

Research Report

What can iconic gestures tell us about the language system? A case of conduction aphasia

Naomi Cocks, Lucy Dipper, Ruth Middleton and Gary Morgan

Language and Communication Science, City University, London, UK

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Abstract

Background: Speech and language therapists rarely analyse iconic gesture when assessing a client with aphasia, despite a growing body of research suggesting that language and gesture are part of either the same system or two highly integrated systems. This may be because there has been limited research that has systematically analysed iconic gesture production by people with aphasia.

Aims: The aim was to determine whether the gesture production of a participant with conduction aphasia was able to provide information about her language system.

Methods & Procedures: The iconic gestures produced by a participant with conduction aphasia (LT) and five control participants produced during the retelling of a cartoon were analysed. In particular, the iconic gestures produced during lexical retrieval difficulties (co-tip-of-the-tongue (co-TOT) gestures) were compared with the iconic gestures produced during fluent speech (co-speech gestures).

Outcomes & Results: It was found that LT produced 57 co-speech gestures that were similar in form to the co-speech gestures produced by the control participants (mean = 34.2, standard deviation (SD) = 22.2). LT also produced an additional eleven co-TOT gestures that were unlike her co-speech gestures and unlike the co-speech gestures produced by the control participants. While the co-speech gestures depicted events, the co-TOT gestures depicted 'things' (for example, objects and animals). Furthermore, all but one of the co-TOT gestures produced by LT was classified as a shape-outline gesture, whereas co-speech gestures were rarely classified as shape-outline gestures. LT also produced a new type of gesture that has not previously been described in the literature: a homophone gesture. This co-TOT homophone gesture depicted the homophone of the target word. The iconic gestures produced by LT suggest that she had an intact semantic system but had difficulties with phonological encoding, consistent with a diagnosis of conduction aphasia. This raises the possibility that iconic gesture production can provide evidence about the level of breakdown in the language system.

Conclusions & Implications: A larger study exploring the gestures produced by participants with aphasia is required. The research also highlights the importance of including gesture assessments in SLT's work with adults with acquired language disorder.

Keywords: gesture, tip of the tongue, conduction aphasia, iconic gesture.

What this paper adds?

Very little is known about the semantic content of gestures produced by people with aphasia. This study describes the iconic gestures produced by a participant LT who has a diagnosis of conduction aphasia. Specifically the study looks at two types of gesture that she produces, gestures produced during fluent speech (co-speech iconic gestures) and gestures produced during word-finding difficulties (co-TOT gestures). The results indicated that the iconic gestures produced by the participant reflected the level of breakdown of her language system. It is concluded that a larger study exploring the gestures produced by participants with aphasia is required.

Introduction

Communication involves both speech and gesture. Psychologists and linguists have long debated the relationship between language and gesture (see McNeill 2000) and have proposed a variety of different models of this relationship. While there is an extensive debate about the exact details of the relationship, what all researchers agree on is that gesture and language are either part of one system or two highly integrated systems (Kita and Özyürek 2003, McNeill 1992). Yet despite this, there has been limited research that has examined the gestures produced by people with language impairments such as aphasia. Furthermore, the most regularly used aphasia assessments do not include or have limited assessment of gesture, suggesting that speech and language therapists rarely analyse gesture in any detail, except simply to indicate whether or not the person with aphasia can gesture. The analysis of gestures produced by a person with aphasia are likely to be informative about their language system. Thus, gesture analysis would be an important and useful addition to the speech and language therapist's assessment battery.

Understanding the relationship between gesture and language impairment in aphasia may also shed light on whether particular therapy approaches will be more effective than others. There is some evidence to suggest that using gesture when having word-finding difficulties is a successful strategy for some people with aphasia (Lanyon and Rose 2009). In a series of therapy studies, Rose and colleagues (for a review, see Rose 2006, Rose and Douglas 2001, 2006, 2008, Rose *et al.* 2002, Rose and Sussmlich 2008) have explored whether encouraging people with aphasia to gesture when having word-finding difficulties improves retrieval. Their findings suggest that this therapy approach was most successful for participants with phonological difficulties rather than semantic difficulties. In the treatment protocol for these studies participants were encouraged to use iconic gesture when experiencing word-finding difficulties and when participants had difficulty producing a gesture the therapist produced a model for them. However, there was no analysis of what gestures people with aphasia used spontaneously during discourse pre-therapy. This information could tell us more about the person with aphasia's impairment.

There are a number of different types of gestures that are produced during communication (for a more detailed description of these gestures and how they are further classified, see Appendix A). Each of these gesture types are linked to the language system in different ways and to different degrees. Analysing gesture production by people with aphasia is therefore not straightforward. Different types of gesture will be informative about different aspects of the communication system

and therefore the types of gesture that are most suitable to be analysed will be dependent on the type and severity of aphasia. For example, there are gestures that occur in the absence of verbal language such as pantomimes and emblems. Assessing these gestures therefore would be suitable for determining whether gesture can be used as an alternative means of communication for a person with severe aphasia with limited verbal output (for example, Helm-Estabrooks *et al.* 1982). However, because they occur in the absence of verbal language, it is uncertain what an analysis of these types of gesture may tell us about the verbal language system. Equally they are unlikely to be of any use to people with mild-to-moderate aphasia whose communication is largely via verbal language.

Analysis of gestures that co-occur with verbal language may be more informative and useful when assessing people with mild-to-moderate aphasia. These gestures include beats and co-speech iconic gestures. Beats are rhythmical movements that consist of two parts, for example left/right or up/down movements and usually co-occur with stressed syllables (McNeill 1992). They are therefore closely tied to the linguistic and affective prosody of the verbal language, and as such their analysis may be informative for types of aphasia in which prosody is impaired, such as Broca's aphasia (Danly and Shapiro 1982). Co-speech iconic gestures differ from beats in that they 'bear a close formal relationship to the semantic content of speech' (McNeill 1992: 12). For example, when describing a person throwing a ball, the speaker gestures the action of throwing a ball. It has been proposed that co-speech iconic gestures in particular are closely integrated with the verbal language system (Kita and Özyürek 2003) or are part of the same system (McNeill 1992). This is confirmed in a number of studies that have analysed the co-speech iconic gestures produced by unimpaired speakers when describing a Sylvester and Tweety Bird Cartoon they have just watched (Kita 2000, Kita and Özyürek 2003, McNeill and Duncan 2000). All researchers have found that the co-speech iconic gestures produced during the speakers' description depict events that have occurred in the video and are directly related to the meaning depicted by the corresponding language. This direct relationship with language suggests that an analysis of iconic gestures in aphasia may provide useful information about the semantic systems of people with aphasia.

