Use of Spatial Communication in Aphasia

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Abstract

Background: Spatial communication consists of both verbal spatial language and gesture. There has been minimal research investigating the use of spatial communication, and even less focussing on people with aphasia.

Aims: The aims of this exploratory study were to describe the frequency and variability of spatial language and gesture use by three participants with aphasia in comparison to nine control participants. This included: 1) frequency of gestures; 2) types of gesture; 3) number of spatial descriptions described by gestures but no language; and 4) frequency and variety of locative prepositional, verb, and noun phrases.

Methods and Procedures: Each participant was videoed undertaking 11 spatial communication tasks: four description tasks, and seven tasks involving directing the researcher in the placement of objects or pictures. Gestures and language produced were transcribed and analysed.

Outcomes & Results: Participants with aphasia used significantly more gesture. Participants with aphasia also used more gesture without spoken phrases when spatial vocabulary was unavailable. Finally, there were differences between the participants with regards to the types of gesture that they used when they were unable to access language.

Conclusion and Implications: The results suggest that the analysis of gesture produced by people with aphasia may provide insight into their underlying language impairment. As this was an exploratory study, with just three participants with aphasia, further research is needed.

What is already known on this subject?

In the general population, gesture increases when speech is spatial in nature (Hostetter & Sullivan, 2011); but while people with aphasia generally produce more gesture than control participants (Carlomagno and Cristilli, 2006), we don't know specifically about gesture alongside spatial language.   There is also evidence that the analysis of gesture may provide crucial insight into the language impairment underlying gesture (e.g. Cocks, Dipper, Middleton & Morgan, 2011)

What this paper adds?

This study adds to the evidence base from unimpaired speakers, providing information about spatial gesture frequency and type in aphasia. It also adds to what we know about locative preposition difficulty in aphasic language.

Introduction

Spatial communication consists of both verbal spatial language and gesture (Emmorey & Casey, 2001). There has been limited research that has investigated the use of spatial communication by people with aphasia despite it being an important aspect of communication.

Gesture appears to be an essential part of spatial communication. Studies with the general population have found an increase in gesture when speech is spatial in nature and that spatial speech production is more difficult when gesture is restricted (Hostetter & Sullivan, 2011). This apparent link between verbal spatial language and gesture could prove useful clinically and should be investigated with people with aphasia.

The majority of studies that have investigated spatial communication by people with aphasia have focussed on verbal language rather than gesture. Studies have found that people with Broca's aphasia have particular difficulty with locative prepositions, and that locative prepositions are often omitted or substituted with other prepositions (Menn, Gottfried, Holland & Garrett, 2005). Such difficulties with prepositions are thought to relate to all levels of language processing (Menn et al, 2005). There is a growing body of research which suggests that people with aphasia produce more gesture than control participants (Carlomagno and Cristilli,2006), and that the analysis of these gestures may provide insight into their underlying language impairment (e.g. Cocks, Dipper, Middleton & Morgan, 2011). These findings suggest that analysing both gesture and spatial language can provide greater insight into the person with aphasia's difficulties.

Research that has investigated spatial gesture use by people with aphasia has been limited to two studies. Menn et al. (2005) explored the expression of spatial relationships and their interaction with pragmatic abilities. They found that participants with aphasia used a higher frequency of gestures than controls to indicate locative prepositions. However, because the focus of this study was on pragmatic abilities, spatial gestures were not analysed in detail. The other study which included spatial gesture was a single case study by Kemmerer, Chandrasekaran & Tranel (2007); although this study also did not specifically explore spatial language. Their participant with severe aphasia had very limited verbal output but was able to depict via gesture those motion events which included spatial information.

The current study aimed to build on these two findings by exploring the patterns of frequency and variability of spatial language and gesture use by three participants with aphasia in comparison to a group of control participants.

Methodology

Participants

Three participants with aphasia (AP1, AP2 and AP3 – see Table 1) were recruited from community stroke groups. They were compared to nine control participants who had no history of neurological illness (female=4; mean age= 59.7, SD= 17.2; mean years of education= 12.3, SD=2). All participants spoke English as a first language and were right handed.

