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Gesture in Experimental Studies: How Videotape Technology Can Advance Psychological Theory

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Abstract

Video recording technology allows for the discovery of psychological phenomena that might otherwise go unnoticed. We focus here on gesture as an example of such a phenomenon. Gestures are movements of the hands or body that people spontaneously produce while speaking or thinking through a difficult problem. Despite their ubiquity, speakers are not always aware that they are gesturing, and listeners are not always aware that they are observing gesture. We review how video technology has facilitated major insights within the field of gesture research by allowing researchers to capture, quantify, and better understand these transient movements. We propose that gesture, which can be easily missed if it is not a researcher's focus, has the potential to affect thinking and learning in the people who produce it, as well as in the people who observe it, and that it can alter the communicative context of an experiment or social interaction. Finally, we discuss the challenges of using video technology to capture gesture in psychological studies, and we discuss opportunities and suggestions for making use of this rich source of information both within the field of developmental psychology and within the field of organizational psychology.

Keywords

video recording technology, gesture, coding system, participant observation, reliability, best practices

Introduction

Video recording in behavioral sciences can provide indispensable information—information that cannot easily be captured through any other methodology. We illustrate this phenomenon using gesture as a case study. Gestures are the spontaneous movements that people produce with their

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hands while speaking (McNeill, 1992). Gestures have the capacity to add spatial or imagistic content to a speaker's message, and as a result, they allow speakers to convey *more* information than they can efficiently say with words alone. For example, a person could say "she ran up the stairs" while using a finger to represent an upward spiral pathway of movement. In this example, the spoken language alone does not tell us the kind of staircase that the speaker mounted. This information is contained only in the speaker's gesture. Interestingly, most speakers are not explicitly aware of the gestures they produce, in part because spontaneous gesture is so well coordinated with everyday speech (McNeill, 1992). Perhaps more surprisingly, most *listeners* are also not explicitly aware of gesture when they see it produced by a speaker, despite the fact that listeners can and do use information contained in gestures to guide their comprehension. As a result, gestures and their effects on cognition can easily go unnoticed in psychological studies and social-communicative contexts.

In this paper, we explore how video technology is allowing researchers to capture, quantify, and better understand gesture. We first examine the ways in which gesture can reveal nondeclarative or unspoken ideas in a speaker. We then turn to how gesture can influence an interlocutor or experimenter, and we outline some of the exciting implications this phenomenon holds for organizational research more broadly. We end by suggesting some best practices for videotaping and coding gesture. In so doing, we hope to emphasize gesture's pervasive influence on nearly all psychological phenomena and interpersonal situations and underscore the importance of videotaping as a methodology for exploring this influence.

Gesture Reflects Nondeclarative Ideas

Gesture can be classified as a nonverbal behavior and as such may have the capacity to reveal implicit ideas absent from the explicit speech stream. Social psychologists have long been interested in nonverbal behavior and have shown that behaviors such as eye contact, facial expressions, blinking, and posture can reveal attitudes and beliefs that a person does not verbalize. For example, White participants may *say* that they have no racial biases in an explicit questionnaire, but when interacting with a Black confederate, they may display implicit nonverbal signs of discomfort, such as limited eye contact, distancing postures, and general "non-verbal unfriendliness" (Dovidio, Kawakami, & Gaertner, 2002; Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997). Many nonverbal behaviors can reveal implicit *feelings.* But because it can represent ideas, gesture is also able to reflect specific implicit *knowledge*, patterns of thinking, or cognitive processes.

For example, imagine a child explaining how to solve a Piagetian conservation task. Jean Piaget developed this task to explore children's understanding of conservation of number—knowing that the number of items does not change even if the items are physically rearranged (Piaget, 1965). In one version of this classic task, an experimenter shows a 5-year-old two rows, each containing six coins. When the two rows are aligned so that both are the same length, the child confirms that the rows have the same number of coins. However, if the coins in one row are spread apart—right in front of the child's eyes—the child will say that the row with the spread coins now contains *more.* Piaget termed these children *non-conservers* and classified them as still being in a *preoperational* stage of development. He documented children's answers and descriptions of this task in his 1965 book, *The Child's Concept of Number*, writing down their explanations as evidence of their immature processing and rudimentary understanding of conservation. However, Piaget, the master observer and arguably the father of developmental psychology, missed something critical—children nearly always gesture as they explain their reasoning on these conservation tasks. But because Piaget only wrote down and reported children's spoken explanations, this observation would go unnoticed in the broader scientific community for several more decades after the publication of his works.

