The influence of conversation parameters on gesture production in aphasia

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Conversation is important in everyday life and this importance is not diminished in aphasia. Context parameters such as topic and partner are known to influence the linguistic content of conversations. With gesture being closely linked to language, these parameters may influence gestures used in conversations. This has not been investigated in previous studies. This study explored the spontaneous use of gestures in the conversations of participants with aphasia (PWA) and neurologically healthy participants (NHP). It aimed to examine the influence of conversation topic and partner on gesture production overall and on the production of semantically rich and empty gestures. 20 PWA and 21 NHP were filmed during conversations with different topics (narrative & procedural) and different partners (familiar & unfamiliar). Analysis 1 investigated the influence of the conversation topic on gesture production overall and on the production of semantically rich and empty gestures. In Analysis 2, the influence of the conversation partner on gesture production was investigated. Both groups produced significantly more gestures in procedural than in narrative conversations. Moreover, PWA and NHP produced significantly more semantically rich gestures in procedural conversations. In terms of the conversation partner, both groups produced significantly more gestures in the conversations with the unfamiliar than in those with the familiar conversation partner. For all findings, there were no group differences and no interactions between group and context parameters. These findings shed light on factors that influence gesture production and suggest that both modalities should be viewed together as a communicative resource for PWA.

Keywords: aphasia, gesture, conversation, topic, partner

# Background

Conversation is of great importance for human communication (e.g. Cassell, 2000; Davidson, Worrall, & Hickson, 2003). It involves the use of language to share opinions, ideas, information, and thoughts between two or more speakers (Clark, 2001). It is striking that conversations are typically accompanied by gestures, and this is observed across multiple cultures and in different speaking contexts (Kita, 2009). There is evidence that gestures are closely linked to the speech flow and are assumed to augment speech and convey a communicative intention (e.g. Kendon, 1980; Kendon, 2000; McNeill, 2000; So, Kita, & Goldin-Meadow, 2009). de Ruiter, Bangerter, and Dings (2012) additionally argue that gesture production increases when speech is difficult, such as in a noisy environment or in the case of aphasia. This has been termed the *Tradeoff Hypothesis*, according to which speech and gesture play mutually compensating roles for the communication of messages.

Conversations differ in various ways, such as in the topic conveyed by the conversation and the people involved. Using the terms of Halliday (2004), the topic (experiential function) and the adaptation to the listener (interpersonal function) form the context of the conversation. These context parameters are known to influence the linguistic content of conversations. The close link between language and gesture suggests that these parameters may also have an influence on the production of gestures. Indeed, models of gesture production allow for this influence. The models proposed by de Ruiter (2000) and Krauss, Chen, and Gottesman (2000) argue that discourse components feed into gesture production via the long and short term memory systems. Thus, context factors, such as the conversation topic and the partner, help to drive conceptualisation and this in turn influences both language and gesture formulation. Yet, the influence of varying these factors on gesture production has not been investigated.

## Conversation parameters and their influence on language

The influence of conversation parameters on language is well established. Ulatowska and colleagues (Ulatowska, Allard, & Chapman, 1990; Ulatowska & Bond, 1983; Ulatowska, North, & Macaluso-Haynes, 1981), for example, compared the language of narrative and procedural conversation topics. They argued that narrative topics (e.g. sharing an experience or retelling a video) mainly serve to entertain other people and therefore consist of components that carry a critical information load and develop the story line. In contrast, procedural topics, which instruct a person about how to do something (e.g. how to make a cup of tea) are goal-oriented. They therefore include more object related language than narrative topics and focus on the actions necessary to complete the task. Furthermore, procedural conversation topics elicit less complex language in terms of syntactic form than narrative conversation topics.

In terms of conversation partner, T. Herrmann (1983), for example, argued that the formality of speech changed according to the familiarity of the conversation partner. A relatively high and formal level of speech in combination with polite language is used when the conversation partners is unfamiliar. When talking to someone familiar, the level of speech is relatively low and informal. This manifests with more implicit language, colloquial terms, abbreviated expressions, and ellipses. Familiar conversation partners (FCP) also tend to shift topics quickly without explicit transitions (Hornstein, 1985) and ask each other fewer questions (Kent, Davis, & Shapiro, 1981). In addition, speakers talking to a FCP use more terms that outsiders would not understand referring to shared experiences, events (Clark & Schaefer, 1987; Fleming & Darley, 1991), and/or mutually known people (Clark & Carlson, 1981) because of already established common ground (Clark & Marshall, 1981) and community co-membership (Clark & Carlson, 1981).

Boyle, Anderson, and Newlands (1994) produced contrastive findings. They investigated several influences on conversation, including the familiarity between the speakers. They used a task that involved speaking about a route on a map and found that when talking to a FCP, participants used more turns and more words than when talking to an unfamiliar conversation partner (UFCP). Furthermore, FCP interrupted each other less frequently and produced less overlapping speech. These different findings reflect the particular nature of the task. For example, describing a novel route cannot draw upon shared reference between familiar speakers.

To summarise, the reported studies suggest that contextual features, such as the conversation topic and partner, influence the use of language. Procedural topics elicit more object-related language and less syntactically complex language than narrative topics. Findings with respect to the partner vary. However, some commentators argue that there are effects on the formality of language and the degree to which language is explicit. This is partly driven by the opportunities of shared reference between familiar partners.

## Conversation parameters in aphasia

Few studies have investigated these conversational parameters in aphasia. As with neurologically healthy participants (NHP), Ulatowska et al. (1981) compared narrative and procedural conversation topics in participants with aphasia (PWA). They argued that procedural language is syntactically simpler than narrative language and that procedural topics are more constrained by temporal order than narrative topics as they describe a process that follows a specific sequence. They therefore hypothesised that PWA would behave differently on each topic, as well as in comparison to NHP. Both PWA and NHP were asked to complete several tasks, like talking about an experience (narrative) and explaining a process (e.g. brushing teeth and changing a tyre; procedural). Results revealed that PWA produced less complex language and fewer utterances in both topics than NHP. The amount of information omitted by PWA did not differ across topics. However, its nature did. In the narrative samples they mainly omitted evaluative comments (e.g. statements of inner feelings or motivation of the participants in the stories). In the procedural samples, small steps were omitted. As a result, the general procedure was explained but with reduced detail and gaps between the steps. These results were confirmed by later studies of the same research team and colleagues (e.g. Ulatowska & Bond, 1983; Ulatowska, Doyel, Freedman-Stern, & Macaluso-Haynes, 1983; Ulatowska, Freedman-Stern, Doyel, & Macaluso-Haynes, 1983).

In their studies, Li, Williams, and Della Volpe (1995) and Williams, Li, Della Volpe, and Ritterman (1994) investigated the influence of conversation partner familiarity on the levels of speech as detailed by T. Herrmann (1983). Similar to studies conducted with NHP, Williams et al. (1994) did not find a difference between the conversation with the FCP and the one with the UFCP. Li et al. (1995), on the other hand, found an influence of the conversation partner but only in the narrative topic. Here, both PWA and NHP were more accurate in providing a setting for the story they were retelling when talking to the FCP. The authors based this effect on the more comfortable situation when talking to a FCP. Despite this finding, Li et al. (1995) did not identify differences in language formality (cf. T. Herrmann, 1983).

