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The Relationship of Aphasia Type and Gesture Production in People With Aphasia

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Purpose: For many individuals with aphasia, gestures form a vital component of message transfer and are the target of speech-language pathology intervention. What remains unclear are the participant variables that predict successful outcomes from gesture treatments. The authors examined the gesture production of a large number of individuals with aphasia—in a consistent discourse sampling condition and with a detailed gesture coding system—to determine patterns of gesture production associated with specific types of aphasia.

Method: The authors analyzed story retell samples from AphasiaBank (TalkBank, n.d.), gathered from 98 individuals with aphasia resulting from stroke and 64 typical controls. Twelve gesture types were coded. Descriptive statistics were used to describe the patterns of gesture production. Possible significant differences in production patterns according to aphasia type were examined using a series of chi-square, Fisher exact, and logistic regression statistics.

Results: A significantly higher proportion of individuals with aphasia gestured as compared to typical controls, and for many individuals with aphasia, this gesture was iconic and was capable of communicative load. Aphasia type impacted significantly on gesture type in specific identified patterns, detailed here.

Conclusion: These type-specific patterns suggest the opportunity for gestures as targets of aphasia therapy.

Key Words: gesture, aphasia, speech-language pathology, discourse, screening

When typical speakers talk, they make gestures with their arms and hands that are closely synchronized with their speech (Kendon, 1980; McNeill, 1992). Interestingly, people with aphasia (PWA) continue to produce these arm and hand gestures after their brain injuries, and for many PWA, gestures form a vital component of co-constructed interaction or independent message transfer (Goodwin, 2000; Lanyon & Rose, 2009; Rose & Douglas, 2003). Such gesture production may be the target of speech-language pathology interventions for both compensation and restorative treatment goals (Rose, 2006).

Models of speech–gesture production have been proposed to explain how gestures are produced and their possible relationship to speech, language, and communication. De Ruiter's (2000) Sketch model[1] of gesture and speech processing is based on Levelt's (1989) speech production model. The Sketch model offers insights into the possible consequences of linguistic impairment on gesture production (see Figure 1). According to the Sketch model, gestures originate from the conceptualizer, and a gestural *sketch* is formed with reference to spatiotemporal/imagistic information in working memory. This spatiotemporal information will later be transformed into a motor/gesture program.

The Sketch model suggests that different processes and knowledge stores are used depending on the type of gestures produced. *Iconic* gesture production relies on the extraction of information from imagery processes; this must be done online "in a novel way" each time an iconic gesture is produced. By contrast, *emblem* production (e.g., an *OK* signal) requires

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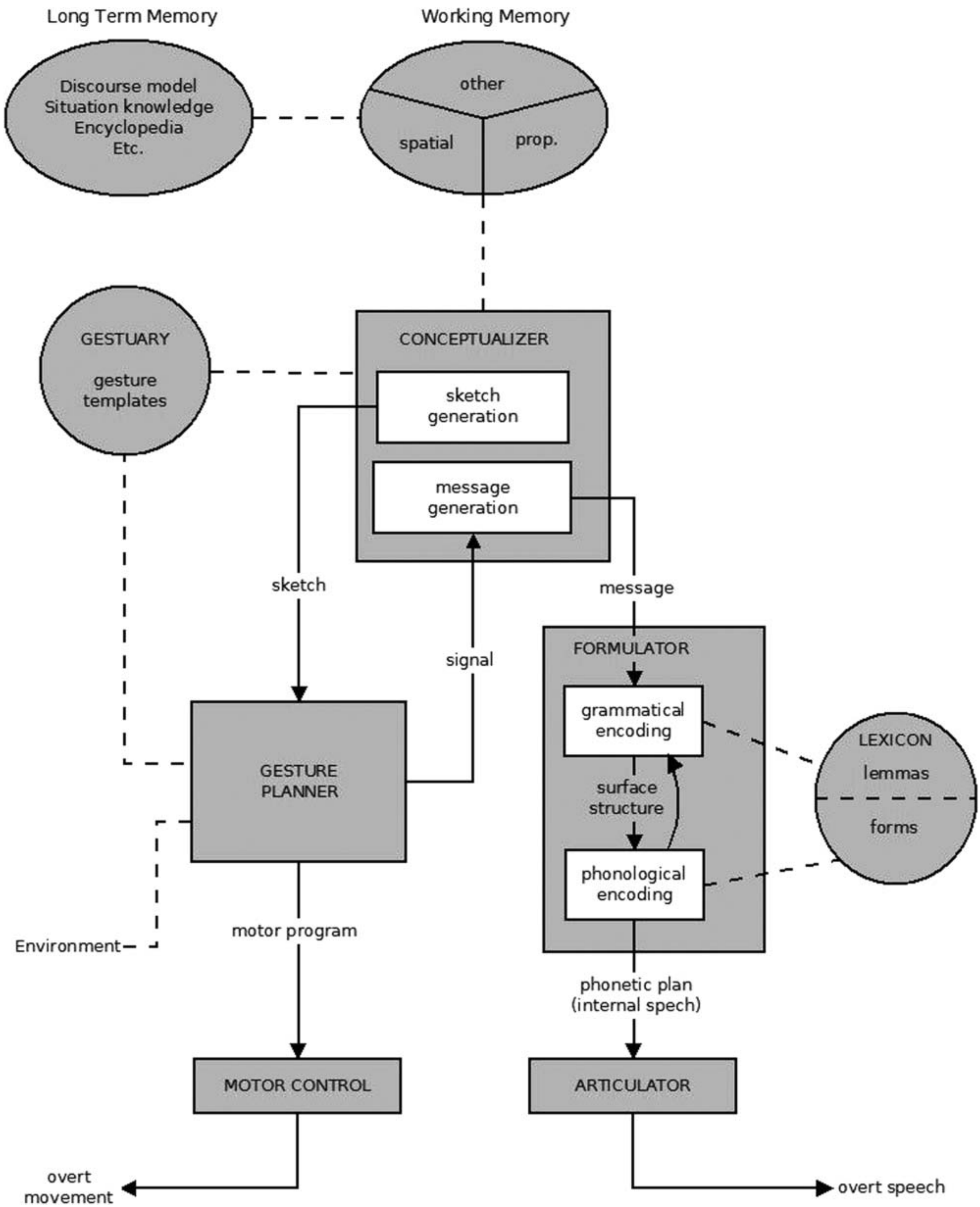
[1]Several models have been proposed to explain how gestures are produced and the relationship between speech, language, and communication (Rose, 2006). However, we focused on the Sketch model (de Ruiter, 2000) in this study because it seems a most valuable tool for speech-language pathologists who are considering gesture as a compensatory or restorative treatment modality for particular clients with aphasia. The Sketch model emphasizes the need to carefully consider all of the types of gesture response that a client may have (e.g., iconic gestures, emblems, pantomimes, deictic gestures), as these potentially could be differentially impaired or spared.

