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Iconic gesture in normal language and word searching conditions: A case of conduction aphasia

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Iconic gesture in normal language and word searching conditions: A case of conduction aphasia

ABSTRACT:

Although there is a substantive body of research about the language used by individuals with aphasia, relatively little is known about their spontaneous iconic gesture. A single case study of LT, an individual with conduction aphasia (Cocks, Dipper, Middleton & Morgan, 2011) indicated qualitative differences between the spontaneous iconic gestures produced alongside fluent speech, and in tip of the tongue states. The current study examined the iconic gestures produced by another individual with conduction aphasia, WT, and a group of 11 control participants. Comparisons were made between iconic gestures produced alongside normal language and those produced alongside word searching behaviour. Participants recounted the Tweety and Sylvester cartoon Canary Row. All gesture produced was analysed qualitatively and quantitatively. WT produced more iconic gestures than controls accompanying word searching behaviour, whereas he produced a similar frequency of iconic gestures to control participants alongside normal language. The iconic gestures produced in the two language contexts also differed qualitatively. Frequency of iconic gesture production was not affected by limb apraxia. This study suggests that there are differences between iconic gestures that are produced alongside normal language and those produced alongside word searching behaviour. Theoretical and clinical implications of these findings are discussed.

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MAIN TEXT:

There is a large field of literature describing the spontaneous gesture used by healthy individuals alongside speech, accounted for by several differing theoretical accounts (e.g. Hadar & Butterworth, 1997; de Ruiter, 2000; Kita & Özyürek, 2003). Although these models differ in the detail, each suggests that gesture interacts with language at some level.

Despite this theoretical interaction between gesture and language, spontaneous gesture is rarely systematically included in clinical language assessment by speech-language pathologists (SLPs). This may in part be due to limited understanding, and limited research profiling of how individuals with language impairment use gesture.

There are a number of studies examining gesture use by individuals with language impairment. Particularly in the case of aphasia, a language impairment following stroke, much of the literature describes the use of pantomime and gesture based interventions, rather than profiling the use of spontaneous co-speech gesture (e.g. Helm Estabrooks, Fitzpatrick & Barresi, 1982). Preliminary work by Cocks, Dipper, Middleton, and Morgan (2011) and Dipper, Cocks, Rowe, and Morgan (2011) described the spontaneous gesture produced by LT, an individual with aphasia, which indicated: 1) a qualitative difference between the gestures produced alongside fluent and impaired language; and that 2) the level of language breakdown was reflected in gesture. These findings indicate

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that gesture may be a useful addition to communication assessment completed by SLPs.

In the following review, the term gesture will first be defined; theoretical accounts of gesture production will then be described; and research profiling spontaneous cospeech gesture used by healthy individuals and individuals with aphasia will be outlined. This section ends by outlining the aims of the current study.

What is gesture?

A broad definition of gesture encapsulates all movements produced by a speaker whilst talking. Kendon's continuum (described in McNeill, 2000) places these movements along a continuum of formality, ranging from spontaneous co-speech gesture to formalised sign language. Each gesture type is described as interacting with language in a different way.

Whilst the difference between gesture at one end of the continuum, and sign language at the other is relatively clear, the distinction between *gesture* and *pantomime*, positioned next to each other, is less obvious. Pantomimes are defined as more formalised than spontaneous gesture; are produced in the absence of speech; and can carry a greater degree of meaning than spontaneous gestures, which are generally not meaningful when separated from the accompanying language (McNeill, 2000). An example of a pantomime is modelling the use of a tool without the object present. This distinction is of importance when considering research completed with individuals

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following stroke, as limb apraxia, a motor impairment that can present following stroke affecting learned and purposeful movement (Geschwind, 1975), can affect gesture and pantomime differently. Several studies indicate a dichotomy between pantomime and spontaneous co-speech gesture (Bartolo, Cubelli, Della Sala & Drei, 2003; Borod, Fitzpatrick, Helm-Estabrooks & Goodglass, 1989; Rose & Douglas, 2003), meaning an individual may have an impaired ability to produce pantomimes, whilst the ability to produce spontaneous co-speech gesture is not affected.

Within Kendon's broad category of *spontaneous gesture*, McNeill (2000) describes subcategories of beats (rhythmical gestures), deictics (pointing gestures), and iconics (containing semantic aspects of the concurrent speech). Iconic gestures were the focus of the current study.

Models of gesture production

Different models and hypotheses, accounting for iconic gesture production within a language output context, are presented by the authors in McNeill (2000); and summarised in a review by Rose (2006).

In the Sketch Model, de Ruiter (2000) describes gesture arising from imagery in working memory, and suggests that gesture has a solely communicative function. Anecdotal observational evidence is presented in support of this model: for example, when verbal communication is compromised in a noisy environment, de Ruiter describes more

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information being carried by gesture. The model is not yet supported by empirical evidence.

McNeill and Duncan (2000) describe the Growth Point Hypothesis, in which gesture and language arise at a conceptual level, and both gesture and speech output originate from a single "psychological predicate". The Growth Point Hypothesis asserts that the core function of gesture is communicative, just as the Sketch Model does, but it adds that information is packaged into the most appropriate form – gestural or verbal– at conceptualisation. For example, a gesture produced depicting an arc shape, alongside the spoken output "the cat swung across the street" (McNeill & Duncan, 2000). In this example, speech is allocated the majority of the information, including information about the trajectory shape of the *swing* movement, but visual spatial information about the specific orientation of the path of movement is added by the accompanying gesture. This hypothesis does not describe gesture and language interacting at a language processing level lower than conceptualisation. Similarly to the Sketch Model, this approach represents a theoretical hypothesis motivated by observations of spontaneously occurring co-speech gesture rather than a model arising from empirical evidence.

