CHAPTER 18

So how does gesture function in speaking, communication, and thinking?

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This concluding chapter reflects on the book's collected works that encapsulate, in the Aristotelian sense, gesture's *efficient* causes (i.e., mechanisms that stimulate gesture) and its *final* causes (i.e., purposes that gesture serves). We conclude that gesture is multifunctional, operating on all levels of analysis (biological, psychological, and social levels), in all time frames (moment-to-moment, ontogenetic, and evolutionary time) and under many different discourse requirements. One over-arching theme emerges. Gesture functions simultaneously for both its producers and its observers, and thus provides a dual function that shapes thinking and language in the producer, which, in turn, shapes thinking and language in the observer – a process that underlies how we share ideas and create community.

In wrapping up this book, we return to and elaborate on themes that were raised in the introductory chapter. Again, borrowing from Aristotle's framework for explaining phenomena, we now reflect on the research that addresses *efficient* causes of gesture (i.e., the underlying mechanisms stimulating gesture, its precursors) and how identification of these mechanisms provides insight into the *final* causes for gesture (i.e., what gesture is for, its purpose). One theme of the book is that functional mechanisms for gesture appear on many levels of analysis – biological, psychological, and social. A second theme is that gesture functions on all time frames – moment-to-moment, ontogenetic, and evolutionary. Parsing gesture phenomena in terms of levels of analysis and time frames is a useful way to organize the information in this book. This organization also makes it clear that gestural communication is deeply embedded in distinctly human operations. A third theme of the book is that the methodology for studying gesture is necessarily varied. Methods have varied in their manipulation of whether gesture is present, the requirements of the task, and the discourse context in which gesture is used. Manipulating the presence of gesture is important for determining whether

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gesture drives thinking, language activity, and communication. Assessing gesture's role in different language and cognitive tasks and under different discourse contexts, such as teaching, narration or conversation, addresses whether gesture is unique to a particular type of communication or ubiquitous across all forms of communication. Finding that gesture occurs across different contexts and under different task requirements tells us that its functions are multi-faceted and flexible. Finally, a fourth theme is that gesture not only functions for the producer, but also for the observer, of gesture. That is, gesture supports speech to enhance internal activities of the speaker, such as thinking and language production, while simultaneously supporting speech to enhance communication to listeners, influencing the listener's thinking and language comprehension.

This book focuses on gesture's functions (see Novack & Goldin-Meadow, Chapter 17, and also Novack & Goldin-Meadow, 2017; Goldin-Meadow, 2003). Each of the chapters in which gesture is manipulated and found to bring about an outcome makes it clear that the effects of gesture are not merely epiphenomenal – that gesture is causally related to the outcome and not just correlated with it. But functions can be more than consequences – they can be part of the mechanism that leads to a phenomenon's recurrence (Goldin-Meadow, McClintock & Wimsatt, 2004). None of the chapters takes this final step in exploring gesture's functions, leaving this important question for future research. Here we review each of the four themes.

Gesture functions at many levels of analysis

Neurological evidence

Kelly's chapter (11) describes the neurological underpinnings of gesture when it accompanies language comprehension activities. There are three main take home messages from this chapter. The first is that, when we look at the neurological evidence, we see that speech and gesture are neurologically integrated for different types of language activities – phonemic, syntactic and semantic. Through methods like fMRI (which highlights regions of the brain in use) and ERP (which shows the timing of neural activation when an individual observes speech and gesture), we see that gesture and speech, in many respects, are treated like an integrated system by the brain.