Figure 1. The Sketch model of speech and gesture interaction. Reprinted from "The Production of Gesture and Speech" (p. 298), by J. de Ruiter, 2000, in *Language and Gesture* (pp. 284–311), D. McNeill (Ed.). Cambridge, United Kingdom: Cambridge University Press. Copyright 2000 by Cambridge University Press. Reprinted with permission.



access to a knowledge store of lexicalized/conventional shapes called the *gestuary*. In order to produce *pantomimes,* procedural motoric knowledge about the relative shapes and movements of real-world objects must be accessed in addition to imagery processes. For *pointing* gestures, relevant hand shapes are accessed in the gestuary and are modified in terms of the direction and location of the referent for the resulting pointing movement.

De Ruiter (2000) argued that the primary function of gesture production is communicative, as many other authors have stated (Beattie & Shovelton, 1999; McNeill, 2000b). However, disagreement exists regarding the function of co-speech gestures in typical speakers, with some authors asserting a lexical facilitation role (Krauss & Hadar, 1999; Lanyon & Rose, 2009). De Ruiter (2006) conceded that the Sketch model can be consistent with a possible lexical facilitation role for gesture, and this is a particularly interesting possibility in speakers with language impairments, such as PWA.

Types of Gestures Used by Typical Speakers

Psycholinguistic research has advanced our understanding of the nature of various gestures that are produced during human communication (McNeill, 2000b). A continuum of gesture was proposed by Kendon (1980) and refined by McNeill (1992, 2000b). *Kendon's continuum,* as it is called, delineates gesture types and defines them along a continuum in terms of (a) whether there is an obligatory presence of speech for the gesture to be meaningful, (b) whether the gesture is socially regulated or idiosyncratic, (c) whether the gesture has language-like properties, and (d) its semiotic characteristics (see Figure 2). It is important to consider this classification of gestures when evaluating the types of gestures produced by PWA as well as the meaning they carry (their iconicity) when they substitute for or embellish impaired language production in PWA. Other gesture types have been defined by various gesture researchers and can be described in terms of their location on Kendon's continuum; we offer this information later in this article.