There is limited research which has described iconic gesture production in aphasia and the majority has focused on the frequency of gesture production (Carlomagno and Cristilli 2006, Cicone *et al.* 1979, Feyereisen 1983, Hadar *et al.* 1998a, Lanyon and Rose 2009, Orgassa 2005, Pedelty 1987). The findings suggest that participants with word-retrieval difficulties (both semantic and phonological) use more gesture than

healthy participants or participants with conceptual difficulties (Hadar *et al.* 1998b, Hadar and Yadlin-Gedassy 1994), but those participants with phonological difficulties used less iconic gesture than those with semantic difficulties (Hadar *et al.* 1998b). The frequency studies often report only limited information about the participants' communication system. For example, in Orgassa (2005) the participant was described as anomic but it was not clear whether they had a semantic or phonological impairment. The study therefore could not shed any light on whether gesture production was informative about the participants' language system.

Carlomagno and Cristilli (2006) made a significant contribution to this area by classifying the gestures produced by ten adults with aphasia (five Broca's and five Wernicke's) according to Beattie and Shovelton's (1999) categorization scheme which included semantic information, for example shape versus direction. However, like nearly all the previous research on gesture production in aphasia, they did not separate gestures that occurred during fluent versus non-fluent phases. Non-fluent speech is often an indication of language breakdown, and so an analysis of gestures produced at this point and a comparison with those produced during fluent speech is particularly important for participants with aphasia who have non-fluent and fluent phases of speech, such as conduction aphasia. While Hadar *et al.* (1998) reported that iconic gestures frequently occurred during hesitant speech for people with semantic difficulties, they did not provide descriptions about the gestures that occurred during fluent versus non-fluent speech or remove these gestures from their overall frequency count.

Only Orgassa (2005) and Lanyon and Rose (2009) examined the differences in frequency of gestures that occur during fluent speech compared with the frequency of gestures that occur during lexical retrieval difficulties or non-fluent speech. Their results differed slightly, while Lanyon and Rose found that more meaningful gestures were produced during occurrences of word-retrieval difficulty than fluent speech, Orgassa found that more pragmatic gestures were produced during word-retrieval difficulties than fluent speech. This difference is probably due to individual variation in their participants, while Lanyon and Rose examined the gestures of 18 different participants with aphasia, with different aphasia subtypes, Orgassa examined the gestures of just one participant with aphasia.

While the findings of both Orgassa and Lanyon and Rose make an important contribution to the literature, they both used very broad categories of gesture, for example iconic gestures versus beats. A comparison of the form and semantic content of specifically iconic gestures produced during lexical retrieval difficulties as compared with those produced during fluent speech

may be more informative about why they are having lexical retrieval difficulties and also provide information about the level of language breakdown, for example whether their language breakdown is at the semantic or the phonemic level.

Gestures that occur during non-fluent speech, speech failure or tip-of-the-tongue states (TOTs) are referred to as 'Butterworths' (McNeill 2000). In their papers on gesture production in aphasia, Orgassa (2005) and Lanyon and Rose (2009) both proposed that Butterworths should be split into two groups: those that are non-iconic which serve a pragmatic function of holding one's turn and those that are iconic gestures which depict semantic information about the target word. We take-up Orgassa and Lanyon and Rose's proposals in this paper and refer to the iconic gestures that occur during TOTs as co-TOT gestures.¹ Co-TOT gestures are similar to co-speech gestures in that they are iconic and depict semantic information but they occur in non-fluent phases of speech, when the language system is breaking down. Co-TOT gestures have not previously been described in the literature in any detail and as already indicated they have often been grouped together with co-speech iconic gestures, so we know very little about what they may be able to tell us about the language system and more specifically whether they can tell us anything different to co-speech iconic gestures.

Perhaps the reason that very little attention has been given to gestures that occur during TOTs is because healthy speakers rarely experience them (Brown 1991). Furthermore, when unimpaired speakers do experience TOTs it is often for proper nouns (Burke *et al.* 1991), for example the name of a city or a person. Proper nouns are not easily gestured, for example it is difficult to gesture 'London'. However, TOTs are frequently experienced by individuals with aphasia, specifically by those with disorders at the phonological encoding level such as conduction aphasia (Kohn 1984) and are therefore of interest and importance in the field of aphasia research. Three different theories have been proposed about the purpose of these iconic gestures that are produced during TOTs and their relationship to the language system. Research which includes participants with aphasia may also shed light on which of these theories more accurately depicts the relationship and purpose of these gestures.

De Ruyter (2000) claimed that difficulties with lexical retrieval are recognized by the conceptualizer which then leads to more of the communicative intention being depicted in gesture than the language. Alternatively, some researchers have proposed that iconic gestures in general have a role in lexical retrieval (Butterworth and Hadar 1989, Hadar and Butterworth 1997, Krauss *et al.* 2000). There has been some debate over what that role is with some proposing they have a

role in lemma retrieval (Butterworth and Hadar 1989) and others proposing that they help maintain semantic information while phonological forms are retrieved (Krauss *et al.* 2000). Hadar *et al.* (1998) proposed that there may be two types of gesture, those that are evoked as part of the speech production in general and those, like co-TOT gestures that are evoked in order to overcome lexical retrieval difficulties. We believe that it is specifically co-TOT gestures that may have a role in lexical retrieval. Therefore, the analysis of the form of co-TOT gestures produced by a participant who has phonological encoding difficulties, such as in conduction aphasia, may shed light on the debate of whether or not gesture has a role in lexical retrieval.