In the Interface Hypothesis, Kita and Özyürek (2003) describe co-speech gesture and speech as two highly integrated systems, with both language and gesture arising at a linguistic formulation stage. This model is based on a cross linguistic study of adults (Kita & Özüyurek, 2003), and supported by subsequent cross linguistic studies of

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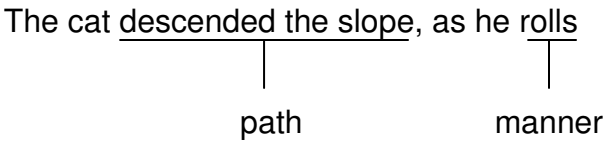
children (Allen, Özyürek, Kita, Brown, Furman, Ishizuka & Fujii. 2007; Özyürek, Kita, Allen, Brown, Furman, & Ishizuka, 2008). Within the study by Kita and Özyürek (2003), English, Japanese, and Turkish speakers described two motion events depicted within the Tweety and Sylvester cartoon Canary Row. Although all participants viewed identical clips, the linguistic typological differences between each language meant that speakers used different grammatical structures to describe the events. Interestingly, these grammatical differences were also reflected in participants' accompanying gesture; for example, when describing the *roll* event, the verbs used by Japanese and Turkish speakers separated the way the cat moved (manner) and the path of motion (path), using utterances equating approximately to:



Alongside these utterances, Japanese and Turkish speakers produced gestures which reflected the language, separating manner and path. By contrast, English speakers, who largely presented the same information conflated within a single clause "the cat rolled down the hill" (manner and path), produced gestures that also conflated manner and path.

Finally, the Lexical Retrieval Hypothesis (Hadar & Butterworth, 1997) suggests that gesture originates from representations in working memory, and arises between semantics and lexical retrieval. The model, based on a combination of findings from

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previous work by both authors, suggests that gesture arising at this level serves a dual purpose: firstly, facilitating word finding when lexical access fails, by strengthening the representations in working memory (based on evidence from Butterworth & Hadar, 1989); and secondly, priming lexical access in a ”feedforward fashion” (Krauss, Chen & Chawla, 1996, p.28).

Data cited in support of the Lexical Retrieval hypothesis by Hadar, Burstein, Krauss, and Soroker (1998) compares the gesture produced by participants with anomic aphasia, participants with visual spatial deficits, and matched controls, when describing a complex picture from memory. Of the three groups, participants with anomic aphasia produced the highest frequency of gestures, a finding which Hadar et al. attribute to deficits in lexical retrieval, the primary language impairment the participants experienced.

The relationship between language output and gesture hypothesised by each of the models raises questions regarding the impact of an impaired language system on gesture production.

Acquired language impairment and gesture production

The majority of literature relating to acquired language impairment and gesture describes the use of gesture as an intervention following stroke. These intervention studies can be categorised into two broad approaches: those which harness gesture to

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augment expression; and those which use gesture to facilitate lexical retrieval of spoken words.

The use of gesture intervention to augment the expression of individuals with global aphasia has been described by Helm-Estabrooks et al. (1982), and Cubelli, Trentini, and Montagna (1991). Helm-Estabrooks et al. found 8 participants made significant progress following a visual action therapy program, with outcomes measured using the Porch Index of Communicative Ability (PICA). Cubelli et al. also described the significant positive gains of a single participant following intervention targeting consistent use of a specific set of gestures.

Findings from both of the above studies indicate that gesture can be used successfully to augment expression in individuals with severe language impairment; and that gesture can be successfully targeted and improved in clinical intervention. The interventions in these studies targeted a specific set of semi-formalised gestures, produced largely in the absence of language, which in terms of Kendon's continuum, described previously, would be categorised as pantomimes. This means that they are not spontaneous co-speech gestures, and it is therefore not possible to use these findings to draw conclusions about how individuals with aphasia use co-speech iconic gesture spontaneously.

An alternative approach to gesture-based intervention is the use of gesture to facilitate lexical retrieval. A number of studies have explored the effectiveness of this approach

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(Rose & Douglas, 2001; Rose, Douglas & Matyas, 2002; Rodriguez, Raymer, & Gonzalez Rothi, 2006; Rose & Sussmilch, 2008). Two of these studies concluded that producing a gesture was as effective in improving confrontation naming scores than other methods of facilitation; for example visualising the target, phonemic cuing (Rodriguez et al., 2006; Rose & Sussmilch, 2008); whilst the remaining two studies concluded that gesture was more effective than other methods of facilitation (Rose & Douglas, 2001; Rose, et al., 2002). The authors conclude that this evidence supports the Lexical Retrieval Hypothesis, with gesture facilitating production of the verbal target. These findings could alternatively be interpreted using the Interface Hypothesis (Kita & Özyürek, 2003), in which there is online interaction between words and gestures.

A more limited body of literature profiles spontaneous gesture used by individuals with aphasia. Although initially of less clear relevance to clinical practice than the intervention studies, these findings allow gesture used by individuals with aphasia to be compared with control participants, with differences potentially illuminating the nature of the underlying processing impairment. Such an approach raises the possibility of using observations of spontaneous gesture as part of clinical assessment.