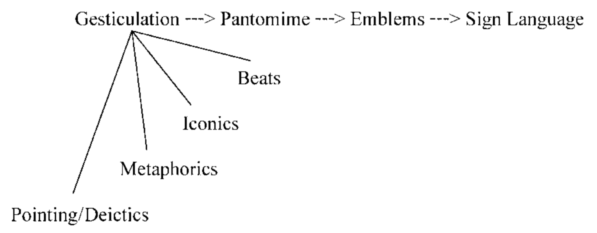
Gesture Production Patterns of PWA

Historically, in the field of speech-language pathology, authors have argued that aphasia is due to a "central symbolic deficit" and that these symbolic deficits would also be realized in poor gesture comprehension and production (Duffy & Duffy, 1981; Pickett, 1974). Further, it has been suggested that PWA and limb apraxia would have poor communicative gesture (Wang & Goodglass, 1992). More recent work has clarified the limitations of these early arguments (Lanyon & Rose, 2009; Le May, David, & Thomas, 1988; Rose & Douglas, 2003). In an extensive review of gesture production in PWA, Rose (2006) highlighted how naturalistic discourse-based methods of measurement are able to provide a more valid description of the spontaneous gestures and emblem/pantomime production abilities of PWA, as compared to the once dominant *gesture-to-command* and limb apraxia assessment methods. Spontaneous gestures (gesticulations on Kendon's continuum) are characterized by "an obligatory accompaniment of speech, a lack of language-defining properties, idiosyncratic form–meaning pairings, and a precise synchronization of meaning presentations in gesture with co-expressive speech segments" (McNeill, 2000a, pp. 22–23). Thus, they are differentiated from other gestures, such as emblems, that have a form–meaning pairing dictated by social convention and that convey meaning without accompanying speech.

Taking these discourse-based assessments into account, there is some preliminary evidence that the type of aphasia a person has affects his or her gesture production, but little has been published about the impact of aphasia severity on gesture production. Individuals with Broca's aphasia, for example, have been shown to be slow to initiate movement and to have long pauses between movements (Duffy, Duffy, & Mercaitis, 1984), but they have a high proportion of representative gestures including iconic gestures, pantomimes, and emblems (Behrmann & Penn, 1984; Lanyon & Rose, 2009; Lott, 1999) as compared to individuals with Wernicke's aphasia (Cicone, Wapner, Foldi, Zurif, & Gardner, 1979; Pedelty, 1987). Further, in preliminary studies, individuals with Broca's aphasia were found to produce significantly greater amounts of pantomime than were individuals with any other aphasia type (Lott, 1999). However, when a ratio is formed of the number of gestures produced during 100 spoken words, individuals with Broca's aphasia were found to use more gesture than typical control participants (Herrmann, Reichle, & Lucius-Hoene, 1988; Le May et al., 1988; Lott, 1999). Participants with Wernicke's aphasia have also been found to use more gestures than control participants, especially *beat* gestures, when measured in a ratio of gestures per 100 words, demonstrating continuous movement with gestures that tend to be vague and difficult to interpret without speech (Le May et al., 1988; Lott, 1999). Individuals with anomic aphasia were found to produce four times more iconic gestures per spoken word than typical control speakers (Carlomagno, Pandolfi, Martini, Di Iasi, & Cristilli, 2005).

These preliminary studies examining the gesture production of PWA have been limited by their small number of participants (< 5 per aphasia type), small range of aphasia types examined, extremely short and uncontrolled samples of discourse analyzed, restricted and underspecified range of

Figure 2. Kendon's continuum. Reprinted from K. Sekine, M. L. Rose, A. M. Foster, M. C. Attard, & L. E. Lanyon (2013). Gesture production patterns in aphasic discourse: In-depth description and preliminary predictions. *Aphasiology, 27*(9), 1031–1049. Taylor & Francis Ltd, www.tandf.co.uk/journals. Reprinted by permission of the publisher.



gestures coded, and lack of reporting of important participant variables that may influence gesture production. What remains unclear are the gesture abilities of PWA and the participant variables that predict successful outcomes from gesture treatments. Such information is necessary to increase the effectiveness of treatments for PWA and reduce unnecessary health care spending. Details about gesture production patterns in PWA are a necessary preliminary step to this goal, particularly where naturally occurring behaviors (such as various types of gestures) are to be shaped in communication treatments.

Study Aim and Hypotheses

To overcome the previously reviewed limitations, in this initial screening-level study, we aimed to examine the gesture production of a large number of individuals across a variety of aphasia types, in a consistent discourse sampling condition and with a detailed gesture coding system, in order to determine broad patterns of gesture production that are associated with specific types of aphasia. This screening-level information may be useful to direct more detailed assessments of gesture production in PWA and to inform clinical reasoning about who benefits from aphasia treatment employing gesture.

On the basis of the preliminary evidence in the literature to date, we hypothesized that (a) a significantly higher proportion of PWA would produce gesture during story retell than typical controls and (b) a significantly higher proportion of individuals with Broca's aphasia would produce pantomime as compared to all other aphasia groups and typical controls. There were insufficient data to formulate hypotheses for the impacts of aphasia type on other gesture types. Thus, the remainder of the analyses were exploratory rather than hypothesis driven.