Conduction aphasia is a specific type of aphasia which is characterized by frequent phonemic paraphasias, frequent *conduite d'approche* where repeated, phonologically related attempts are made at a target word (for example, 'the /ka/ the /ke/ the /pu/ um pissy er pussy cat'), poor word or sentence repetition but good comprehension (Kohn 1984). While participants with conduction aphasia generally have fluent speech, they frequently have difficulty at the phonological encoding level of processing (Kohn 1984). The function of this level of processing

is to retrieve or build a phonetic or articulatory plan for each lemma and for the utterance as a whole. . . . The result of phonological encoding is a phonetic or articulatory plan. It is not yet overt speech; it is an internal representation of how the planned utterance should be articulated—a program for articulation. (Levelt 1989: 12)

Participants with conduction aphasia therefore frequently experience TOTs associated with non-fluent phases of speech.

Very few participants with conduction aphasia have been included in studies which have investigated the gestures spontaneously produced during discourse. One participant was included in the study by Lanyon and Rose (2009) and three participants were included in the study by Hadar *et al.* (1998). Hadar *et al.* found that the participants with conduction aphasia produced a similar number of iconic gestures and had a similar distribution of gesture types to control participants. Lanyon and Rose reported that spontaneously produced gestures did not aid the participant with conduction aphasia's word-retrieval. The same participant was included in a therapy study by Rose *et al.* (2002), who suggested that gesture may be a more effective strategy for cuing shorter and more phonetically simpler words, as there is less likely to be phonological encoding errors. However, the paper by Rose *et al.* was a therapy study, and thus the gestures were not spontaneously produced alongside discourse. While all these studies make an important contribution, none

of them investigated the semantic content and form of the iconic gestures produced. In order to have a fuller understanding of whether gesture is a useful strategy for word-finding difficulties, it is necessary to explore the gestures that are spontaneously produced during word-finding difficulties in greater detail.

In summary, there are a range of different gesture types that have different functions and different relationships with language. Those that co-occur with verbal language or are produced during lexical retrieval difficulties may be particularly informative about the person with aphasia's language system. However, there has been limited research which has explored the relationship between gesture and language production or described the semantic content of the gestures produced by people with aphasia and those that have, have often failed to differentiate between those gestures produced during fluent speech compared with those produced during lexical retrieval difficulties.

The current study

In the current study, we aimed to determine whether gesture production is informative about the language system of a person with mild-to-moderate aphasia. To do this we carried out an extensive assessment of a participant with conduction aphasia in order to develop a clear understanding of their language system and to confirm our initial diagnosis of conduction aphasia which was essential if we were to determine whether gesture production was informative about language production. A participant with conduction aphasia was chosen for this study because they experience phases of both fluent and non-fluent speech therefore comparisons could be made between co-TOT and co-speech iconic gestures. This comparison was essential for our aim of furthering our understanding of the relationship between iconic gesture and language and more specifically whether this relationship changes when there are lexical retrieval difficulties. As conduction aphasia does not specifically affect syllable stress patterns (Odell *et al.* 1991), beats were not analysed. There is limited published research which has investigated the gestures spontaneously produced during discourse by a participant with conduction aphasia. However, despite the limited data available on participants with conduction aphasia, clear predictions could be made about the semantic form of LT's co-TOT iconic and co-speech iconic gestures based on our understanding of her language system and what we already know about the function of these gestures. LT's gestures were compared with five control participants. We hypothesized that in the fluent phases of speech where LT had no evident phonological encoding difficulties, she would produce co-speech gestures that were similar

to the gestures produced by the control participants. However, because she frequently experienced phonological encoding difficulties, we predicted that in addition to these co-speech gestures, LT would also produce co-TOT gestures during these lexical retrieval difficulties. Because of the different function of co-TOT gestures and co-speech gesture, we hypothesized that these two types of gesture would differ in form and because of their different relationships with the language system they would also differ in the information that they revealed about the language system. Instead of representing the events of the narrative, co-TOT gestures would represent the labels for 'things' (for example, objects and characters) that the speaker was attempting to retrieve. We also hypothesized that her gesture production would reflect the profile of her impairment. As the semantic system is intact in conduction aphasia, we hypothesized that LT would, firstly, produce co-TOT gestures and, secondly, that these would depict semantic information about the target word rather than semantically unrelated information. As co-TOT gestures have not been described in detail before in the literature, we were also interested in identifying the features that were common to gestures classified as co-TOT and the success of these gestures as a strategy for a participant with conduction aphasia.

Method

Participants

LT was a 44-year-old right-handed English female who had an intra-cranial haemorrhage 18 years previously. Computed tomographic (CT) scans indicated damage to the left parietal lobe.

Following the haemorrhage she had speech and language therapy for 6 months working on production of verbs, production of adjectives, reading and writing. Prior to this study she had never received speech therapy that promoted gesture production, and she reported that she was actively discouraged from using gesture immediately post-stroke by hospital staff. Prior to her haemorrhage, she completed 15 years of education and began a career as an actress. Following her haemorrhage she has had a range of occupations including modelling and charity work.

Nine control participants were recruited; however, four were excluded as they did not gesture during data collection. All participants had English as their first language and had no history of psychiatric disorder or neurological illness or injury. The average age of control participants was 60.2 years old (standard deviation (SD) = 8.53) and they had an average of 15 years of education (SD = 0.89).

Assessment data

Motor assessment

LT's upper limb movement was assessed using the ARAT (Lyle 1981). She did not present with any upper limb weakness. The Limb Apraxia Screen by Poeck (1986), in which LT was required to gesture in response to command, was carried out and LT did not present with any signs of ideomotor apraxia. This was also confirmed in the New England Pantomime Production Test (Duffy and Duffy 1984) in which she received a score within the normal range. LT also reported that she did not have any difficulties with limb movement. For exact scores, see table 1.