## Gesture production in conversation

Speakers are known to use a wide range of gesture types during conversation (e.g. McNeill, 1992, 2012). Kendon’s continuum by McNeill (1992, 2000) is a widely used system for classifying gesture. This separates gestures that are employed with speech (i.e. gesticulations) from gestures used without speech. Gesticulations are further subdivided into iconics (i.e. gestures depicting an action or an object, such as holding a cup for “drinking”), metaphorics (i.e. gestures representing an abstract idea or concept, such as a flat upwards palm for “a problem”), deictics (i.e. pointing gestures), and beats (i.e. rhythmic movements) (see Kistner, Dipper, and Marshall (2019) for details of the different gesture categories). Pantomimes and emblems are gestures that usually occur without speech. While the former are complex and often sequential gestures, the latter are culturally formed. Sign language is also included in Kendon’s continuum. As it is an independent and complex linguistic system, it will be disregarded in the current study.

For this study, Kendon’s continuum was slightly modified by (1) adding two gesture types: air writing and numbers and (2) by introducing overarching categories of semantically rich and semantically empty gestures. Air writing involved tracing the spelling of a word either in the air or on a flat surface. Numbers involved tracing an Arabic numeral or holding up fingers to signal an amount. Both types of gesture have been previously observed in the communication of PWA (e.g. Cicone, Wapner, Foldi, Zurif, & Gardner, 1979; Sekine & Rose, 2013; Sekine, Rose, Foster, Attard, & Lanyon, 2013) and were similarly employed in this study. The overarching category of semantically rich gestures comprised: iconics, metaphorics, pantomimes, emblems, air writing, and numbers. All conveyed semantic content that mirrored or supplemented what was said. The overarching category of semantically empty gestures included deictics and beats. These gesture types did not carry semantic content but either referred to a concept, for example, by pointing (deictics) or underlined prosodic features (beats). For further details on the modification please refer to Kistner et al. (2019).

## Influence of conversation parameters onto gesture production

The use of gesture in conversation has been widely investigated, including in speakers with aphasia (e.g. Behrmann & Penn, 1984; Glosser, Wiener, & Kaplan, 1986; M. Herrmann, Reichle, Lucius-Hoene, Wallesch, & Johannsen-Horbach, 1988; Kong, Law, Wat, & Lai, 2015; Le May, David, & Thomas, 1988; Macauley & Handley, 2005; van Nispen, van de Sandt-Koenderman, Sekine, Krahmer, & Rose, 2017; Wilkinson, Beeke, & Maxim, 2010). For example, a recent study shows that PWA employ more essential gestures in conversation than NHP (van Nispen et al., 2017). These are gestures that convey information that is omitted from speech, indicating that the gestural modality plays an important communicative role in the conversation of PWA.

Despite these findings, no studies could be found that investigated the influence of conversation topic or partner on gesture production in either NHP or PWA. However, hypotheses can be formed from language analysis.

The studies conducted by Ulatowska and colleagues (Ulatowska et al., 1990; Ulatowska & Bond, 1983; Ulatowska et al., 1981) show that topic defines the type of language that is produced in conversation, with procedural topics particularly focussing on required actions and the use of tools. Given the close association between gesture and language, it was hypothesised that procedural topics would elicit more object- and action-related gestures, such as depicting tools and their movement, than narrative topics (Pritchard, Dipper, Morgan, & Cocks, 2015).

It is difficult to hypothesise about the effect of conversation partner on gesture production, given the conflicting findings that have emerged with respect to the influence on speech. The finding that speech becomes less detailed and more elliptical (e.g. T. Herrmann, 1983; Li et al., 1995) when talking to a familiar partner might predict a reduced use of gesture. Alternatively, if, as suggested by de Ruiter et al. (2012), there is a trade-off between speech and gesture then gesture production might be expected to increase alongside the reduced speech in this context. To make matters even more difficult to predict, Boyle et al. (1994) found that there were more words and more turns in conversations with familiar partners. In this case, if the two modalities parallel each other, then a greater use of gesture might be hypothesised; conversely, if there is a trade-off, enhanced speech may reduce the production of gesture. Finally, a more general point might be made. There is a debate in the literature about whether gesture is produced primarily for the sake of the listener, for example, as a communicative device (e.g. van Nispen et al., 2017), or for the sake of the speaker, for example, as a resource to aid word retrieval (e.g. Hadar, Wenkert-Olenik, Krauss, & Soroker, 1998; McNeill, Cassell, & McCullough, 1994). If the familiarity of the conversation partner affects gesture production, this would suggest that gesture production is, at least in part, listener focussed, in order to add more clarity.

# The current study

The current study examined gesture production in the conversations of 20 PWA and 21 NHP. It aimed to explore the influence of conversation topic and conversation partner on the production of gestures as well as the differences between the two participant groups.

Two analyses were conducted. In the first analysis, the influence of the conversation topic was investigated: Two conversation topics (i.e. narrative and procedural) were analysed against the number of gestures produced in those conversation settings. Furthermore, semantically rich and semantically empty gestures were identified to investigate the influence of the conversation topic on the type of gesture produced. Therefore, this analysis addressed the following questions:

* Do narrative and procedural conversation topics elicit a different number of gestures? Is there a difference between PWA and NHP?
* What is the influence of narrative and procedural conversation topics on the number of semantically rich and semantically empty gestures? Is there a difference between PWA and NHP?

As argued above, procedural topics were hypothesised to elicit the greatest number of gestures. It was also hypothesised that procedural topics would particularly elicit semantically rich gestures, as they would augment the action-related instructions being conveyed. Semantically empty gestures, and particularly beats, relate to prosodic features of the discourse, such as intonation and stress. It was therefore hypothesised that these would particularly accompany narrative speech where more emotional and evaluative content is being conveyed (Prieto, Alice, Kushch, Rohrer, & Vilà-Giménez, 2018). Furthermore, beats mark narrative structure, for example, in the case of topic changes. Narrative speech is expected to be structurally more variable than procedural speech (McNeill, 1992, p. 15)

The second analysis investigated the influence of the conversation partner on gesture production. Two conversation partners (i.e. familiar and unfamiliar) were identified and analysed against the different conversation settings. There was no reason to believe that the semantic content of gestures would be influenced by the conversation partner. Thus, the third research question addressed by this analysis was the following:

* Does the familiarity of the conversation partner (i.e. familiar vs. unfamiliar) have an influence on the overall use of gesture? Is there a difference between PWA and NHP?