Method

Participants

To analyze gesture production in PWA, we used data from AphasiaBank (TalkBank, n.d.), which is a multimedia database of discourse samples that have been gathered from both PWA and typical controls (MacWhinney, Fromm, Forbes, & Holland, 2011). The database contains video samples of discourse obtained from aphasic and healthy control speakers in four genres (i.e., personal narrative, picture description, storytelling, procedural discourse). The samples were obtained using a standardized protocol for collection. In addition, the results of the Western Aphasia Battery—Revised Aphasia Quotient (WAB–R AQ; Kertesz, 2007), short-form version of the Boston Naming Test, Second Edition (BNT–2; Kaplan, Goodglass, & Weintraub, 2001), Verb Naming Test (Cho-Reyes & Thompson, 2012), and Aphasia Bank Repetition Test (TalkBank, n.d.) are included for almost all of the PWA. Extensive demographic data for the participants are also reported, including gender, date of birth, race, handedness, education, occupation, aphasia etiology and duration, aphasia type, site of lesion, depression, and history of communication disorders.

The database available as of September 2010 consisted of 102 PWA and 99 controls. For purposes of this study, we refer to them as the group with aphasia and the control group. Four PWA and 35 controls were excluded from further analysis due to missing story retell samples or poor camera views of their arm and hands preventing their gestures from being analyzed.

Thus, the group with aphasia included 98 participants (34 females and 64 males), with a mean age of 64 years (range = 30–91 years). Their data were collected from nine different locations in the United States. The control group included 64 participants (36 females and 28 males), with a mean age of 59 years (range = 23–88 years). Their data were collected from three different locations in the United States. All of the participants were native English speakers or had English as their primary language (six bilinguals acquired a second language after age 6 years, and seven were early bilinguals), resided in the United States, had experienced a single unilateral left-hemisphere cerebrovascular accident on neurological and ancillary examinations (EEG, CT scan), and were at least 6 months post onset. Language profiles and aphasia severity ratings for participants with aphasia were completed according to the clinical criteria outlined by the WAB–R. Individual participant details are summarized in the online supplemental materials.

In the group with aphasia, 24 participants presented with Broca's aphasia, eight with Wernicke's aphasia, 41 with anomic aphasia, 15 with conduction aphasia, six with transcortical motor aphasia, three with global aphasia, and one with transcortical sensory aphasia. Nine individuals with a WAB–R AQ above the cutoff for a diagnosis of aphasia (score of 93.8) and one individual rated as having "unknown" aphasia were included in this study due to their obvious word-finding difficulties in discourse and to the AphasiaBank expert clinician ratings of anomic aphasia,[2] as listed in the database (details are summarized in the online supplemental materials).

Discourse Samples

To examine the gestures that the participants spontaneously produced in a standardized narrative, we extracted a videotaped story retelling task from the databank for each participant and analyzed each one. In the task, the speech-language pathologist (SLP) asked the participant whether he or she had ever heard the story of Cinderella. The participant was then instructed to look at a picture book depicting the

[2]A preliminary analysis was conducted to see if there were differences in the proportion of participants who produced a certain type of gesture with the WAB–R AQ diagnosis of anomic aphasia (n = 31) and the expert clinician diagnosis of anomia (n = 8). A chi-square test was conducted for each gestural type. Because there were no significant differences in the proportion of participants who produced different gesture types in these two subgroups, we collapsed them into one anomic group for the remainder of the study.

Cinderella story (Disney, 2002) with the written text blanked out. The book was then put away, and the participant was asked to retell the story to the SLP. If the participant gave a response with fewer than three utterances or seemed to falter, after ~10 s, the SLP used prompts such as, "What happened next?" or "Go on." This process continued until the participant concluded the story or it was clear that he or she could not continue. There was no time limit required to remember and retell the story.

Data Analysis

To investigate the relationship between aphasia type and the types of gestures produced, we coded nine gesture types based on classifications that have been used in previous studies (Cicone et al., 1979; Gullberg, 2006; McNeill, 1992). These types of gestures have been widely used in both psycholinguistic gesture studies and nonverbal communication studies (see, e.g., Efron, 1972; Ekman & Friesen, 1969; Gullberg, 2006; Kendon, 1980; Kita & Davies, 2009; McNeill, 1992) as well as in studies investigating gesture production in PWA (see, e.g., Cicone et al., 1979; Lanyon & Rose, 2009; Lott, 1999; Pedelty, 1987).

The classification of each gesture type in this study was mutually exclusive. The various gesture types are summarized in Table 1 (see McNeill, 1992, for greater detail about the gesture types). In addition, three gesture types were further defined by us during the current project to account for gestures that did not fit with previously defined codes: pointing-to-self, pantomime, and time gestures. Overall, 10 of the 12 gesture types used in this study can be characterized as gesticulations, with the addition of the emblem and pantomime types.

For the current study, we modified the definition of pantomime from that used in previous studies. Previously, pantomime was generally defined as hand movements that demonstrate objects or actions in complex and sequential movements. The definition of pantomime used in linguistic and psychology studies to date states that pantomime is produced without speech (see, e.g., Efron, 1972; Kendon, 1980; McNeill, 1992), but studies in speech-language pathology and aphasia have sometimes allowed speech to be

Table 1. Types of gestures.