Gesture comprehension

The assessment from Cocks *et al.* (2009) was used to assess LT's gesture comprehension. This assesses comprehension of gesture in isolation and the integration of information from gesture produced alongside speech. In the gesture-in-isolation task LT was required to watch a video in which an actor produced gestures which depicted actions. She was then required to point to the picture that best represented the action. In the integration-task, gestures that depicted actions were produced alongside speech and LT was required to select from four pictures, one that was the target, one that was a verbal foil, one that was a gesture foil and an unrelated item. The results indicated that LT was able to comprehend gestures-in-isolation on 100% of occasions. She had some mild difficulties with gesture and speech integration but this fell within the normal range of the control participants. For exact scores, see table 1.

Language assessments

The Pyramids and Palm Trees (Picture Version) (Howard and Patterson 1992) was used to determine whether LT had intact semantic knowledge. Her score on this assessment was within the normal range suggesting that her semantic system was unimpaired. This was further confirmed by the absence of semantic paraphasias in her discourse. The Action and Object naming test (Druks 2000) indicated that LT had impaired naming of both actions and objects, with actions being slightly worse. On the Western Aphasia Battery (Kertesz 1982) LT obtained an aphasia quotient of 74.2 and a profile of scores consistent with moderate conduction aphasia. For exact scores, see table 1. Her discourse was characterized by *conduite d'approche* (multiple attempts at the same word with phonological errors), phonemic paraphasias and frequent word-finding difficulties. LT did not present with any muscle

Table 1. LT's assessment scores

Assessment	Subsection scores				
Limb Apraxia Screen (Poeck 1986)	Meaningful 10/10		Meaningless 10/10		
ARAT (for left and right upper limbs) (Lyle 1981)	Grasp 18/18	Grip 12/12	Pinch 12/12	Gross 12/12	Movement 12/12
Pyramids and Palm Trees (Howard and Patterson 1992)	49/52				
Gesture comprehension (Cocks et al. 2009)	In isolation 21/21		Integrated with speech 15/21		
Pantomime expression (Duffy and Duffy 1984)	14.09/15				
Object and Action Naming Battery (Druks 2000)	Action naming 63%		Object naming 85%		
Western Aphasia Battery (Kertesz 1982)	Speech fluency 7/10	Comprehension 9/10	Repetition 3.4/10	Naming 7.7/10	Aphasia quotient 74.2/100

weakness or speech behaviours that would be consistent with a diagnosis of verbal dysarthria. She also did not present with any disturbance of prosody or intrusion of schwa that would be consistent with a diagnosis of verbal dyspraxia (McNeil et al. 2008).

Procedure

Participants were invited to take part in a project entitled 'The Describing Events Project'. They were told that the aim of the project was to determine whether aphasia impacts on the way events are described. They were not told that the experimenters were interested in their gesture production until the end of their involvement in the project.

The Tweety Bird and Sylvester 'Canary Row' cartoon was split into eight segments. Participants watched one segment at a time and were instructed to

Watch the cartoon very carefully as after you have watched it I will ask you to tell me as much as you can remember. When you are describing what you saw, imagine you are talking to someone who has never seen the cartoon before.

After each segment they described what they had seen. This description was videotaped.

Analysis

The narratives were transcribed verbatim. The videos of participants were segmented and coded using the gesture and sign language analysis program ELAN (Wittenburg et al. 2006).

TOTs were defined as a 'point in the narrative that the participant is experiencing word-finding difficulties'. TOTs were usually mid-sentence and accompanied by a pause, a filler, for example 'um', *conduite d'approche*

or verbal indication of word-searching behaviour, for example 'it's the um what is it again the um I can't remember'. Co-TOT gestures were those iconic gestures that appeared during a TOT. The completion of the co-TOT gesture was defined as either when the participant said the hypothesized target (a 'resolved TOT') or when the participant appeared to move on in the narrative or 'give up' (an 'unresolved TOT'). All co-TOT gestures were described in detail and grouped according to similarities.

All iconic gestures were coded as either 'co-TOT gesture' or a co-speech gesture and/or 'Other'. 'Other' was defined as clearly representative (that is, iconic) but unclear as to what the gesture represented or conveyed for example, where the participant appeared to be holding an object but it was unclear what the object was. The gestures that were only classified as 'other' and not as a co-TOT gesture or a co-speech iconic gesture were removed from the analysis. There were 20 'other' gestures removed from LT's transcripts and there were 42 'other' gestures removed from the control participants' transcripts (mean = 8.44, SD = 11.99).

To determine whether the co-TOT gestures depicted semantic features that were different to co-speech iconic gestures, each of the classifiable co-speech iconic gestures and co-TOT gestures were coded using a similar coding system to Kita and Özyürek (2003). An additional gesture that was not reported by Kita and Özyürek, the shape-outline gesture had to be added to complete the coding. Müller (1998) classifies these as moulding (whole hand or hands used to depict the outline of an object) and tracing (a single finger used to trace the outline of an object) gestures. We classified these gestures together as semantically they depict the same information; an outline of the shape of the object.

Co-speech iconic gesture and co-TOT gestures were therefore classified using the following headings:

- Shape-outline gestures: these included moulding and tracing gestures. Moulding gestures convey the shape of the object by appearing to 'mould' the object by touch. For example, the hands outline the square shape of a picture frame. Tracing gestures convey the shape of the object by drawing an outline of the object with an index finger. The shape-outline gesture is not conflated with manner or trajectory, for example finger outlines a circular shape to represent cake.
- Attribute (not shape outline): conveys an aspect of the shape or size of the object but is conflated with trajectory or manner for example, flat palm indicates the flatness and size of a box and moves the hands as though placing the box on a surface.
- Manner: conveys the way in which action is carried out for example, palms facing towards body and circling round each other to represent rolling.
- Path: conveys the direction in which an object/person moves, for example the hand moves in diagonal direction across the body indicates an object moved down a hill.

Additionally, in order to determine if there was a relationship between the type of semantic information conveyed by co-TOT gestures and the linguistic classification of the hypothesized target word, co-TOT gestures were classified as 'noun' 'verb' or 'other'. This classification was dependent on the linguistic classification of the hypothesized target word. For example, when LT was in a TOT state she says

yeah the um sss the um sss I can't even remember what the name of it is, not the pussy cat the . . . oh god what's it called . . . the um . . . oh god what is it in the actual cage now and again.