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

Ethical Approval

The study was approved by the School of Health Sciences, City University Ethics Committee. All participants were given written information about the study and given time to read the information sheet and to discuss it with relatives or friends. For participants who had aphasia, an 'aphasia friendly' information sheet was provided. All participants were also given an opportunity to ask the researchers questions about the study before agreeing to take part. All participants signed a consent form indicating that they agreed to take part in the study. For participants with aphasia, the consent form was written in an 'aphasia friendly' format.

Assessments

A range of standardised assessments were undertaken with the participants with aphasia in order to determine their language, cognitive and motor abilities (Tables 2 and 3).

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

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

AP1 presented with transcortical motor aphasia, characterised by non-fluent speech with anomia and agrammatism. She had deficits with locative relations: making mostly reversible errors in input; and in output was only able to appropriately produce 'on top', 'behind' and 'in'. AP1 obtained a low score on the Montreal Cognitive Assessment (Nasreddine et al., 2005), however, the heavy reliance of this assessment on expressive language may have influenced the results. Both production errors and difficulties with word retrieval were evident despite intact semantic representation, suggesting an impairment at the level of the phonological output lexicon.

AP2 presented with Broca's aphasia, characterised by anomia with phonological paraphasias. There was no evidence of receptive aphasia. She demonstrated appropriate expression of 'inside', 'in front' and 'on top' but no other locative relations. Comprehension of locative relations also fell below normal limits with mostly reversible errors and confusion with 'behind' and 'in front of'. AP2s noun production difficulties were aided by phonemic cues, indicating incomplete retrieval of words and a likely deficit at the phonological output lexicon.

AP3 presented with severe Broca's aphasia and auditory comprehension difficulties. She obtained a very low score on the Montreal Cognitive Assessment (Nasreddine et al., 2005), suggesting a significant cognitive impairment, however, the heavy reliance of this assessment on expressive language may have influenced the results. Her difficulties with locative relations in both comprehension and production suggested a significant spatial semantic impairment.

Both AP1 and AP3 had no movement of their right hand or arm and had mild limb apraxia in the left upper limb as indicated on the BUCS and Limb Apraxia Screen. AP2 presented with intact motor skills in both left and right arms and hands, and there was no evidence of limb apraxia.

Tasks

All participants were asked to undertake 11 tasks, four in response to questions and seven involving them directing the researcher in placement of objects / pictures. A variety of tasks were chosen to elicit as broad a range of spatial communication as possible.

The tasks were as follows

1) Describe,
    a. the lay-out of the property where you live,
    b. the layout of items of furniture / items in your kitchen,
    c. how to locate your toothbrush from entering the front door of your property.
2) Explain the route taken to a local amenity from your property.
3) Direct the researcher in how to arrange the following items:
    a. dinner plate, two forks, two knives, dessert spoon, wine glass, and napkin (to correctly lay a table),
    b. four blue shapes to form a given picture (item adapted from Lowenstein Occupational Therapy Cognitive Assessment for Geriatric Population (LOTCA), Elazar & Itzkovich, 1996),
    c. seven coloured blocks to form a given picture of the construction (item adapted from LOTCA: Elazar & Itzkovich, 1996),
    d. nine picture cards to form a given picture (item adapted from LOTCA: Elazar & Itzkovich, 1996),
    e. objects in order for them to match a given picture and then a second given picture,
    f. 12 yellow blocks in order for them to match a constructed model (item adapted from Rivermead Perceptual Assessment Battery: Whiting, Lincoln, Bhavnani & Cockburn, 1985).

Data Analysis

Responses were recorded on a Sony DCR-HC62E Handycam camera, transferred to a computer, edited using Microsoft Movie Maker and analysed using the ELAN package (version 4.1.2, 2012: http://www.lat-mpi.eu/tools/elan/) (Sloetjes & Wittenburg, 2008).

Gestures were classified as one of the following types: points, deictics, orientation and shape outlines. These groups were chosen as they were felt to be most relevant in relation to spatial communication. Gestures that did not fall into these categories e.g. beats, were not included in the analysis. Points and deictics were treated as two separate categories as it was considered important to distinguish between these. Points were defined as direct pointing to an area and deictics for other directional indications. eg. hand moving up to indicate 'up'. Orientation gestures were defined as those that indicated the positioning/ orientation of an object eg. hand / finger being moved in a circle or turned over to indicate 'turn around' or 'turn over', or hand being positioned at the angle / orientation required of the object. Shape outline gestures were those that traced the outline of an object eg. drawing the sides of a square with a finger. Head gestures were classified in the same way with the head being substituted for the hand / finger. Gestures were also classified as either occurring with speech or without speech.