In 1986, Church and Goldin-Meadow decided to videotape children as they explained their solutions to a series of Piagetian conservation problems. They not only discovered that almost all children gestured as they explained their reasoning on this task, but they also noticed that the manner in which children gestured differed from one child to the next. Some children's gestures matched what they said in speech, while some children's gestures were different from what they said in speech. For example, a child with matching gesture and speech said, incorrectly, that the longer row of coins contained more coins "because you spreaded them out" while at the same time producing a spreading out gesture over the longer row. In contrast, another child with mismatching gesture and speech said, also incorrectly, that the longer row contained more coins "because you moved them," but this child pointed back and forth between corresponding coins in the two rows, thus indicating in his gestures the correct idea of one-to-one correspondence. Importantly, Church and Goldin-Meadow found that children who produced *different* information across speech and gesture were more likely to subsequently benefit from instruction about conservation than children who produced the *same* information across speech and gesture. This finding was the first of its kind to show that a child's gesture can serve as an indicator of the child's "readiness to learn." This observation, made possible by video technology, challenged Piaget's original categorization of all non-conservers into the same preoperational stage and began a new field of research into what gesture can tell us about a person's nondeclarative knowledge.

This phenomenon—that information conveyed uniquely in gesture can predict readiness to learn—has now been observed for learners across multiple ages and domains. For example, gesture combined with different speech has been found when toddlers are on the cusp of a vocabulary spurt (Gershkoff-Stowe & Smith, 1997) or when they are making the transition from one-word utterances to two-word utterances (Iverson & Goldin-Meadow, 2005), in young children just learning the meaning of the numbers in the count list (Gunderson, Spaepen, Gibson, Goldin-Meadow, & Levine, 2015), in 9-year-olds who are ready to learn about mathematical equivalence problems (Perry, Church, & Goldin-Meadow, 1988), and even in adults who are reasoning about stereoisomers in organic chemistry (Ping, Larson, Decatur, Zinchenko, & Goldin-Meadow, 2016). In each of these examples, spoken language falls short of conveying what learners *really* know. Thus, it seems that observing what people do with their hands while they speak provides a more accurate indication of what is going on inside their heads than listening to speech alone.

Gestures not only serve as an index of when a person is ready to learn, but they can also reflect the manner in which something was learned. For example, Cook and Tanenhaus (2009) manipulated the manner in which adults solved the Tower of Hanoi—a logic puzzle in which one has to move a stack of disks from one peg to another while following a set of movement restrictions. One group of participants solved the task with real three-dimensional objects; a second group solved the task on a computer, using a mouse to click and move the disk icons. Then both groups were videotaped as they explained their solutions to another participant. The researchers found that although the verbal explanations from the two groups were indistinguishable, the gestures differed. Participants who solved the task with real disks used more curved gestures, reflecting the fact that they had to physically lift a disk off of one peg to move it to another peg. In contrast, participants who solved the task on the computer produced flatter movements, reflecting the fact that on the computer, one can simply drag disk icons from one peg to another without "lifting" it over the peg. Even though participants did not think that the way in which they interacted with the objects was important enough to mention in speech, this information still came through in their gestures.

