about word meaning than on expectations about their social and communicative intentions. Accordingly, the neurocognitive architecture that supports these processes goes considerably beyond that traditionally associated with the translation of sounds to meaningful speech.

In addition to historically defined frontoparietal language networks, discourse comprehension recruits a highly distributed set of brain regions more typically associated with social reasoning and executive function (e.g., the temporoparietal junction as well as the medial and dorsolateral prefrontal cortices). One upshot is that deficits in communicative pragmatics can arise from a wide variety of neurological disorders, including schizophrenia, ASD, and dementias. While such deficits can be more difficult to detect and assess than those that result from more direct damage to the language system (e.g., , in aphasia), they can nonetheless have a detrimental impact on patients' social, personal, and professional lives.

Future investigations into the development of discourse and pragmatic abilities across the lifespan will help hone our understanding of how these skills relate to more domain-general cognitive faculties, such as inhibition and working memory. The study of discourse processing will also reap significant benefits from the continued refinement of neurobiologically informed models of social–cognitive processes, such as mentalizing, and from an improved understanding of the functional consequences of hemispheric asymmetries.

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