The majority of studies describing spontaneous gesture use by individuals with aphasia describe gesture frequency: specifically, they have found that individuals with Broca's and Conduction type aphasias produced a higher frequency of gesture than control participants (Cicone, Wapner, Foldi, Zurif, & Gardner, 1979; Feyereisen, 1983; Hermann, Reichele, Lucious- Hoene, Wallesche, Johannsen-Horbach, 1988; Hadar, et

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al., 1998; Lanyon & Rose, 2009; Calomagno & Christilli, 2006; Orgassa, 2005). Although this is interesting in its own right, further qualitative information is required about the gesture in order for theoretical and clinical conclusions to be drawn, for example, information about the gesture type and form.

Further qualitative data about gesture produced by participants with aphasia is given in studies completed by Carlomagno and Christilli (2006) and Kemmerer, Chandrasekaran, and Tranel (2007). Carlomagno and Christilli used Kendon's continuum to describe the types of gestures produced by 5 individuals with fluent aphasia, 5 individuals with non fluent aphasia and control participants, when narrating two news items. Findings indicated that individuals with non fluent aphasia produced a lower frequency of iconic gestures than individuals with fluent aphasia, and healthy participants. Although this study codes the gestures produced, it does not describe the accompanying language and so does not allow for a comparison of gesture produced alongside typical as opposed to impaired language. Kemmerer et al. (2007) describe the form of gestures produced by Marcel, an individual with severe anomic aphasia. Using the cartoon clip Canary Row used in Kita and Özyürek (2003), Kemmerer et al. collected the gesture produced by Marcel when describing the *swing* and *roll* events. Marcel's descriptions of the events were then compared to those of the English speakers in the Kita et al. study. Marcel's gesture differed from the control participants: he consistently produced a path only gesture to describe the *swing* event (contrasting with 90% of participants described by Kita et al., who produced a conflated path +manner gesture); and a manner only

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gesture to describe the *roll* event on 2/3 trails (contrasting with 85% of the English speaking participants in Kita and Özyürek (2003), who produced a conflated path and manner gesture). The findings of this study are limited by Marcel's language impairment: due to anomia, several of the gestures were produced in the absence of language, meaning not all gestures produced were co-speech gestures.

A number of studies make a distinction between gesture produced by individuals with aphasia in normal and impaired language conditions (Cocks et al., 2011; Lanyon & Rose, 2009; Orgassa, 2005). Within the Lanyon and Rose study, which analysed the gesture produced by 18 individuals with aphasia, significantly more gesture was produced during incidences of word retrieval difficulty. The majority of these were unresolved, and were "meaning-laden" gestures, defined as iconic, pantomime, and emblem type (p. 814). Although this study segments the language condition in which gesture occurred, it does not describe whether the gestures produced in typical and impaired language conditions differed qualitatively.

Orgassa (2005) compared the gesture produced by a single participant with anomic aphasia, retelling Canary Row, and a procedural narrative, with a matched control participant. Unlike the participants in the previous study, Orgassa's participant with aphasia produced a lower frequency of iconic gesture than the control participant alongside impaired language, as well as a higher frequency of iconic gestures alongside fluent language. Similarly to the above Lanyon and Rose study, further qualitative information about the form of the gesture is not described.

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Further qualitative detail about gesture form, and language condition in which gesture was produced, is described in the case of LT (Cocks et al., 2011; Dipper et al., 2011), who presented with conduction aphasia, frequent conduit d'approche and phonemic groping behaviours. Cocks et al. segmented the gestures produced by LT when describing Canary Row into gestures occurring in fluent speech, and in tip of the tongue conditions (co-TOT); and Dipper et al. analysed the gesture produced in the fluent language condition in further detail.

Within the study by Cocks et al., a total of 11 gestures were coded co-TOT, which qualitatively differed to the co-speech gestures. LT produced co-speech gestures largely alongside verbs, which contained semantic elements of events, and were largely path gestures; whilst she produced co-TOT gestures when attempting to retrieve nouns, which depicted a single target lexical item, and were largely shape outline gestures. LT's co-TOT gestures did not successfully cue production of the target. This finding is consistent with the single participant in Lanyon and Rose (2009) with conduction aphasia, for whom gesture did not facilitate language.

Dipper et al. (2011) analysed LT's fluent language and gesture further, and compared this with the language and gesture produced by control participants. Findings indicated that within the language coded as fluent, LT used the semantically light verb *go* more frequently than control participants (LT= 8 uses; Healthy participant average=2.6 uses). In addition to this difference in language, there was a difference in gesture form: whilst healthy speakers and LT predominantly produced a path only gesture alongside the

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semantically light verb *go*, on 3 occasions LT produced a gesture alongside *go* which contained an atypical amount of semantic weight, conflating path and manner. Dipper et al. suggest that on these three occasions, LT substituted *go* at the last minute, due to difficulties accessing a heavier target verb. This suggestion raises a possibility that gesture may reveal information about language impairment, pointing to lexical access difficulties in more fluent phases of speech where they are not immediately apparent because of substitution or circumlocution.