Finally, gesture can offer a window onto someone's ideas even when that person is not speaking aloud—that is, sometimes people produce gestures when just *thinking* to themselves, and those gestures provide information about their thoughts. For example, expert dancers will "mark" their movements when practicing a routine, producing minimalized or reduced versions of the steps (Kirsh, 2010, 2011). People will also gesture to themselves as they encode a visual map of an unfamiliar area (Jamalian, Giardino, & Tversky, 2013), think through a mental rotation task (Chu & Kita, 2008), and even add multidigit addends via a mental abacus (Brooks, Barner, Frank, &

Goldin-Meadow, 2016). In sum, gesture provides a window onto a learner's current and potential future understanding of an idea. By collecting video data on people's nonverbal behaviors during a given task or interaction, we gain deeper insight into their underlying cognitive processes.

Producing Gesture Affects the Communicative Context

We have established that gestures can reflect what speakers themselves know. Next we ask whether interlocutors are sensitive to this information and if so, whether they use it to shape the subsequent conversational context. This question is crucial not only for understanding how participants' gestures can influence other participants or social partners but also for understanding how participants' gestures can unwittingly influence an experimenter or a video coder. As mentioned earlier, one fascinating aspect of gesture is that people are not always explicitly aware of producing or observing it despite the fact that it is used spontaneously and prolifically in all communicative contexts (e.g., Goldin-Meadow, Kim, & Singer, 1999). Yet somehow, these under-the-radar cues end up having an impact on communication—changing the thoughts, behaviors, and interactions of others.

First, gesture from a parent, teacher, or supervisor can affect how listeners process information, respond to instructions or orders, or learn from accompanying speech instruction. Even the mere presence of gesture can change a listener's response. For example, infants are more likely to produce a behavioral response to a question that contains a gesture than one without a gesture (Allen & Shatz, 1983). Slightly older children are more likely to learn from instruction that includes gesture than instruction that contains spoken instruction only (e.g., Macedonia, Müller, & Friederici, 2011; Ping, Ratliff, Hickey, & Levine, 2011; Singer & Goldin-Meadow, 2005; Valenzeno, Alibali, & Klatzky, 2003; Wakefield & James, 2015). Finally, the presence of gesture leads listeners to gesture more themselves. Fourteen-month-old infants are more likely to gesture if their parents use gesture when speaking to them (and subsequently, child gesture rates at 14 months predict vocabulary rates at 54 months) (Rowe & Goldin-Meadow, 2009). Relatedly, instructors who gesture during a lesson are more likely to elicit gestures from their students, which in turn predicts the degree of student learning in that lesson (Cook & Goldin-Meadow, 2006).

Gestures can also change listeners' responses in very specific ways, which requires sensitivity to the iconic or representational content of the hand movements. For example, children who were interviewed as witnesses to an event were likely to incorporate specific information encoded in the interviewer's gestures into their eyewitness testimony accounts, even if that gesture was misleading and did not match the event they actually witnessed (Broaders & Goldin-Meadow, 2010). As a specific example, if an interviewer asked a child an open-ended question (e.g., "what else was he wearing?") while producing a gesture that provided false information (e.g., a gesture for putting on a cap), children were just as likely to falsely report the information in the gesture (e.g., "he was wearing a hat") as they were to falsely report information explicitly mentioned in a targeted (and misleading) question without gesture ("was he wearing a hat?").

Adults, too, are sensitive to the content conveyed uniquely in gesture. For example, in the Cook and Tanenhaus (2009) Tower of Hanoi study previously mentioned, not only did the manner in which the actual task was performed affect the nature of participants' gestures, but those gestures in turn affected the way in which the *listeners* subsequently solved the problem. If the speaker produced highly arched gestures as a consequence of having solved the problem on the physical device, then listeners were more likely to produce higher arched movements when subsequently solving the problem themselves on a computer (even though on the computer there is no need to arch the movements at all)—the greater the arch in the gestures a listener saw, the more arch that listener put into his or her moves on the computer. These findings make it clear that listeners can and do process speakers' gestures in a way that profoundly affects their own thinking and judgments.