Neurological imaging tells us that the brain treats speech and gesture stimuli as if they belong together. Compelling evidence for this effect comes from the fact that, when gesture information is truly incongruent with speech, either in terms of timing or content, the brain reacts as if this incongruence is unexpected. For example, when an individual processes a gesture conveying information that is incongruent or in conflict with the information conveyed in speech (gesturing *short* while saying "tall"), a large negativity at 400 ms is produced (Kelly et al., 2004; the N400 is known to be sensitive to incongruent semantic information, Kutas & Hillyard, 1980). Interestingly, gestures conveying information that is different from, but complementary to, information conveyed in speech (gesturing *thin* while saying "tall" to describe a tall, thin container, a so-called *gesture-speech mismatch*, Church & Goldin-Meadow, 1986; Goldin-Meadow, 2003) are processed no differently at this stage from gestures that convey the same information as speech (gesturing *tall* while saying "tall"; Kelly et al., 2004). Neither one produces a large negativity at 400 ms; that is, neither one is recognized as a semantic anomaly.

Kelly's chapter suggests that the brain's processing of speech and gesture is complex and nuanced at different levels of comprehension. So, referring back to the gesture-speech mismatch example, at early stages of sensory/phonological processing (P1-N1 and P2), speech accompanied by gestures conveying different but complementary information (e.g., gesturing *thin* while saying "tall") *is* processed differently from speech accompanied by gestures conveying the same information (gesturing *tall* while saying "tall"), suggesting that, at the phonemic processing level, these differences between speech and gesture are salient to the brain. Complementary differences between the modalities (i.e., the information conveyed in gesture is different from, but has the potential to be integrated with, the information conveyed in speech) are thus noted at early stages of processing, but not at later, higher-level stages. The larger point is that the brain expects gesture information to coordinate with speech information. This expectation has implications for gesture function in communication and thinking, as all of the other chapters in the book make clear.

The second take home message is that there may be a reason for this neurological expectation. Gesture, because it presents information in a holistic format using space and time, provides a more transparent version of events than speech. For this reason, as Kelly puts it: "… gesture adds what is *newsworthy* to speech (McNeill, 2005). That is, gestures index imagistically what is novel or relevant in a spoken utterance within a given context. For example, making a "tall" gesture would add newsworthy information to the utterance "No, it was other guy," (pp. 4). The added information that gesture provides, functions in a variety of ways. The newsworthiness of gesture can enhance, or even expand, the spoken message – essentially changing the spoken message in ways that transform our thinking and communication, as virtually all of the chapters demonstrate (see also Goldin-Meadow, 2003).

The third message is more thought provoking as we move forward with research on gesture. Gesture may be reflecting the degree to which language is grounded in bodily action, which appears to run counter to the idea that language is a disembodied activity, as has been previously suggested (e.g., Chomsky, 1980; Fodor, 1983). Kelly suggests a paradox with respect to the way gesture functions for language activity and argues that we should not be so quick to dismiss the disembodied function of language. The abstract nature of language allows us to be free from bodily constraints and therefore promotes expedient and efficient processing. Gesture may get in the way of this process. One striking example of this property was described in Chapter 2 (Alibali, Yeo, Hostetter & Kita). In a study designed to show how gesture production influences the way we speak, children were asked to explain quantity transformations in a Piagetian conservation task while their hands were placed in a cloth muff – effectively discouraging gesture production. Normally during Piagetian explanations, when allowed to gesture, children talk about the perceptual features present in the task objects – the width of a dish or the height of a glass – the very features that encourage children to think that there is more water in the tall glass than in the shorter dish. However, when children's hands were placed in a cloth muff, they produced fewer verbal explanations focusing on the features of the objects, and instead often mentioned transformations ("You just poured it before") or hypothetical states ("If you poured the water back, it would be the same amount"). Preventing children from gesturing thus freed their language from a focus on misleading perceptual features; their language was less grounded in bodily action, which, in turn, may have promoted abstract thinking, at least in this instance.

