What can co-speech gestures in Aphasia tell us about the relationship between language and gesture? A single case study of a participant with Conduction Aphasia

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A**bstract**

Cross-linguistic evidence suggests that language typology influences how people gesture when using 'manner-of –motion' verbs (Kita 2000; Kita & Özyürek 2003) and that this is due to 'online' lexical and syntactic choices made at the time of speaking (Kita, Özyürek, Allen, Brown, Furman & Ishizuka, 2007). This paper attempts to relate these findings to the co-speech iconic gesture used by an English speaker with conduction aphasia (LT) and five controls describing a Sylvester and Tweety[1] cartoon. LT produced co-speech gesture which showed distinct patterns which we relate to different aspects of her language impairment, and the lexical and syntactic choices she made during her narrative. (106)

Keywords: aphasia, co-speech iconic gesture, manner of motion verbs, English.

[1] Warner Brothers cartoon (1950)

Introduction

It is a matter of common observation that gesture co-occurs with speech during everyday interaction in all cultures and societies. The term gesture covers many types of hand and arm movements ranging from conventionalised emblems (such as the 'thumbs-up' sign), through pantomimes, to the spontaneous and idiosyncratic movements that often accompany speech which are referred to as co-speech gestures . The particular type of gesture of interest here is the subcategory of co-speech *iconic* gesture:gesture which directly depicts the attributes of a particular event or the attributes and uses of a particular object, without being a conventionalised symbol (McNeill, 1992). For example a sentence such as, '*he swung across on a rope'*, might be accompanied by a gesture where the hands move from right-to-left in an arc trajectory.

This example also serves to illustrate the different ways in which linguistic information might influence gesture. Influence from the lemma, such as from the semantic information about the manner of the movement indicated by 'swing', might inform the arc shape of the gesture; influence from the clause, i.e. from the combination of the verb 'swing' and the preposition 'across' might encourage the conflation of path and manner into a single gesture. It is also important to consider the influence of discourse planning, where factors such as topic prominence and the given/new distinction might affect the informational content of the gesture.

There is evidence of a close synchrony between speech and gesture in terms of both meaning and timing (see review by Streeck, 1993), which has led researchers to attempt to explain how it is that the two modalities encode different aspects of meaning (linguistic and imagistic) and yet operate in collaboration (de Ruiter, 2000,

2007; Krauss, Chen & Gottesman, 2000; Goldin-Meadow, 2003; Kita & Ozyuerek, 2003; McNeill 1992). This has resulted in a number of competing hypotheses about the nature of the process or processes that underpin the two modalities. The key distinction within these different models for our purposes concerns how and where in the language processing system, language might shape gesture. A systematic analysis of co-speech gesture and spoken language in cases of linguistic disorder may reveal more about the cognitive architecture of the unimpaired system.

Cross-linguistic variation in Motion Events

A key finding in the gesture literature is cross-linguistic variation in gesture content, which appears to co-ordinate with cross-linguistic variation in syntactic and/or semantic encoding in language (for a review see Kita 2009). A rich source of data in this area is the analysis of manner of motion verbs, such as 'swing' in the example above. Building on Talmy's influential work (Talmy 1985; 2000), manner of motion verbs are generally thought to include all manner verbs that can lead to a change of location, both verbs of self-motion (e.g. 'run', 'jump') and verbs of caused-motion (e.g. 'hit', 'push'). The semantics of such verbs include information about path (the start point, route or end point of the motion), manner (the way in which the motion is carried out) and cause (the initiator of the event). There are no precise boundaries of what constitutes a path or manner meaning, but there is some agreement on definition, for example manner is generally agreed to be a multidimensional domain (e.g. Talmy 2000, Slobin 2004), which can include, amongst others, motor pattern (e.g. 'crawl'), rate (e.g. 'run'), and attitude (e.g. 'sneak'). The semantics of a motion verb can include any number and combination of these components, or it can contain none of them (e.g. 'go'), and the combination will vary across languages.

In English, the preference is to encode both Manner and Path components of events like SWING or ROLL in a single syntactic clause in speech, e.g. '[*rolled down the hill]*' (Slobin 2004). In contrast, in languages such as Turkish and Japanese the preference is for two clauses, e.g. [*yuvarlan-arak*] [*cadde-den iniyor*], [*he descends on the street*] [*as he rolls*] (Kita and Ozyuerek 2003). In order to investigate whether there is also cross-linguistic variation in the gestural encoding of motion events, and if so to explore how it interacts with cross-linguistic variation in speech, Kita and Ozyurek (op cit) showed a Sylvester and Tweety Pie cartoon ('Canary Row') to speakers of American English, Japanese and Turkish and then asked them to re-tell the story. Analyses were made of the speakers' patterns of co-occurring speech and gesture while describing two key scenes: the SWING event and the ROLL event.

In the SWING event, Sylvester and Tweety are across the street from each other in the windows of different high-rise buildings and, in an attempt to catch Tweety, Sylvester swings across the street on a rope. American English speakers used the verb 'swing' to describe the event but Japanese and Turkish speakers, lacking a readily available verb for an arc shaped trajectory, described the event by using verbs with related meanings, such as 'go' and 'fly'. Different patterns were also observed in the gesture of the participant groups. Almost all (15/16) of the American English speakers used arc gestures, whereas less than a quarter of the Japanese speakers and less than half of the Turkish speakers produced isolated arc gestures. Instead, the majority of participants in these two groups preferred to use either arc gestures in combination with straight gestures, or exclusively straight gestures. Kita and Ozyurek (2003) argue that the Japanese and Turkish participants' more frequent selection of straight

gestures reflected the semantics of the motion event in speech, specifically the absence of a verb like 'swing' in their lexicon.