The language produced by the participants was also transcribed and the spatial language was identified. For the purpose of this study, spatial language was defined as: locative prepositional phrases such as "on the table"; locative verb phrases such as "put it there" or "turn it around"; the locative pronouns "here" and "there"; and finally the locative nouns "(the) left" and "(the) right" Cases of ungrammatical verbal spatial language, for example “turn around” rather than “turn it around” or “there … put it” were included in this count.

Inter-rater agreement

One randomly selected control participant, as well as question 11 of all three participants with aphasia, was rated by a second rater. 92.86-100% agreement across participants was reached on the number of instances of spatial language and 93.55-100% on the measure of variety in spatial language. 86.36-100% agreement was reached on the numbers of gestures produced alongside spoken spatial language and 88.89-100% on the number of relevant gestures produced without spoken spatial language. 88.00-94.74% agreement was reached on the classification of gestures.

Results

Analysis of data was undertaken using descriptive statistics and modified t-tests (Crawford & Howell, 1998). Participants with aphasia were compared to the nine control participants. The modified t-test is recommended for use when comparing an individual’s performance to a small group of control participants. In particular, Crawford and Howell (1998) recommend that the modified t-test should be used when the group of control participants is less than 50[1].

All three participants with aphasia used significantly more gestures with their verbal spatial language than did the control group (AP1: $t(10)= 4.962$, $p< 0.01$; AP2: $t(10)= 2.558$, $p<0.05$; AP3: $t(10)=2.950$, $p<0.02$) . Figure 1 shows the percentage of spatial language that was accompanied by gesture.

[1] A detailed discussion of the rationale for this approach and a list of publications on this topic can be found at: http://homepages.abdn.ac.uk/j.crawford/pages/dept/SingleCaseMethodology.htm

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

There were no statistical differences between the participants with aphasia and the control participants for any of the gesture types. All participants used predominantly deictics, with most also using a range of points and orientation gestures. See figure 2 for the relative proportion of different types of gesture use.

---------------------------Insert Figure 2 about here---------------------------

All three participants with aphasia produced significantly more gestures without spoken spatial language than the controls (AP1: $t(10)= 23.246$, $p<0.001$, AP2: $t(10)= 2.440$, $p<0.05$, AP3: $t(10)= 66.014$, $p<0.001$ (figure 3 shows the numbers of relevant gestures used without spatial language).

When unable to access verbal language, AP1 and AP2 used a range of gesture types including points, deictics and orientation gestures. AP3 appeared to have a limited number of prepositions in her vocabulary which may account for her use of 115 hand gestures to indicate locative relationships without speech. 56.25% of these gestures were points, many of which were very vague. The remainder were split between deictics and orientation gestures. See figure 4 for the distribution of types of gestures used without spatial language.

---------------------------Insert Figure 3 about here---------------------------

---------------------------Insert Figure 4 about here---------------------------

AP1 (93) and AP3 (only 25) both used fewer tokens of locative prepositional, verb and noun phrases in comparison to the controls ($M= 198.33$, $SD= 43.53160$), (AP1= $t(10)=-2.295$, $p<0.05$ (one tailed); AP3= $t(10)= -3.777$, $p<0.01$). AP2 however, used a similar number of tokens of verbal spatial language (254) to the control participants. She often incorrectly selected phrases but was predominantly aware of these errors and attempted self-correction, resulting in the increased overall number produced. See figure 5 for the number of tokens of verbal spatial language use across participants.

AP1 (16) and AP3 (8) also used less variety of types of verbal spatial language than the controls ($M=31.889$, $SD= 5.66667$) (AP1=$t(10)= -2.660$, $p<0.05$; AP3= $t(10)= -3.999$, $p<0.005$). AP2 (22) was not significantly different to the combined controls on this measure. See figure 6 for the number of types of verbal spatial language use across participants.

While AP1 and AP2 often substituted locative prepositional, verb and noun phrases for incorrect ones e.g. ‘other side’ for ‘left’ or ‘right’, AP3 omitted the speech entirely.

