CHAPTER 10

Multi-modal communication of common ground

A review of social functions

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Until recently, the literature on common ground depicted its influence as a purely verbal phenomenon. We review current research on how common ground influences gesture. With informative exceptions, most experiments found that speakers used fewer gestures as well as fewer words in common ground contexts; i.e., the gesture/word ratio did not change. Common ground often led to more poorly articulated gestures, which parallels its effect on words. These findings support the principle of recipient design as well as more specific social functions such as grounding, the given-new contract, and Grice's maxims. However, conceptual pacts or linking old with new information may maintain the original form. All together, these findings implicate gesture-speech ensembles rather than isolated effects on gestures alone.

Coordination of mental states and behaviour is foundational to the joint actions constituting human interaction. The cognitive, neural, and behavioural mechanisms underlying the coordination of joint actions, such as two people carrying a piece of furniture together, have been well researched (for a review, see Sebanz & Knoblich, 2009). One particular type of joint action at the core of human interaction has received less attention in this respect: face-to-face conversation, the primary site of language use (e.g., Chafe, 1994; Clark, 1996; Fillmore, 1981; Firth, 1935/1957; Levinson, 1983; Luckmann, 1990; Linell, 1982/2005; Pickering & Garrod, 2004). This chapter focuses on how interlocutors coordinate in conversation, specifically on the interlocutors' visual and verbal behaviour when communicating knowledge they already share, as well as when they create newly shared knowledge in their interaction.

Central to these issues is the principle of *recipient design* (Garfinkel, 1967; Sacks, Schegloff & Jefferson, 1974) or *audience design* (Clark & Carlson, 1982; Clark & Murphy, 1983), which proposes that individuals adapt their communication to

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the particular characteristics and requirements of their interlocutors. An integral aspect of this process of adaptation is *common ground*, defined as the knowledge, beliefs, and assumptions that interlocutors share, combined with their mutual *awareness* that they share this particular common ground (Clark, 1996; Clark & Marshall 1981; Stalnaker 1978; Tomasello, 2008). Specifically, Clark (1996) described common ground deriving from three domains:

1. *Communal common ground* (pp. 100–112), which is the knowledge shared in cultural or sub-cultural communities.
2. *Personal common ground* (pp. 112–116), which is knowledge shared by particular interlocutors as a result of their prior common experience or their current situation.
3. *Incremental common ground* (pp. 38–39, 221–251), which is based on the interaction between interlocutors during their dialogue, specifically, the process of *grounding* – the moment-by-moment exchanges that establish information as common ground within a conversation (Clark & Schaefer, 1987, 1989; Clark & Brennan, 1991).

Despite these categorical distinctions, the boundaries may blur in any particular conversation. For example, references to something that happened at a neighbourhood fund-raising event would reflect both community membership and joint personal experiences if the interlocutors were familiar with the particular community and had also attended the event together.

Common ground and verbal utterance design

Personal common ground

When speakers design their utterances to be appropriate for particular audiences or recipients, they take into account their common ground. Clark, Schreuder, and Buttrick (1983) formulated the *principle of optimal design*, which predicts that utterances designed for recipients with whom the speaker shares certain knowledge differ in their form and information content from utterances designed for recipients who do not share this knowledge with the speaker. The data support this prediction: Empirical investigations of utterances conveying information that is communal or personal common ground at the outset of a conversation have shown that such utterances are systematically different from utterances conveying the same information when it is not common ground. The common ground utterances tend to include fewer words and employ a less diverse vocabulary and

fewer figurative descriptions (Fussell & Krauss, 1989). They also tend to be less carefully articulated (Bard et al., 2000; Fowler, 1988; Fowler & Housum, 1987).[1]

Incremental common ground

There is also evidence that similar changes emerge during conversation (Brennan & Clark, 1996; Clark & Brennan, 1991; Clark & Schaefer, 1987, 1989; Clark & Wilkes-Gibbs, 1986). In referential communication tasks where common ground accrues over time through grounding, the interlocutors' references require fewer turns, fewer words, and less information content (Clark & Wilkes-Gibbs, 1986; Fussell & Krauss, 1992; Isaacs & Clark, 1987; Krauss & Glucksberg, 1977; Krauss & Weinheimer 1964; Schober & Clark, 1989). This effect is particularly apparent in the *given-new contract* (Clark & Haviland, 1977; Haviland & Clark, 1974). Although references to new information are explicit and carefully articulated, repeated use of the reference with the same addressee leads to attenuation of form (e.g., shorter and less clearly articulated; Fowler, 1988; Fowler & Housum, 1987). This attenuation signals "the distinction the speaker is obliged to make between given information and new information" (Clark & Haviland, 1977, p. 3). These and other findings underline the important role reciprocal interaction plays in conversation (e.g., Bavelas, Coates & Johnson, 2000; Krauss & Weinheimer, 1966; Kraut, Lewis & Swezey, 1982; Kuhlen & Brennan, 2010).