In the ROLL event, Sylvester (having swallowed a bowling ball) rolls down the street into a bowling alley. In retelling this event, the American English speakers produced single clause expressions (most often, '*roll down'*) whereas Japanese and Turkish speakers produced two clauses. Gesturally the participant groups also differed, this time reflecting, not the lack of a particular verb in the lexicon but the different syntactic packaging of the motion event in speech. American English speakers used Manner-Path conflated gestures (e.g. hand circling in the air while tracing a downward trajectory) more often than did Japanese and Turkish speakers; and Japanese and Turkish speakers produced separate gestures for Manner and Path more often than did English speakers.

In a subsequent paper (Kita, Özyürek, Allen, Browm, Furman and Ishizuka, 2007) the authors elaborate on their findings by testing whether these cross-linguistic differences were motivated by 'online' lexical and syntactic choices or by a habitual conceptual schema congruent with the linguistic typology. English-typical and atypical clausal structures were elicited from English speakers using cartoon sequences which manipulated the relationship between the manner and path information in various novel events. So, for example one event showed an object rolling down a slope whereas another showed an object spinning as it descended: in the former scene the rolling manner could be conceptualised as the means of descent whereas in the latter it could not. These stimuli were designed in such a way that English speakers would verbally express manner and path sometimes in a single

clause (*he rolled down the hill*) and sometimes in two clauses (*he went down as he spun*, or *he went down and he was spinning*).

The co-occurring gesture was found to reflect these syntactic choices and the authors conclude that speech and gesture production processes 'interface' online at the conceptual planning phase. Although the interaction between gesture and speech is posited at the conceptual stage, it should be noted that the language choices that inform this interaction occur further on in language processing (lexical selection and sentence structuring which begins pre-lexically and is completed after lexical selection). Kita and Özyürek (2003) also claim that there is feedback from the language system, where lexical and syntactic encoding takes place, to both gesture and language planning processes. These claims for a direct and 'online' effect of language formulation on gesture at the moment of speaking is important for this investigation of co-speech gesture in aphasia, where the underlying language impairment will have an effect on language formulation during the speaking process.

Competing theories characterize the gesture-speech interaction differently, for example although de Ruiter (2000) also claims that gesture arises at a pre-linguistic conceptual stage in processing, in his approach no feedback from the language system is involved. Iconic gesture is formulated from imagery in working memory. The fact that both the linguistic 'message' and the gestural 'sketch' are produced at this conceptual stage, and that both are subject to similar planning and selection processes, accounts for the semantic and temporal synchronisation of gesture and speech. So, for example, the manner and motion components of the 'roll' event in the Sylvester and Tweety cartoon are salient both imagistically and linguistically, and so are

encoded in both modalities in a similar way. To account for the cross-linguistic differences found by Kita and colleagues, de Ruiter claims that the fact that Turkish and Japanese have no word for 'swing', "....is known by the process responsible for encoding the communicative intention." (de Ruiter 2007), in other words, language-specific lexical and syntactic encoding differences are planned for in advance. In cases of lexical retrieval difficulty, de Ruiter's model predicts a compensatory effect in the accompanying gesture such that more of the communicative intention is depicted in gesture than the language. These claims are important for this investigation of co-speech gesture production in aphasia where there will be both lexical retrieval difficulties, and lexical and syntactic encoding choices which are not planned in advance but that have to be re-formulated at the point at which a particular speech production difficulty is encountered.

Other researchers have proposed that iconic gestures have a 'priming' role in lemma retrieval by strengthening semantic representations (Butterworth and Hadar, 1989; Krauss et al, 2000; Hadar and Krauss, 1998); or have a role between lemma and lexeme retrieval, maintaining semantic information while phonological forms are retrieved (Krauss et al. 2000). In the Krauss model (op cit) although gestures are planned for at the conceptual stage, alongside planning for speech, the effect gesture has on speech happens later. These authors claim that "the output of the gesture production system [feeds] into the phonological encoder where it facilitates retrieval of the word form" (op cit, pg. 267), acting as a cross-modal prime by facilitating retrieval of form most closely related to the communicative intention.

These claims are important for this investigation of co-speech gesture production in aphasia as they predict that, in situations where there is difficulty speaking, the original communicative intention will be retained in the accompanying gesture.

Gesture in Aphasia

Aphasia is an acquired disorder of language comprehension and/or language production affecting communication. There is a range of language difficulties that may be experienced which, if we focus on speaking, can include pre-lexical problems accessing the semantics of lexical items (word meaning) or their phonological form (abstract sound), or post-lexical problems encoding the phonology and assembling the chosen lexical items into specific clauses. There are many studies which report on the effects of gesture on aphasic language (for a review, see Rose 2006) but only a few investigating the reverse relationship: the potential impact of aphasia on gesture production.

A number of studies suggest that people with aphasia use more iconic gestures than do healthy controls (Feyereison, 1983; Hadar, Burstein, Krauss & Soroker, 1998; Kemmerer, Chandrasekaran & Tranel, 2007; Lanyon & Rose 2009; Pedelty, 1987). Other studies looking at gesture frequency found a range of patterns depending on aphasia type. For example, while Hadar, Wenkert-Olenik, Krauss and Soroker (1998) found that participants with phonological and semantic impairments produced iconic gesture with a similar frequency to control participants, Hadar & Krauss (1999) reported that participants with anomia produced more gestures than controls or participants with other types of aphasia.