Does gesture itself inhibit abstraction? In fact, gesture may play a special transduction role between acting on the environment and creating an abstract representation of acting on the environment (see Nathan, Chapter 8). For example, Novack, Congdon, Hemani-Lopez and Goldin-Meadow (2014) asked children to gesture during a mathematical equivalence lesson (e.g., to place a V hand under the 2 and 4 in the problem 2 + 4 + 7 = _ + 7, and then point at the blank in the problem, a gestural instantiation of the *grouping* problem-solving strategy) and compared them to children who were asked to act directly on plastic numbers placed on top of the problem (to pick up the 2 and 4 and hold them both under the blank, a physical instantiation of the *grouping* strategy). Novack et al. found that children in both groups learned how to solve problems of this form equally well. However, when it came time to generalize what they had learned to mathematical equivalence problems in a new format (e.g., 2 + 4 + 7 = 2 + _, or 2 + 4 + 7 = 5 + _), children who gestured during the lesson outperformed children who manipulated the actual numbers. In other words, gesturing helped the children abstract away from the details of the problem and transfer what they had learned (see also Wakefield, Hall, James & Goldin-Meadow, 2017, who found the same effect in word-learning). Gesturing may thus play a unique role in transfer and memory (see Cook, Duff & Goldin-Meadow, under review, for a theoretical account of gesture's role in forming declarative and non-declarative memories).

Psychological evidence

The second section of the book focuses on the role gesture plays psychologically for the gesture producer. Chapters in the book identify a number of intriguing functions for gesturing. For example, gesture appears to be linked with language to support the way spatial information is packaged in speech (Alibali et al., Chapter 2; Ozyurek, Chapter 3). As another example, gesture appears to reflect action in a simulated form in problem-solving contexts (Hostetter & Boncoddo, Chapter 7; Nathan, Chapter 8); this simulation allows for greater abstraction, promoting transfer, consolidation, and retention of newly learned conceptual information (see also Novack et al., 2014; Wakefield et al., 2017).

McNeill and Lopez-Ozieblo's chapter (Chapter 5 with supplement) lays out the features of the *Growth Point Theory (GPT):* (1) gesture and speech are synchronized; (2) gesture's format, which is gestalt, 3D, and imagistic, is distinctly different from speech's format, which is analytic, 2D, and linear; and (3) because these two formats are different, the combination of gesture and speech modalities reflects a more complete version of an idea than either modality alone.

One implication of the GPT made evident in this book is that gesture helps speech package spatio-visual, motoric information. Alibali, Yeo, Hostetter & Kita's chapter (Chapter 2), provides evidence for the Information Packaging Hypothesis (IPH), which suggests that the type of gestures produced constrains the way speakers package their ideas in speech. For example, in Mol and Kita (2012), individuals who were asked to produce a conflated gesture for two motions shown in an animated cartoon – rolling the hand while moving it downward – were likely to describe the two motions in speech within a single clause ("He rolled down the hill"). In contrast, if asked to produce two separate gestures for these same two motions – a roll motion of the hand, followed by a separate downward movement – the two motions were described in speech in two separate clauses ("He was rolling. He went down the hill").

Interestingly, the way these two types of motions, directional/path motion (going down) and manner motion (rolling), are expressed reflects a typological difference across languages. Some languages conflate manner and path within a single clause (English is an example), whereas other languages express manner and path across two clauses (Turkish and Spanish are examples). And it turns out that the gestures produced by speakers of these two different language types differ systematically – speakers of English tend to produce a single gesture that conflates manner and path (roll+down); speakers of Turkish tend to produce a separate gesture for manner (roll) and a separate gesture for path (down). Thus, the way information in gesture is packaged appears to be linked with language representation. The gestures speakers spontaneously produce when they talk – conflated vs. separated – mirror the typological formats of their spoken language, which looks like an effect of linguistic structure on co-speech gesture, e.g., Ozcaliskan, Lucero, & Goldin-Meadow, 2016a, b).