Gesture type	Definition	Reference
Referential	Is used to assign the entity of referents, such as objects, places, or characters in the story, into the space in front of a speaker where any concrete object is absent. The hand shape of the gesture usually takes the form of a pointing gesture or of holding some entity.	Gullberg (2006)
Concrete deictic	Indicates a concrete referent in the physical environment, such as a picture book or an item of actual clothing.	McNeill (1992)
Pointing to self	The speaker points to his or her own body (mostly the chest) in order to refer to him- or herself.	The present study
Iconic observer viewpoint (OVPT)[a]	Depicts a concrete action, event, or object as though the speaker is observing it from afar. For example, to depict someone running, the speaker traces her index finger in the frontal space from left to right as if she is seeing the scene as an observer.	McNeill (1992)
Iconic character viewpoint (CVPT)[a]	Uses the speaker's own body in depicting a concrete action, event, or object, as though he is the character/object itself. For example, to depict someone running, he swings his arms back and forth, as if he is running.	McNeill (1992)
Pantomime	Consists of two or more CVPT gestures, which occur continuously within the same gesture unit. No matter how many CVPT gestures occur continuously, they are counted as one pantomime. A *gesture unit* is defined as the period of time between successive rests of the limbs (McNeill, 1992).	The present study
Metaphoric	Presents an image of an abstract concept, such as knowledge or justice, language itself, the genre of the narrative, and so on. It often has a cup-shaped hand shape.	McNeill (1992)
Emblem	Form and meaning are established by the conventions of specific communities and can usually be understood without speech, such as thumb and pointer finger making a circle shape for *OK*.	Kendon (1980)
Time	Indicates some space to denote a time, such as past (back of the body) or future (front of the body).	The present study
Beat	Movements that do not present a discernible meaning and are recognized by their prototypical repetitive movement characteristics timed with speech production.	McNeill (1992)
Letter	Movements associated with writing letters in the air or on the desk or on one's thigh with an empty hand or fingers.	Cicone et al. (1979)
Number	Uses the speaker's fingers to display numbers.	Cicone et al. (1979)

[a]*Iconic gestures* are defined as gestures that depict some aspect of a concrete event or object by creating a homology to aspects of the event/object. They display, in their form and manner of execution, aspects of the same scene that speech also attempts to present.

present during pantomime (see, e.g., Cicone et al., 1979; Goodglass & Kaplan, 1963; Lanyon & Rose, 2009). This is mainly because PWA have frequent periods of word retrieval difficulty, during which they produce paraphasia and often engage in verbal speech repair sequences. During these periods of speech error and repair attempts, PWA produce pantomime. *Pantomime* involves performing some sort of iconic action and, therefore, includes elements similar to the category of iconic gesture, but importantly, pantomimes are more complex and, unlike other types of gestures, can be joined together to create sentence-like expressions (McNeill, 2000b). Previous studies have defined pantomime very broadly, offering little in terms of an operational definition. In this study, complex and sequential pantomime was coded with and without accompanying speech and was contrasted with iconic (nonsequential) gesture, as this difference was particularly useful in coding aphasic discourse.

The first author viewed all 201 AphasiaBank story retell samples using the gesture analysis program titled the EUDICO Linguistic Annotator (ELAN; The Language Archive, n.d.) and recorded the gesture types that were produced in each sample. He then reviewed all of the samples a second time to check the initial codes. The *total speaking time*—defined as the duration between when a speaker starts and ends speaking—for each sample was measured by ELAN. This study simply aimed to explore the broad relationship between aphasic type/severity and the types of gestures produced. Therefore, we examined whether participants produced each type of gesture at least once in their narratives.

Reliability

To ensure the reliability of the gesture coding, after all of the data were twice coded by the first author, a trained and independent second coder re-analyzed the data from 25 randomly selected participants from both the aphasia and the control groups in terms of whether a gesture was present or not. There was 100% agreement between the first and second coder for both participant groups. Next, the second coder recoded the retell samples of 23 PWA (25% of the total PWA who gestured) and 15 control participants (32% of the total control participants who gestured) in terms of whether they contained each type of gesture or not. The agreement between the coders was calculated in terms of how many gesture types were agreed on out of 12 gesture types for each participant. The percentage of agreement between the coders was then calculated for each of the two participant groups. The rate of agreement for the group with aphasia was 86%, and the rate for the control group was 94%. Any coding disagreements were resolved through discussion.

Results

Overall Production of a Gesture

The number of participants who produced a gesture at least once in their narratives, regardless of the type of gesture produced, was analyzed. The analysis revealed that 92 of 98 PWA (94%) and 47 of 64 controls (73%) produced a gesture at least once, and this difference was significant, $\chi^2(1, N = 162) = 13.28$, $p < .001$. The participants who did not produce any gestures were excluded from the remaining analyses. Following this exclusion, the number of participants in each aphasic subgroup was 23 Broca's, eight Wernicke's, 39 anomic, 15 conduction, six transcortical motor, and one global. This left 47 participants in the control group and 92 participants in the group with aphasia. The control group included 27 females and 20 males, with a mean age of 57 years (range = 23–85 years). The aphasia group included 33 females and 59 males, with a mean age of 63 years (range = 30–91 years). In the six PWA who did not produce any gestures at all, three had Broca's aphasia and three had anomic aphasia.