Limb apraxia and gesture

In addition to language impairment, stroke can cause physical impairments, such as limb apraxia. Geschwind (1975) defines limb apraxia as a group of neuropsychological impairments, affecting the execution of learned and purposeful movement, which cannot be accounted for by weakness, incoordination, sensory loss, or attention and comprehension difficulties. Research findings regarding the impact of apraxia on gesture production are inconsistent, which may be explained in part by difficulties regarding definitions, and methods of assessment.

Studies by Wang and Goldglass (1992), and Borod et al. (1989) indicate that apraxia inhibits gesture production, indicated by a negative correlation between degree of apraxia and gesture frequency. Contrary to this, several studies describe apraxia negatively impacting on individuals' ability to produce pantomimes, but not gesture (Bartolo et al., 2003; Borod et al., 1989; Rose & Douglas, 2003). These differences in

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findings could be attributed to differences in participants' aphasia severity: in both studies indicating a negative correlation between level of apraxia and gesture frequency, participants also presented with severe aphasia.

The current study

The current study aimed to compare the spontaneous iconic gesture produced by WT, an individual who presented with assessment scores indicating conduction aphasia and ideomotor apraxia. Co-speech gesture was observed in two language conditions, termed “normal” and “word searching”, identified using the language features described in the Western Aphasia Battery (WAB) Spontaneous Speech task scoring criteria (Kertesz, 2006). Condition 1, the “word searching” condition included disruptions of fluency, or expected information content; and condition 2, the “normal language” was where these features did not occur. Furthermore, the study aimed to compare WT’s language with the gesture produced by 11 healthy control participants, matched for age and years of education; and to compare the gestures produced.

Hypotheses were formulated based on the findings of the previous studies described above. These were: 1) apraxic impairment would not negatively impact on the frequency of WT’s spontaneous iconic gesture production; 2) WT would produce a similar frequency of gestures to control participants alongside normal language, and additional gestures alongside word searching behaviour; 3) the gestures produced alongside word searching behaviour would differ in form to those produced alongside normal language,

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consistent with the Interface Hypothesis of gesture production described by Kita and Özyürek (2003); and 4) that WT's gesture would not facilitate verbal language.

Method

Participants

WT

WT was a 63-year-old male who had experienced three strokes, the most recent occurring two years before the current study took place. An MRI scan completed following the first stroke (see figure 1) indicated a lesion in the left parietal lobe. Following this, WT reported experiencing two strokes simultaneously - one in the right hemisphere and one in the left hemisphere; however, detailed information about the precise location of these subsequent strokes was not available.

WT completed 6 months of SLP intervention following both strokes, which did not target gesture. Premorbidly, WT was right handed, had completed 17 years of education, and worked as a head teacher in a secondary school.

----------Figure 1 about here----------

Healthy participants

Data from 11 neurologically healthy control participants was used for the study. The average age of control participants was 60.1 years old (SD= 6.02), and the average

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years of education was 17.4 (SD= 2. 06). All participants completed a medical questionnaire before participation: no participants reported any history of psychiatric disorder, neurological illness or insult, nor any other serious medical condition.

Assessment data

Assessment data are summarised below; WT's full assessment data are presented in table 1.

Motor skills and apraxia

All participants completed the *Action Research Arm Test* (Lyle, 1981), which tested strength and range of movement in the right and left limb. No healthy participant demonstrated any difficulty with this test. WT demonstrated mostly full strength and range of movement in both limbs, with only a slight weakness observed in the right hand when using a pincer grip to pick up a ball bearing, indicating no significant physical impairment that may have affected gesture production.

WT completed two apraxia assessments: the *Birmingham University Praxis Screen* (BUPS) (Bickerton, Samson, Humphreys, Riddoch, Kumar, Mortensen, Forti, & Punt, 2006), and the test for motor apraxia (Poek, 1986). WT obtained a ceiling score in the BUPS subsection "object use", which required the assembly and lighting of a torch, indicating that he did not present with conceptual apraxia. The test for motor apraxia and the subsection "gesture production" from the BUPS, which required WT to produce a

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range of transitive and intransitive gestures, indicated difficulties consistent with ideomotor apraxia (Bickerton et al., 2006).

Language

A battery of formal language assessments was completed, consisting of *Western Aphasia Battery* (WAB) (Kertesz, 2006); *Pyramids and Palmtrees* (Howard & Patterson, 1992); and *Object and Action Naming Battery* (Druks & Masterson, 2000).

WT obtained a WAB aphasia quotient of 56, with scores profiling moderate conduction aphasia. Further assessment scores were consistent with this profile: WT's near ceiling *Pyramids and Palmtrees* indicated an intact semantic system; and *Object and Action Naming Battery* scores indicated a severe impairment in naming objects, and moderate impairment in naming actions (See table 1 for exact scores).

When completing the *Object and Action Naming Battery*, WT spontaneously produced gestures when experiencing difficulty naming 25 of the 81 objects; four of these word finding difficulties were resolved, a total which did not reach significance (Fisher exact, *p>0.05),* indicating that spontaneously produced gesture did not facilitate naming for WT in this task.

Summary

WT's assessment scores were consistent with a profile of conduction aphasia, with associated strengths in semantics, auditory comprehension, and fluent spontaneous

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speech; and difficulties in naming and repetition. WT's spontaneous speech was relatively fluent, with a notable lack of conduit d'approche and phonemic groping behaviours frequently displayed by individuals with this aphasia profile. Within the WAB Spontaneous Speech task, a range of features of WT's language could be identified as *word searching behaviour*. These are described in further detail in the analysis section.