As argued above, the influence of partner is unpredictable, given the contrastive findings with respect to speech. Several studies (e.g. Boyle et al., 1994; T. Herrmann, 1983; Li et al., 1995) suggest that speech is reduced in the context of a familiar conversation partner, which may argue for a similar reduction in gesture. However, contrary findings (e.g. Bortfeld, Leon, Bloom, Schober, & Brennan, 2001; Williams et al., 1994) would challenge this view. Similarly, there are two possibilities with respect to the effect on gesture of a variation in speech content.

Both analyses explored group effect, that is, whether the effect of conversation parameters on gesture differed for PWA and NHP. Here again, the lack of previous evidence precluded the formation of hypotheses. Similar patterns across the groups would suggest that PWA retain sensitivity to discourse parameters, such as the needs of the conversation partner. Group differences might suggest less sensitivity but could equally arise from other causes. For example, PWA might make greater use of gesture in an attempt to compensate for their speech difficulties.

# Method

## Ethical approval

On 22nd February 2013, ethical approval was granted by the ethics committee of the School of Health Sciences (Division of Language and Communication Science) at City, University of London. This included recruiting (1) PWA through community stroke groups in and around London and through previously established aphasia community links within the division and (2) NHP through an existing database stored at the Department of Psychology at City, University of London as well as through personal contacts of the investigators.

## Participants

*Participants with aphasia (PWA).* Nine female and 11male PWA were recruited via community groups to take part in this study. They were more than 6 months post-stroke (range = 11 months to 9 years, *M* = 51.90, *SD* = 25.221) and between 23 and 83 years old (*M* = 60.60, *SD* = 15.537). Eleven PWA had completed tertiary education and nine PWA had reached and finished secondary education. All PWA were (originally) right-handed, 11 PWA had right hemiplegia. Inclusion criteria for the study were: (1) a left hemispheric stroke with aphasia, (2) at least six months post-onset to ensure medical stability, (3) fluent users of English prior to the stroke (via self-report), (4) normal or corrected-to-normal vision and hearing, and (5) meeting pre-determined screening cut-offs. Exclusion criteria included: (1) coexisting neurological diagnoses such as dementia and (2) being unable to consent to participation due to significant comprehension difficulties that were evident in conversation.

*Neurologically healthy participants (NHP).* Twelve female and nine male NHP were recruited through an existing database stored in the Department of Psychology at City, University of London(all participants in this database had previously given consent to be contacted about other research projects taking place at City, University of London) and through personal links of the principal investigator to take part in this study. They were between 27 and 89 years old (*M* = 60.19, *SD* = 20.764). Seventeen NHP had completed tertiary education and 4 had reached and finished secondary education. Four NHP were left-handed. Participants had to be fluent users of English (established via self-report) and have normal or corrected-to-normal vision and no reported hearing loss. Exclusion criteria were history of neurological illness or insult and any other serious medical condition. PWA and NHP did not differ with respect to age (*t* (39) = 0.071, *p* = .944), gender (*X2* (1) = 0.605, *p* = .437), and education (*t* (39) = -1.643, *p* = .108).

*Familiar conversation partners (FCP).* PWA and NHP nominated one FCP each (i.e. family member or friend; 30 female, 9 male)[[1]](#footnote-1). They were between 16 and 85 years old (*M* = 53.85, *SD* = 17.089). Thirty FCP had completed tertiary education (level 4 to level 7), 9 had reached and finished secondary education (level 2 and level 3) (*M* = 4.4, *SD* = 1.483). FCP were included if they met the assessment screening cut-offs. Meeting these cut-offs meant that they had no physical, cognitive, and linguistic deficit influencing the research.

*Unfamiliar conversation partners (UFCP).* Twenty-eight UFCP[[2]](#footnote-2) were included into the study (all female). UFCP were either SLT students in their final year at City, University of London or researchers working within the department. They were between 20 and 49 years old (*M* = 30.93, *SD* = 6.960). Twenty-six UFCP had completed tertiary education (level 4 to level 7), only two had reached and finished secondary education (level 2 and level 3) (*M* = 4.93, *SD* = 1.184). None of them had a self-reported history of neurological illness, insult, or any other serious medical condition.

## Assessment data

Assessment data are summarised below and in Table 1 (also below).

*Language skills.* All PWA completed the Western Aphasia Battery – Revised (WAB-R; Kertesz, 2007). The aphasia quotient score (AQ) on the WAB-R ranged from 31.60 to 90.08 (*M* = 68.08, *SD* = 16.946), with nine PWA having mild (76.0-93.7), eight having moderate (51.0-75.9), and three having severe (26.0-50.9) aphasia. Furthermore, seven PWA were diagnosed with Broca’s, five with Conduction, five with Anomic, and three with transcortical motor aphasia (TMA). Fluency scores ranged between 2 and 9 (*M* = 4.08, *SD* = 2.093).

*Cognitive skills.* All participants, except UFCP (i.e. PWA, NHP, and FCP) completed the non-linguistic subtests of the Cognitive Linguistic Quick Test (CLQT; Helm-Estabrooks, 2001) to rule out any major cognitive impairment. Since all UFCP were either students in their final year or researchers working within the department, it was assumed that they did not have any cognitive impairments. The scores for PWA ranged from 39.00% to 94.30% (*M* = 75.09%, *SD* = 17.608), indicating performances both within normal limits (WNL) and mild impairment. All NHP and all but one FCP performed within normal limits (NHP: from 75.20% to 100.00%, *M* = 90.88%, *SD* = 7.963; FCP: from 69.50% to 100.00%, *M* = 93.50%, *SD* = 6.418).

*Motor skills.* To ensure complete use of at least one upper limb, all participants were given the Action Research Arm Test (ARAT; McDonnell, 2008). All NHP, FCP, and UFCP% scored 100% for both left and right upper limb, while this was the case for only nine PWA. Therefore, 11 PWA gestured unilaterally while the rest were able to gesture bilaterally. Additionally, PWA and NHP were given the Birmingham Praxis-Screen (BCoS-Praxis), a subsection of the Birmingham Cognitive Screen (BCoS; Bickerton et al., 2012). The scores of 12 PWA indicated that they had limb apraxia.

