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Aphasia after left hemisphere stroke in users of British Sign Language

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Abstract

Aphasia after stroke in users of British Sign Language is an understudied area with patients often missing a diagnosis hence unable to access appropriate rehabilitation services for aphasia post-stroke. There is a lack of understanding of British Sign Language in stroke units and the need for further assessment of these patients with respect to aphasia is often not recognised. Aphasias in British Sign Language are complicated by the physical element of speech using bilateral hand use which is often not possible post-stroke, as well as the lack of staff understanding of the language and the difference between sign language and gesture. Here, the processing of British Sign Language is outlined with similarities and differences between post-stroke aphasias in spoken language compared to British Sign Language. Current research highlights the necessity for appropriate and timely assessment of these patients for improved outcomes.

1 Introduction

Approximately 100,000 people in the UK suffer from a stroke each year with one third resulting in aphasia Stroke Association (2015). Aphasia is assessed typically within the first week post-stroke by professional speech and language therapists (SALT). Where a patient's first language is a non-spoken language such as British Sign Language (BSL), assessment is challenging and often, aphasia in deaf patients is not acknowledged. Approximately 200 people from the deaf community in the UK experience strokes (or other aphasia causing injuries), every year. Indeed, aphasia does occur in deaf users of sign language depending on lesion location. However, few of these patients receive language therapy compared to the hearing population Marshall, Atkinson, Thacker, and Woll (2003). This is due to several reasons: Clinicians are inexperienced with BSL, with no reference to normal signing; patients and clinicians are unable to communicate and deaf signers use gesture well, potentially misinterpreted as fluent BSL.

Aphasia has profound outcomes for patients including quality of life, depression, and has been associated with a worse prognosis. Moreover, subtypes of aphasia have different outcomes 1-year post-stroke Pedersen, Vinter, and Olsen (2004). Therefore, proper assessment is important to access appropriate therapy and ensures healthcare is equitable in the population. Left-sided lesions most commonly result in aphasia, where language centers are dominant for most people. Common post-stroke aphasias are global, Broca's and Wernicke's aphasia Pedersen et al. (2004), presenting with phonological, semantic, agrammatic and anomic errors amongst others. Whether aphasias are similar in signed languages depends on the way it is processed. Evidence is presented showing sign language has similar unilateral processing as spoken languages, and common errors in aphasia are compared between English and BSL for parallel presentations.

2 Methods

Articles were acquired through PubMed, Google Scholar and Mendeley. Search syntax included: Stroke, Sign Language, BSL, deaf patients, aphasia and subtypes, in combination. Relevance was evaluated based on the inclusion criteria: English language; published from year 2000 onwards; peer reviewed; patients fluency in British Sign Language where applicable; primary research data and reviews, and the exclusion criteria: Dissertations; abstract only; editorials; unpublished comments; articles published prior to the year 2000. Aphasia in deaf patients is an understudied topic with few papers addressing this problem directly. A wide publishing range (up to the year 2000) was chosen to accumulate sufficient data. Articles published before 2000 were omitted to present up to date evidence. Reviews were used in support of primary literature only where highly applicable.

3 Results and Discussion

3.1 Is sign language processed similarly to spoken language?

In most right-handed hearing individuals, language is processed in the front-left cerebral hemisphere. Broca's area is activated in speech production, with Wernicke's area posterior, including the temporal lobes, for comprehension Campbell, MacSweeney, and Waters (2008). It was previously thought sign language was processed bilaterally due to the visual elements of the language, which would require right hemisphere activation. Hickok et al., (2002) showed deaf signers with left hemisphere damage (LHD) from stroke, have reduced linguistic ability compared with right hemispheric damage (RHD), despite visuospatial impairment. Lesions in the left frontal regions were associated with poor speech production, and perception difficulties were associated with damage to the temporal lobe. The study found LHD with temporal lobe involvement, induced more severe impairment than LHD without temporal lobe involvement, concordant with speaking languages. This would suggest sign language is more lateralized than previously thought.