---------------------------Insert Figure 5 about here---------------------------

---------------------------Insert Figure 6 about here---------------------------

Discussion

The aims of the study were to explore the spatial communication of three participants with aphasia. All participants with aphasia used significantly more gestures alongside their verbal spatial language than the mean of the control sample. Carlomagno and Cristilli (2006) also found that people with aphasia used more gestures and an increased number of gestures per word than controls; however this was during a narration task rather than in relation to verbal spatial language. The current study therefore suggests that the high frequency of gestures by people with aphasia occurs across a range of discourse tasks.

There were interesting differences between the gestures of the participants with aphasia when verbal language failed. When verbal spatial language for AP1 and AP2 failed, they were able to use a range of gesture types to communicate their message. This is similar to the case described previously in the literature by Kemmerer et al. (2007). AP3 however, had more difficulties with both comprehension and production of verbal spatial language suggesting a more significant spatial communication difficulty. Unlike AP1 and AP2, she relied heavily on the same few gestures: point, slight movement of hand for direction, and rotating her finger for ‘turn around’. With the exception of pointing, AP3 did not use gesture spontaneously. When she was unable to convey her message, she continued to point without attempting to provide further information and only occasionally used additional gestures. Thus when AP3’s language failed, she was often unable to use gesture in a compensatory way to convey her message. This suggests that she was unable to retrieve neither the verbal nor gestural representation of the required word or phrase. While the reasons for this are not clear from the assessment data, the results suggest that AP3 had a more significant spatial communication deficit that affected her ability to use an alternative modality of communication when verbal language failed. The current study therefore adds to the growing body of research (e.g. Cocks et al.

2011) which suggests that the analysis of gesture by people with aphasia may be a useful addition to the speech and language therapists’ assessment toolkit.

Although this was an exploratory study with a small number of participants, the key finding - that participants differed in their ability to use gesture when unable to access verbal spatial language, and that the differences can be related to their language profile – justifies further exploration with a larger number of participants.

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FIGURES

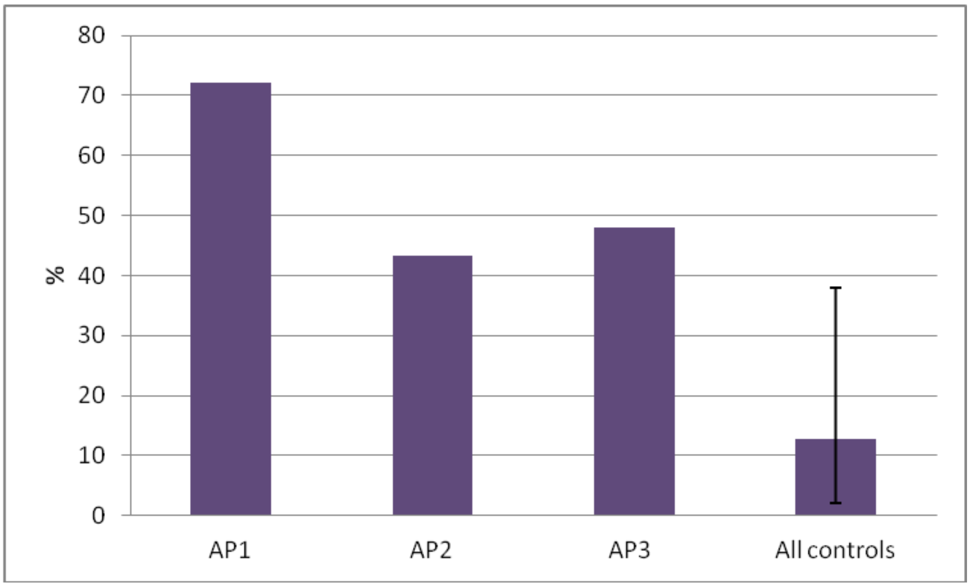

Figure 1.
Percentage of tokens of verbal spatial language accompanied by gesture, with the scores for participants with aphasia and the mean and range of the control group.