But the direction of the gesture-speech linkage is complex, as argued by Özyürek (Chapter 3) and de Ruiter (Chapter 4). Özyürek makes a compelling case that understanding the nuances of speech – particularly differences across different languages – is necessary in order to fully understand how gesture functions in a communicative context. For example, using a similar methodology as Mol et al. (2012) but flipping the manipulation from gesture to speech, Shanley et al. (2007) asked individuals to *verbally* describe manner and path within one clause (conflating manner and path) or across 2 clauses (separating manner and path). Conflating or not conflating manner and path in speech influenced whether manner and path were conflated in gesture. *Talking* about manner and path within a clause ("he rolled down the hill") resulted in a gesture that similarly conflated manner and path (hand simulates rolling while moving in a downward motion). De Ruiter echoes the idea that speech influences gesture and, on this basis, argues that the function of gesture is to supply information that is redundant with speech, rather than information that adds to the information conveyed in speech. However, as referenced throughout the book, gesture often conveys information that is not found in speech (in gesture-speech mismatches, e.g., "they're different because you moved them," said while indicating in gesture the alignment between two rows of checkers, which doesn't involve movement at all, Church & Goldin-Meadow, 1986).

Moreover, as GPT makes clear, even when gesture content mirrors speech content, because gesture's format is 3-D and nonlinear, it is never fully redundant with speech. This difference in format has implications for thinking and problem solving. Gesture provides visuo-spatial information that reflects 3-dimensional, dynamic, as well as perceptual features (Hostetter et al., Chapter 7). This feature of gesture has been associated with embodied cognition – our understanding of concepts may be grounded in the way we physically interact with the world, which is reflected in the way we gesture about the world (Cook & Fenn, Chapter 6; Hostetter et al., Chapter 7; Nathan, Chapter 8; Novack & Goldin-Meadow, Chapter 17; Hostetter & Alibali, 2008; Alibali & Nathan, 2007; McNeill, 2005; Núñez & Lakoff, 2005). The fact that gesture is a type of action may account for some of the effects it has on cognition. However, as Novack & Goldin-Meadow discuss (Chapter 17), it is important to point out that gesture is a unique form of action – it represents information about a direct effect on the world *without* having a direct affect on the world (e.g., twisting a jar lid results in an open jar in a way that producing a twisting gesture does not; see also Goldin-Meadow, 2015, and Novack & Goldin-Meadow, 2016, for discussion). One might say that gesture is in between worlds – the world of the mind and the world of concrete engagement. This *in between* place may serve a particularly important purpose for cognition. As Cook and Fenn's and Nathan's chapters indicate, movement can lead to learning. However, *gesturing about acting on objects* is more likely to lead to generalization and retention than *actually acting on objects* (see Novack & Goldin-Meadow, Chapter 17 and also Novack, Congdon, Hemani-Lopez & Goldin-Meadow, 2014; and Congdon, Novack, Brooks, Hemani-Lopez, O'Keefe & Goldin-Meadow, under review; Wakefield, Hall, James & Goldin-Meadow, 2017).

Nathan's Chapter 8 indicates that gestures are influential in creating mental models when adults are asked to solve and explain abstract mathematical proofs. Nathan argues that gestures are a special type of action that can result in the generation of new ideas (see also Goldin-Meadow, Cook & Mitchell, 2009), albeit ideas that may be incubating. Gestures, particularly during problem solving, can often depict primordial ideas that have not yet been fully realized in speech and thus have the potential to help the gesturer think, remember, and learn. For example, Cook and Fenn (Chapter 6) illustrate how gesture mechanisms interact with memory mechanisms, an interaction that impacts a variety of processes, such as long-term, semantic and episodic memory, as well as learning. Children were instructed in mathematical equivalence problems of the form, $3 + 4 + 5 = \_ + 5$. Some children were asked to produce gesture along with speech indicating an equalizer strategy for solving the problems (i.e., solving by finding the number that would make both sides of the equation equal in amount). Some children were asked to only produce speech indicating an equalizer strategy. Children asked to produce the equalizer gestures were significantly more likely to benefit from instruction than children who were asked only to produce equalizer speech. Moreover, children required to gesture transferred that learning to new problem forms (not taught) and retained that new knowledge over a period of a few days. Cook and Fenn argue that gesture representations result in a more richly embedded representation making consolidation more likely. Cook and Fenn also suggest that gesture as a vehicle for offloading information during active processing can reduce cognitive load, making mastering and remembering information easier (see also Goldin-Meadow et al., 2001; Wagner et al., 2004; Ping & Goldin-Meadow, 2010).