The above experiments show that speakers do indeed adapt their utterances to whether their interlocutor shares certain common ground with them. However, reduction or simplification is not a universal rule. In certain contexts, it can be optimal to stick with firmly established referential phrases – called *conceptual pacts* – even if these references could be shortened or simplified further (Brennan & Clark, 1991; Metzing & Brennan, 2003). Nevertheless, speech that is characterized by reduction and ellipsis is certainly a prevalent pattern when speakers convey information that is or becomes part of the interlocutors' mutual knowledge.

1. There is an extensive literature on whether and when during utterance production and comprehension common ground is taken into account (e.g., Brennan & Hanna, 2009; Brown-Schmidt, 2009; Brown-Schmidt, Gunlogson, & Tanenhaus, 2008; Hanna & Tanenhaus, 2004; Horton & Keysar, 1996; Keysar, Barr, Balin, & Brauner, 2000; Kronmüller & Barr, 2007; Lockridge & Brennan, 2002; Metzing & Brennan, 2003), a discussion that goes beyond the scope of the present chapter.

Multi-modal investigations of common ground

It is important to point out that the above investigations of the effects of common ground on utterance design have been carried out in speech-only contexts (e.g., through a partition, where the interlocutors could not see each other). Thus, they provide a good idea of how common ground affects verbal utterances in mono-channel, telephone-like interactions, but they do not show how speakers draw on, establish, maintain, and deal with common ground in face-to-face interaction. A central question in multi-model interactions is whether the same effects occur when speakers have the opportunity to distribute information across a combination of speech and gesture, treated as speech-gesture ensembles (Kendon, 2004). That is, does common ground produce similar patterns of reduced frequency and/or attenuated form for both speech and gesture?

Reduction of word frequency

Recently, researchers have begun to address these questions. The overwhelming majority of these multi-modal investigations have shown that when speakers in face-to-face interaction convey information that is already in common ground, they significantly reduce the number of words they use (e.g., Campisi & Özyürek, 2013; Galati & Brennan, 2010, 2014; Hoetjes, Koolen, Goudbeek, Krahmer, & Swerts, 2015; Holler & Wilkin, 2009; Holler, Tutton, & Wilkin, 2011; de Ruiter, Bangerter, & Dings, 2012; Schubotz, Holler, & Özyürek, 2015; but see Hilliard & Cook, 2015, for an exception). They also reduced the amount of semantic information in their words (Holler & Wilkin, 2009). Even when their utterances were analyzed as speech-gesture ensembles (i.e., combining speech and gestures), speakers encoded less information in terms of semantic content when common ground existed than when it did not (Holler & Wilkin, 2009).

The rest of this chapter will focus on the diverse effects of common ground on gestures. First, however, it is useful to have a brief summary of the effect of social aspects of communication on gesture use in general, which will demonstrate the link between gesture and recipient design, a prerequisite for asking whether (and if so how) common ground affects gesture.

Social effects on the frequency and form of gestures

Visibility

The simplest social factor is mutual visibility – whether the interlocutors can see each other or not. The extensive literature has produced two different effects, each

well-replicated. Bavelas and Healing (2013) reviewed 14 experiments. In seven of these, the addressee was either a confederate (Cohen & Harrison, 1973; Krauss, Dushay, Chen, & Rauscher, 1995, Exps. 1 & 2; Mol, Krahmer, Maes & Swerts, 2009), the experimenter (Cohen, 1977; Emmorey & Casey, 2001), or another participant with constraints on interacting (Alibali, Heath & Myers, 2001; Mol, Krahmer, Maes & Swerts, 2009, 2011). In all seven, the speakers gestured at a significantly lower rate in the absence of visibility. (See Bavelas & Healing, pp. 73–75, for a possible artefact that may produce this effect.)

In contrast, seven other experiments employed an unconstrained dialogue between two participants (Bavelas, Chovil, Lawrie, & Wade, 1992, Exp. 2; Bavelas, Gerwing, & Healing, 2014a; Bavelas, Gerwing, Sutton, & Prevost, 2008; Holler, Tutton, & Wilkin, 2011; Pine, Gurney, & Fletcher, 2010; Rimé, 1982; de Ruiter, Bangerter, & Dings, 2012[2]), with *no* effect of visibility on the rate of gesturing. However, several studies showed a significant effect of visibility in the unconstrained dialogues when the *form* of gestures is analyzed (see Bavelas & Healing, Table 5, p. 15).