----------Table 1 about here----------

Procedure

In order to maintain the naturalness of gesture, participants were not told that the project focused on gesture production until after participation. Instead, they were invited to take part in the *describing events* project, examining the impact of stroke on narrative.

All participants watched the Sylvester and Tweety cartoon Canary Row, divided into 8 episodes of approximately 1 minute, to reduce demands on working memory. Before the cartoon clips were presented, checks took place to ensure stimuli were audible and visible to participants. Immediately after viewing each episode, participants were asked to describe the clip they had just watched, as though describing it to somebody who had not seen the cartoon before. All narratives were unprompted.

Narratives were recorded on a digital video camera approximately 1 metre from the participant, positioned to obtain a front view, with only the participant visible in the frame.

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Before each narrative, participants were asked to turn and face the camera, and any obstructions to arm movement, such as chair arms, were removed.

Equipment

Cartoon clips were presented to participants on a laptop with a 15 inch screen, using Apple QuickTime player. Video recordings of participants were transferred directly from the digital camera to a computer for analysis.

Analysis

All narratives were transcribed verbatim. Please see Appendix 1 for example transcripts from WT and a control participant. All narratives were then coded using the scoring criteria for information content and fluency from the WAB spontaneous speech task (Kertesz, 2006).

WT produced a shorter narrative than control participants (WT= 727 words; Control mean=970 words, SD=97.6). Word searching language features were not present in the narratives produced by controls, besides minimal presence of longer than typical pauses (mean= 1.8, SD= 2.2). WT produced a total of 51 instances of word searching behaviour within the 5 minute 58 second narrative, including:

- Long pauses of approximately > 3 seconds (41%);
- Circumlocution e.g., “against all the [points at the light]… um Christ what makes all this lot work”, for the lexical target *electricity* (13.72%)

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- Omission or contractions of obligatory verb arguments e.g., "[the cat]'s [in a…] and [the bird] is [...another]", when describing the characters in buildings on opposite sides of the street (9.8%);

- Substitutions e.g., "the cat is downs… uh outside" (5.88%)

- Phonemic paraphasias e.g., "in the the train... /gɹɑf/... urgh... whatever", for the target *drain* (3.92%)

- Mis-use of semantically light verbs and nouns. This was where a light verb or noun was used to describe new information, a new event, or a new character (25%). The verb used most frequently was *go* in place of a semantically heavier verb such as *hit*. Whilst *go* is a highly frequent verb and was used frequently in control narratives (mean= 6.1, SD= 2.4), WT used this more frequently (total= 16), in manner judged to be omitting the target information of the utterance. The use of *go* in place of semantically heavier verbs by individuals with verb impairments has been described widely within aphasiology literature (e.g. Berndt, Haendiges, Mitchum & Sandson, 1997).

Utterances with these features were categorised as word searching, and those without them were categorised as normal. Language was also categorised based on the hypothesised lexical target. Of the 51 instances of word searching behaviour, 69% occurred when WT was attempting to access noun targets; 27% occurred when

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attempting to access verb targets; and 4% occurred when attempting to access prepositional targets.

Iconic gestures were identified and coded using the sign analysis program ELAN (Wittenburg, Brugman, Russel, Klassmann & Sloetjes, 2006), which allowed frame by frame analysis of gesture. Gesture and language were also coded qualitatively, using the following categories based on Kita and Özyürek (2003), and used by Cocks et al. (2011):

1) **Path**: depicts the direction of movement e.g., hand moves up to depict a cat climbing up a drainpipe

2) **Manner**: depicts the way in which a movement or action takes place e.g., index finger and thumb form a pincer grip to depict how an item has been picked up

3) **Attribute**(not shape outline): depicts the shape or size of an item, but contains information about path or manner of movement e.g., hands shaped as though holding a birdcage, whilst moving and placing it on a surface

4) **Shape outline**: Moulds or traces the outline of an object e.g., hands mould two hollow tubes in front of the eyes which the participant looks though to represent binoculars.

5) **Other**: Gestures are clearly iconic, but semantic features or representation to cospeech is unclear.

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Inter-rater reliability

Identification and categorisation of word searching behaviour within all narratives, and coding of gesture types in all videos was completed by two qualified speech and language pathologists. Inter-rater reliability for word searching behaviour was found to be Kappa= 0.833 ($p<0.05$), and for gesture coding was found to be Kappa= 0.81 ($p<0.05$), in both cases indicating an almost perfect agreement. There was a total of 10 coding non agreements, resolved through discussion.

Results

Frequency

WT produced a total of 49 gestures when recounting the Tweety cartoon which was a higher frequency than control participants, even when individual variability was considered (mean= 23.55, SD= 16.4). WT's overall rate of gesture production was also higher when viewed as a ratio with language: WT produced on average 1 gesture per 17 words, a rate over three times higher than the control average (mean= 1 gesture per 54 words, SD= 15.3).

When gestures were segmented by language condition, it was observed that WT produced an additional 26 gestures in the word searching condition, and a comparable number of gestures to control participants in the normal language condition (WT normal language total= 23). Despite this comparable frequency, when viewed as a gesture to

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word ratio, WT's rate of gesture production in the normal language condition was still, at 1 gesture to 24 words, higher than control participants.