Social evidence

Part two of the book, Chapters 11 through 16, focuses on the role that gesture plays for social interaction. As noted earlier, gesture adds to the spoken message. As a result, when taken in conjunction with speech, gesture can transmit a more complete version of a speaker's ideas than speech alone, and can promote comprehension and shared understanding.

Kopp (Chapter 12) argues that gesture is so essential to social interaction that robots have to be programmed to convey speech information with gestural enhancements in order to be considered humanoid. Without gestures, robots are too robotic.

Holler and Bavelas (Chapter 10) and Nathan et al. (Chapter 13) begin with the assumption that communicators are sensitive to listeners' comprehension and negotiate the input they offer to maintain or establish *common ground* (Vygotsky, 1978; Evans, Feenstra, Ryon, & McNeill, 2011). Holler and Nathan et al describe ways in which gesture functions along with speech to establish and maintain common ground. For example, Holler demonstrates that gesture's relationship to speech, as an *ensemble*, can vary; gesture can be abbreviated when a speech message is cumbersome, or expanded to support an abbreviated speech message – all in service of using the fewest message units for optimal comprehension. Gesture thus shows flexibility during communication, changing its form and content to address the comprehension needs of the interlocutor.

As Singer (Chapter 14) suggests, gesture can help shape knowledge in social interactions through a process of representation sharing. Singer describes this interaction as co-construction of meaning. Stam, Tellier and Bigi (Chapter 16) also argue that co-construction of meaning between a teacher and a second language learner can be facilitated by gesture, in particular, by gesture-filled speech pauses that disassociate gesture from speech, thus allowing gesture to scaffold the comprehension of words.

Sauer and Iverson (Chapter 15) show that gesture can be an invaluable source for scaffolding understanding in individuals whose language capacity is compromised (see also Goldin-Meadow, 2015). They suggest that this social process is bidirectional in children with language delay – the gestures produced by a child with a language delay can shape the input that the teacher or caretaker offers that child, which, in turn, can promote changes in the child. This bidirectional influence of gesture is also evident in nonclinical populations, particularly in learning contexts (see Goldin-Meadow, 2003, for discussion). Adults can gain insight into a child's understanding of a task from looking at that child's gestures (Kelly & Church, 1997, 1998; Goldin-Meadow, Wein & Chang, 1992; Alibali, Flevares, & Goldin-Meadow, 1997; Goldin-Meadow & Sandhofer, 1999). They can then use that information to tailor their input to the child (Goldin-Meadow & Singer, 2003), which, in turn, can have a positive effect on learning (Singer & Goldin-Meadow, 2005).

Gesture functions in all time frames

Aristotle's typology of causes can play out at different time frames (e.g., Tinbergen, 1963; see Goldin-Meadow, McClintock & Wimsatt, 2004, for discussion). Both efficient and final causes can affect phenomena in the moment (i.e., a microgenetic time span, Siegler, 1991; Alibali & Goldin-Meadow, 1993), across the life span, (Piaget & Inhelder, 1969) and across the evolutionary time span (Overton, 1994; Edelman, 1993). The book offers compelling examples of the functions that gesture can serve at each of these time frames.