Addressee effects

Another social effect is found in the evidence that the addressee affects a speaker's gestures. First, speakers adapt their gestures to the informational needs of their addressee in several ways. They adjusted the kinematic form of their pointing gestures (e.g., by performing pointing gestures more slowly and carefully) when the gestures facilitate the addressee's identification of a specific visual target among distractor targets (Peeters, Chu, Holler, Hagoort, & Özyürek, 2015). Similarly, speakers made their iconic gestures larger, more precise, or visually more prominent in response to an addressee's clarification requests (Holler & Wilkin, 2011a). Speakers used more gestures when they knew that the information they conveyed was of high (as opposed to low) relevance for their interlocutors (Kelly, Byrne, & Holler, 2011). Similarly, they designed the semantic content of their gestures with their addressee in mind; for example, when using homonyms, they produced gestures that disambiguated speech (Holler & Beattie, 2003). The speaker's motivation to assist the addressee can also affect the form of their gestures; when they believed that their addressee would cooperate (vs. compete) with them in a game, speakers made larger gestures (Hostetter, Alibali, & Schrager, 2011). Speakers even adjust their gestural frequency and use of gesture space depending on the attentiveness of

2. The authors reported "no systematic effect": Lack of visibility significantly reduced pointing and obligatory iconics but not the largest group, nonobligatory iconics. Iconics as a whole were not significantly affected by visibility (J.P. de Ruiter. Personal communication to JB, July 13, 2012).

their addressees during the interaction (Jacobs & Garnham, 2007; Kuhlen, Galati, & Brennan, 2012). Finally, several studies have shown that speakers and addressees converge on gestural forms as their interaction unfolds (Holler & Wilkin, 2011b, Kimbara, 2009; Mol, Krahmer, Maes & Swerts, 2012), which presumably contributes to mutual understanding.

Dialogue vs. monologue

Dialogue itself also affects gestures. Speakers interacting in a dialogue gesture at a significantly higher rate than speakers describing the same material alone, in a monologue (Bavelas et al., 2008; Bavelas et al., 2014a; Holler, Turner, & Varcianna, 2013). Speakers in a dialogue (vs. monologue) also produced a higher rate of gestures specifically designed for dialogic interaction with an addressee, that is, *interactive* gestures, which are oriented towards and refer to the addressee (Bavelas et al., 1992). In a within-subjects design, speakers used interactive gestures at a significantly higher rate when they were engaged in face-to-face dialogue than when they were also in each other's presence but talking in sequential monologues (Bavelas, Chovil, Coates, & Roe, 1995).

Taken together, the above findings suggest that the social, dialogic, and interactive processes of communication can crucially shape speakers' gestures. Highlighting the evidence for a close link between recipient design and gestures is an important steppingstone to investigations of how common ground affects gestural communication. The next section will review the core experiments in this domain, focusing first on personal (prior) common ground, followed by experiments on incremental common ground. (There were no experiments on gesture and communal common ground).

Effects of personal (prior) common ground on gestures

At the time of writing, there were eight investigations of gesture and personal common ground (see Table 1). These manipulated personal common ground in two different ways: The speaker-addressee pairs either did or did not receive the same information before they interacted, or a speaker interacted with an addressee who had the same information and another who did not. Dependent variables were either gesture rate (usually per 100 words), gesture form, or both.

Rate measures

Four of the six experiments using gestures per 100 words found no significant difference between conditions (Campisi & Özyürek, 2013; Galati & Brennan, 2014; Hilliard & Cook, 2015; Schubotz et al., 2015 [older adults]). It would be easy to

Table 1. Overview of the effects of personal (prior) common ground on gestures

Year	Authors	Design[a]	Task/topic	Gestures: Individual or aggregated?	Quantitative DVs[b]	Comparison of form
2004	Gerwing & Bavelas (Study 1)	Within: speakers had two different addressees	Previously handled the same toy or not	Gestures for one toy	–	Gestures to same addressee judged significantly less "complex, precise, or informative"
2007	Holler & Stevens	Between: two groups	Addressees did or did not have prior knowledge of size of key features in pictures	Aggregated	Proportional frequencies: No-CG = mainly gesture + speech CG = mainly speech only	CG gestures were smaller than no-CG (i.e., did not represent actual size)
2007	Jacobs & Garnham (Condition 1 vs. 2)	Within: same speaker, different addressees	Describing same comic strip 3 times to same or to different addressees	Aggregated	Significantly lower rate of gestures per 100 words for CG; frequencies not reported	–
2009	Holler & Wilkin	Between: two groups	Addressees had previously watched same film or not	Aggregated	Significantly higher gesture rate per 100 words in CG; word frequency declined more than gesture frequency	CG gestures contained the same amount of semantic information as gestures produced in no-CG condition
2013	Campisi & Özyürek	Within: same speaker, different (imagined) addressees	How to make coffee (adult expert, adult novice, child)	Aggregated	Effect of rate per 100 words n.s. for experts vs. novices; word frequency declined	No difference in informativeness or size for experts vs. novices

(*continued*)

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Year	Authors	Design[a]	Task/topic	Gestures: Individual or aggregated?	Quantitative DVs[b]	Comparison of form
2014	Galati & Brennan	Within: same speaker, different addressees	Narrating cartoon stories	Aggregated gestures for the same narrative element (not matched gestures)	Marginally significant decrease of representational gesture frequency per narrative element with 'old' addressee; n.s. when divided by number of words; word frequency declined	Second telling to same vs. new addressee decreased the size and precision of gestures for same narrative element
2015	Hilliard & Cook	Between: two groups	Tower of Hanoi task, change of procedure	Aggregated gestures for movement trajectories	N.s. effect of common ground on gesture rate per 100 words; word frequencies not reported	CG gestures were lower (less conspicuous) but did not differ in size or trajectory
2015	Schubotz, Holler, & Özyürek	Within: speaker and addressee share knowledge about half of the stimuli	Saw same half of comic strips or not (young and old pairs)	Aggregated	Significantly lower gesture rate per 100 words in CG for young adults only; fewer narrative words in CG condition for young adults	–

a. Some studies had additional independent variables (e.g., adult vs. child). We have only reported the common ground results here.
b. See text re interpretation of rate per 100 words when word frequencies are known.