Table 1. Information and test scores of PWA.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ID | Gender | Age | Months post stroke | Type/location of stroke | WAB-R | BCos-Praxis |
| AQ | Severity | Syndrome | Fluency | O | P | R | I | Apraxia |
| 1A | F | 71 | 38 | CVA, ischemia, left | 68.2 | Moderate | Conduction | 4 | 12 | 10 | 5 | 10 | N |
| 2A | F | 79 | 50 | CVA, ischemia, left posterior putamen, insular cortex, and corona radiata | 86.6 | Mild | Anomic | 9 | 12 | 11 | 5 | 10 | N |
| 3A | M | 40 | 43 | *no information available;* left | 62.7 | Moderate | Broca’s | 4 | 12 | 8 | 5 | 9 | Y |
| 4A | M | 75 | 83 | CVA, ischemia, left MCA | 75.6 | Moderate | Conduction | 5 | 12 | 11 | 6 | 9 | N |
| 5A | M | 73 | 19 | CVA, ischemia, left MCA, frontal lobe | 76.6 | Mild | TMA | 4 | 12 | 12 | 5 | 9 | N |
| 6A | F | 64 | 11 | CVA, ischemia, left MCA | 82.9 | Mild | Anomic | 9 | 11 | 9 | 5 | 6 | Y |
| 7A | M | 64 | 65 | CVA, ischemia, left, basal ganglia | 90.8 | Mild | Anomic | 9 | 12 | 10 | 4 | 8 | Y |
| 8A | M | 79 | 31 | CVA, ischemia, left MCA | 66.9 | Moderate | Conduction | 6 | 12 | 8 | 5 | 6 | Y |
| 9A | M | 58 | 40 | CVA, ischemia, left MCA | 68.6 | Moderate | Conduction | 5 | 12 | 6 | 5 | 9 | Y |
| 10A | F | 54 | 55 | CVA, ischemia, left MCA | 84.2 | Mild | Anomic | 5 | 12 | 8 | 6 | 7 | Y |
| 11A | M | 56 | 23 | CVA, ischemia, left MCA | 81.1 | Mild | Anomic | 5 | 12 | 11 | 6 | 12 | N |
| 12A | F | 54 | 65 | CVA, ischemia, left MCA | 76.6 | Mild | Conduction | 5 | 12 | 12 | 6 | 9 | N |
| 13A | F | 65 | 72 | *no information available*; left | 36.7 | Severe | Broca’s | 2 | 12 | 6 | 5 | 7 | Y |
| 14A | F | 47 | 117 | CVA, ischemia, left MCA | 37.2 | Severe | Broca’s | 2 | 12 | 4 | 1 | 6 | Y |
| 15A | M | 77 | 36 | *no information available*; left | 63 | Moderate | Broca’s | 4 | 12 | 8 | 4 | 6 | Y |
| 16A | M | 56 | 56 | CVA, ischemia, left MCA | 31.6 | Severe | Broca’s | 2 | 12 | 6 | 3 | 9 | Y |
| 17A | M | 83 | 44 | CVA, ischemia, left MCA | 77.2 | Mild | TMA | 4 | 12 | 10 | 4 | 11 | N |
| 18A | F | 23 | 58 | CVA, ischemia, left MCA | 64.1 | Moderate | Broca’s | 4 | 12 | 9 | 5 | 12 | Y |
| 19A | F | 54 | 60 | *no information available*; left | 53 | Moderate | Broca’s | 4 | 12 | 11 | 5 | 8 | Y |
| 20A | M | 40 | 42 | CVA, ischemia, left MCA | 77.8 | Mild | TMA | 4 | 12 | 10 | 6 | 10 | N |

*Note.* PWA = participant/s with aphasia; F = female; M = male; WAB-R = Western Aphasia Battery – Revised; AQ = aphasia quotient; TMA = transcortical motor aphasia; BCoS-Praxis = Birmingham Cognitive Screen – Praxis; O = object use; P = pantomime; R = recognition; I = Imitation; Y = yes; N = no.

## Procedure

Participants were invited to take part in a project about conversation in aphasia and comparing the effect of different conversation topics and partners. Hence, none of the participants was informed about gesture production being the focus of the study until after their participation.

*Setup/materials.* PWA/NHP, their conversation partner and the camera were set up in a triangle. In this way, participants and their conversation partner could face each other while their upper body part (from knees up to an arm length above the head and to either side) was still able to be captured fully with the camera. To ensure that participants’ gestures were fully visible, the dominant or functional arm respectively was facing the camera (12 left, 8 right for PWA and 4 left, 17 right for NHP). Furthermore, participants and their conversation partners were not allowed to have anything on their laps, in their hands and next to their chairs to ensure that gesturing was not impeded.

*Conversations.* NHP and PWA were filmed in two conversation sessions, one with the FCP and one with the UFCP. In each of these sessions, participants were asked to have conversations on two narrative topics (i.e. ‘happy memory’ and ‘busy weekend’) and two procedural topics (i.e. ‘how to wrap a parcel’ and ‘how to make scrambled eggs’). The order of the conversation sessions was semi-randomised: about half of the PWA and NHP started with the FCP, the other half with the UFCP. Between the two sessions, there had to be at least a one-week-gap. The order of the conversation topics was semi-randomised as well.

It was targeted for each conversation to run for at least 02:30 min but there was no set end point by the examiner. As soon as there was a natural stop in the conversation (e.g. when the participant said something like ‘that’s it’ or there was a long pause with no further contribution to the conversation), the camera was stopped as well. Only the middle 02:00 min of the conversation sample went into analysis, so that there were 16:00 min of conversation per participant that were analysed.

*Coding procedure.* All videos were coded using the gesture and sign language analysis program ELAN (Wittenburg, Brugman, Russel, Klassmann, & Sloetjes, 2006). Different tiers below the video were created for coding. In a first instance, all gestures were identified as well as co-occurring speech was transcribed (in ordinary orthographic conventions and, if necessary, broad phonemic transcription). The adapted version of Kendon’s continuum (McNeill, 1992, 2000) was used to categorise all identified gestures: iconic, metaphoric, deictic, beat, pantomime, emblem, air writing & numbers, and other (i.e. gestures that did not fit in any of the categories). In a further step, all gestures with semantic content (i.e. iconic, metaphoric, pantomime, emblem, and air writing & number gestures) were collapsed into semantically rich gestures. Of the remaining gestures, beats and deictics were collapsed into the category of semantically empty gestures.

## Inter-rater agreement

The principal investigator, an English-speaking SLT with experience in aphasia coded and analysed the videos of all conversations. To assess reliability, 10% of the videos were coded by a second judge, a native English speaker, for identifying gestures and different types of gestures. If there were differences in coding, the version of the principal coder went into analysis.

Overall, there was better percentage agreement for NHP than for PWA on the identification of gestures (PWA: 92.39%; NHP: 98.49%). Reliability for the different type of gesture was tested using Cohen’s *κ*. Substantial agreement was reached for the gesture type in PWA, *κ* = .637, *p* < .001, and moderate agreement for gesture type in NHP, *κ* = .585, *p* < .001.

## Analysis 1: Influence of the conversation topic

This analysis compared the gesture production in narrative and procedural conversations. A 2x2 repeated measures 2-way ANOVA was used to explore whether the number of gestures produced was influenced by conversation topic and/or group (PWA and NHP). Two more 2x2 repeated measures ANOVA were conducted to investigate the influence of the conversation topic on the production of semantically rich gestures and/or group (PWA and NHP) as well as the influence on the production of semantically empty gestures and/or group.

## Analysis 2: Influence of the conversation partner

In this analysis, the gesture production was compared in conversations with familiar and unfamiliar conversation partners. A 2x2 repeated measures 2-way ANOVA was used to explore whether the number of gestures was influenced by conversation partners an/or group (PWA and NHP).