Finally, in an educational context, sensitivity to gestures allows teachers and educators to gain insight into a child's cognitive state and then to adapt their instruction to match the child's needs. For example, in one study, teachers were asked to instruct children individually on how to solve a difficult math problem. The teachers, who were completely untrained in gesture coding, spontaneously offered richer and more varied instruction to children who produced different but complementary "mismatching" strategies in their speech and gesture while explaining their incorrect answers on a pretest than to children who produced only "matching" strategies in their speech and gesture (Goldin-Meadow & Singer, 2003). All of the teachers in this study were experienced and thus may have been more sensitive to children's gesture production than novice teachers. However, additional research has shown that adults need not be trained educators to have these insights. For example, in another study, adults were shown videos of children explaining their solutions to math problems and were then asked to assess and explain that child's math understanding. Two-thirds of the adults never explicitly noticed or mentioned the children's gestures, but they were just as likely to use information expressed uniquely in those gestures to assess the child's understanding of the math problem as the one-third of adults who did explicitly mention gesture (Alibali, Flevares, & Goldin-Meadow, 1997; see also Goldin-Meadow, Wein, & Chang, 1992, who explored comparable effects in a conservation task). This finding suggests that even when listeners aren't explicitly aware of observing gesture, they can and do incorporate it into their understanding of a child's skills.

Taken together, these findings have startling implications for anyone using video technology to record and analyze any kind of psychological phenomenon. Namely, it is clear that people who see gestures are affected by them even when they are not explicitly aware of seeing those gestures. Accordingly, any researcher who is collecting video data ought to specifically consider the potential impact of gesture not only on the other participants or interlocutors in the study but also on the video coders themselves.

Finally, though most of these examples have focused on the role of gesture in learning and problem-solving situations, the implications of this work reach far beyond the classroom. In fact, the teacher-student dynamic we have drawn on here is a useful metaphor for any leader-subordinate or trainer-trainee dynamic in which there is a knowledge differential. Our work suggests that in any situation in which a leader is trying to convey new information to his or her audience, he or she ought to be aware of how gesture can clarify (or obscure) a message, emphasize a point, and reveal his or her own implicit ideas and thinking. Furthermore, we have given evidence that allowing young students to gesture to themselves or to an interlocutor during problem solving can help them to succeed on a difficult problem. Understanding this powerful effect should inform our understanding of productive group dynamics in the workplace. It may be the case that simply encouraging coworkers to talk through ideas aloud could lead to insight via gesture production that otherwise would remain entirely unspoken. Much work remains to be done to unlock the full potential of gesture research within the field of organizational psychology, but given the obvious parallels to the learning context, there is reason to believe that it is a fruitful direction for future research.

Gesture Coding—Categorical Versus Continuous Methods

The goal of this paper thus far has been to highlight the importance of using video technology to capture and study gesture production in learning contexts and emphasize that gesture is often overlooked in standard psychological observation and research. More specifically, we have stressed the importance of considering gesture's effect on both a participant's own thought process and the thought process of any interlocutors, whether they be participants themselves or individuals overseeing the research—experimenters, coders, or field workers. In this section, we take a moment to describe, in detail, a case study of a student's gestures produced in a problem-solving context. In

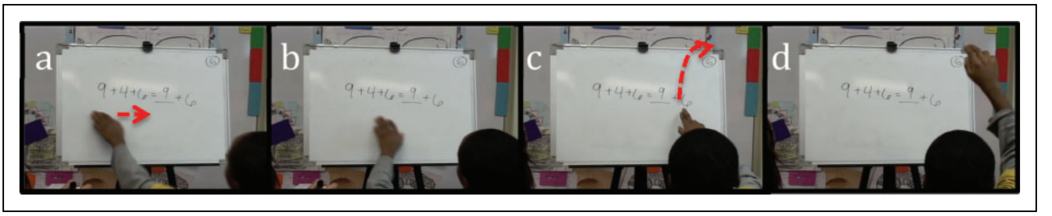

Figure 1. These four panels are sequential screen shots taken from a video of a child explaining his answer to a mathematical equivalence problem. Taken together, his gestures convey an *add-subtract* problem-solving strategy.

doing so, we remind the reader that the general principles we describe here can be applied to many other contexts and fields of research.