These frequency studies tend to report only limited information about the participants' communication system, such as whether their aphasia can be broadly classified as phonological or anomic, and so they are limited in their ability to shed light on possible interaction between specific aspects of language processing difficulty and the accompanying gesture. For example, Carlomagno and Cristilli (2006) classified the gestures produced by ten adults with aphasia (five non-fluent and five fluent) according to Beattie and Shovelton's (1999: cited by Cartlomagno & Cristilli 2006) categorization scheme which included semantic information, for example shape versus direction, however they did not provide specific detail about the language which accompanied each type of gesture. While Hadar et al. (1998) reported that iconic gestures frequently occurred during hesitant speech for people with semantic difficulties, they did not provide further information about the language or the gesture on these occasions.

Lanyon and Rose (2009) carried out a study observing the co-speech gesture produced by 18 people with aphasia alongside conversational narratives. Overall, their results indicate a significantly higher frequency of gestures alongside word retrieval difficulties. They also found more meaning-laden gestures were produced during occurrences of word-retrieval difficulty than fluent speech. However, this study used broad categories of gesture, such as iconic versus beats, rather than providing detail about the form and semantic content of iconic gestures that would have been useful for comparison with the form and semantic content of the accompanying speech.

Only two studies of gesture production in aphasia (Kemmerer, Chandrasekaran & Tranel, 2007; Pedelty, 1987) have attempted to link specific linguistic properties of

the impaired language with the semantic content of the accompanying gesture. Kemmerer et al (op cit.) reported a single case study of a man, Marcel, who following a head injury to the left hemisphere had profound difficulties producing words (anomia). In re-telling the Canary Row story Marcel did not use either of the target verb labels ('swing' and 'roll') instead he producing alternative verb and preposition combinations (e.g. "*go here"*, for the SWING event, and "*run, run, run"* for the ROLL event). Difficulty producing verbs, in aphasia, often results in the replacement of the intended verb with a semantically 'light' one (e.g. Berndt et al 1997). Light verbs are relatively unspecified semantically, and their meaning often makes up part of the semantic specification of a heavier verb so, for example, the meaning of the light motion verb 'go' (to move along a path) forms part of the meaning of manner of motion verbs such as 'swing', 'fly' and 'run'.

The notation used by Kemmerer et al (op cit) meant that it was not always clear which part of the language was actually concurrent with the gesture and so, although we also have information about the co-speech gesture Marcel produced, we are not able to be specific about the relationship with the impaired language. On one occasion, Marcel accompanied his verbal description of the SWING event with a conflated gesture encoding both Manner and Path (an arc). This is significant, given the fact that the lexical item '*swing'* was not used in the associated speech and seems to conflict with the findings from unimpaired speakers that linguistic packaging is reflected in the accompanying gesture. The authors suggest that "…the role of the co-speech gesture seems to be to supply information missing from the speech." (op cit: pg 24). In two descriptions of the ROLL event, Marcel firstly produced co-verbal gesture depicting manner information, then gesture depicting path information, and then gesture which

conflated the two. In the light of this, the authors propose that "interruption in the normal flow of linguistic processing may have been partly responsible for his production of separate manner-only and path-only gestures instead of an English-typical conflation." (op cit: pg 17). The author's explanation for the gesture produced in describing the SWING event seems to be at odds with their explanation for the English atypical gesture produced for ROLL. In the former the hypothesis seems to be that co-speech gesture can augment aphasic language by providing missing semantic detail whereas in the latter the hypothesis is that co-speech gesture mirrors impaired linguistic processing. A tighter comparison between the gesture and specific components of the linguistic description would be necessary to resolve this apparent contradiction.

Pedelty (1987) looked at the relationship between aphasic language and gesture much more broadly, and included investigations of frequency of gestures (both iconic and non-iconic and both co-speech and in the absence of speech) across different types of aphasia which supported the patterns reported in the literature. She notes that "gestural deficits" tend to parallel linguistic deficits in that the most severely impaired patients tended to provide the sparsest and most inadequate gesture and speech; a conclusion which appears to lend support to the idea that gesture mirrors aphasic language. Because of the heterogeneous nature of aphasia, even within aphasic sub-types, this possibility is best explored in single-case studies (Willmes, 1990). Caramazza (1986) argues that valid inferences about the link between language impairment and other cognitive systems, such as gesture, are only possible from single-patient studies, which allow for a fine-grained mapping of the component parts of the language processing system.

Conduction Aphasia

Aphasia is a communication impairment resulting from head injury or stroke, which can take a number of forms ranging from having difficulty remembering words to being completely unable to speak, read, or write. Conduction aphasia is charactersied by good comprehension along side fluent but errorful speech. There is considerable debate about the source of the impairment underlying conduction aphasia, although the surface symptoms are relatively clear: word-finding problems and phonemic errors in the context of fluent speech, as well as significant difficulty with verbal repetition (Bartha & Benke, 2003). Phonological deficits in production extend across all production tasks including conversation, narrative and naming (Nadeau 2001: cited by Simmons-Mackie, 2005). According to Simmons-Mackie (op cit) , the primary criteria for diagnosis of conduction aphasia are : "1. fluent, paraphasic conversational speech; 2. no significant difficulty in comprehension of normal conversation; 3. significant verbal repetition disturbance; and 4. a preponderance of phonemic paraphasias." (pg 157). People with conduction aphasia have significant problems retrieving words for production which results in hesitations and circumlocutions as well as phonemic errors, and it has been reported (Kertesz, 1979) that some people with conduction aphasia do better on single naming tests than they do in narrative or conversation. Kohn (1992) considers phonemic errors to be the key characteristic of conduction aphasia, along with frequent attempts at self-correction and 'conduit d'approche': sequences of self-correction attempts which tend to get closer and closer to the target. The phonemic errors include substitution of one phoneme with another as well as the movement or transposition of a phoneme within a word. Although there is some evidence (Goldrick & Rapp, 2007; Laganaro & Zimmermann, 2010) that

these two error types are due to different underlying impairments, this is far from conclusive and other researchers (e.g. Bartha & Benke, 2003) report that these error types can co-occur.