She was clearly trying to access the word 'bird'. The gestures that were produced during this TOT state were therefore classified as 'noun'.

Inter-judge agreement

All narratives were watched by two judges independently. One judge coded all gestures (both co-speech iconic and co-TOT gestures). The other judge was required to identify only the clearly iconic co-TOT gestures (this excluded the gestures that were only classified as 'other' described above). There were three gestures that one judge classified as co-speech iconic and one judge classified as co-TOT gestures. These gestures occurred in the shortest duration of all co-TOT gestures

and so it was difficult to determine whether this was a hesitation to find the word or simply a short pause for breath. It was subsequently agreed that they should be classified as co-speech gestures.

A total of 14% of the iconic gestures from all participants were coded by a third judge with 87.5% agreement as to their classification. This particular percentage of samples was chosen as it was in line with methodologies used in previous research which has examined gesture production in discourse (for example, Cocks *et al.* 2007).

Results

LT produced a similar number of co-speech iconic gestures (57) to the control participants (mean = 34.2, SD = 22.2). As predicted, she had many more TOTs (23) compared with the control participants (mean = 0.4, SD = 0.54). The two control participants who experienced one TOT state each, both produced co-TOT gestures during those states. While LT experienced a TOT state on 23 occasions, she only produced co-TOT gestures during eleven of these.

Differences in form between co-speech and co-TOT gestures

In order to determine whether co-speech iconic gestures were informative about LT's communication system we compared the information that was conveyed in LT's co-speech iconic gestures with the information that was conveyed in the co-speech iconic gestures of the control participants. We then compared these co-speech iconic gestures with the co-TOT gestures in order to determine whether there were differences in form and content of these two gesture types. As the control participants only produced two co-TOT gestures we anticipated that comparisons between co-TOT gestures produced by the control participants and LT, would not be particularly informative.

The majority of co-speech iconic gestures produced by the control participants (mean = 12.6, SD = 10.85) and LT (17) conveyed aspects of path. Co-speech iconic gestures produced by the control participants were rarely classified as shape-outline gestures (mean = 2.5, SD = 1.91). While they were produced with slightly higher frequency by LT (7) they were less frequent than gestures that depicted path or manner. Whereas, ten of the eleven co-TOT gestures produced by LT, and both the co-TOT gestures produced by the two control participants were classified as shape outline or shape outline plus manner gestures. The only co-TOT gesture that was not coded as a shape outline or a shape outline plus manner gesture was for the target 'tram'. During

this TOT, LT moved both hands forward with her palms facing each other. While both judges coded this as a path plus manner gesture, it could however be argued that this too was a shape-outline gesture, outlining the shape of the tram and/or the track that it travels down. The only two gestures that depicted an aspect of manner (bowling ball and catapult) began as a shape-outline gesture. For a more detailed description of these gestures, see the supplementary material available in the online version of the journal. Please find this material with the direct link to the article at: [http://www.informaworld.com/\(DOI number\)](http://www.informaworld.com/(DOI number)). In addition, see figure 1 for a full breakdown of how gestures were classified. A Fisher's exact test indicated that LT's co-TOT gestures were classified as having an element of shape outline (those classified as shape outline and shape outline plus manner) more often than her co-speech iconic gestures, $p < 0.001$.

Further analysis of the co-speech iconic shape-outline gestures produced by LT, revealed that more than half (4/7) occurred during speech difficulties, with two occurring during description of the same event. Interestingly, three of these were the items that the judges who identified TOTs disagreed on. Additionally, three shape-outline co-speech iconic gestures were produced alongside 'gear'; a semantically non-specific noun that may well have been produced because LT was unable to access a specific noun (such as 'tools' or 'equipment'). Similarly, of the ten co-speech iconic shape-outline gestures produced by the control participants, two also occurred during difficulties with lexical retrieval (for details, see table 2) and one was produced alongside a non-specific noun 'thing', also suggesting lexical retrieval difficulties. While neither judge classified these as TOTs, it could be argued that they were produced when participants had speech difficulties. For an exact breakdown of

the way in which the co-speech iconic gestures and co-TOT gestures were classified, see figure 1.

In addition to the form of the co-speech and co-TOT iconic gestures, we were also interested in the language they co-occurred with (in the case of co-TOTs this would be the hypothesized target word). All of the eleven co-TOT gestures produced by LT and the two co-TOT gestures produced by the two control participants co-occurred with hypothesized nouns.

Other interesting findings

In the analysis of both the co-TOT and the co-speech iconic gestures a number of additional features were apparent, features that were informative about LT's language system and the relationship between gesture and the language system.

Co-TOT gestures that were classified as 'Other' but became more specific

Three of the co-TOT gestures (bird, bowling ball and catapult) began as non-specific holding gestures and then became more specific shape-outline gestures. None of the co-speech gestures were classified as other and became more specific. For a more detailed description of these gestures, see the supplementary material available in the online version of the journal. Please find this material with the direct link to the article at: [http://www.informaworld.com/\(DOI number\)](http://www.informaworld.com/(DOI number)).

Gestures that depicted movements or objects not in the cartoon

The co-TOT gestures corresponding to four targets (bird, drainpipe, ring and bowling ball) appeared to contain movements or aspects of objects that were not in the cartoon. None of the co-speech iconic gestures conveyed aspects that were not in the cartoon. These co-TOT gestures are described in table 3.