# Results

For every analysis, variables were checked for normality by Shapiro-Wilk. While most variables were normally distributed, some instances were not. These are reported in the paragraphs below. As the not-normally-distributed data were only minimally skewed and studies have shown that an ANOVA is robust in this circumstance, parametric analyses were conducted.

PWA and NHP produced a high number of gestures during the conversations – the number of gestures produced by NHP was slightly higher than those produced by PWA. While the number of iconic gestures was similar in PWA and NHP, PWA produced more pantomime, emblem, air writing & number, and deictic gestures than and fewer metaphoric and beat gestures than NHP. Additionally, the gestures that could not be categorised was more than two times higher in PWA than in NHP. Table 2 gives more details about the distribution of gesture types:

Table 2. Mean number of gestures produced across all conversations per participant.

|  |  |  |
| --- | --- | --- |
|  |  PWA |  NHP |
| *M* (*SD*) | % | *M* (*SD*) | % |
| Overall | 355.21 (92.545) | n/a | 384.10 (76.674) | n/a |
| Semantically rich gestures iconic metaphoric pantomime emblem air writing & numbers | 205.26 (71.248)114.47 (53.131)72.32 (45.382)0.68 (0.885)0.84 (1.259)16.95 (28.448) | 57.7832.2220.360.190.244.77 | 239.00 (79.385)132.40 (38.602)105.00 (57.857)0.35 (0.988)0.45 (1.572)0.80 (1.765) | 62.2334.4727.340.090.120.21 |
| Semantically empty gestures deictic beat | 94.00 (50.370)49.74 (22.905)44.21 (34.271) | 26.4514.0012.45 | 119.50 (52.786)24.70 (13.413)94.80 (55.287) | 31.116.4324.68 |
| Other gestures | 56.00 (26.160) | 15.77 | 25.60 (13.430) | 6.66 |

*Note.* PWA = participant/s with aphasia; NHP = neurologically healthy participant/s; *M* = mean; *SD* = standard deviation.

## Analysis 1: Influence of the conversation topic

*All gestures.* The first analysis investigated the influence of the conversation topic (narrative vs. procedural) on gesture production. For PWA, only the data for the narrative conversations were normally distributed, *W* (19) = .973, *p* = .836 for PWA (narrative), while those of the procedural conversations were not, *W* (19) = .884, *p* = .025 for PWA (procedural). For NHP, all variables were normally distributed, *W* (21) = .973, *p* = .836 for NHP (narrative) and *W* (20) = .979, *p* = .927 for NHP (procedural). A 2x2 repeated measures 2-way ANOVA with one between-factor (PWA vs. NHP) and one within-factor (narrative vs. procedural) was conducted to investigate the influence of the conversation topic on gesture production. There was a significant main effect of the conversation topic, *F* (1, 37) = 44.807, *p* < .001 ( = .548) with a large effect size. Procedural topics elicited significantly more gestures than narrative topics. There were no main effect of group *F* (1, 37) = 1.132, *p* = .294 ( = .030) and no interaction between topic and participant group, *F* (1, 37) = 3.401, *p* = .073 ( = .084). The non-significant main effect (group) had a small effect size, while the effect size of the interaction was medium. The results are illustrated in Figure 1:

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Figure 1. Influence of the conversation topic on gesture production for PWA and NHP, including error bars of +/-1 SD. Significant differences are marked with \*.

Figure 1 shows, that both participant groups produced significantly more gestures in procedural than in narrative conversations. It also illustrates that both groups performed alike and there was no significant difference between PWA and NHP.

*Semantically rich gestures.* In the second part of the first analysis, the influence of the conversation topic on the production of semantically rich gestures was investigated. For PWA, only the data for semantically rich gestures produced in narrative conversation were normally distributed, *W* (19) = .977, *p* = .901, while the date for semantically rich gestures produced in procedural conversations were not, *W* (19) = .878, *p* = .020. For NHP, the data for semantically rich gestures produced in both narrative and procedural conversations were normally distributed, *W* (20) = .963, *p* = .600 (narrative) and *W* (20) = .976, *p* = .868 (procedural). A 2x2 repeated measures 2-way ANOVA was conducted to explore the influence of the conversation topic on the production of semantically rich gestures. The between-factor was group (PWA vs. NHP) and the within-factor was topic (narrative vs. procedural). There was a main effect of topic, showing that procedural conversation topics elicited more semantically rich gestures than narrative conversation topics, and the effect size was large, *F* (1, 37) = 87.115, *p* < .001 ( = .702). There was no main effect of group, *F* (1, 37) = 1.944, *p* = .172 ( = .050) and no interaction of topic and group, *F* (1, 37) = 2.130, *p* = .153 ( = .054). Here, the effect sizes of the main effect of group and of the interaction were small. The scores of the semantically rich gestures that were produced in procedural and narrative conversation topics are displayed in Figure 2:

Figure 2. Influence of the conversation topic on the use of semantically rich gestures.

Figure 2 shows that again, both participant groups performed alike and there was no significant difference between PWA and NHP. Furthermore, it shows that both groups produced significantly more semantically rich gestures in procedural conversations.

*Semantically empty gestures.* In the final part of the first analysis, the influence of the conversation topic on the production of semantically empty gestures was investigated. For PWA, none of the data were normally distributed, *W* (19) = .875, *p* = .018 (narrative), *W* (19) = .736, *p* < .001 (procedural). For NHP, the data for semantically empty gestures produced in both narrative and procedural conversations were normally distributed, *W* (20) = .944, *p* = .280 (narrative) and *W* (20) = .927, *p* = .135 (procedural). A 2x2 repeated measures 2-way ANOVA was conducted to explore the influence of the conversation topic on the production of semantically empty gestures. The between-factor was group (PWA vs. NHP) and the within-factor was topic (narrative vs. procedural). There was a main effect of topic, showing that narrative conversation topics elicited more semantically empty gestures than procedural conversation topics, and the effect size was large, *F* (1, 37) = 16.729, *p* < .001 ( = .311). There was no main effect of group, *F* (1, 37) = 2.387, *p* = .131 ( = .061) and no interaction of topic and group, *F* (1, 37) = 3.022, *p* = .090 ( = .076). Here, the effect sizes of the main effect of group and of the interaction were small. The scores of the semantically empty gestures that were produced in procedural and narrative conversation topics are displayed in Figure 3:

Figure 3. Influence of the conversation topic on the use of semantically empty gestures.

Figure 3 shows that again, both participant groups performed alike and there was no significant difference between PWA and NHP. Furthermore, it shows the opposite effect as Figure 2, in that both groups produced significantly more semantically empty gestures in narrative conversations.

Overall, analysis 1 shows that the conversation topic had an influence on both the overall gesture production and on the production of semantically rich and empty gestures. Procedural conversations elicited both significantly more gestures overall and significantly more semantically rich gestures than narrative conversations. Narrative conversations, on the other hand, elicited significantly more semantically empty gestures.