Types of Gestures Produced

We compared the types of gestures that were produced by those participants who produced gestures. As shown in Table 2, the group with aphasia produced the full range of gesture types, whereas the control group did not produce any concrete deictic, pointing-to-self, pantomime, or letter gestures. Further, the proportions of participants who produced concrete deictic (Fisher's exact test, $p < .001$), pointing-to-self ($p = .033$), pantomime ($p = .021$), letter ($p = .033$), and number ($p = .014$) gestures were significantly higher in the group with aphasia than in the control group.

Relationship Between Aphasia Type and Gesture Production

We next examined whether the participants in the aphasia subgroups produced each type of gesture at least once. These results are summarized in Table 3. All of the aphasia subgroups produced concrete deictic gestures and emblems. To investigate the presence of significant associations between the type of gesture produced and each aphasia type, we conducted a chi-square test. Participants with transcortical motor aphasia ($n = 6$) and global aphasia ($n = 1$) were excluded from this analysis due to their small numbers. Significant differences were found for concrete deictic gestures, $\chi^2(3, N = 85) = 9.88$, $p = .020$, and iconic

Table 2. The proportion of participants who produced each type of gesture at least once.

Group	Referential	Concrete deictic	Pointing to self	Iconic OVPT	Iconic CVPT	Pantomime	Metaphoric	Emblem	Time	Beat	Letter	Number
Aphasia (*N* = 92)	.74	.48	.09	.90	.36	.10	.60	.27	.11	.62	.09	.34
Control (*N* = 47)	.74	.00	.00	.96	.26	.00	.55	.19	.02	.66	.00	.15

Table 3. The number and percentage of people who produced each type of gesture for the people with different types of aphasia and the control group.

Group	Referential		Concrete deictic		Pointing to self		Iconic OVPT		Iconic CVPT		Pantomime		Metaphoric		Emblem		Time		Beat		Letter		Number	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Aphasia																								
Broca's (n = 23)	15	65	16	70	2	9	19	83	12	52	5	22	12	52	8	35	4	17	13	57	1	4	11	48
Wernicke's (n = 8)	7	88	5	63	0	0	8	100	2	25	1	13	7	88	2	25	1	13	5	63	1	13	2	25
Anomic (n = 39)	31	80	12	31	3	8	35	90	8	21	1	3	22	56	7	18	3	8	27	69	4	10	13	33
Conduction (n = 15)	11	73	6	40	2	13	15	100	10	67	2	13	10	67	6	40	2	13	9	60	2	13	5	33
TransMotor (n = 6)	4	67	4	67	1	17	6	100	1	17	0	0	4	67	1	17	0	0	3	50	0	0	0	0
Global (n = 1)	0	0	1	100	0	0	0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0
Control (n = 47)	35	74	0	0	0	0	45	96	12	26	0	0	26	55	9	19	1	2	31	66	0	0	7	15

Note. TransMotor = transcortical motor aphasia.

character viewpoint (CVPT) gestures, $\chi^2(3, N = 85) = 12.87$, $p = .005$.

To determine where the significant difference among aphasia types lay, we performed a residual analysis (see details in Haberman, 1973). This analysis indicated that the proportion of participants with Broca's aphasia who produced concrete deictic gestures was significantly higher than the proportion of participants with anomic aphasia, and that the proportion of participants with Broca's aphasia and those with conduction aphasia who produced iconic CVPT gestures was significantly higher than the proportion of participants with anomic aphasia.

Based on the results in Table 3, it is clear that PWA show specific gesture production patterns according to their aphasia type. More than half of the participants with Broca's aphasia produced referential, concrete deictic, iconic observer viewpoint (OVPT) and CVPT, beat, and number gestures, and this group had the highest number of pantomime users (22%) and high users of emblems (35%). Overall, the gestural expression of the participants with Broca's aphasia was characterized by a depiction of concrete images and a rich demonstration of the characters' actions in the story. Similarly, all of the participants with conduction aphasia produced iconic OVPT gestures (100%), most of them produced iconic CVPT gestures (67%), and there was some use of pantomime (13%) and emblems (40%). Their profile of gesture production was most similar to that of the participants with Broca's aphasia.

All of the participants with Wernicke's aphasia used iconic OVPT gestures (100%) and had a high use of metaphorics (88%) and referential gestures (88%) but no use of pointing-to-self gestures (0%). These participants' gestures depict the story abstractly. In contrast, the participants with anomic aphasia used all of the gesture types examined in this study. The proportion of participants with anomic aphasia who used concrete deictic (31%) and iconic CVPT gestures (21%) was lower than that of participants with other aphasia types. This gesture pattern most closely resembled that of the control group. Similarly, the pattern of gesture production of the participants with transcortical motor aphasia also resembled the control group, except for the high number of individuals using concrete deictic (67%) and pointing-to-self gestures (17%).