misinterpret these results as "no effect of common ground on gesturing," but that is not what this rate measure means. Although many authors describe the use of a gesture rate-per-word ratio as "adjusting," "normalizing," or even "avoiding" any effects of the number of words, in fact it indicates *whether common ground affects gesture frequency in the same way as common ground affects word frequency*. More specifically, it means that, just as speakers use fewer words when they share common ground with their addressee, they also use proportionally fewer gestures – not a trivial finding. As Galati and Brennan put it "This suggests that adaptive processes attenuate both speech and gesture in parallel" (p. 444). A term such as "gesture/word ratio" (rather than "gesture rate") conveys this implication more clearly.

To support the above interpretation, it is necessary to focus on both raw frequencies that go into gestures per 100 words or similar ratios. Several studies have shown that when speaker and addressee share common ground, *word frequency* is significantly lower than when they do not (e.g., Campisi & Özyürek, 2013; Fussell & Krauss, 1989; Galati & Brennan, 2010, 2014; Holler & Wilkin, 2009; Schubotz, et al., 2015). In these cases, a non-significant difference in the ratio of gestures to words can only happen if the gesture frequency is also lower in the common ground condition. Thus, to fully interpret the ratio in any specific case requires knowing at least the word frequencies. Table 1 indicates articles that provided the necessary information on at least word frequencies. If word frequency was lower in the common ground condition, even if gesture frequency was not reported, simple algebra shows that a non-significant difference between the gesture/word ratios must mean that gestures also became proportionately fewer than words. If the difference in this ratio is significant, it means that *gestures and words did not remain proportional,* with either a proportionally higher or a proportionally lower use of gesture relative to words (not that there were more or fewer gestures).

The two remaining studies using a gesture per 100 words measure yielded opposing results. Holler and Wilkin (2009) found a significantly higher gesture/word ratio when there was common ground, so word frequency was proportionately lower than gesture frequency in the common ground condition. Speakers were drawing more on their gestures relative to their words. Jacobs and Garnham (2007) found a significantly lower ratio when the narrator shared prior common ground with the addressee but unfortunately did not provide frequency data.

In short, rate measures such as gestures per 100 words are opaque, at least for common ground experiments. A non-significant result is misleading (because it suggests 'no difference' while, in fact, gestures may have increased or decreased in frequency, in parallel with words). Significant findings in either direction are also easy to misinterpret (i.e. as speakers gesturing more or less in absolute terms). It would help to avoid terms such as "normalizing" or "adjusting" and especially

not to consider gestures per 100 words the best measure for all occasions. Instead, its specific strength is to provide insight into the relative weighting of speech and gesture, specifically, whether common ground effects a shift in the extent to which speakers draw on gesture *relative to words*. Including frequencies for words and gestures can help make these abstracted findings clear (Holler & Stevens, 2007).

In the six experiments using a gesture/word ratio, the nature of the stimulus did not seem to affect the results. Experiments with dissimilar stimuli had the same results, and studies with similar stimuli had different results. However, the nature of the semantic information the speakers chose to provide using speech and gesture may have affected their ratio. For example, Holler and Wilkin (2009) distinguished between core propositional semantic information (i.e., constituting the central events in a story) and peripheral information. They explained their finding of a higher gesture/word ratio in the common ground condition by arguing that, while words included peripheral information,

> Closer examination of the speech and gesture data revealed that speakers in both conditions appeared to accompany the core components of the scene descriptions with gestures; that is, those components that were retained despite speech being more elliptical when common ground existed. (p. 279)

The result of this difference was that, although the frequency of both words and gestures reduced in the common ground versus no-common ground condition, words reduced more – namely, by dropping the more peripheral information and retaining most of the words describing the core semantic event elements, which were exactly those elements that were primarily accompanied by gesture. This possibility suggests a different gesture ratio, namely the frequency of gestures to the frequency of core semantic elements mentioned in speech. Galati and Brennan (2014) and Hoetjes et al. (2015) applied such an approach in addition to the traditional rate per 100 words and, indeed, found somewhat different results.

Comparison of form

In most of the experiments on personal (prior) common ground, the speakers' task was to convey specific information to their addressees, that is, some information was more important than other information. Therefore, it is useful to examine how they used gesture to carry out this social function. The four experiments described below found differences in speakers' use of gestures to convey *specific identifying information* to addressees who were or were not already aware of this information.

When speakers were describing a specific object that their addressee had not seen before, their gestures were judged to be "more complex, precise, or informative" than the same speakers' gestures to an addressee who was already familiar with the object (Gerwing, 2003; published in Gerwing & Bavelas, 2004, Study 2).