For decades, our lab has capitalized on the fact that children frequently gesture as they explain their conceptual reasoning. Here, we focus on a third grader who is explaining his solution to the mathematical equivalence problem, $9 + 4 + 6 = \_\_ + 6$. In this specific case, the boy does not fully understand how to solve the problem correctly, having written 9 in the blank space as his solution. Yet we are able to code features in his gesture to make inferences about his implicit understanding of the problem. As is the case with most gesture coding endeavors, we begin by carefully watching the video and transcribing (1) the hand or hands the child is using (left or right), (2) the hand shape (e.g., "full palm" or "1 finger"), (3) the gesture motion (e.g., "point," "sweep," or "pull"), and (4) the gesture referent (e.g., "left side addends" or "answer") of each distinct gesture movement. Then, we can piece together these "gesture phrases" to make inferences about the concepts the child is representing in his hands, which may or may not be present in speech. We use cues in the gesture itself to mark the ending of a gesture phrase, such as a change in hand shape (i.e., transitioning from an index point to a whole hand sweep), a change in hands (i.e., switching from gesturing with the right hand to the left hand), or a long pause in the gesture stream.

Figure 1 shows a series of screen shots taken from the videotaped explanation of this third-grade student. The child has solved the problem incorrectly and is offering an incorrect verbal explanation, but a careful analysis of his gesture reveals that he has some correct understanding of the structure of the problem. The child first sweeps his open left hand below the three addends on the left hand side of the equation (panel a), pauses (panel b), switches to his right hand and a two-finger point, and makes a pulling away motion at the addend on the right hand side of the equation (panels c and d). The pause, hand shape change, and hand change represent a meaningful break in the gesture sequence (just one of them would have been sufficient for us to code a break), allowing us to gloss the first half of the gesture string as "take the three addends on the left side of the equation" and the second half of the gesture string as "pull away or remove the addend on the right side of the equation." Taken together, these two gesture phrases, "add the three addends on the left" and "subtract the addend on the right," represent a *correct* strategy for solving the problem—*add-subtract*. The fact that this child can convey a correct strategy in gesture (while articulating the wrong answer) indicates that the child has an implicit understanding of the structure of the equation. As a counterexample, had the boy used the same four-finger hand shape to refer to all addends on both the right- and left-hand side (instead of switching hands and changing his hand shape), that gesture phrase would instead be glossed as an *add-all* strategy, in which children incorrectly add together all of the numbers in the equation. As one can see, this type of categorical gesture coding is largely dependent on having a reliable coding manual. In this particular example, we used a previously established gesture coding system (see Perry et al., 1988) to translate this child's gestural string into the *add-subtract* strategy (we discuss the development of such a gesture coding system in the next section of this paper).

As an alternative to this type of categorical gesture coding in which the goal is to understand what strings of gesture *mean*, we can pose experimental questions about the *form* of the gesture itself—coding the speed and trajectory of a given gesture by noting its spatial coordinates in a video. Hilliard and Cook (2016) describe this type of continuous gesture coding in detail in their recent methodological paper published in *Behavioral Research Methods*. Essentially, continuous gesture coding involves downsampling videos (they suggest 10 frames per second) to create a set of images. The coder can then use a system such as ELAN (Wittenburg et al., 2006) to click on the hands (or parts of the hands, e.g., the tips of the fingers) in each frame to create a set of x-y coordinates across time. Data from these spatial coordinates can then be transformed into movement information (e.g., speed, trajectory). For example, this method could be applied to the child described earlier. In addition to coding the problem-solving strategy he expressed in gesture, we could code the speed of the transition he made from the sweeping motion to the pointing motion. Gesture speed might be useful not only as a measure of manual fluency or dexterity but also as a marker of fluency of cognitive processes. The rise of motion capture technology (e.g., Xbox Kinect, Flex camera), when used in conjunction with video recording, could provide a wealth of this type of data. The possibilities are endless, but the field is in its infancy, and there is much work needed to understand the type of information that can be gleaned from coding the continuous features of gesture.