G*esture types*

In the normal language condition, WT produced gesture types which were in line with those produced by healthy participants. The largest category of gestures produced by both WT and the controls was path-only gestures (see table 2). These, overwhelmingly occurred alongside verb targets; i.e. 89% of WT's and 96% of the controls' path gestures accompanied verbs. For example, whilst saying "he goes off the scene again", WT produced a gesture in which his right hand moved to the right approximately 10cm. This gesture appears to represent the path of movement of the cat.

The second largest category of gestures produced by all participants with normal language was conflated path and manner gestures, also alongside verb targets (WT, 100%, Control average 96%). For example, whilst saying "walk upstairs", WT produced a gesture in which the right hand moved from waist to shoulder height, whilst the extended middle and index fingers moved up and down alternately in a stepping motion. This gesture simultaneously demonstrates the path of movement of the cat (up) and the manner of his movement (walking).

In the word searching condition, WT produced shape outline gestures most frequently. Although these were produced alongside both nouns and verbs (Nouns= 46%, verbs= 36%), all shape outline gestures depicted objects. For example whilst saying "the um….

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… Tweety Pie's bird cage", WT repeated the same gesture twice, in which he moved both hands to the middle of his chest, and then moved his hands down and away from each other in small arcs of approximately 10cm. This appears to illustrate the shape outline of the item (a bird cage).

In the word searching condition, WT also produced other gestures, which were clearly iconic but not identifiable, largely alongside noun targets (83%). These were not produced in the typical language condition, and were produced only minimally by healthy participants (mean= 0.4, SD= 0.1). An example of an *other* gesture was alongside "and the cat has managed to… …" *,* when WT moved his hand to chest height, formed a fist with the palm facing down, and rotated his hand clockwise several times. This gesture is clearly iconic as it is not a beat, deictic or emblem gesture; however, it does not relate clearly to any of the items or events depicted within the preceding cartoon, or the lexical item *walk* which WT reached.

The forms of gestures produced by WT in the two language conditions (see Table 2) is a notable but non-significant difference (Fisher's exact, $p>0.05$).

Gesture and word finding

Unresolved targets were defined as occasions where WT displayed word searching behaviour and did not access the target lexical item e.g. "the cat is looking through… through… these" alongside a gesture depicting *binoculars*.

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Within the word searching condition, overall, WT produced a higher frequency of unresolved targets (table 3). Whilst the frequency of unresolved targets was higher than resolved targets both with gesture, and without gesture, WT was marginally more likely to gesture alongside a resolved than an unresolved target (resolved= 62%; unresolved- 57%). However, overall, a non significant difference (fisher's exact, $p>0.05$) between the gesture and non gesture conditions indicated that WT's lexical retrieval was not affected by the production of a gesture.

The majority of word searching behaviour was produced alongside noun targets (resolved= 7, unresolved= 9) and verb targets (resolved= 3, unresolved= 6).

----------Table 2 about here----------

----------Table 3 about here----------

Discussion

The aims of the current study were to compare gesture produced by WT in typical and word searching conditions with gesture produced by control participants.

Findings supported the hypotheses: 1) ideomotor apraxic impairment did not negatively impact on the frequency of WT's spontaneous gesture production; 2) WT produced a similar frequency of gestures to control participants alongside in the normal language condition, and additional gestures alongside word searching language and; 3) the gestures produced alongside word searching behaviour qualitatively differed in form to

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those produced alongside normal language; and 4) WT's gesture did not significantly facilitate verbal language.

The finding that WT, an individual with conduction aphasia, produced a higher frequency of gesture than control participants is consistent with findings of previous studies which report overall higher frequency of gesture use (Cicone et al., 1979; Feyereisen, 1983; Hermann et al., 1988; Hadar et al., 1998; Lanyon & Rose, 2009; Carlomagno & Christilli, 2006; Orgassa, 2005). The finding that WT produced additional gestures in the word searching language condition but a comparable frequency of gesture in the normal language condition is consistent with both Orgassa (2005), and Cocks et al. (2011).

Considering and comparing the findings of Cocks et al. (2011) with those of the current study in a little more depth, it initially appeared that the frequency of gesture produced by WT alongside word searching behaviour (26 gestures) was much higher than the frequency of gestures produced by LT in tip of the tongue states (11 gestures). This may be explained to some degree by matters of definition: the criteria of word searching behaviour used within the current study are broader than the definition of "co-TOT" used by Cocks et al. study. This means only the subcategories of *longer than typical pauses* and *phonemic paraphasias* (and not the other four subcategories, see Analysis section of the Methodology) within the current study are comparable to the data reported by Cocks et al. Therefore, it is necessary to also consider the data reported by Dipper et al. (2011), which described the gesture accompanying both atypically light verbs and atypical multi-clause structures used to describe motion events. This adds a further 5

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gestures, produced alongside atypically light verbs, and a further 3 gestures produced alongside multi-clause structures, to LT's total word searching gestures (LT= 19 gestures, WT= 26 gestures). The remaining discrepancy may be accounted for by WT's frequent use of circumlocution as well as his with a more severe aphasia rating (WT WAB AQ= 56; LT WAB AQ= 74.2).

In terms of gesture form, the finding that WT's produced shape outline and other gestures in the word searching condition is consistent with the findings of Cocks et al. (2011). Similarly to Cocks et al., WT tended to produce a shape outline gesture alongside word searching behaviour such as the semantically light pronoun *these* in "he's looking through these", depicting *binoculars*, rather than alongside normal language, where his gesture tended to represent semantic features of the whole clause, such as path and manner information.