The homophone gesture

One co-TOT gesture that LT produced was particularly informative about her language system. This was a gesture that has not previously been described in the literature. When trying to retrieve the word 'ring' for the telephone bell, LT gestured a ring (item of jewellery). We referred to this gesture as the homophone gesture. This

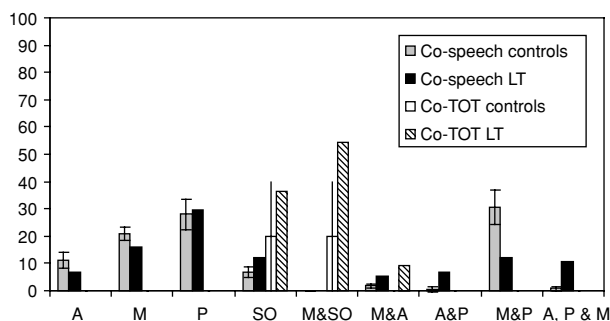


Figure 1. Proportion of LT's and the average proportion of the control participant's co-speech iconic and co-TOT gestures classified as attribute (A), manner (M), path (P), shape outline (SO), manner plus shape outline (M&SO), manner plus attribute (M&A), attribute plus path (A&P), manner plus path (M&P) and attribute, manner plus path (A,P&M). Error bars represent the standard error of the mean (SEM) for control participants.

Table 2. Co-speech iconic gestures classified as shape outline but which co-occured with questionable lexical retrieval difficulties

Participant	Co-occurring speech	Description of Difficulty
LT	(LT19) 'in the a bowling street into b into the alley alley street um alley bowl oh ah oh ah ew the alley alley alley bally b whatever the alley'	In this example, LT was trying to describe the ball rolling into the bowling alley. The repeated attempts suggest she is having phonological encoding difficulties
LT	(LT57) 'on he's his dror drawings'	The repeated attempts of 'his' and then 'drawing' suggests she was having phonological encoding difficulties
LT	(LT31) 'and finds the granny is in something, I can't really remember'	Two of these co-speech iconic shape outline gestures during this description when LT was trying to describe that the older woman character was in a birdcage. While she implies she is having memory difficulties at this point, it is likely that was not a memory difficulty but a word-finding difficulty with the word 'cage'
C1	C1(6) 'so he goes rolling down the road with his um weight down by the um cannonball inside him'	When describing Sylvester who has swallowed a bowling ball and is rolling down the street, the shape outline gesture was produced at the same time as the filler, suggesting an inability to describe the situation clearly with the vocabulary to hand
C2	C2(12) 'the birdcage is a piece of cloth'	When describing a cloth placed over a birdcage, she has used a grammatically incorrect statement. She either chose the wrong verb, so that although the syntax is appropriate 'the cage is [something]' the semantics are incorrect or she was aiming for another verb such as 'has' and is missing the information that 'has' needs, that is, the noun phrase and the prepositional phrase after it (for example [a piece of cloth] [on it]), so she may have mis-selected the verb and is also missing a prepositional phrase. This also suggests lexical retrieval difficulties

Table 3. LT's co-TOT gestures that depicted movements or objects not in the cartoon

Target	Brief description of the gesture	Aspect of the gesture that is not depicted in the cartoon
Bird	LT appears to move an object. The size of the object is indicated by her hands. From the accompanying narrative context it is very likely that the object she appears to move is a birdcage	In the cartoon the cage never moves from the windowsill
Drainpipe	LT appears to outline the shape of a drainpipe. However, the shape outline is not standard, consisting as it does of two parts: an upward tall, thin gesture, suggesting a pipe, and a square shape at the bottom, suggesting a drain cover	LT appears to gesture a drainpipe that is of a different shape to the drainpipe in the cartoon
Ring	LT gestures a ring (an item of jewellery) whilst saying 'ring' (telephone bell), that is, she gestures the homophone	The entire gesture matches the homophone of one of the lexical items in the accompanying speech 'there was a ring up from the lobby'
Bowling ball	After accessing 'bowling', LT outlines the shape of a bowling ball and then appears to carry out the action of bowling, and then accesses 'ball'	There is no action of bowling in the cartoon

homophone gesture suggested she had even processed as far as the lexeme.

Gestures that depicted information that was not conveyed verbally

An additional finding was that some co-speech gestures conveyed information that wasn't conveyed verbally, for example, for the phrase produced verbally 'hits him over the head' the gesture that occurred with this phrase added more information about the method of the hitting (manner).

Success of gesture as a strategy for resolving TOTs

There was no difference in the resolution of TOT states: 7/11 that co-occurred with gesture were resolved, whereas 9/12 not co-occurring were resolved ($p > 0.05$, Fisher's exact test). Thus, producing gesture did not appear to be a useful strategy for LT to resolve TOTs. Overall, there was no pattern for the types of gestures for example, shape outline or manner used and whether the target was resolved. There was also no pattern for word frequency or phonetic complexity, however, all of the one syllable words that were accompanied with co-TOT gestures were resolved. For a full breakdown of

Table 4. Success of the co-TOT gestures as a strategy to resolving tip-of-the-tongue (TOT) states

Target	Classification	Resolved or unresolved
Bird	Shape outline	Resolved
Drainpipe	Shape outline	Resolved
Bowling ball	Shape outline Manner	Resolved
Catapult	Shape outline Manner	Unresolved
Weight	Shape outline Manner	Resolved
Telegraph pole	Shape outline	Unresolved
Rope	Shape outline	Resolved
Tram	Shape Manner	Resolved
Suitcase (1)	Shape outline Manner	Unresolved
Suitcase (2)	Shape outline Manner	Unresolved
Ring	Shape outline	Resolved

TOTs that were resolved and the classification of their associated gestures, see table 4.

Discussion

The main aim of this study was to determine whether an analysis of the semantic form of the iconic gesture produced by a participant with aphasia was informative about the impaired language system. This was done by analysing the iconic gestures produced by a participant with conduction aphasia (LT) and five control participants during fluent and non-fluent phases of speech. The results were as predicted. LT's co-speech iconic gestures, which were produced during fluent speech, were similar in semantic form to the co-speech iconic gestures produced by the control participants. However, in addition to the co-speech iconic gestures produced by LT, she also produced eleven gestures during lexical retrieval difficulties (co-TOT gestures) which differed in form to the co-speech iconic gestures and were informative about her language system.