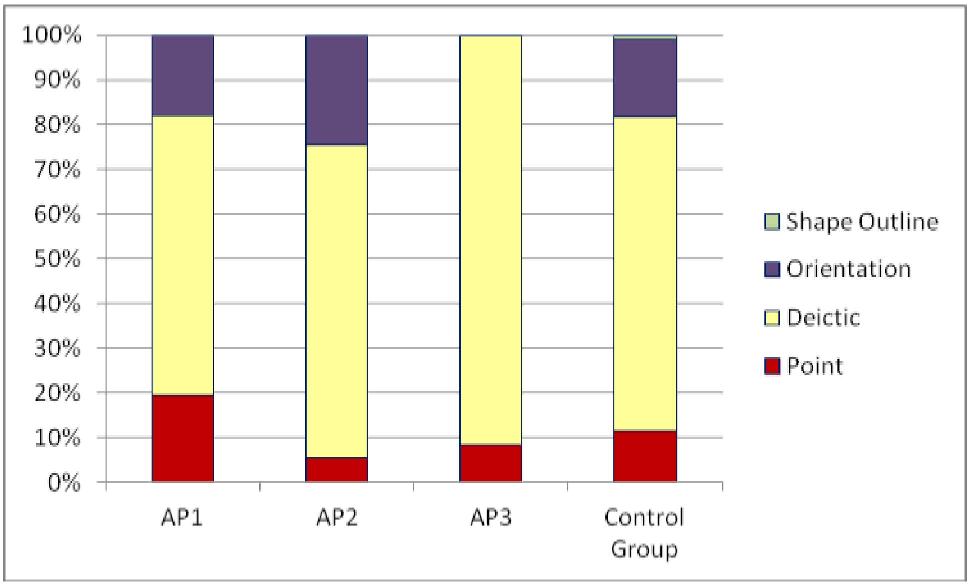

Figure 2. Proportion of different types of gesture , with scores for participants with aphasia and the means of the control group.

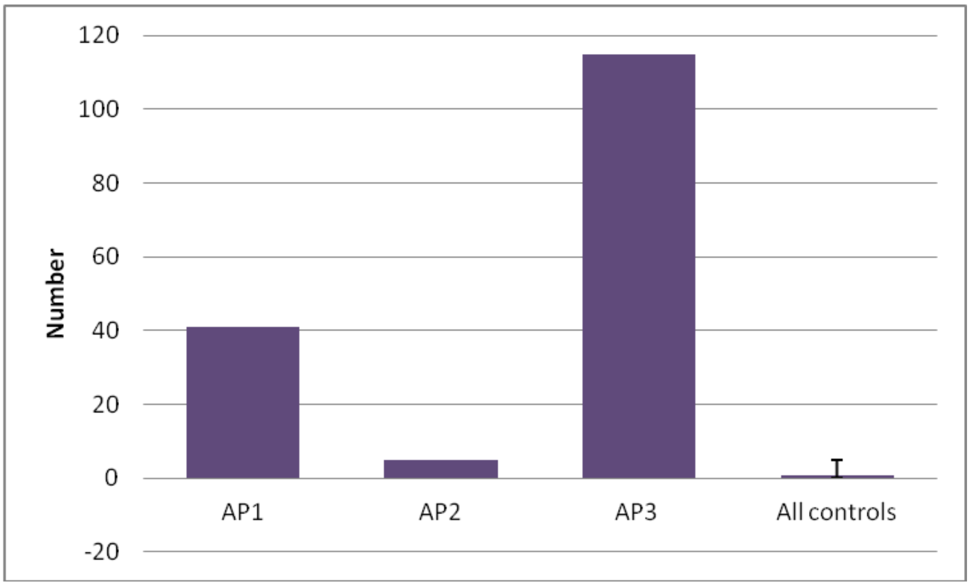

Figure 3. Numbers of gestures used without verbal spatial language, with scores of participants with aphasia and the mean and range of the control grou