When the size of a specific feature in a picture was relevant, speakers whose addressees had not seen the picture represented size more accurately, whereas speakers with addressees who shared common ground made smaller, less accurate gestures (Holler & Stevens, 2007). When describing a change in a key feature of the task (the height of a movement) to addressees who were not aware of the change, speakers made higher gestures, and speakers whose addressees were aware of the change made lower, less conspicuous gestures (Hilliard & Cook, 2015). Speakers who were describing the same narrative elements to a new addressee made more precise gestures than did speakers who were retelling to the same addressee (Galati & Brennan, 2014). Thus, when their addressees lacked common ground about key information, speakers often used gestural form (but not necessarily frequency or gesture/word ratio) to depict this information accurately. When their addressees shared personal common ground, they were gesturally less accurate. This "sloppiness" could simply be due to economy of motion, but it might also serve to mark this information as common ground – a possibility that arises again in the next section.

Effects of incremental common ground on gestures

At the time of writing, there were seven studies of how incremental common ground influenced gestures (summarized in Table 2), all of which used within-participants (or mixed) designs. Each speaker described the same information to the same addressee more than once, thereby presumably increasing their common ground. The dependent variables were rate, form, or both. (Note that two of the experiments nested this manipulation inside a more complex design so that these speakers were the same group as the speakers in their personal common ground condition; Galati & Brennan, 2014; Jacobs & Garnham, 2007.)

Rate measures

Five experiments used gesture/word ratio, with the same potential problem of interpretation as found in the personal common ground experiments. Three found no significant decrease in gestures per 100 words (Galati & Brennan, 2014; Hoetjes et al., 2015; de Ruiter et al., 2012). All three articles reported word and gesture frequency, so we can re-interpret "not significant" as showing that gestures *declined* proportionately with words. Out of the two remaining studies, one found a lower (Jacobs & Garnham, 2007) and one a higher (Holler, Tutton, & Wilkin, 2011) gesture rate when common ground existed compared to when it did not. Thus, the gesture rate analyses yielded a mixed pattern of results, as they did for personal common ground experiments.

It is worth noting that the four articles that included frequencies also tended to be more sensitive to the meaning or vulnerability of rate-per-word measures (Galati

Table 2. Overview of the effects of incremental common ground on gestures

Year	Authors	Design[a]	Task/topic	Gestures: Individual or aggregated?	Quantitative DVs[b]	Comparison of form
2004	Gerwing & Bavelas, Study 2	Within: successive descriptions	Explaining a toy that was not familiar to the addressee	Individual gestures	–	Change from larger and clearer to smaller and less precise forms of the gesture
2005	Woods	Within: over six trials	Teaching sequences of dance steps with hand gestures	Individual gestures	Duration of each gesture	First presentation significantly longer than later versions
2007	Jacobs & Garnham, Condition 1	Within: over three tellings	Describing same comic strip 3 times	Aggregated	Gestures per 100 words decreased significantly over tellings; word frequencies not reported	–
2012	de Ruiter, Bangerter, & Dings	Within: over three trials	Referential communication task	Aggregated	N.s. difference in gesture rate per 100 words; word frequency decreased significantly over trials	–
2011	Holler, Tutton, & Wilkin	Within: over six trials	Referential communication task	Aggregated	Gestures per total words increased (word frequency decreased significantly over the trials, more than gesture frequency)	No effect of CG on number of allo- and egocentric gestures in initial compared to later trials

(*continued*)

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Year	Authors	Design[a]	Task/topic	Gestures: Individual or aggregated?	Quantitative DVs[b]	Comparison of form
2014	Galati & Brennan	Within: over three tellings	Narrating cartoon stories	Aggregated gestures for the same narrative element (not matched gestures)	N.s. difference in gestures per words in narrative element; word frequencies for first and second retellings to the same addressee not reported	Second telling decreased the size and precision of gestures for same narrative element
2015	Hoetjes, Koolen, Goudbeek, Krahmer, & Swerts	Within: over two repetitions	Referential communication task	Aggregated gestures for shape of the same figure (not matched gestures)	N.s. difference in gesture rate per 100 words. (Gesture data distribution per attribute U-shaped)	Initial gestures for a figure's shape were judged more precise than later ones; no difference in duration, size, number of hands, or repeated strokes

Note. Some studies had additional independent variables (e.g., codability, visibility). We have only reported the common ground results here.
a. See text re interpretation of rate per 100 words when word frequencies are known.

& Brennan, 2014, p. 444; Hoetjes et al., 2015, p. 9; Holler et al., 2011, para. 3.2; de Ruiter et al., 2012, p. 240). There is a case to be made for requiring raw frequencies in addition to ratios rather than supplanting them with abstracted indices.