The findings relating to co-speech iconic gestures indicate that LT's co-speech iconic gestures were similar to healthy speakers' co-speech iconic gestures. Previous research has found that the co-speech iconic gestures produced by healthy participants during the description of the Sylvester and Tweety Bird 'Canary Row' cartoon, depict events (aspects of path plus manner) and co-occur with verbs and verb phrases (Kita 2000, Kita and Özyürek 2003, McNeill and Duncan 2000). This finding has been used to suggest that co-speech iconic gesture plays a role in the packaging of conceptual information (Kita 2000, Kita and Özyürek 2003) and may arise along with speech from a single conceptual unit which McNeill and Duncan (2000) refer to as the Growth Point. The gestures produced by LT and the control participants often added more information about the cartoon, thus both co-speech iconic gesture and speech are used together to convey meaning.

The observation that LT's co-speech iconic gestures are similar to healthy speakers is consistent with her diagnosis of conduction aphasia, in that it suggests her semantic system is intact.

Where her gestures differed to the control participant was that in addition to 57 co-speech iconic gestures, LT produced eleven co-TOT gestures. These co-TOT gestures differed in form to the co-speech iconic gestures in that the majority were classified as shape-outline gestures whereas co-speech iconic gestures were rarely classified as shape-outline gestures. Instead of depicting events, they represented 'things' (characters and objects), and co-occurred when she was unable to access noun labels. In addition these co-TOT gestures sometimes depicted content that was not in the cartoon. Three co-TOT gestures evolved from having less detail to having more specific detail. These characteristics are not commonly associated with the reported co-speech iconic gestures produced by unimpaired speakers when describing the Sylvester and Tweety Bird 'Canary Row' Cartoon and were not found in the co-speech iconic gestures produced by the participants in this study. Also, co-TOT gestures represented 'things' (for example, cage) alongside speech exhibiting difficulty accessing nouns whereas the co-speech iconic gestures represented events (for example, sneak through), alongside verb phrases. While co-speech iconic gestures tend to occur during fluent speech and have a communicative function, co-TOT gestures occur during non-fluent speech when an individual is having phonological encoding difficulties. The co-TOT gestures produced by LT therefore depicted the lexical items (or semantically or phonologically related items) that she was attempting to retrieve and not the events of the cartoon.

As predicted these co-TOT gestures produced by LT reveal information about her communication system. Four of the co-TOT gestures produced by LT did not reflect what occurred in the cartoon. These included a gesture that depicted an individual moving a cage, a gesture that depicted a drainpipe that was a different shape to the drainpipe in the cartoon, a gesture that depicted a homophone of the target 'ring' and finally a gesture that depicted the action of bowling. These gestures indicate that she had intact semantic knowledge about the target words, which is again consistent with a diagnosis of an intact semantic system but difficulties at the level of phonological encoding. One of the gestures (the homophone gesture) indicated that she had processed as far as the lexeme but was unable to encode that lexeme. These observations along with those made about her co-speech iconic gestures, suggest that the form of gestures reflects the level of breakdown of the language system.

Some researchers have proposed that gestures may aid in lexical retrieval and there is some debate over the

role that gesture plays in lexical retrieval. Butterworth and Hadar (1989) propose that gesture plays a role in lemma access. Whereas, Krauss *et al.* (2000) propose that gesture may help maintain semantic information about the target word in the mind while phonological forms are retrieved. The data from the current study lends support to Krauss *et al.*'s version of the model. LT's co-TOT gestures indicate she has intact semantic information about the target word suggesting access to the lemma. The homophone gesture indicates that LT even had information about the phonological form but had difficulties at the level of phonological encoding. This gesture therefore may have been produced in order to aid in phonological encoding of the lexeme. If this is the case, then the results are consistent with Krauss *et al.*'s version of the model.

Alternatively, De Ruiter (2000) proposed that when a TOT occurs, the conceptualizer identifies that there is a problem and more of the communicative intention is depicted in the gesture than the language. This implies that the gestures produced during TOTs would depict more information about the cartoon. The results do not clearly support this proposal, as the gestures produced during the TOT state could not always be described as depicting more information about the cartoon. However, when LT had difficulty producing a word her gestures often depicted movements or objects that were not in the cartoon. Thus, rather than more of the communicative intention being depicted in the gesture, the gestures provided information about her processing problem.

Comparisons of success at retrieval between TOT states in which LT produced co-TOT gestures and those in which she did not, indicated that production of co-TOT gesture was not a particularly successful strategy for LT. In their study of gestures produced during discourse, Lanyon and Rose (2009) described a single case with a similar profile to LT; they also found that gesture did not aid lexical retrieval. In a therapy study using the same case, Rose *et al.* (2002) suggested that gesture may be a more effective strategy for cuing shorter and more phonetically simpler words, as there is less likely to be phonological encoding errors. Visual inspection of our data for co-TOT gestures indicates that all of the attempts to retrieve one syllable words were resolved when accompanied by a gesture. However, it is important to note that there were only five of these and there were also a similar number of one syllable TOTs that were resolved and did not co-occur with gesture. This suggests that single syllable words were easier to retrieve and that gesture did not necessarily aid in the retrieval. However, with such small numbers the data should be interpreted with caution. Further research should use a larger discourse sample to investigate whether more TOTs are resolved if they are accompa-

nied with co-TOT gestures and if this is affected by phonetic complexity.

A reasonable question, given LT's language profile, is why the majority of her TOTs were for noun targets, particularly given that the assessment results indicated she also had difficulty with retrieval of verbs. Previous research has found differences between noun and verb production by participants with aphasia in confrontation naming tasks compared with production in narrative tasks (Pashek and Tompkins 2002). In confrontation naming tasks, where participants are required to label a picture with a specific noun or verb, people with aphasia have significant difficulties. In narrative or sentence construction tasks however, people with fluent aphasia, such as conduction aphasia, who have difficulty retrieving specific verbs, can avoid them and instead use semantically light verbs, for example 'go' (Brandt *et al.* 1997, Gordon 2008). This means that, in spontaneous speech, people with fluent aphasia may not experience TOTs for verbs very often. We note that LT frequently used 'light' verbs in her 'Canary Row' narrative, for example, to describe Sylvester pacing up and down thinking, she says 'he's going round and round thinking'. This could therefore account for the low frequency of tip-of-the-tongue states (TOTs) for verbs. The observation that LT's co-speech iconic gestures are not dissimilar to the control participants' or the healthy speakers' co-speech iconic gestures, again indicates that her semantic knowledge of these verbs is intact and that it is 'lower' level processing that is difficult.