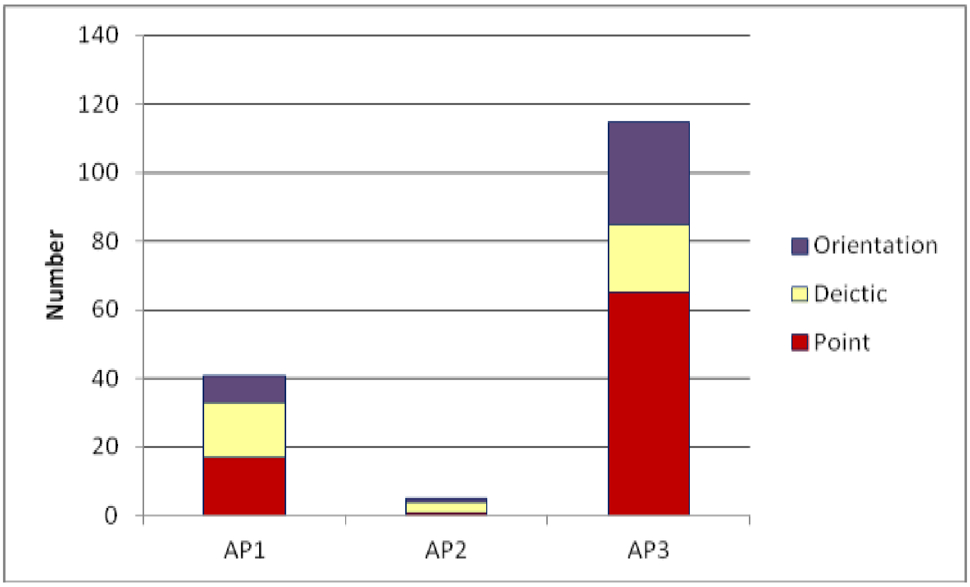

Figure 4. Distribution of types of gestures used without verbal spatial language by participants with aphasia.

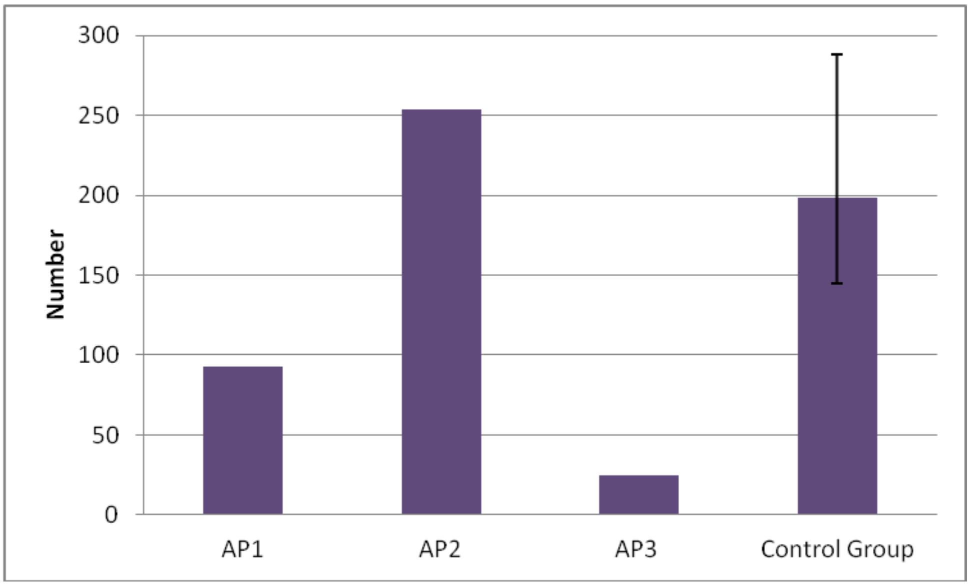

Figure 5. Number of tokens of verbal spatial language, with scores of participants with aphasia and the mean and range of the control group.