Moment-to-moment

Much of the research reviewed in this book indicates that gesture functions to enhance communication in the moment. Using neurological timing technology, Kelly (Chapter 11) demonstrated the influence of gesture in on-line processing at phonemic, syntactic, and discourse levels. Almost every chapter in this book reviews research in which gesture occurs during on-line activities, such as describing, explaining, or teaching. In general, the chapters find that individuals comprehend and react to speech differently if it is accompanied by gesture than if it is not accompanied by gesture (e.g., Hostetter & Boncoddo, Chapter 7; Kelly, Chapter 11; Singer, Chapter 14; Kopp, Chapter 12; Sauer & Iverson, Chapter 15; Novack & Goldin-Meadow, Chapter 17). For example, in a learning situation, when gesture occurs with speech (either when it comes from an instructor or from the child him or herself), learners react differently than when it occurs without speech (Nathan et al., Chapter 13), which, in turn, affects how they solve cognitive problems (Cook & Fenn, Chapter 6) and social dilemmas (Beaudoin, Chapter 9). Gesture can alter, in the moment, how speech packages information (Alibali et al., Chapter 2) and can, in turn, be altered by the structure of speech (Ozyurek, Chapter 3, De Ruiter, Chapter 4).

Developmental time frame

The function of gesture is not limited to moment-to-moment communication processes. Gesture functions on the developmental time frame as well. The chapters that explore gesture's effects on learning (e.g., Cook & Fenn, Chapter 6; Nathan et al., Chapter 13 and Novack & Goldin-Meadow, Chapter 17) show how gesture can serve as a mechanism of developmental change (see also Goldin-Meadow, 2015). In addition, gesture's role in communication begins early in the development of language (see Goldin-Meadow, 2014, for review), paving the way for adult language functioning (Ozyurek, Chapter 3, and Kelly, Chapter 11).

Evolutionary time frame

Only a few chapters focus on how gesture functions in an evolutionary time frame. A number of authors have explored the role that gesture may have played in the evolution of human communication (e.g., Armstrong & Wilcox, 2007; Corballis, 2003; Tomasello, 2009; Goldin-Meadow & McNeill, 1999). McNeill and Lopez-Ozieblo (Chapter 5 with supplement) argue that speech and gesture have always been integrated communication partners and evolved together in communication, as opposed to the view that gesture came before speech in the evolution of language. Kelly (Chapter 11) argues that, whether or not gesture communication preceded speech communication, gesture is the product of evolutionary sculpting. Kelly's evidence for neurological underpinnings of gesture activity suggests that there is a neural architecture for speech-plus-gesture processing. Some aspects of this neurological architecture are influenced by immediate and developmental factors, but the basic neurological structure is the product of eons of human communication. The neurological underpinnings of the speech-gesture communication system are most likely the result of a system that has evolved for the purposes outlined in this book – effective communication, language use, and cognitive capacity.

Methods for understanding the functions of gesture

Descriptions of how people use gesture in communication have made it clear that gesture is an integral part of the communicative act, and have led researchers to hypothesize that gesture plays a role in communication (Kendon, 1994) and in thought (Streeck, 2009). But descriptions, on their own, cannot tell us whether gesture plays an essential role in this process, nor can they elucidate the mechanisms and functions underlying gesture's role in communication. Pinning down gesture's role in communication is best accomplished through experimental manipulation – isolating and controlling gesture to determine its causal effects on other psychological and social variables. The book explores a number of experimental and natural variations that reveal how gesture functions in communication and thinking. We describe here three variations: (1) manipulating the presence or absence of gesture, (2) variation in discourse context in which gesture appears, and (3) variation in tasks in which gesture appears.

Manipulating the presence or absence of gesture

The most compelling evidence that gesture plays a causal role in communication and thinking comes from experimental studies that manipulate the presence of gesture. When gesture is either prevented (Alibali et al., Chapter 2, Cook & Fenn, Chapter 6, Beaudoin, Chapter 9) or encouraged (Cook & Fenn, Chapter 6, Nathan et al., Chapter 8, Beaudoin, Chapter 9), we see a profound effect on the gesturer's ability to learn new concepts. Interestingly, *prohibiting* gesture has been found to promote abstract and sophisticated thinking on some tasks (Alibali et al., Chapter 2) but, on other tasks, *encouraging* gesture has been found to promote abstract thinking (Novack & Goldin-Meadow, Chapter 17; Novack et al., 2014; Wakefield et al., 2016).