Comparison of form

The most consistent experimental findings on incremental common ground come not from aggregated data, but from direct comparisons of the original and subsequent form of *the same* gestures. The qualitative analysis by Gerwing and Bavelas (2004, Study 2) found that successive gestures for the same action were smaller or less precise. Woods's (2005) quantitative follow-up found that the duration of later gestures was significantly shorter than their initial presentation. Both studies invoked Clark and Haviland's (1977) *given-new contract*, in which speakers are obliged to distinguish for their addressees between information that is *new* to their dialogue (i.e., is not common ground) and *given* information (i.e., has become common ground between them). Attenuation of the original form of a gesture, such as making it smaller, less precise, or shorter, would mark it as given, just as attenuation of a word does (Fowler & Housum, 1987; Fowler, 1988). As Gerwing and Bavelas pointed out: "[These later gestures] might be seen as "sloppier," but we propose that this change is systematic and directly analogous to the "sloppier" articulation of words and serves the same function, namely, to mark the information as given" (p. 176). The same theory also suggests why aggregated rate is not as informative as direct comparisons of the original and subsequent forms of the same gesture. If the speaker has an obligation to mark specific information as given, then modification of form would serve this function, whereas an overall decrease in gesturing probably would not. Thus, these studies support recipient design.

Two other studies may also offer evidence for attenuation. Hoetjes et al. (2015) found that initial gestures were judged to be significantly more precise than later gestures for the same general referent. (Size and several other differences were not significant.) These authors were not testing the given-new contract, so their analysis compared initial and later gestures describing the shape of the same target object. Because the target objects had several shape features, it must be acknowledged that the later gestures might not have referred to the same specific shape as the initial gesture did. Similarly, Galati and Brennan's (2014) finding of less precise gestures in later presentations might also support attenuation, but the gestures were matched at the level of narrative elements, not individual gestures.

General conclusions

Many studies of common ground refer simply to effects due to *repetition*. A close examination of both groups of studies reviewed here suggests that recipient design is a better fit. Qualitative features, which can also be quantified, tend to provide more direct evidence than the aggregated measures. It is likely that it is only by changing the form of a still-recognizable gesture that a speaker can clearly convey to a particular addressee that this gesture is one that was made before.

Our analyses of past studies on personal and incremental common ground raise several possibilities for future research:

1. What is the best way to represent an increase or decline of gestures in common ground experiments?
2. Should words and gestures be considered separately or as interacting with each other?
3. Is attenuation of gesture a usual marker of common ground? Is it more informative to addressees than a reduction in gesture/word ratio?
4. Do gestures tend to retain the core propositional information when speakers communicate information that is common ground?

Finally, research on common ground is curiously shallow theoretically. The most common explanation for personal common ground is previous similar experience; for incremental common ground, it is repetition. Both are operational definitions, not theories – especially not theories that focus on the immediate social context of common ground, yet there is a wide range of social functions that may be served by the way in which speakers mark common ground. The next section proposes several social functions garnered from a wide range of experimental and non-experimental studies on gesture and common ground, all of which illustrate the broader principle of recipient design. They also make clear why studies employing gesture/word ratio measures may have led to heterogeneous results and why analysing the connection between form and function of gestures appears to be more informative about how interlocutors use gesture in common ground contexts.

Social functions of gestures in common ground contexts

Functions of gestures in studies of personal common ground

Gestures can serve the maxim of quantity

One way in which gestures may function in personal common ground contexts is to provide a "safety net for over-suppositions" (Enfield, Kita, & de Ruiter, 2007,

p. 1732) in cases where speakers are uncertain whether their addressee actually shares certain knowledge. For example, a speaker may need to refer to a specific event at a previous meeting but be unsure whether the addressee witnessed the particular event or even attended the meeting, so the speaker is uncertain whether the information is in their common ground. Or, for any number of other reasons, the speaker may doubt the addressee's ability to notice, remember, or bring to mind this information. In the face of such uncertainty, it is difficult for the speaker to follow the Gricean (1975) principle of quantity: "Make your contribution as informative as is required; do not make your contribution more informative than is required".

Holler and Wilkin (2009) proposed that gestures, in contrast to words, are less like to be perceived as violating this maxim. That is, gestures may provide any missing common ground (i.e., "an informational safety net", Enfield et al., 2007, p. 1734). For example, Enfield et al. (2007) found that speakers continued to use pointing gestures when referring to the location of referents in their surrounding despite these locations potentially being part of the common ground they shared with their addressee. The authors proposed that this pointing was due to the speakers' uncertainty about their common ground. Note that while these gestures occured frequently in cases of uncertainty in common ground contexts, they were not full-blown in form. Enfield et al. found that these pointing gestures tended to be smaller than points towards locations that were definitely not common ground.

Gestures may avoid prolixity

Gestures can facilitate ellipsis in speech in order to avoid unnecessary prolixity. Studies of the detailed semantic interaction of speech and gesture at the level of individual utterances have shown that informative gestures can complement or even replace speech. For example, teachers used more gestures – but not more words – following moments in a lesson where common ground with students was lost (Alibali et al., 2013). In addition, several of the functions of interactive gestures (Bavelas et al., 1992; Bavelas, Chovil, Coates, & Roe, 1995; Holler, 2010) refer to the common ground status of information *in lieu* of the verbal equivalent. For example, these gestures marked shared information (instead of saying "as you know"), cited the addressee's contribution (instead of "as you said earlier"), or denoted ellipsis (instead of "you know the rest"). As well, they marked new information with exaggerated "delivery" gestures, typically pushing two open hands toward the addressee. These interactive gestures were significantly less likely to be paraphrased in words (Bavelas et al., 1992, Table 3).