Relationship Between Gesture Production, Speech Fluency, and Word Retrieval in PWA

To examine the relationship between gesture production and speech fluency, we divided the PWA who produced a gesture at least once into two groups based on their WAB–R Spontaneous Speech Fluency score. As shown in Table 4, 40 of the PWA were categorized in a low fluency group (score range = 0–5), and 48 were categorized in a high fluency group (score range = 6–10). A Fisher's exact test showed that the proportion of participants who used concrete deictic gestures and pantomime at least once in their narratives was greater in the low fluency group than the high fluency group (Fisher's exact test, $p = .048$ and $p = .007$, respectively). This finding was further verified through an examination of the relationship between gesture production and degree of word retrieval impairment.

To examine the relationship between gesture production and degree of word retrieval impairment, we divided the PWA who produced a gesture at least once into two groups based on their BNT–2 short-form score. As shown in Table 5, 42 of the PWA were categorized in a low score group (score range = 0–7), and 49 were categorized in a high score group (score range = 8–15). A Fisher's exact test showed that the proportion of participants who used concrete deictic, iconic OVPT, and pantomime gesture at least once in their narratives was greater in the low score group than in the high score group (Fisher's exact test, $p = .001$, $p = .048$, and $p = .001$, respectively), and that the proportion of participants who used beat gestures at least once in their narratives was greater in the high score group (Fisher's exact test, $p = .01$).

Discussion

This study was novel in its aim to examine the broad patterns of gesture production in a large corpus of standardized discourse with respect to aphasia type and to include a wide range of gesture types across Kendon's continuum. Specific gesture production patterns were found.

Contrary to older reports in the literature that PWA have concomitant gesture production impairments (when measured on limb apraxia tests; see, e.g., Duffy & Duffy, 1981; Kadish, 1978; Pickett, 1974), this study showed that consistent with the first hypothesis, as a group, more PWA gestured as compared to typical controls, and that for many PWA, the gestures produced were iconic. In contrast to PWA, the controls did not use any concrete deictic, pointing-to-self, letter, or pantomime gestures, and significantly fewer used number gestures. These gestures have a tight semantic relationship with the referent and high iconicity, possibly allowing for communication when verbal output fails. Pantomime in particular is capable of directly substituting for verbal output.

Importantly, aphasia type appeared to have an impact on the types of gesture the PWA produced. Whereas concrete deictic gestures and emblems were used by individuals with all types of aphasia, significantly higher proportions of individuals with Broca's and Wernicke's aphasia produced concrete deictic gestures; significantly higher proportions of individuals with Broca's and conduction aphasia produced iconic CVPT gestures; and, consistent with the second hypothesis, a significantly higher proportion of individuals with Broca's aphasia produced pantomime and number gestures.

Considering the Sketch model of gesture and speech production outlined by de Ruiter (2000; see Figure 1), it seems likely that as linguistic encoding fails in aphasia, individuals rely more heavily on the gesture channel. This idea is consistent with reports of typical speakers who are prevented from speaking (e.g., in noisy environments), where gesture takes on the full burden of communication, using language-like forms toward the right-hand side of Kendon's continuum (see Figure 2; Goldin-Meadow et al., 1996).

Table 4. The number and percentage of participants with aphasia who used each type of gesture at each speech fluency level.

	Referential		Concrete deictic		Pointing to self		Iconic OVPT		Iconic CVPT		Pantomime		Metaphoric		Emblem		Time		Beat		Letter		Number	
Speech fluency	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Low (*n* = 40)	27	68	23	58	3	8	35	88	17	43	8	20	22	55	11	28	5	13	21	53	4	10	17	43
High (*n* = 48)	38	79	18	38	4	8	44	92	14	29	1	2	30	63	13	27	4	8	34	71	4	8	13	27

Table 5. The number and percentage of participants with aphasia who used each type of gesture at each word retrieval level.

	Referential		Concrete deictic		Pointing to self		Iconic OVPT		Iconic CVPT		Pantomime		Metaphoric		Emblem		Time		Beat		Letter		Number	
BNT score	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Low group, < 7 (*n* = 42)	30	71	28	67	4	10	35	83	18	43	9	21	26	62	12	29	4	10	20	48	3	7	13	31
High group, > 7 (*n* = 49)	37	76	15	31	4	8	47	96	15	31	0	0	28	57	13	27	6	12	36	74	5	10	18	37

In our study, for individuals with relatively intact conceptual systems but limited ability to linguistically encode propositions (as is usually seen in people with Broca's, transcortical motor, or conduction aphasia), employing iconic and pantomime gestures is a feasible and positive coping strategy that can be used to minimize communication breakdown. However, these gestures do not appear to be employed by individuals with better linguistic resources, such as those with anomic aphasia, where the gesture patterns more closely resemble those of typical speakers. In contrast, people with Wernicke's aphasia appear to use a more restricted range of vague and abstract gestures and do not employ pantomime or iconic CVPT gestures. This possibly reflects additional cognitive or semantic impairments that may limit how flexibly people with Wernecke's aphasia respond during communication breakdown.