Bartha and Benke (op cit) conducted a wide-ranging review of the language and cognitive profiles of 20 people with conduction aphasia and they concluded that, although all their participants showed characteristic phonemic paraphasias, conduite d'approche, and word-finding difficulties in spontaneous speech, the profound repetition impairment was the most impaired language function. This repetition difficulty is more likely to occur with phrases, sentences and polysyllabic words than with familiar single words and so aphasia batteries, such as the Western Aphasia Battery (WAB-R; Kertesz, 2007), include a repetition subtest with items ranging from single words and polysyllabic words to phrases and sentences.

Summary

This paper aims to relate the findings from co-speech gestural studies of unimpaired speakers to the iconic gesture produced alongside aphasic language in a single case study of conduction aphasia. The reviewed literature points toward either the reflection of language processing choices in gesture; or gestural compensation for language processing difficulty. Accordingly we propose that the particular 'online' choices made by a speaker with conduction aphasia will either be reflected in her gesture; or that her gesture will compensate for her aphasic language difficulties by encoding more of her communicative intention than the language.

In a related study (Cocks, Dipper, Middleton and Morgan 2010), we focus on the gesture co-occurring with the non-fluent phase of LT's speech, whereas in this study we focus solely on the gesture that co-occurs with relatively fluent speech. This is the speech LT produced without major disruptions, where there are no clear lexical access failures, but where there may still be processing difficulty evidenced by uncommon or ungrammatical lexical and sentence-structure choices. The analysis of gesture co-occurring with word-finding has not been combined with the analysis of co-speech gesture because we consider them to be different types of gesture (see Cocks et al op cit for detail). The current paper focuses on the co-speech iconic gestures used by a woman with acquired language impairment to talk about motion. Systematically analysing the relationship between gesture and spoken language in this way has the potential to further our understanding of the mechanisms of gesture production.

Methodology

Participants

LT was a 44-year-old right-handed English female who had had an intra-cranial haemorrhage 18 years previously. Computed tomographic (CT) scans indicated damage to the left parietal lobe. Prior to her haemorrhage, she had completed 15 years of education, obtaining a degree in Drama and Politics, and had begun a career as an Actor. Nine control participants were also 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. Three control participants were female and two were male; they were aged 42- 62; and 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), which indicated that she did not have any upper limb weakness. The Limb Apraxia Screen by Poeck (1986), in which LT was required to gesture in response to command, indicated that LT did not have ideomotor apraxia. This was confirmed in the New England Pantomime Production Test (Duffy and Duffy 1989) in which she received a score within the normal range. For exact scores, see table 1.

Gesture comprehension

The assessment from Cocks et al. (2009) was used to assess LT's gesture comprehension. This assessment compares comprehension of gesture in isolation with the integration of information from gesture and the speech produced alongside it. LT was able to comprehend gestures-in-isolation with no errors and, although she had some mild difficulties with the integration of gesture and speech, her scores fell within the range of the control participants. For exact scores, see table 1.

Language assessments

LT's speech was relatively fluent with frequent word-finding difficulties characterised by phonemic errors and conduit d'approche (multiple attempts at the same word with phonological errors) as well as paraphrasing, as can be seen in the following narrative extract:

> *The /ka/ the /ke/ the /pu/ um pissy er pussy cat no the um bird/ /s/ /fwa/ / w/ watching carefully for something/ and the / k/ the cat also looking very carefully with it's monoculars (laughs)...*

This expressive language pattern is associated with conduction aphasia (Bartha & Benke, 2003).

In single-word picture naming tasks (see the relevant sub test of the WAB and the Objects and Actions Test scores in table 1) she made a number of errors consistent with the pattern seen in her narrative, i.e. phonemic rather than semantic substitutions. Her score on the Pyramids and Palm Trees Test (Picture Version) (Howard and Patterson 1992) also supported the contention that LT had intact semantic knowledge. The Object and Action 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 (WAB-R: Kertesz, 2007) LT obtained an aphasia quotient of 74.2, indicating that she had moderately severe aphasia, and a profile of scores consistent with conduction aphasia. On the WAB-R, the aphasia quotient is a composite score which reflects the severity of aphasia, regardless of diagnostic type. The diagnosis of conduction aphasia comes from the comparison of fluency and comprehension scores with the scores from a repetition test, which consists of 15 items ranging single words and polysyllabic words to phrases and sentences. Other variables taken into account in this subtest include oral agility and articulatory difficulty, as well as the ability to repeat content words, function words and number words (Kertesz, op cit). To score this test, a point are deducted from a total of 100 for each phonemic or word sequencing error.

LT did not present with any muscle 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).