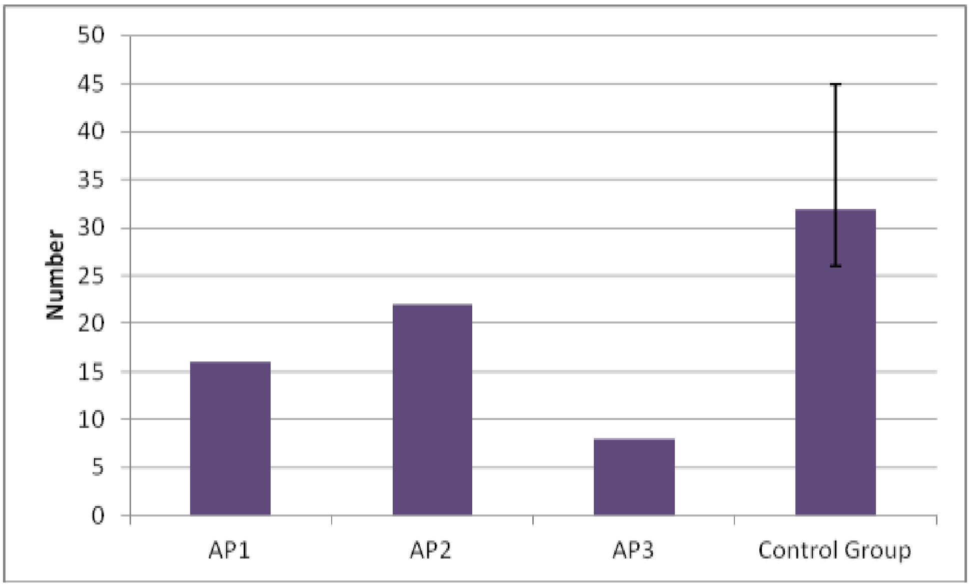

Figure 6. Number of types of verbal spatial language, with scores of participants with aphasia and the mean and range of the control group

.Table 1- Demographics of participants with aphasia

Participant	Gender	Age	Type of stroke	Date of stroke	Handedness	Education history	Employment history	Additional Languages
AP1	Female	43	Large infarct left temporoparietal region	MRI: 30.05.09 Stroke approx 1 year previously	Right	12 years of school	Restaurant and grocery manager in family business from school until stroke- 12 years	Shona Ndebele
AP2	Female	78	Infarct in left perisylvian frontal and temporal lobes	21.03.10	Right	11 years of school Nursery nursing at college	Nursery nurse for 8 years	None
AP3	Female	62	Infarcts- subcortical and peri ventricular white matter, posterior limb of internal capsule and lentiform nucleus on left, thalamus bilaterally	CT: 30.10.08 Initial stroke 12.04.02	Right	10 years of school Diploma at - London school of fashion Various IT courses	Nanny Seamstress Domestic sector	Ghanaian Twi

Table 2- Raw scores for Comprehensive Aphasia Test:

Participant	Auditory Comprehension	Written comprehension	Repetition	Spoken Language	Reading	Writing
AP1	Single words- 14/15, 24/30 just below normal limits (25) Sentences- 13/16, 22/32- aphasic (26) Paragraphs- 4/4 WNL	Single words- 14/15, 26/30 WNL (27) Sentences- patient not wishing to attempt after first- 0/32	Words- 15/16, 31/32 WNL Complex words- 3/3, 6/6 WNL Non-words- 5/5, 9/10 WNL Digit strings- 8/14 just WNL Sentences- 6/12 BNL (10)	Naming Objects- 21/24, 39/48 BNL (43) Naming Actions 1/5, 1/10 BNL Spoken picture description- 18 BNL (33)	Words- 8/24, 16/48 BNL (45) Complex words- 0/3, 0/6 BNL (4) Function words- 0/3, 0/6 BNL (3) Non-words 0/5, 0/10 BNL (6)	Copying- 27/27 WNL Picture names- no attempt Dictation- no attempt Picture description- no attempt
AP2	Single words- 15/15, 28/30 WNL (25) Sentences- 14/16, 27/32- WNL (26) Paragraphs- 4/4 WNL	Single words- 14/15, 28/30 WNL (27) Sentences- 13/16, 26/32 WNL (23)	Words- 11/16, 20/32 BNL (29) Complex words- 2/3, 3/6 BNL (5) Non-words- 3/5, 6/10 WNL (5) Digit strings- 6/14 BNL (8) Sentences- 6/12 BNL (10)	Naming Objects- 22/24, 39/48 BNL (43) Naming Actions 4/5, 8/10 WNL (8) Spoken picture description- 11 BNL (33)	Words- 13/24, 25/48 BNL (45) Complex words- , 1/3 1/6 BNL (4) Function words- 3/3, 6/6 WNL (3) Non-words – 1/5, 2/10 BNL (6)	Copying- 27/27 WNL Picture names- 21/21 WNL (15) Dictation- 25/28 WNL (24) Picture description- 2 BNL (19)
AP3	Single words- 12/15, 21/30 BNL (25) Sentences- 13/16, 22/32- BNL (26) Paragraphs- 3/4 WNL	Single words- 12/15, 21/30 BNL (27) Sentences- 9/16, 9/32 BNL (23)	Words- 16/16, 32/32 WNL (29) Complex words- 3/3, 6/6 WNL (5) Non-words- 5/5, 10/10 WNL (5) Digit strings- 6/14 BNL (8) Sentences- 8/12 BNL (10)	Naming Objects- 0/24, 0/48 BNL (43) Naming Actions 0/5, 0/10 BNL (8) Spoken picture description- 5 BNL (33)	Words- 11/24, 17/48 BNL (45) Complex words- , 0/3 0/6 BNL (4) Function words- 1/3, 2/6 BNL (3) Non-words – 1/5, 2/10 BNL (6)	Copying- 26/27 WNL (25) Picture names- no attempt Dictation- no attempt Picture description- no attempt