In this study, we found it necessary to use two novel gesture types (i.e., time and pointing to self) and to refine the definition of the previously used pantomime type. The vast majority of gesture types, listed in Table 1, typically detailed in the literature have emerged from the study of gesture use in typical speakers (Ekman & Friesen, 1969; Kendon, 1980; McNeill, 1992). Researchers investigating gesture production in aphasic discourse have tried to use these codes (see, e.g., Cicone et al., 1979; Lott, 1999). However, it appears that there is something fundamentally different about the gesture production of PWA that requires a revision of gesture types. For example, several definitions of pantomime include reference to the "absence of speech" during its production (McNeill, 1992), and previous coding of aphasic production seems to have skirted this component of the definition (see, e.g., Cicone et al., 1979; Lanyon & Rose, 2009). In the current study, PWA produced pantomimes during word retrieval failure and during communication repair attempts, many of which included attempts at speech production. This hints at the different functions that gesture serves during aphasic discourse and suggests the need for caution when directly applying models of speech and gesture interaction, including the Sketch model (de Ruiter, 2000), and gesture codes derived from investigations of typical speakers.

Our refinement of the patterns of gesture production in PWA in this study may be useful in considering candidacy for gesture-based treatments, and we encourage empirical investigation of this proposition. For example, individuals with Broca's, transcortical motor, or conduction aphasia—who are likely to be capable of pantomime production—could be encouraged to produce these gestures during communication repair, especially if the individual is not spontaneously doing so.

Study Limitations

There were four main limitations of this novel, larger scope study. The first limitation was the decision to broadly analyze which individuals produced various gesture types at least once in discourse, rather than the more detailed approach of analyzing the actual frequency of production of each gesture type for each individual. This decision was made on the basis of the need for this first exploratory-level study. If meaningful patterns were discernible, it would make sense to invest in the more time-consuming and expensive detailed gesture frequency count work. The latter approach will provide a more comprehensive view of the nature of gesture production across aphasia types and also allow for a robust statistical analysis of the interactions of aphasia type and comorbidities. Further, the identification of each occasion of gesture type production will allow for investigation of the speech–gesture relationship at the time of production, providing a view of possible facilitation effects during word retrieval difficulties, as previously documented (Lanyon & Rose, 2009; Rose & Douglas, 2001). However, the current initial screening-level data provided in this article may be useful to inform clinicians about who to invest time in for more detailed gesture assessments. This will be particularly pertinent should the future, more detailed analyses find similar production patterns to those found here in the "produced once/screening"-level analysis.

The second study limitation was that we were not able to provide data concerning the levels of limb apraxia in the participants of this study, as this is not currently coded in the AphasiaBank samples. Recent data (Lanyon & Rose, 2009; Marshall et al., 2012; Rose & Douglas, 2003) suggest that, at least for mild and moderate levels of limb apraxia, there is no negative effect on co-verbal gesture production. However, the relationship between the presence of limb apraxia and the gesture abilities of PWA remains unclear. Future studies could investigate this suggestion more explicitly. The data bank does not provide information concerning participants' general cognitive or neuropsychological profiles. Such information may be related to gesture use (Hogrefe, Ziegler, Weidinger, & Goldenberg, 2012). Future studies using prospective data could examine these variables. The third limitation of the current study was the choice of story retell as the discourse sample. Although story retell provides a consistent sampling environment, and the speech targets are largely predictable even during speech breakdown, it is a more limited genre than conversation. However, a preliminary study of 15 PWA (five with anomic, five with Broca's, and five with Wernicke's) revealed similar gesture distribution patterns across discourse genres for each type of aphasia, with slightly higher overall gesture production in free conversation (Lott, 1999). On the basis of the current broad descriptive work, we will analyze gesture production type, frequencies, and location in conversation samples in future studies.

The fourth limitation was that we were unable to examine the impact of aphasia severity (based on the WAB–R AQ) on gesture production. Given that previous studies have reported a correlation between aphasia severity and gesture complexity (see, e.g., Glosser, Wiener, & Kaplan, 1986), it is important to investigate the influence of aphasia severity on gesture production. However, in our data, there were low numbers of individuals with very severe aphasia ($n = 4$, WAB–R AQ score range = 0–25) or severe aphasia ($n = 9$, WAB–R AQ score range = 26–50) compared with individuals with moderate ($n = 37$, score range = 51–75) or mild aphasia ($n = 38$, score range = 76–93.8). This prevented robust statistical analysis of the impact of severity on gesture production in our study. Future studies on gesture production in PWA need to consider these four limitations.

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