[insert Table 1 here]

Table 1 - LT's Assessment Scores

Language	
i. standardised assessment battery	
Western Aphasia Battery – revised (Kertesz 2007)	-
Speech fluency	7/10
Comprehension	9/10
Repetition	3.4/10
Naming	7.7/10
Aphasia Quotient	74.2
ii. naming test	
Object and Action Picture Naming Battery (Druks 2000)	-
Objects	85/100
Actions	63/100
iii. semantic assessment	
Pyramids and Palm Trees (Howard and Patterson 1992)	49/52
Motor	
New England Pantomime Expression Test (Duffy & Duffy, 1984)	14.09 /15
Action Research Arm Test (Lyle, 1981)	66/66
Limb Apraxia Screen (Poek, 1986)	10/10
Gesture	
Gesture Comprehension (Cocks et al, 2009)	-
Gesture alone	21/21
Gesture + speech	15/21

Summary and Hypotheses

LT's language profile is characterised by relatively fluent speech containing phonemic errors. There is also evidence of some compensatory strategies – such as word substitutions and paraphrasing – which are consistent with the fact that the haemorrhage occurred 18 years prior to this study. This profile is consistent with the diagnosis of conduction aphasia, obtained from the WAB-R (Kertesz 2007) on the

basis of low scores for repetition alongside high scores for speech fluency and comprehension.

On this basis, the following hypotheses are proposed:

1. when LT can produce a manner-of-motion verb in speech and realize it alongside its associated prepositional phrase in a single clause, she will produce co-speech gesture where manner and path information is conflated;
2. when LT's speech encodes manner and path information separately – such as by producing two clauses, or by separating (by a pause or an intervening phrase) the manner–of-motion verb from a related preposition - this will be reflected by co-speech gesture conveying manner only or path only information;
3. when she paraphrases the manner-of-motion event by using a semantically 'light' verb such as "*go*" which is manner-neutral, this choice will be reflected in co-speech gesture conveying only path information.

Note that, if co-speech gesture 'compensates' by containing more information about the event than the accompanying speech, hypotheses 2 & 3 will be rejected.

Materials and Procedure

Participants were told that they were participating in a storytelling experiment, and were shown a Sylvester and Tweety cartoon[2] with the instruction to remember the stimulus as well as possible so as to be able to retell it to someone who had not seen it. Gesture was not mentioned in the instruction.

[2] For a detailed description of the cartoon, see the appendix of McNeill (1992).

The cartoon was sub-divided into 8 episodes of approximately equal length to reduce memory load, and shown to the participants on a laptop PC screen. Immediately after watching each episode, the participant retold the story to the listener whilst being videotaped.

Analysis

The resulting narratives were analysed separately for speech and for gesture. The verbal narratives were transcribed verbatim, main verbs were identified, and a broad syntactic analysis was made of each clause. Only two semantic categories of verb were relevant to our research question:

- manner-of-motion verbs: verbs which lead to a change of location, and which include path information (the start point, route or end point of the motion) *and* manner information (the way in which the motion is carried out)
- path-only verbs: verbs which lead to a change of location and include path information *but not* manner information.

The videos of the participants were segmented and coded using the gesture and sign language analysis program ELAN (Wittenburg et al. 2006), and by using a coding system similar to Kita and Ozyurek (2003). In order to categorise only the relevant gesture, all gestures that did not occur alongside speech or that were not iconic were discounted (this included all beats, mimetics, emblems and deictics). The resulting set of gestures was then categorized as follows:

- Manner: conveys the way in which action is carried out, for example the hands circling round each other, palms facing towards body, to represent rolling.

- Path: conveys the direction in which an object/person moves, for example - the hand moves in diagonal direction across the body to represent the path an object took in its motion down a hill.
- Manner + Path: conveys both manner and path information simultaneously, for example the hands circling round each other whilst moving in a diagonal direction across the body to represent an object rolling down a hill.
- Other: conveys semantic information not included in the above categories, such as shape and/or orientation information mostly associated with objects. These gestures[3] were removed from further analysis as they are not of direct relevance to the investigation of manner of motion events.

All of the co-speech iconic gestures were categorized by two people (inter-rater agreement = 83%) and 25% were also checked by a third person (inter-rater agreement = 87.5%).

Results & Analysis

LT produced a total of 37 co-speech iconic gestures across the whole narrative, of which 17 (46%) were path-only; 11 (30%) manner only; and 9 (24%) were manner + path conflations. The controls produced a mean of 26 co-speech iconic gestures; 6 (23%) path, 10 (37.5%) manner, and 10 (37.5%) manner + path.

Within these overall totals, the hypotheses lead us to consider only those co-speech iconic gestures that co-occurred with either manner of motion or with path verbs. The resulting subset of 34 gestures includes 17 gestures produced by LT and a mean of

[3] the 'other' gestures removed from the analysis represented 35% of LT's co-speech iconic gestures and 24% of the control group mean.

16.8 produced by the controls. This narrowing of the analysis allows for detailed linguistic description of the accompanying speech – which is necessary in an investigation of clinical language – as well as a direct comparison with the manner-of-motion verbs 'swing' and 'roll' focussed on in the cross-linguistic literature. The next section further analyses the co-speech iconic gestures which co-occurred with manner of motion verbs; following that there is a section of analysis on the co-speech iconic gestures which co-occurred with path verbs; and finally there is some specific analysis focussed on 'swing' and 'roll'

Manner of Motion Events

[insert table 2 here]

Table 2

Gesture types and clause structure for manner-of-motion events.