In some scenarios, a similar strategy to that applied to verbs could be used when experiencing difficulty accessing nouns. That is, pronouns could be used instead of the specific noun. However, in narratives that include more than one character or object, as is the case with the Sylvester and Tweety Bird cartoon in this research, there is a need to differentiate the characters or objects in order for the narrative to make sense. LT therefore frequently attempted to retrieve the specific noun rather than use the pronoun alternative. This resulted in LT's TOTs tending to occur more frequently for noun retrieval and subsequently her co-TOT gestures tended to depict objects.

The observation that ten of her eleven co-TOT gestures were produced when trying to retrieve a noun may also explain why LT's co-TOT gestures nearly all were classified as shape outline. There are two ways in which one can depict an object through gesture. One can either depict its function or depict its shape. While for some objects a function gesture may be easier than a shape gesture, for example scissors, in this narrative the functions of the objects are not easily gestured, for example drainpipe. This could explain why LT's co-TOT gestures were shape-outline gestures. Alternatively, the form of the co-TOT gesture could reflect

LT's thinking process; when she described what she did during a TOT, she said she focused her thought on the image of the object. Therefore, the co-TOT gestures she produced could reflect her focus on the physical form, rather than the function. Similarly, the finding that LT's co-TOT gestures became more specific also could indicate that as she attempted to retrieve the target she became more and more focused on the physical attributes of the target. When after focusing on the physical attributes she was still unable to retrieve the word, she focused in on the function of the object, as was the case when trying to retrieve 'bowling ball'. Previous research has indicated that the act of visualization itself does not aid in lexical retrieval for people with aphasia (Rose and Douglas 2001). Rose and Douglas (2001) compared the naming abilities of participants with phonological difficulties as a result of aphasia using iconic gesture, visualization of object, visualization of using the object, pointing and cued articulation strategies. They found that only iconic gesture was an effective strategy to improve naming. Therefore, it is the act of gesturing that is important. However, our findings suggest that gesturing was not an effective strategy for LT.

While gesturing did not appear to be an effective strategy for resolving LT's TOTs, it may have increased the communicative value of her message. Research by Tompkins *et al.* (1982, 2006) found that gesture produced by people with aphasia when having difficulties with lexical retrieval aided the listener in understanding the speaker's message. While this was not directly measured in this study, this should be a topic of future research.

This study describes the gestures produced by a participant with conduction aphasia and, more specifically, two types of gesture: co-TOT gestures and co-speech iconic gestures. The study found that analysis of both types of gesture revealed information about the communication system of the participant with aphasia. LT's co-speech iconic gestures were similar to the control participants and speakers presented in previous research, consistent with a profile of an intact semantic system. However, in addition to the co-speech iconic gestures LT also produced eleven iconic gestures alongside periods of word-finding difficulty (co-TOT gestures), which differed in form from the co-speech iconic gestures and conveyed additional information that was not in the cartoon. These gestures also were consistent with LT's language impairment profile: that is, an intact semantic system with difficulties at the phonological encoding level of processing. These finding suggests that analysis of gesture may be a useful method of diagnosing level of breakdown in aphasia.

While the findings support Krauss *et al.*'s (2000) version of the Lexical Retrieval Hypothesis, they provide

a challenge to the assumptions made by both Krauss *et al.* and Butterworth and Hadar (1989) that co-speech iconic gestures and co-TOT gestures are the same and support the approach adopted by McNeill (2000) and Kita (2000) who have treated co-TOT gestures and co-speech iconic gestures separately. We therefore propose that co-TOT gestures and co-speech iconic gestures have different roles and should therefore be considered separately in the evaluation of past research and in the planning of new research.

The findings of this research are limited to one participant with a distinct profile of communication difficulties and the gestures were produced in only one type of discourse. However, the findings suggest that research into gesture production in aphasia may be useful clinically. Therefore, future research should explore whether co-TOT and co-speech iconic gestures share similar features to those described in this paper when produced by a range of participants with and without aphasia in a variety of types of discourse. The use of gesture analysis as an assessment tool for participants with aphasia with a range of presentations should also be explored in future research.

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Note

1. The term 'co-TOT' is coined for these gestures, which occur alongside episodes of word-finding difficulty where LT was in a 'tip-of-the-tongue' (TOT) state.

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Appendix A: Glossary of terms

Term	Definition and description
Co-speech gesture	Occurs at the same time as speech. These can be further classified as beats or iconic gesture
Butterworths	Occur during word-finding difficulties, can be iconic (co-TOTs) or non-iconic
Beats	Are swift up-and-down movements that occur on stress syllables
Iconic co-speech gesture	Iconic co-speech gestures co-occur with speech and 'bear a close formal relationship to the semantic content of speech' (McNeill 1992: 12). For example, when describing a person throwing a ball, the speaker gestures the action of throwing a ball. These can be further classified as path, manner, attribute, shape outline or other
Co-TOT gesture	This new terminology is being introduced to classify iconic gesture produced during a tip-of-the-tongue state (TOT), not during fluent speech, but instead during hesitant speech or during a pause. For example, when trying to access the word 'ball', the hands mould the shape of a ball. These can be further classified as path, manner, attribute, shape outline or other
Path	Indicates the direction in which an object moves. For example, the arm moves from left to right indicating the movement of an object
Manner	Indicates the method in which an action is carried out. For example, the right hand actions the process of moving a ball
Attribute	Indicates an aspect of the shape of an object, but it is not a shape-outline gesture. For example, a flat hand indicating the flat side of a box
Shape outline	Either a moulding or a tracing gesture that depicts the shape of an object. For example, both hands move in a circular movement to represent a circular cake
Other	Unable to be classified as path, manner, attribute or shape outline, but clearly iconic