Methodological Challenges and Suggestions for Good Practices

In this final section, we explore some of the methodological opportunities and challenges that arise when studying gesture with video technology and offer some suggested best practices for incorporating gesture-based results and conclusions into a scientific paper. First, it is important to acknowledge the subjectivity of camera placement in any study that sets out to capture gesture. In experimental studies, the researcher must anticipate the appropriate visual angle and in so doing make guesses about the type and range of gestures that may be produced by the participant. For example, in the case study presented earlier, the camera was placed to capture the math problem and any potential gestures that might reference the problem. This camera angle then has to be adjusted for different children—taller children could obstruct the camera view, which would cause researchers to miss essential information, and the gestures of shorter children may not be captured on the video at all. In addition, if we want to examine the child's facial expressions as he gestured, we would have to add a second camera to capture this perspective. Missing even something as small as a point to a single number in the equation can affect a child's assigned gesture strategy or cause a gap in continuous data coding. A researcher who sets out to intentionally study gesture production may need to ask participants to shift their position or may need to adjust the camera mid-experiment, which could affect the experimental pragmatics in unintended ways.

Yet the challenges of capturing gesture in a controlled experimental setting pale in comparison to the issues that arise when studying gesture in naturalistic or non–experimentally contrived settings. For example, in a longitudinal study at the University of Chicago known as the Language Development Project, children were videotaped in their homes doing everyday activities for approximately 90 minutes every 4 months from the age of 14 months to 58 months (see Goldin-Meadow et al., 2014, for a description of the data and sample). This study required that trained research assistants followed children around the house with handheld cameras to capture their behaviors, speech, and social interactions during the 90-minute session. The project provides a wealth of naturalistic speech and gesture data, and resulting publications have emphasized the relationship between parental speech input and later child outcomes. As the child is the main subject of interest, the camera sometimes does not show the parent on camera. This is not an issue for transcribing parent speech (which can still be heard), but it does limit a coder's ability to capture rich *gestural* input from parents. Dealing with this issue in a naturalistic setting might involve having and coordinating numerous cameras, which might feel prohibitively obtrusive to the participants.

Once the challenges of collecting gesture data are addressed, the researcher is left with the onerous task of figuring out how to code and quantify the data. Depending on the task and study, there might be anywhere from several minutes to several hours of videotape data on a single participant. Capturing data on videotape allows the researcher to relive, rewind, slow down, or fast-forward through the experimental session at will. Yet the richness of the data can also be one of its principal drawbacks, particularly when trying to capture or transcribe nonverbal behaviors like gestures. As described in the previous section, continuous methods can provide qualitative movement data, but categorical coding manuals must be developed specifically for each study—there is no standardized dictionary for gesture.

The decisions that go into developing a coding system must be driven by the experimental question, much in the same way that independent variables of any experiment must be selected from an infinite number of possibilities. As such, some level of subjectivity is inherent to the process and must be acknowledged. For example, a researcher who is interested in when infants first begin to produce deictic pointing gestures would be ill advised to try to quantify and capture every manual movement a young baby makes during an observational session. Instead, the researcher must decide what "counts" as a point and write down a set of clear and concise guidelines that a second gesture coder could easily be trained to follow. Reliability between multiple coders in such instances is crucial, and the reasoning underlying each coding decision should be transparent or readily explicable to a third party. Some experimental questions may seek to quantify individual gesture types (e.g., "What is the relative prevalence of deictic pointing gestures, iconic representational gestures, or conventional gestures in the first three years of life?"). Other questions may pertain to gesture's relation to speech ("Does the gesture convey information that matches or mismatches the information conveyed in speech?") or to gesture's relation to external objects ("How do expert geologists use their hands to explain continental drift?"). Each of these questions requires a different level of analysis, which means that the same physical movement, such as a pointing gesture, might be coded and analyzed very differently across contexts.

Given gesture's close relationship to spoken language, it is particularly important to consider whether gesture should be coded in the context of that speech or with the sound muted. This decision is important because, as previously noted, the presence of gesture influences a listener's interpretation of an explanation. If a researcher's question is focused on whether speech and gesture convey the same or different information, coding one while being affected by the other will influence the coding decision. For example, when we code children's explanations of math problems to determine whether gesture reveals *different* information from speech, we typically code gesture with the speech muted and then code speech without looking at the video. This procedure allows us to provide a strategy code for each modality that is independent of the code in the other modality and to compare, as cleanly as possible, whether the two codes match or not.