This similarity in gesture forms is of interest, as WT and LT presented with different patterns of impairment: WT's speech was more fluent (WT WAB fluency=8; LT WAB fluency= 7), despite a more severe aphasia quotient (reported above), although both had conduction aphasia. Based on these two cases, it is not yet possible to identify whether the presence of shape outline and other gestures alongside word searching behaviour is a feature of gesture production by individuals with aphasia, or individuals with conduction type aphasia. Further research to distinguish between these two possibilities would be of benefit.

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Producing gestures in naming assessment and spontaneous narrative tasks did not facilitate WT's access to target lexical items. This lack of facilitatory effect of gesture on language is consistent with the findings of Cocks et al. (2011) and the single participant with conduction aphasia reported by Lanyon and Rose (2009). It is not, however, consistent with the remaining data reported in the Lanyon and Rose study, which found an overall significant facilitatory effect of gesture spoken language in a heterogeneous group of individuals with aphasia, predominately Broca's (12/18). Therefore, it is possible that the impairments of individuals with conduction aphasia, which is thought to be due to phonological encoding difficulties, prevent the facilitation effects of gesture from taking place.

Theoretical modelling implications

Interpreting the findings of the current study theoretically, the main challenge for any model of gesture production is to account for the qualitative difference in the forms of gestures WT produced alongside normal language and word searching behaviour, as the difference has implications for the level of language at which gesture arises. For example, whilst the Growth Point Hypothesis suggests that a speaker packages information in language and gesture flexibly, dependent on both the message and the context, it also suggests that gesture arises at a conceptual level, with no feedback from lower levels of language e.g., when experiencing lexical access difficulties. As conceptualisation is a pre-verbal level of processing, in order for growth point packaging to be reflected in the data, gestures produced by WT in the normal and word searching

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language conditions should appear qualitatively identical. The difference in gesture forms demonstrated within WT and LT's data indicates interaction between language and gesture, because gesture is qualitatively different when access is compromised.

Due to this difference in gestures produced in the normal and word searching language conditions, as predicted, the model which most adequately accounts for the findings of the current study is that described by Kita and Özyürek (2003); and not The Sketch Model (de Ruiter, 2000), the Lexical Retrieval Hypothesis (Hadar &Butterworth, 1997), and the Growth Point hypothesis (McNeill & Duncan, 2000). Within the study by Kita and Özyürek (2003), typological linguistic differences in the language spoken by participants influenced gesture form, indicating a dynamic online interaction between lexical forms and gesture. This hypothesised interaction between language and gesture would account more directly than the other models for the qualitative differences observed within the current study.

Alternatively, the qualitative differences could be accounted for by a hybrid model, incorporating aspects of two or more of the models, or the models working in tandem to describe different aspects of the same highly complex systems.

Clinical implications

In addition to implications for theoretical modelling, findings within the current study are of clinical relevance. The first finding of relevance is that despite assessment scores profiling ideomotor limb apraxia, WT produced clearly identifiable gesture that was

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comparable to control participants in the typical language condition, and additional gestures alongside word searching behaviour, which qualitatively differed. This means that the presence of limb apraxia should not automatically preclude assessment or intervention based on gesture from taking place.

Also of clinical relevance and interest is the qualitative difference in gestures alongside word searching behaviour. Shape outline gestures (which trace or mould the outline of a single lexical item) and other gestures (clearly iconic but unidentifiable) being produced alongside word searching by an individual with conduction aphasia are in line with previous findings, indicating that these may be hallmarks of gesture produced alongside word searching in conduction aphasia.

These may be particularly useful in the clinical assessment of language by individuals with fluent aphasia such as WT, as the production of specific gesture types within spontaneous discourse may support identification of word searching language where it may otherwise prove challenging e.g. in episodes of circumlocution.

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Summary

WT produced the same quantity and types of gesture as healthy participants alongside normal language; and additional gestures which co-occurred with word searching behaviour and differed in form. The gestures produced alongside word searching

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behaviour were not significant in facilitating word finding. The findings of this study contribute to the profile of how aphasia affects gesture use, and more specifically, together with the findings of Cocks et al. (2011) how conduction aphasia affects gesture use. This has potential implications for clinical work, contributing to a profile of language strength and impairment.

Further studies profiling gesture use by people with aphasia in word searching and normal language conditions will strengthen these findings, which will in turn help determine the most appropriate means of incorporating gesture into clinical language assessment for individuals with aphasia.

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Appendix 1: Example transcripts from a control participant and WT describing one of the cartoon episodes

Control transcript

Right, this time the cat came up with the idea of making a see saw so he made a see saw with a box and a plank of wood and then he went and found a really heavy weight, walked along, stood on one end of the plank of wood and threw the weight at the other end so then he bounced up in the air. He caught the bird, and on the way back down landed, ran off but then the weight landed on top of him and squashed him with the bird, and he escaped again.

WT transcript

He's still trying to catch the bird and he's got some… uh a weight a hard weight and he's made a… uh what do you call that… anyway he's got a piece of wood. And um… the idea being that that he would drop the weight and he would go /pɛ☠/ up, which he has, he's caught the bird and he's going back down and of course the weight is now coming back down and it's landed on Sylvester and he's got his comeuppance.