## Analysis 2: Influence of the conversation partner

In the second analysis, the influence of the conversation partner (familiar vs. unfamiliar) on the production of gestures was investigated. All variables for this analysis were both normally distributed for PWA and NHP, *W* (19) = .971, *p* = .802 for PWA (FCP), *W* (20) = .963, *p*= .596 for NHP (FCP), *W* (20) = .956, *p* = .471 for PWA (UFCP), and *W* (21) = .961, *p* = .531 for NHP (UFCP). Therefore, parametric analyses were applied and a 2x2 repeated measures 2-way ANOVA with one between-factor (PWA vs. NHP) and one within-factor (FCP vs. UFPC) was conducted. There was a main effect with a large effect size of the conversation partner on the number of gestures produced in conversation, *F* (1, 37) = 24.358, *p* < .001 ( = .397), with both PWA and NHP producing more gestures in the conversations with the unfamiliar conversation partner. There was no main effect of group, *F* (1, 37) = 1.124, *p* = .296 ( = .029) and no interaction between conversation partner and participant group, *F* (1, 37) = 0.979, *p* = .329 ( = .026). Both non-significant results revealed small effect sizes. The results are depicted in Figure 4:

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Figure 4. Influence of the conversation partner on gesture production for PWA and NHP, including error bars of +/-1 SD. Significant differences are marked with \*.

Again, both participant groups performed in a similar pattern with significantly more gestures in the conversations with the UFCP than in the conversations with the FCP.

## Post-hoc analyses

*Influence of the conversation topic on the overall number of word-finding difficulties (WFD).* Both participant groups produced significantly more gestures in the conversations with a procedural topic than in the narrative conversations. There was no difference between PWA and NHP. A potential explanation for the increased number of gestures in procedural conversations may be an increased number of WFD, therefore descriptive post-hoc analyses were conducted. Indicators of a WFD were, for example, a pause of at least 500ms, a circumlocution around the target word, onomatopoeia in the place of a target word, a semantic or phonological error, a neologism, a metalinguistic comment, a repetition, or a filling utterance. For more details on the list of indicators of WFD see Kistner et al. (2019). Results showed that PWA experienced almost the same number of WFD in narrative and in procedural conversations. For NHP, a marginal difference was found, with more WFD occurring in procedural conversations (see Table 3).

Table 3. Overall number of WFD, comparing procedural and narrative conversation topics.

|  |  |  |
| --- | --- | --- |
|  |  WFD narrative |  WFD procedural |
| *M* | *SD* | *M* | *SD* |
| PWA | 54.11 | 15.888 | 53.74 | 15.954 |
| NHP | 57.43 | 11.927 | 60.60 | 13.667 |

*Note.* PWA = participant/s with aphasia; NHP = neurologically healthy participant/s; WFD = word-finding difficulty/ies;
 *M* = mean; *SD* = standard deviation.

Therefore, these results suggest that the increased gesture production in procedural conversation topics could not be explained by an increased number of WFD.

*Influence of the conversation topic on the production of different gesture types.* Descriptive analysis of the distribution of the different gesture types over the conversation topic was conducted. Overall, there were not many differences between PWA and NHP the use of different types of gestures. Both participant groups produced more than four times as many iconic gestures in procedural than in narrative conversations. They used more metaphoric, deictic, and air writing & number gestures in narrative conversations than in procedurals, though. In terms of the beat gestures, PWA produced marginally more in narrative than in procedural conversations, while NHP produced a similar number of beat gestures in both conversation topics. The few pantomime gestures produced by PWA and NHP were mainly produced in procedural conversations. For the few emblem gestures, PWA produced almost twice as many in procedural than in narrative conversations, while NHP used a similar amount over both conversation topics. Finally, both participant groups produced more other gestures in procedural than in narrative conversations (see Table 4).

Table 4. The mean number of gesture types produced per conversation topic.

|  |  |  |
| --- | --- | --- |
|  |  PWA |  NHP |
| *M* | *SD* | *M* | *SD* |
| Iconic gestures Narrative Procedural | 114.4719.8494.11 | 53.13115.89342.194 | 132.4020.57111.25 | 38.60215.13134.031 |
| Metaphoric gestures Narrative Procedural | 72.3244.7927.00 | 45.38227.49721.263 | 105.0058.6743.75 | 57.85742.99322.557 |
| Deictic gestures Narrative Procedural | 49.7433.1116.63 | 22.90516.56310.447 | 24.7015.009.35 | 13.41311.0826.627 |
| Beat gestures Narrative Procedural | 44.2124.5319.68 | 34.27118.06018.337 | 94.8047.2446.10 | 55.28726.37631.258 |
| Pantomime gestures Narrative Procedural | 0.680.630.05 | 0.8850.8310.229 | 0.350.330.00 | 0.9880.9660.000 |
| Emblem gestures Narrative Procedural | 0.840.320.53 | 1.2590.8201.073 | 0.450.240.20 | 1.5720.8890.696 |
| Air writing & number gestures Narrative Procedural | 16.9510.796.16 | 28.44815.08715.196 | 0.800.520.25 | 1.7651.4010.716 |
| Other gestures Narrative Procedural | 56.0023.7932.21 | 26.16014.08114.961 | 25.609.6215.85 | 13.4306.4467.856 |

*Note.* PWA = participant/s with aphasia; NHP = neurologically healthy participant/s; *M* = mean; *SD* = standard deviation.

*Influence of the conversation partner on the overall number of WFD.* Both participant groups produced significantly more gestures in the conversations with the UFCP than in those with the FCP. One explanation for the increase in the number of gestures when talking to someone unfamiliar may be an increased number of word-finding difficulties. Descriptive post-hoc analyses revealed marginal differences in the number of WFD arising in each of the different conversation-partner-conditions. This was true for both PWA and NHP, but the effects differed. NHP experienced marginally more WFD in the conversations with the UFCP whereas PWA showed the opposite effect and experienced marginally more WFD when talking to the FCP. Details are given in Table 5 below:

Table 5. Overall number of WFD, comparing conversations with FCP and UFCP.

|  |  |  |
| --- | --- | --- |
|  |  WFD FCP |  WFD UFCP |
| *M* | *SD* | *M* | *SD* |
| PWA | 54.95 | 15.522 | 52.85 | 15.567 |
| NHP | 57.62 | 14.016 | 60.14 | 11.141 |

*Note.* PWA = participant/s with aphasia; NHP = neurologically healthy participant/s; WFD = word-finding difficulty/ies;
 FCP = familiar conversation partner/s; UFCP = unfamiliar conversation partner/s; *M* = mean; *SD* = standard
 deviation.

Both differences were marginal which suggested that it was not the number of WFD having an influence on the increased gesture production in the conversation with the UFCP.

*Relationship between aphasia severity and the overall number of gestures.* Surprisingly, there was no difference between PWA and NHP in either influence of the conversation topic or conversation partner on gesture production. One explanation for this may be that PWA had to fall below a certain threshold in terms of aphasia severity to show an effect. Post-hoc analyses investigated the relationship between aphasia severity (WAB-R AQ) and the total number of gestures produced. Results were not significant (*rs*(17) = .410, *p* = .081), suggesting that aphasia severity did not have an overall influence on gesture production.