	No. of conflated gestures		No. of manner only gestures		No. of path only gestures		TOTAL
	Single-clause	>1 clause	Single-clause	>1 clause	Single-clause	>1 clause	
LT	6	0	0	1	0	2	9
Mean of controls	8.4 (SD = 5.0)	0	3.8 (SD = 2.6)	0	2 (SD = 1.7)	0	14.2

As table 2 shows, an average of 23.2 co-speech iconic gestures occurred alongside manner of motion verb phrases (9 LT, and the control mean of 14.2). Although the

number and type of co-speech gestures produced by LT was very similar to the mean of the controls, the structure of the accompanying language differed. All gestures produced by the controls were produced alongside single-clause verbal descriptions, whereas LT produced single-clause verbal descriptions alongside all of her conflated gestures but not alongside either the path-only or the manner-only gestures. The latter gestures were associated with the clause structures set out in table 3.

[insert table 3 here]

Table 3

LT's speech co-occurring with gestures encoding only path and only manner information.

"...and he rolls and keeps going[4] *falling falling falling falling..."* {2 clauses}	Both hands circling each other forwards. [MANNER only]
"... and then pushing him... (2 second pause) *...down.."* {1 clause} {V [NP] separated from [PP] by pause}	Right hand, palm open, moves across chest in a short, fast sweeping/pushing motion. [MANNER only] Both hands, palms semi-open, push downwards. [PATH only]

As table 3 shows, there were three co-verbal gestures produced by LT alongside manner of motion events in which manner and path information was produced either in isolation or separately. In each case the co-occurring language departed from the expected single clause (V + PP) packaging. In the first, manner information is included in one clause and path in a second clause; and in the second the manner and

[4] the underlined parts of the transcript shows where the gesture occurred

path information, although in a single clause in the speech, is separated by an unusually long pause.

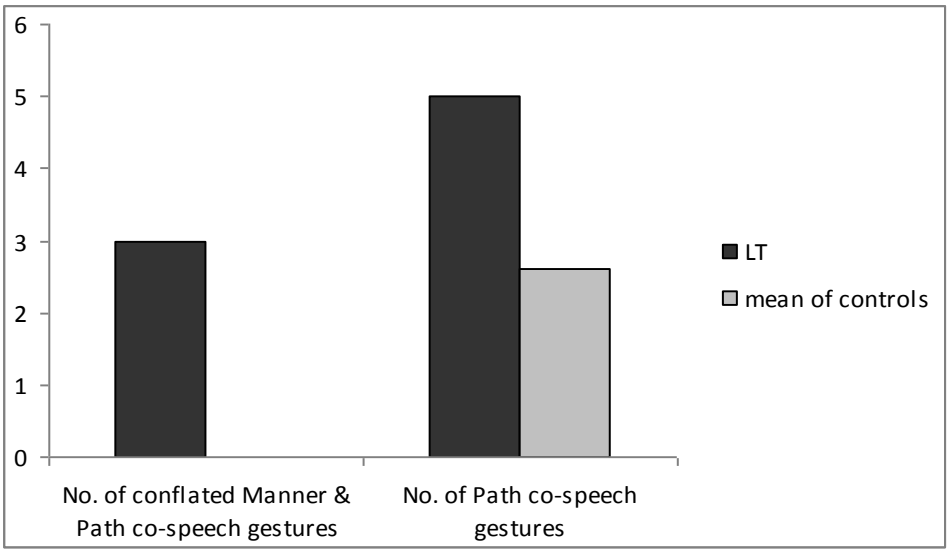
Path events

Of the 34 gestures analysed in detail, 11 occurred alongside path-only verb phrases (8 LT, and a control mean of 2.6). Figure 1 shows the categories into which these gestures fell.

[insert figure 1 here]

Figure 1

Co-Speech Gestures produced alongside 'go'



As figure 1 shows, LT used five path-only gestures and three manner-and-path conflations whereas, on average, the controls used 'go' with co-speech iconic gesture only 3 times (mean = 2.6, SD = 3.7) and in each case the accompanying gesture depicted only path information. The standard deviation figure indicates a large variability in the number of uses of 'go' with co-speech gesture within the control group. The large range was due to a single control outlier who used 'go' with path-

only gesture nine times. Two other controls did not use 'go' with co-speech gesture at all and the final two did this twice each.

All of the co-speech gestures associated with 'go' overlapped with a single clause in the speech, however there were some differences in the structure of the clauses accompanying LT's gesture such that: five contained 'go' as a main verb (e.g. '[it] goes into the pussy cat') and two contained a 'go' verb that was subordinate in some way to another verb ("..*bringing a … bowling ball to go down the …drain pipe*" and "*…then you see him going all the way all the way all the way through the street…*"). The three gestures depicting conflated manner-and-path co-occurred with the subordinated 'go' verbs described above.

Comparing LT's data to the published literature

In the vast majority of other studies using this methodology, two key scenes were singled out for analysis: *ROLL* and *SWING*. For the *ROLL* event, the results for LT, our 5 control participants, and the cross-linguistic data reported in the literature are presented together for comparison in table 4.

[insert Table 4 here]

Table 4

Comparing LT's description of the ROLL event with unimpaired speakers.

		Language	Gesture
LT		multi clause	separate M
Controls[5] C1 C4 C5		 single clause single clause single clause	 M & P conflation M & P conflation M & P conflation
		Language Preference	Gesture Preference
Other unimpaired adult speakers (Ozyurek & Kita 1999; Kita 2000; Kita & Ozyurek 2003)	English	single clause	M & P conflation
	Turkish & Japanese	multi clause	separate M separate P

To describe the ROLL scene, LT says,

"..*and he rolls and keeps going falling falling falling /n/ falling*".