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TABLES:

Table 1: WT's Assessment Scores

Assessment	Subsection scores			
ARAT: Action Research Arm Test (Lyle, 1981)	Right arm: 55/57	Left Arm: 57/57		
BUPS: Birmingham University Praxis Screen (Bickerton et al., 2006)	Object use: 12/12	Gesture production: 8/12	Meaningless gesture imitation: 3/12	
Test for motor apraxia (Poek, 1986)	Pantomime production: 0/ 3	Transitive gesture production: 0/3	Meaningless gesture production: 3/8	
WAB: Western Aphasia Battery (Kertesz, 2006)	Spontaneous speech: 16/20	Auditory comprehension: 6.1/ 10	Repetition: 2.1/10	Naming: 3.2/ 10
Pyramids and Palmtrees (Howard & Patterson, 1992)	58/60			
Object and Action naming battery (Druks & Masterson, 2000)	Object naming 24/ 81 (29.6%)	Action naming 22/50 (44%)		

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Table 2- Percentages of gesture types used by participants

	Path	Path and manner	Manner	Shape Outline	Attribute	Other
Healthy participants average	49% (SD=4%)	19% (SD=2.4%)	17% (SD=0.8%)	7% (SD=0.5%)	8% (SD=0.8%)	0% (SD=0.8%)
WT- normal language condition	43%	24%	14%	9.5%	9.5%	0%
WT- word searching behaviour condition	20%	16%	19%	29%	3%	13%

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Table 3: Gestures produced by WT alongside resolved and unresolved targets

	Resolved target (21)	Unresolved target (30)
Gesture produced	13	17
No gesture produced	8	13

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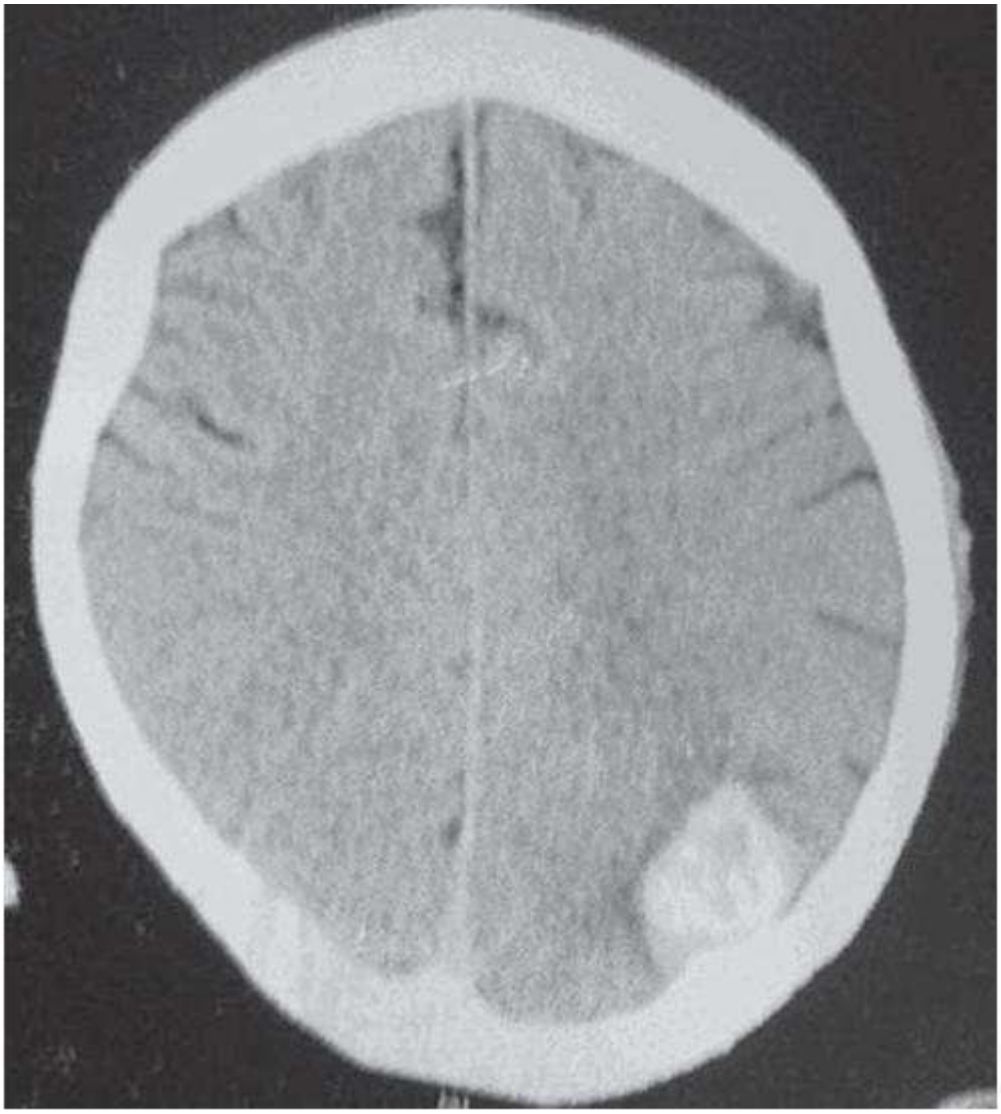
FIGURE CAPTIONS:

Figure 1: MRI scan taken after WT's first stroke



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