# Discussion

This study aimed to examine the influence of conversation parameters such as conversation topic and partner on gesture production in PWA and NHP. All participants were filmed during two conversation topics (narrative and procedural) and with two conversation partners (familiar and unfamiliar). Overall, sixteen minutes of conversation per participant were analysed. To ensure naturally occurring gestures, participants were only informed afterwards of gesture being the focus of the study.

All three research questions raised in the beginning can be answered with ‘yes’. Yes, the topic of the conversation had an influence on the overall number of gestures, the number of semantically rich gestures, and the number of semantically empty gestures. It was the procedural conversations that elicited both significantly more gestures in general and more semantically rich gestures, while narrative conversations elicited more semantically empty gestures. And yes, the conversation partner also had an influence on the production of gestures. Here, the UFCP led to significantly more gestures. Perhaps the most striking finding was that in none of these analyses, was there a difference between the participant groups. In fact, the gesture production of PWA and NHP followed a similar pattern in all analyses.

## Influence of the conversation topic

Both PWA and NHP produced significantly more gestures in procedural conversations. Despite the lack of studies investigating the effect of conversation topic on gesture production, there is evidence that the conversation topic has an effect on the type of language used, such as the core vocabulary used by speakers (Ulatowska et al., 1990; Ulatowska & Bond, 1983; Ulatowska, Doyel, et al., 1983; Ulatowska, Freedman-Stern, et al., 1983; Ulatowska et al., 1981).

One explanation for the increased use of gestures in procedural conversations may be down to the restricted and very precise vocabulary that is needed to describe a process. This may put speakers under pressure and may therefore lead to more WFD in those conversations. As WFD are often accompanied by gesture (e.g. Ahlsén & Schwarz, 2013; Hadar, 1991; Hadar, Burstein, Krauss, & Soroker, 1998; Hadar, Wenkert-Olenik, et al., 1998; Hadar & Yadlin-Gedassy, 1994; Kistner et al., 2019; Lanyon & Rose, 2009), this could explain the inflation of gesture production. However, descriptive post-hoc analyses revealed only marginal differences between the number of WFD experienced in narrative and procedural conversations. Therefore, these results suggest that the increased gesture production in procedural conversation topics does not relate to occurrences of WFD.

Alternatively, the increased number of gestures in procedural conversations may be down to the different type of gesture elicited by narrative and procedural topics. This brings us directly to the second finding: Both participant groups produced significantly more semantically rich than semantically empty gestures in procedural conversations. Furthermore, within that category, it was the iconic gestures that seemed to be driving the effect. Thus, the most likely explanation for the rise in gesture production relates to the specific type of language needed to describe a process. That language is detailed, action-focussed and likely to contain frequent reference to object terms (e.g. Pritchard et al., 2015). This is the very type of language that most typically accompanies iconic and pantomime gestures (cf. van Nispen, van de Sandt-Koenderman, Mol, & Krahmer, 2014). Descriptive post-hoc analyses revealed that both participant groups produced more than four times as many iconic gestures in procedural than in narrative conversations.

Further findings with respect to gesture and conversation topic revealed an increased use of semantically empty gestures in narrative conversation topics, especially beats. Beat gestures are rhythmical gestures during which the “hand moves along with the rhythmical pulsation of speech” and “reveal the speaker’s conception of the narrative discourse as a whole (McNeill, 1992, p. 15). Unlike semantically rich gestures, they do not refer to the semantic content of speech, but carry a prosodic and pragmatic function. Based on their characteristics, beat gestures had been expected to occur more often alongside narrative topics. However, although both groups produced significantly more semantically empty gestures alongside narrative topics, this difference was not led by the beat gestures. Descriptive post-hoc analyses revealed that there was only a marginal difference between beat gestures produced in narrative and procedural conversations for PWA and for NHP (see Table 4). Although not explored statistically, another interesting finding was that narrative conversation topics elicited more metaphoric gestures than procedural topics (see Table 4). This may again reflect differences between narrative and procedural language, in that abstract references, which accompany metaphorical gestures, are probably more likely in narrative accounts.

The language accompanying gesture in this study was not analysed. Thus, conclusions must be tentative. Nevertheless, findings show that there were significant differences between gesture use in narrative and procedural discourse. These differences are likely to reflect the properties of the accompanying language. We propose that the concrete and goal-directed language pf procedural discourse drove the production of semantically rich, and particularly iconic gestures.

## Influence of the conversation partner

Turning towards the influence of the conversation partner, both groups produced significantly more gestures in the conversations with the UFCP than with the FCP. Similar to the findings above, this may be explained by the underlying language produced during the conversations. Previous studies investigating the influence of different conversation partners on language production in neurologically healthy speech (e.g. Bortfeld et al., 2001; Boyle et al., 1994; Clark & Carlson, 1981; Clark & Marshall, 1981; Clark & Schaefer, 1987; Fleming & Darley, 1991; T. Herrmann, 1983; Hornstein, 1985; Kent et al., 1981; Li et al., 1995) came to the conclusion that the familiarity of the conversation partner is linked to the formality of language used in the conversation. In their language analysis, Boyle et al. (1994) and T. Herrmann (1983), for example, found that abbreviated, informal, and implicit language was used in the conversations with a FCP as speakers could rely on shared knowledge and experiences. In the conversations with a UFCP, however, there was no previously established common ground between the speakers, which led to more concrete, detailed, formal, and explicit language. The formality of language is characterised by lexical items that are relatively independent from the context (e.g. full nouns instead of pronouns) and by redundancy (Labov, 1972). Extrapolating from these findings, it can be hypothesised that the participants in the current study may have used more formal and detailed language when talking to a UFCP and that this in turn led to the production of more gestures.

There are two potential explanations for why formal language may be associated with the production of more gestures. One is related to WFD. Similar to restricted vocabulary required by a specific conversation topic (see above), the more concrete, direct, formal, and explicit language employed with a UFCP may put pressure on the speaker and so lead to more WFD. As WFD are associated with gesture production (e.g. Ahlsén & Schwarz, 2013; Hadar, 1991; Hadar, Burstein, et al., 1998; Hadar, Wenkert-Olenik, et al., 1998; Hadar & Yadlin-Gedassy, 1994; Kistner et al., 2019; Lanyon & Rose, 2009) this might explain the increased number of gestures in the conversations with the UFCP. However, descriptive post-hoc analyses did not support this argument for either participant group. Both PWA and NHP produced a similar number of WFD in the both conversation settings. In fact, PWA experienced slightly more WFD in the conversations with the FCP (*M* = 54.95, *SD* = 15.522) than with the UFCP (*M* = 52.85, *SD* = 15.567) while NHP experienced marginally more WFD in the conversations with the UFCP (*M* = 60.14, *SD* = 11.141) than with the FCP (*M* = 57.62, *SD* = 14.016). Therefore, this effect of increased gesture production in the conversations with the UFCP cannot be explained by WFD.