Table3- Raw scores for other standardised assessments:

Participant	Boston Naming Test	Pyramids and Palmtrees (3 picture version)	Comprehension of locative relations (PALPA 58)	Expression of locative relations (adapted PALPA 59)	Montreal Cognitive Assessment	Birmingham University Praxis Screen	Limb Apraxia Screen	Motor Assessment Scale
AP1	22/60 0/14 semantic cues 7/29phonemic cues BNL- mean= 56.8, SD 3	49/52. WNL	12/24 BNL Living things 5/8 Abstract 4/8 Inanimate 3/8 Errors: 10/12 reversible 2/12 other	6/24	15/30 BNL Visuospatial/ executive- 3/5 Naming -2/3 Attention- 3/6 Language- 0/3 Abstraction- 1/2 Delayed recall- 0/5 Orientation- 6/6	Left arm/ hand only Multi-step object use- 11/12 WNL Gesture production- 9/12 BNL Gesture recognition- 6/6 WNL Meaningless gesture imitation 6/12 BNL	Left arm/ hand only 15/20 Meaningful 7/10 Meaningless 8/10	Left arm/ hand only WNL Upper arm function-5 Hand movements- 6 Advanced hand activities- 6 General tonus-4
AP2	32/60 (+ 5 phonological paraphasias) 1/12 semantic cues 13/23phonemic cues (+ 3 phonological paraphasias) BNL- mean= 48.9, SD 6.3	49/52. WNL	14/24 BNL Living things 5/8 Abstract 5/8 Inanimate 4/8 Errors: 4/10 reversible 6/10 other	10/24	22/30 BNL Visuospatial/ executive- 4/5 Naming -2/3 Attention- 6/6 Language- 0/3 Abstraction- 2/2 Delayed recall- 3/5 Orientation- 5/6	Both arms/hands Multi-step object use- 12/12 WNL Gesture production- 12/12 WNL Gesture recognition- 6/6 WNL Meaningless gesture imitation R & L 12/12 WNL	Both arms/hands 20/20 Meaningful 10/10 Meaningless 10/10 14 with right, 4 with left, 2 with both	Both arms/hands WNL Upper arm function-5 Hand movements- 6 Advanced hand activities- 6 General tonus-4

Participant	Boston Naming Test	Pyramids and Palmtrees (3 picture version)	Comprehension of locative relations (PALPA 58)	Expression of locative relations (adapted PALPA 59)	Montreal Cognitive Assessment	Birmingham University Praxis Screen	Limb Apraxia Screen	Motor Assessment Scale
AP3	2/26 0/17 semantic cues 8/24 phonemic cues 1 semantic paraphasia Description- 2 7 gesture 3 pointing Significantly BNL Mean= 53.3, SD 4.6	46/52- just BNL	12/24 BNL Living things 4/8 Abstract 3/8 Inanimate 5/8 Errors: 7/10 reversible 5/10 other	0/12 Stopped half way through as participant unable to complete	4/30 BNL Visuospatial/ executive- 2/5 Naming -0/3 Attention- 1/6 Language- 0/3 Abstraction- 0/2 Delayed recall- 0/5 Orientation- 1/6	Left arm/hand only Multi-step object use- 9/12- BNL Gesture production- 8/12- BNL Gesture recognition- 5/6 - WNL Meaningless gesture imitation Left arm 5/12- BNL	Left arm/hand only 18/20 Meaningful 9/10 Meaningless 9/10	Left arm/hand only Upper arm function-5 Hand movements- 6 Advanced hand activities- 1 General tonus-4