Here she produces two clauses [*he rolls*] and [*keeps going falling* ...]; the first clause lexicalises the manner of motion of the event into the verb but excludes any reference to path, and the second (ungrammatical) clause includes both the semantically light path verb 'go' and a semantically heavier verb 'fall' which encodes a downward path. As table 4 shows, such a multi-clause description differs from our controls as well as from the majority of both the adult and child English speakers. LT's gesture coincides with the whole of both clauses, depicting only manner information, and consists of a reduplicated rolling action involving both hands, index fingers extended, circling forward at chest height.

[5] Here we report the sentence structure used by all those speakers using the verb 'roll' to describe the ROLL scene, and excluding all those speakers who used other verbs or who did not produce any gesture concurrent with a description of this event.

For the SWING event, the results for LT, our 5 control participants, and the cross-linguistic data reported in the literature are presented together for comparison in table 5.

[insert table 5 here]

Table 5

Comparing LT's description of the SWING scene with unimpaired speakers.

	Language		Gesture
LT		no arc[6]	Arc
Controls			
C1		arc	arc (+ flat path)
C2		arc	arc
C3		no arc	flat path
C4		arc	flat path[7]
C5		arc	arc
Other Unimpaired Adult Speakers (Ozyurek & Kita 1999; Kita 2000; Kita & Ozyurek 2003)	English	arc	Arc
	Turkish & Japanese	no arc	no arc

In response to the SWING scene, LT says,

"*... he has the the um the <u>rope ready to go from one building to the other</u>*"

Here she used the semantically 'light' verb 'go' to describe the manner of motion event described by all English speakers in the published literature and the majority of our controls with the word 'swing'. The motion verb, 'go', is in an infinitival form subordinated to the main clause 'have the rope ready'. Accompanying the underlined section of this speech she uses a two-handed gesture, beginning at her right shoulder and swinging to the left-side with an arc shape (i.e. depicting both manner and motion). This is not in line with those speakers of other languages who, like LT in this particular instance, did not use 'swing' in the accompanying speech; nor is it in

[6] used the word 'go'

[7] This speaker's description, although including the verb 'swing', differed from the other controls in that the VP was 'swing out of the window' rather than the more usual 'swing across to the other building'.

line with the single English speaking control who used a verb other than 'swing'. Most usually in cases where the accompanying language does not encode path, neither does the gesture (i.e. no arc in either gesture or speech).

Discussion

Taking the narrative as a whole, LT produced a similar number of co-speech gestures which conflated manner and path information into a single gesture to the controls (9 vs. 10) and more gestures encoding only path information (17 vs. 6.4) than the controls. This reflected the semantic content of her verbal narrative. When only the gesture coinciding with manner of motion verbs was considered, LT produced gestures conflating manner and path information alongside single clauses but gestures separately encoding manner or path information alongside other clause structures. In contrast, the control group produced only single clauses and gesture conflating manner and path information.

The fact that LT produced single-clause structures with gesture conflating manner and path information supports the first hypothesis that when access to the spoken target is unproblematic, the accompanying gesture would conflate manner and path as would be expected for an English speaker. Such a finding is consistent with the comparative findings from Kemmerer et al. (2007): in one of the three descriptions of the 'roll' event produced by Marcel, he verbally encodes the event in a single clause and in his gesture conflates manner and path.

The other two descriptions of 'roll' produced by Marcel involved problematic sentence construction as well as gesture separately encoding manner or path

information. The three occasions where LT's language departed from the expected single clause pattern are similarly revealing: for all of them, the accompanying gesture mirrors the language by separately encoding manner or path information. For example, to describe the scene where Sylvester, having swallowed the bowling ball, rolls down the hill, LT says *"...and he rolls and keeps going falling falling falling falling..."* whilst her hands circled each other, depicting only manner information. In the language, LT encodes manner and path information in two separate clauses and this separation is reflected in her gesture, a pattern which supports Kita's contention that "… what can be linguistically packaged in a unit (e.g. clauses) for speech production in a given language is reflected in gestural representation of the equivalent information." (Kita 2009, pg.156).

LT's language difficulties stem from post-lexical phonological encoding, the purpose of which is described by Levelt (1989) as being

> "*…to retrieve or build a phonetic or articulatory plan for each lemma and for the utterance as a whole. . .* " (Levelt 1989: 12)

LT's impairment could therefore affect both the encoding of the verb 'roll' and its prepositional argument phrase. In de Ruiter's theory (2000), such lexical difficulties should have led to a compensatory effect in the accompanying gesture such that more of the communicative intention was depicted there, but this was not the case. Nor did the results provide evidence of a 'priming' role (Butterworth and Hadar, 1989; Krauss et al, 2000; Hadar et al, 1998) or a role in maintaining semantic information while phonological forms are retrieved (Krauss et al. 2000). Instead, the results suggested that co-verbal gesture reflected lexical and syntactic choices made at the moment of speaking (Kita, Özyürek, Allen, Browm, Furman and Ishizuka, 2007).

Although there is published evidence of language impairment affecting co-speech gesture in terms of frequency (e.g.Pedelty 1987), fluency (Mayberry and Jaques 2000), and type (beats vs. iconics, e.g. Lanyon and Rose 2009) this suggestion that language impairment can also affect the semantic content of co-speech iconic gesture is new and has the potential to shed further light on our understanding of the relationship between language and gesture.