A second explanation would be that increased gesture production with UFPC is influenced by the pragmatic demands of a conversation with someone unfamiliar. Holler and Beattie (2003), for example, investigated the pragmatic role of gestures in ambiguous situations. They asked nine participants to retell picture stories. The stories included homonyms (i.e. ambiguous words, such as *glasses* or *toast*) and control words. The study found that participants gestured more in situations with ambiguous words, probably to disambiguate them in order for clarification. It seems that increased gesture production is stimulated when language has to be explicit or meaning has to be disambiguated for the sake of the listener. Such conditions may apply more often when conversations are conducted with unfamiliar conversation partners, mainly because of the lack of shared reference or knowledge. The use of gestures helps to transmit more explicit information. A final point might be made here. The fact that the needs of an UFCP was reflected in the number of gestures produced suggests that one role of gesture production is communicative; that is, we can conclude that gestures were employed, at least in part, to supplement the information conveyed to the listener. This is similar to the conclusion reached by van Nispen et al. (2017) who highlight the importance of gesture in aphasic conversation.

## Similar performance in PWA and NHP

There was another striking finding which was the similar performance of PWA and NHP. None of the previously discussed research questions showed a significant group effect. One explanation for this similar performance may be the characteristics of the participants. A difference in gesture production between PWA and NHP may only arise when aphasia is severe. However, post-hoc analyses did not reveal a relationship between aphasia severity and gesture production overall. It seems that either severity did not have an influence on gesture production or the sample did not include enough participants with severe aphasia (n = 3) for this to have an effect. A sample with a larger contingent of severely impaired participants might have shown a group effect. Further research is needed to investigate the influence this, and other participant characteristics, on gesture production.

Another explanation for similar patterns across the groups may be that PWA retain the ability to indicate macrostructural discourse patterns in both speech and gesture despite their linguistic difficulties. There is evidence, for example, that PWA produce key elements of narrative structure in speech (e.g. Ulatowska, Doyel, et al., 1983; Ulatowska et al., 1981) and the obligatory elements in procedural discourse (e.g. Ulatowska, Freedman-Stern, et al., 1983; Ulatowska et al., 1981). The finding that their gesture patterns resemble those of NHP may reflect this retained ability at the macrostructural level.

If PWA had strategically adapted their gesture production to overcome linguistic difficulty one might have expected this to lead to more gestures by PWA than NHP. An alternative hypothesis is that gesture adapts to linguistic difficulty not in terms of quantity but in terms of function. For example, in the context of reduced language, the semantic and pragmatic function of the gesture increases, giving the gesture more responsibility for conveying meaning. Our companion paper (Kistner et al., 2019) indeed suggests that the gestures produced by PWA played a different role from those produced by NHP. For example, over 90% of gestures produced by NHP accompanied resolved WFD or fluent speech. Gestures similarly accompanied resolved WFD for PWA, but, for this group, over a quarter of the gestures accompanied word-finding failures. It can be hypothesised, therefore, that more of the communicative burden for PWA was carried by gestures. In their study, Pritchard et al. (2015) investigated gesture production and language structure in procedural discourses by PWA and NHP. Results revealed that while PWA used syntactically simpler language and fewer spatial words than NHP, the two groups did not differ in terms of number and form of gestures. This suggests that PWA put more of the communicative burden into their gestures. Unfortunately, as language analysis was not conducted in the current study, this change in the relative burden carried by speech and gesture cannot be further investigated, but remains a possibility to be explored in future research.

## Clinical implications

The findings of the current study have implications for clinical practice. Most importantly, results revealed that PWA and NHP produced a high number of gestures during conversations. This shows that gesturing is a natural process and plays a vital part in human communication. Because of the importance of gesture production, it is questionable, whether gesturing should be inhibited during rehabilitation attempts, as advocated in some studies (e.g. Breier, Maher, Novak, & Papanicolaou, 2006; Maher et al., 2006; Martin et al., 2014). If gesturing was restricted, PWA may be forced to use an unnatural communicative behaviour and may be deprived of a potential facilitative function of gestures during WFD (see Kistner et al., 2019).

The influence of conversation parameters, such as conversation topic and partner on gesture production can be taken into consideration when assessing gesture use in aphasia. To get a full picture of a participant’s ability to use gesture in spontaneous speech, both the topic of the conversation and the familiarity of the conversation partner play an important role. Nevertheless, speech and language therapists usually have limited time to assess language skills. Therefore, taking the results of the current study into consideration, the least time-consuming way to assess gesture production is to ask PWA to talk about a procedural topic, such as how to make scrambled eggs or how to wrap a parcel for a present, ideally combined with an unfamiliar conversation partner. In both situations, participants in the current study produced most gestures overall. Additionally, procedural conversation topics elicited more semantically rich gestures. These gestures are presumably very important for PWA to facilitate, supplement and/or replace speech.

## Limitations

Before concluding, a number of limitations need to be acknowledged in this study. Adaptations to the design could further illuminate the influence of the conversation partner on gesture production. It is possible that aspects of their behaviour (other than just being familiar or unfamiliar) had an influence on gesture production. For example, there may have been variations in the amount of gestures that they used or in the degree to which they overtly responded to gesture. These aspects were not investigated in the current study. Observations beyond gesture suggest that there was considerable variation in the behaviour of the conversation partners. For example, while some conversation partners remained passive and were mainly listening to what the participant was saying, others engaged more with the conversation and sometimes even helped to structure the narrative, especially in procedural conversation topics.

Another point is that the similar performance of PWA and NHP has to be explored further. Did participants perform similar because of the participant effects of PWA? Or did PWA not manage to strategically adapt their gesture production? In terms of the communicative value of gestures, language analysis may provide an insight into the communicative burden carried by either language or gesture or both.

# Conclusions

This was the first study to explore the influence of conversational parameters on the production of co-speech gestures. Results showed that both conversation topic and partner influenced the overall number of gestures produced. The findings underscore the relationship between speech and gesture, and are in line with models that allow for the influence of discourse context on gesture production (e.g. de Ruiter, 2000; Krauss et al., 2000). The conveyance of meaning via gesture also seemed critical, since different patterns emerged for semantically rich and empty gestures. There is debate about the role of co-speech gesture, and whether it is produced for the sake of the speaker or listener (e.g. Hadar, Wenkert-Olenik, et al., 1998; McNeill et al., 1994). The influence of the partner here suggests that at least a component of gesture production is listener focussed. Our findings indicate that gesture is intrinsic to human conversation, regardless of whether that conversation is taking place in the context of aphasia or neurologically healthy speech.

# Disclosure of interest

The authors report no conflict of interest.

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1. The potential FCP of 8A did not give consent to data collection. Due to limited availability of 8A, there was no time to find an alternative. Therefore, the data were not included into the analyses investigating the difference between the conversation partners. [↑](#footnote-ref-1)
2. Ten participants served as UFCP for two or three participants. In addition, two participants served as both FCP and UFCP for different participants. [↑](#footnote-ref-2)