"Remember when …. ?": Prominent gestures may link common ground with new information

We have shown that attenuation of gestural form for material that is (or that may be) common ground fits the principle of not telling others what they already know (Grice, 1975; Levinson, 1988, 2007). However, in some contexts, gestures for shared knowledge are often visually prominent (e.g., large) and rich in information. One possible reason for using prominent gestures in such contexts is that they may facilitate the addressee's identification of the referent and referent-related information tagged as common ground in their memory, thus providing a visual cue to trigger and link to further associated shared knowledge. This proposed function is illustrated by the following example from a spontaneous conversation between several participants in the UK who were chatting about Iceland as a holiday destination:

> Speaker: "Remember the [volcano eruption]."
> → [accompanied by a large, bi-manual gesture depicting an explosion with material being expelled from the mouth of a volcano]
> *The other participants express positive confirmation.*
>
> Speaker: "Well, we were actually in Iceland when it [erupted]."
> [very similar gesture to the preceding one, but much smaller in size and less precisely articulated]

Because of the geographical proximity of the UK and Iceland, it is highly likely that any UK resident would have been aware of the Icelandic volcano eruption at the time. The event was part of common ground through community membership. The speaker's use of the first, large gesture (→) is particularly interesting, considering that the event he referred to with this gesture was shared knowledge between the interlocutors. Such a gesture may best be described as functioning as a *visual anchor* for the addressees. The gesture linked information that was already common ground (that there had been a major volcano eruption in Iceland) to new information (that the speaker had actually been on holiday in Iceland at the time), and it did so in an embodied manner. The initial gesture also appeared to seek addressee feedback to confirm mutual awareness of their common ground, which would either confirm the addressees' successful recall and identification of shared knowledge or reveal problems in this respect.

Instances of such large and informative gestures for common ground occurred quite frequently in some of the data of Holler and Wilkin (2009), an experiment that aimed to reproduce the way speakers switch between new and old information in everyday discourse by embedding scenes constituting common ground within longer narrative sequences. The prominent gestures appeared to be used

by speakers in the manner illustrated above, that is, linking common ground with new information. The new information tended to follow the addressee's successful identification of the common ground referent. In sum, re-activating prior common ground in order to link it to new information may be one social function that leads a gesture to become more prominent rather than reduced.

Functions of gestures in studies of incremental common ground

Gestural form can mark information as given

We proposed above that the given-new contract explains an important aspect of incremental common ground. The speaker has an obligation to this particular addressee to show whether a gesture is new to this dialogue or, having occurred earlier, is now part of their common ground. An overall decline in gesture rate would not provide information about any particular given gesture. Except, perhaps, for the case of conceptual pacts, the absence of a particular gesture may not be as efficient, because it would require the addressee to remember which gestures occurred earlier that are not occurring now. The clearest way to serve this social function is to make the gesture again – but in a modified form. Experiments that compared initial with later gestures revealed that speakers used gestural attenuation as a social strategy for marking information as given versus new.

Grounding

Common ground can accumulate over the course of a conversation only when the interlocutors are able to ground their conversational contributions. Clark and Brennan (1991) proposed that

> In communication, common ground cannot be properly updated without a process we shall call grounding …. In conversation, for example, the participants try to establish that what has been said has been understood. In our terminology, they try to ground what has been said – that is, make it part of their common ground. (p. 128)

Previous experiments using speech-only tasks have shown that the process of grounding referential terms is crucial to successful communication (e.g., Brennan & Clark, 1996; Clark & Wilkes-Gibbs, 1986; Schober & Clark, 1989). If gestures are also part of the process of grounding, this would explain why speakers continue to use them (even in changed form) rather than reducing their rate. Therefore it is necessary to show that the grounding process is not solely verbal and that gestures can play a role as well.

Bavelas, Gerwing, Allison, & Sutton (2011) carried out a microanalysis of the grounding sequences initiated by 552 non-redundant gestures. Pairs of participants

were cooperating to develop a floor plan for a student apartment. They had no writing materials, so they "drew" their proposals with abstract deictic gestures on the table between them. A microanalysis of their final plan showed a consistent process in which speakers, first, presented new propositional information (e.g., "There's a *bathroom*, with a *shower*") using non-redundant gestures that provided the location, size, or shape of the room or object in it. The analysis then traced these presentations through the subsequent interactive steps of grounding: the addressee's display of understanding and the speaker's acknowledgement of the accuracy of the display (Clark & Schaefer, 1987, p. 22; see also Bavelas, De Jong, Korman, & Smock Jordan, 2012). This was a strong test of grounding with gestures:

> Mutual understanding was potentially even more difficult in this task because the gestures lacked any external anchor or referent. There were no real objects or spaces to point at or manipulate. The dyad had to co-construct and sustain the invisible floor plan with their words and abstract deictic gestures. In spite of the difficulty of their task and the speed of spontaneous dialogue, only 4.5% of the addresses' 552 responses [were not grounded]. (Bavelas et al., 2011, p. 59)

Other studies have also documented gestural facilitation of the grounding process. Addressees physically depicted interactional alignment through mimicry of gestures (Holler & Wilkin, 2011b). That is, by re-using a speaker's gesture for a particular referent, addressees signalled their understanding of the referent, re-introduced the referent at a later point, or signalled incremental understanding when communication problems had occurred. Speakers also used interactive gestures for grounding (Bavelas at al., 1995; Holler, 2010). For example, they gestured toward their interlocutor when referring to – and marking – information that was already common ground between them with the gestural equivalent of "As you know …".

In classroom studies, teachers used gestures to ground abstract concepts in the physical world and to establish embodied links (or catchments; McNeill, 1992) between new and already learned material. This kind of grounding allowed teachers to gesturally transport information across contexts or to enhance understanding when trouble spots occurred (e.g., Alibali & Nathan, 2012; Alibali et al., 2013; 2014; Nathan, 2008; Nathan & Alibali, 2011). Similarly, Levinson (2007) illustrated speakers' use of pointing gestures to ensure mutual understanding in the context of person reference (for persons that are mutually known to the interlocutors) within an absolute spatial reference system. In short, analyses of how gestures function in the grounding process can reveal how interlocutors are using their gestures to create common ground.

Conceptual pacts

Brennan and Clark (1996, p. 1484) proposed that interlocutors can collaboratively create verbal *conceptual pacts* or "temporary agreements about how the referent is to be conceptualized," which they may continue to use later even when they could use simpler references. Applied to gestures, conceptual pacts may explain why both words and gestures may persist long after they are clearly in the interlocutors' incremental common ground. In an experiment with Tangram figures, Holler et al. (2011) observed that, as common ground increased, speakers often continued to use the same gestures (depicting the referent in its entirety or by one particularly characteristic referent feature) even when they had already established agreement on verbal labels for these referents. It appears that these speech-gesture ensembles may constitute something like multi-modal conceptual pacts and, like verbal conceptual pacts, may tend to resist further change, even though they could, in principle, be reduced. Through the process of grounding, they would have become the referent that these two specific partners arbitrarily settled on. If some gestures function as parts of multi-modal conceptual pacts, this would explain why these gestures could be maintained and remain prominent, rather than reducing in rate or attenuating in form, in some common ground contexts.

The flexible interplay of speech and gesture in common ground contexts

At the heart of the variation in gesture rate and form reviewed here is the striking flexibility of the speech-gesture system. Speakers draw on the verbal and gestural modalities in ways that combine their respective strengths best – and they use the two modalities *jointly* to get their intended message across as one integrated message (Bavelas & Chovil, 2000, 2006), a speech-gesture ensemble (Kendon, 1972, 1980, 1985, 2004), or an integral part of language (McNeill, 1985, 1992, 2005, 2012).

Despite the two modalities forming one system, gesture can interact differently with speech, especially when interlocutors have shared knowledge. As seen here, speech and gesture often follow similar patterns in common ground contexts. However, speakers sometimes reduce and attenuate their gestures significantly more than their speech, leading to small and very infrequent gestures or even speech-only utterances. In other cases, speakers may reduce speech while maintaining gestures. That is, speech that ranges from explicit to elliptical to absent can combine with gestures that range from full-blown, large, informative, and frequent to gestures that are attenuated in form and semantic content, infrequent, or even absent. Focusing on words or gestures separately or using ratios of gestures-to-words alone does not capture these possibilities. We propose that speakers' recipient design will become evident only through considering the social function of

the interplay of the speech and gesture modalities. Assuming integrated and often complementary forms of expression as the *modus operandi* for speech-gesture ensembles is more likely to produce clearer evidence of recipient design.

Conclusions

This chapter began by placing conversational gestures in their intrinsically social context, reviewing the evidence for how, like words, they shape and are shaped by social interaction. A review of the core experiments on the role of gestures in personal and incremental common ground revealed that analysis of aggregate data such as gesture/word ratios were often not sufficiently informative, whereas analysis of the form of *specific* gestures showed considerable promise. We further proposed that principles such as Grice's maxims, the given-new contract, grounding, and conceptual pacts could generate entirely new directions in multi-modal common ground research.

One theme has been implicit throughout this review: To understand how gestures work – in common ground or other contexts – it is essential to see them *multi-modally, socially, and in detail*. It may at first seem counter-intuitive, but we propose that the apparent complexity of gesture can be simplified, not by isolating it, but through a theoretically informed fine-grained, examination of what the gesture is *doing* at a particular moment in the interaction (Kendon, 1985, 2004), in a multi-modal combination of words and hand gestures that might ultimately include facial gestures (Bavelas, Gerwing, & Healing, 2014b) and gaze (Goodwin, 1986; Gullberg & Kita, 2009; Holler & Wilkin, 2011a; Streeck, 1993).

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