When only the gestures coinciding with manner neutral verbs like ‘go’ were considered, it was found that all of the gestures produced by the controls and five of the eight (63%) gestures produced by LT encoded only path information. This is not a surprising finding given that the semantics of the verb label does not include manner information; however it is a finding which further contradicts the idea of a compensatory role for co-speech gesture (de Ruiter 2000). We would argue that the reason this explanation does not hold here is to do with the structure of the discourse: on the majority of occasions that the participants used ‘go’ in this narrative, path information is prominent (and manner information back grounded). The importance of the path information is reflected both in the content of the accompanying gestures and in the verb label chosen (non-specific motion verb ‘go’ rather than other possible manner of motion verbs).

In these cases, we are arguing that LT did not necessarily have a specific manner of motion event in mind for which she substituted ‘go’ but instead, like the three controls, focussed intentionally on path to the exclusion of manner. In other words, she is not substituting ‘go’ for a verb label that she cannot access but is

conceptualising GO + path from the outset. The accompanying gestures encoding path alone are a reflection of this conceptualisation. In these cases, the semantic content of the gesture mirrors rather than compensates for the language.

To explore this possibility further, a post-hoc discourse analysis was carried out on the narratives and it was found that 10 of the 13 'go' verbs used with path gesture by the controls were part of a larger discourse chain describing a complex movement. For example, C5's description of the 'Bellboy' scene includes this discourse chain, (with those parts of the narrative co-occurring with path gestures underlined):

"so he goes in gets the bag and the bird cage
walks away from the door
throws away the bag the case
goes down the stairs goes out of the back of the apartments."

LT also produces similar discourse chains involving the verb 'go', for example in describing the 'Bowling Ball' scene:

"*… and he goes right into the the al the a the pussy cat..*
into his mouth and goes into his body"

There are also three occasions on which, unlike any of the controls, LT accompanies 'go' with a gesture conflating manner and path information. These three occasions could be argued to be insignificant, or they could be markers of linguistic difficulty for LT. In order to explore this possibility further, we looked at the accompanying language and found that whereas all the 'go' verbs accompanied by path gestures are main verbs, the three 'go' verbs accompanied by conflation gestures by LT are subordinated to a main verb.

This sentence structure difference may be significant, in that it is possible that the use of 'go' in subordination to a main verb reflects a 'last minute' substitution due to post-lexical problems consistent with conduction aphasia. It is possible that in these cases, LT had a problem with either with the phonological encoding of a verb or with the assembly of the clause around it and so compensated by substituting an alternative clause (one that encodes path information in the verb 'go' and packages this with another verb). In such a case, she will have had an event in mind which includes both manner and path information ('swing' or 'zigzag') but she encoded only path information in speech ('ready to go' and 'see him go'). There is some further evidence in the language that she had the specific manner event 'zigzag' in mind, for example, although she produces:

> *"and then you <u>see him going all the way all the br all the way through</u> the street"*

Here the repeated NP *all the way* suggests manner information although the verb 'go' does not encode it. This suggests that LT was experiencing a production problem that was highlighted by the speech-gesture mismatch.

Such an explanation could also be applied to some of the data in Kemmerer at al.'s (2007) study, although caution must be exercised both because it is not clear which part of the spoken phrases were co-expressive with the gesture in this data, and because Marcel's language problems resulted from a head injury which caused language processing problems that were not the same as LT's. However, Marcel seems to be using strategies similar to LT's which result in 'substitute' phrases which were co-expressive with conflated gestures. In such instances, the role of the co-speech gesture seems to be to supply information missing from the speech. For

example, Marcel describes the 'roll' scene with "*he run run run"*. What is striking about this utterance is the use of repetition, much like LT's description of the 'zig-zagging' scene which, we would argue, serves the communicative function of conveying manner in the absence of an appropriate manner verb. In light of this claim, it is interesting to note that in both examples (one from Marcel and one from LT) we have an associated conflated gesture. This seems to support the idea that there is a 'last minute' substitution during lexical processing whilst the conceptualisation of the scene remains unaffected. In their 'interface' model, Kita and Özyürek (Kita 2000; Kita & Özyürek 2003) argue that speech and gesture production processes 'interface' online at the conceptual planning phase, and we are arguing that it is precisely this unaffected nature of conceptualisation that results in manner and path being conflated in the gesture.

In these two examples we do find some evidence for either a compensatory role for co-verbal gesture (de Ruiter 2000), or for its role in maintaining semantic information while an attempt is made to retrieve appropriate phonological forms (Krauss et al. 2000). We don't find evidence for such roles elsewhere in our data: neither in the situations, like 'roll', where LT produces multiple clauses alongside manner or path gesture; nor in the situations where she produces 'go' alongside path gestures. Instead we are arguing that distinct language processes have distinct effects on the accompanying gesture.

Overall, our findings support the hypotheses that when LT was able to produce the spoken target, she would produce co-speech gestures that conflate manner and path information but when spoken language was problematic, this would be reflected in the

co-speech gesture. We find support in our data for the idea that there is a distinction between the gesture accompanying LT's fluent, unimpaired, speech and that accompanying unusual or ungrammatical sentence construction. We also distinguish between the planned use of manner-neutral verbs such as 'go' and 'last minute' lexical substitutions with 'go' where the underlying conceptualisation retains information about manner.

Our data support the claim that that co-verbal gesture reflects lexical and syntactic choices made at the moment of speaking (Kita, Özyürek, Allen, Brown, Furman and Ishizuka, 2007), and in addition the data shows that this is the case even when those lexical and syntactic choices are driven by an underlying language impairment. Because of the heterogeneous nature of aphasia we explored these ideas using a single-case study; this however limits the power of our conclusion. Further investigations with different types of aphasic language need to be carried out to substantiate these claims, and also to uncover other correspondences between the semantics of speech and the associated co-speech gesture.

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