There are, of course, some instances in which speech is *only* meaningful when we look at gesture. And in these instances, it is important to point out that coding gesture without speech can only be done on tasks where we already know a great deal about the gestures that the tasks elicit. For example, before we were able to determine which mathematics problem-solving strategies a child was using in gesture, we had to spend a substantial amount of time developing a taxonomy of the gestures that children typically produce on this task. We then developed a system for coding the meanings that those gestures typically convey—which we did with the sound turned on (see Perry et al., 1988, for a detailed description of the coding scheme). In doing so, we established the set of problem-solving strategies that children produce on this task in speech; we then determined which gestures frequently accompany these spoken strategies and express the same information (i.e., we developed a parallel coding system for gesture on the same task). The net result was a lexicon of gestures (form-meaning pairings) that we could use when coding gesture without speech in future studies using this task (see Goldin-Meadow, 2003, chapter 3, the section on how to study mismatches, for further discussion). A new gesture coding system needs to be developed for each phenomenon we study, and having expertise in the area is often crucial to the enterprise. For example, in order to study the gestures produced by expert geologists, we need to first understand and then develop a coding system for the geology concepts that the experts express in speech and then relate the experts' gestures to those speech codes.

Finally, after data collection, coding, and analysis, there remains the issue of how to convey conclusions about gesture, a three-dimensional movement, in a two-dimensional paper. As of now, veridical depictions of gestures in the form of video clips are relegated to supplemental materials. In-text images arrayed like a comic book strip and accompanied by lengthy verbal glosses are the best approximation we have. Given that many journals have electronic versions, one potential area of improvement for the field would be to allow short video clips or gifs to be embedded directly into online versions of publications.

Despite all of the challenges, it is clear that video data collection offers a wealth of opportunities with respect to gesture. Even if gesture was not a researcher's original focus, video data can always be revisited to explore how gestures, or other nonverbal behaviors, interact with or affect previously reported phenomena. As an example, in 2009, Goldin-Meadow, Cook, and Mitchell published a study demonstrating the causal role of gesture in learning. The researchers taught children to produce a specific set of movements instantiating a gesture strategy that they were to use during math instruction. Importantly, the researchers never told the children what those movements meant. Nevertheless, they found that even without being told to do so, children integrated information from the movements they produced, their gestures, into their verbal explanations and learned more than a group of children who were not asked to produce the movements. Now, six years later, in search of further mechanistic clues to explain this phenomenon, the same researchers have gone back to the original videos to apply the continuous coding method described by Hilliard and Cook (2016) to code the physical properties of the movements that the children produced during instruction as they transitioned to becoming successful problem solvers. The researchers are recoding the gestures to ask whether the physical properties of a child's gestures change as that child acquires expertise in solving the math problems (Mangelsdorf, Goldin-Meadow, & Cook, 2016). The answer to this question, made entirely possible by access to a preexisting video corpus, will enrich our understanding of how the continuously shifting properties of gesture might reflect shifts in conceptual knowledge.

In conclusion, although recording video in experimental studies certainly introduces challenges, it allows us to study otherwise transient, easily missed, yet essential phenomena, such as gesture. Gesture research has fundamentally changed the way psychologists think about language, learning, and reasoning. But gesture is only one example of why video technology should be strongly considered in all research pursuits. Videos allow us, in a sense, to freeze time. We can revisit old ideas as our scientific theories evolve and arrive at novel observations and insights that wouldn't otherwise have been possible. Given the changes in psychological research in the past decade and the growing popularity of anonymous Internet-based testing resources such as Amazon Mechanical Turk (Crump, McDonnell, & Gureckis, 2013), it is more important than ever to consider what we might be losing by collecting data without video recording and to work to continue to incorporate it into everyday experimental practices.

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