In language comprehension, manipulating the presence of gesture when processing speech results in altered brain activity (Kelly, Chapter 11). In language production, manipulating the content of gesture drives the content of speech (Alibali et al., Chapter 2 and Ozurek, Chapter 3).

Variation in context

The book illustrates a wide range of discourse contexts in which gesture functions have been explored: general social conversations (de Ruiter, Chapter 4; Holler & Bavelas, Chapter 10; Kopp, Chapter 12; Sauer & Iverson, Chapter 15), learning language (Alibali et al., Chapter 2; Ozyurek, Chapter 3; Kelly, Chapter 11; Stam, Tellier & Bigi, Chapter 16, Novack & Goldin-Meadow, Chapter 17), learning mathematical concepts (Cook & Fenn, Chapter 6; Nathan et al., Chapter 8; Nathan et al., Chapter 13, Singer, Chapter 14, Novack & Goldin-Meadow, Chapter 17); and learning moral reasoning (Beaudoin, Chapter 9). This diversity makes it clear that gesture's functions are not limited to a particular discourse context. It may be important to ask, however, whether gesture is necessary in some situations but not others. In addition, asking which tasks generate gesture, and which tasks fail to generate gesture, is also an important question for understanding gesture's functions.

Variation in task

The book also illustrates the variety of tasks in which the functions of gesture have been examined: language production, language comprehension, problem solving in both spatial and non-spatial domains, and social perception tasks. Understanding gesture requires examining the goals that underlie these varied tasks and determining whether there is a common goal underlying the tasks that elicit gesture. Kopp, in Chapter 12 argues that the primary function of gesture is to signal humanness, rather than to influence how information is processed. Kopp comes to this conclusion by comparing nonhuman robots who produce gestures with robots who do not gesture. However, when we compare humans who are gesturing to those who are not, we do find that gesture has an impact on information processing formation (e.g., Cook et Fenn, Chapter 6). Gesturing is not likely to have only one primary function.

The chapters in this book suggest that, in all tasks, gestures provide information in a different format than speech, thus complementing (and often adding to) the information conveyed in speech. But there may also be variations in task requirements that make gesture function differently, or not serve a function at all. In fact, we know very little about whether gesture rates or gesture types differ across domains (e.g., whether one is more likely to gesture, or to gesture differently, when explaining a physics problem than when critiquing a short story). We also know little about the circumstances under which gestures fail to occur or fail to help communication. In addition to fleshing out our descriptive picture of gesture, answers to these questions can help us understand the role that gesture plays in communication and cognition.

Gesture supports speech for the producer as well as the observer

Finally, the chapters in the book make it clear that gesture functions both for the producer and the observer. Contrary to Krauss (1998) who claims that gesture functions only for the producer, many studies have shown that the message listeners glean from speech is influenced by the gestures that accompany the speech. Part 1 of the book presents studies showing that producing gesture aids the speaker in many ways – by packaging visuo-spatial information into linguistically appropriate units and by learning new information. Part 2 of the book presents studies showing that seeing gesture also aids the listener – by affecting how the accompanying speech is processed and interpreted, by adding a representational format that augments the information conveyed in speech, and by making the speaker seem more human.

If gesture is playing a role for both producer and observer, it must be doing so at the same time – an internal and external function for the price of one communicative act. This dual role for gesture (and speech) may be the cornerstone of human connection underlying phenomena like sympathy, empathy and engagement (i.e., *Mead's Loop*, as discussed in McNeill's chapter; Gallese & Goldman, 1998; Iacoboni, 2009). Gesture supports speech to shape thinking and language for the producer, in turn enhancing the communication of information to shape the thinking and language of the observer.

Gesture's dual role highlights a central theme of this book – that gesture serves a multitude of functions. No one function predominates. Gesturing is a ubiquitous part of communication, contributing to how we develop ideas, share those ideas and thereby create community, and engineer innovative solutions to problems.

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