Most studies analysing sign language processing report post lesion dysfunction. Lesions may have indirect effects on proximal regions not directly involved in language. Imaging techniques showing activity during comprehension/production such as fMRI would remove this. fMRI has shown healthy non-deaf English speakers reading English activate the same left-sided regions as deaf signers watching sign language Campbell et al. (2008), supporting previous studies. The right hemisphere is more engaged in sign language than spoken language, particularly the visual cortex Campbell et al. (2008). Patients with RHD still perform under average in aphasia testing with some extra-grammatical errors after RHD (Atkinson, Campbell, Marshall, Thacker, & Woll, 2004; Hickok, Love-Geffen, & Klima, 2002). Nonetheless, the evidence overwhelmingly favors the left temporal and peri-sylvian involvement in deaf signers and visuospatial problems do not necessarily result in aphasia.

3.2 Symptoms of spoken aphasias after stroke

The most common spoken aphasias post-stroke are global (30-40%), Wernicke's (15%) and Broca's aphasia (12%), Pedersen et al. (2004). Anomic and transcortical aphasias also manifest Hoffmann and Chen (2013). Common aphasic errors are outlined in table 1.

3.3 Clinical presentation of aphasia in deaf users of sign language: Similarities with spoken language

Studies have shown these errors occur in sign language aphasia. Unfortunately, as this topic is understudied, most studies rely on single patient analysis, however the results are profound and demonstrate that rather than aphasia presenting differently to spoken language, the current lack of knowledge of BSL may be the limiting factor in establishing a diagnosis. Table 2 outlines the presentation of aphasias between spoken language and users of BSL.

3.4 Anomia

A case study by Marshall et al., (2003) found several errors in a patient after a left 106 sided stroke. In a picture-naming task, the patient was presented with 3 pictures (1 target and 2 semantic distractors) and asked to point to one in response to a sign. The patient scored well in this test and avoided semantic errors. In another test, the patient was asked to sign the word for pictures presented to him. Here, the patient was unable to retrieve many signs, often using finger spelling or gesture instead. These results indicated understanding was intact, but sign finding/word retrieval was impaired, indicating anomia. Visuospatial tasks were performed normally, hence language problems cannot be attributed to this. As in spoken anomia, the patient performed better on high frequency words than lower frequency words. Hemiplegia was accounted for, and all targets used were known to be in the patient's vocabulary. This should be considered by SALTs, as deaf signers have different cultural references to English speakers.

3.5 Phonology

BSL is lexical, with signs produced in specific places, motions and hand shapes. Phonological errors are produced when one component is incorrect. In the same study errors such as the correct hand motion and location but with the incorrect hand shape were made Marshall, Atkinson, Smulovitch, Thacker, and Woll (2004). Phonological errors may not have meaning, however errors can be made between meaningful signs also (which may not be phonologically related in English). The authors gave phonological cues when the patient struggled to find a sign, which was helpful, and could be valuable in developing therapy.

The authors should consider including MRI or CT scans to further evidence similarities between spoken and sign aphasia to give a diagnosis akin to that of spoken language, for example for the patient, either Broca's or anomic aphasia Alexander and Hillis (2008). A firm diagnosis may give better access to appropriate treatment.

Table 1: Common errors made in aphasias of spoken language

Error type	Presentation in spoken language
Phonological	Incorrect syllable used/understood in a word. For example, mistaking DOOR for FLOOR, or BOOK for LOOK
Semantic	Mistaking a word for another noun in the same category. For example, mistaking DOG for CAT or TOMATO for CARROT
Anarthria	Inability to articulate remembered words
Agrammatism	Producing sentences with content but not meaning/lack of grammar
Anomia	Trouble remembering words
Repetition and jargon	Repeating words often in the same sentence and producing words with no meaning

Table 2: Parallel aphasic presentations between spoken and signed languages

Error type	Presentation in spoken language	Presentation in signed language
Phonological	Incorrect syllable used/understood in a word	One of the 3 components of a sign is incorrect: hand shape, motion, position in space
Semantic	Mistaking a word for another noun in the same category	Identical to spoken language
Anarthria	Inability to articulate remembered words	May attempt to finger spell or make use of gesture
Agrammatism	Producing sentences with content but not meaning/lack of grammar	Identical to spoken language, lack of head, torso movement
Anomia	Trouble remembering words	May see 'groping' for signs and hesitant language
Repetition and jargon	Repeating words often in the same sentence and producing words with no meaning	Identical to spoken language

3.6 Anarthria

Saito et al., (2007), described the substitution of meaningless finger patterns when asked to name a line drawing, and related this to anarthria. The authors do not confirm that the patient recognized the word they were trying to sign by performing the inverse test (picture pointing after seeing a sign), therefore anomia cannot be ruled out here. Notably the patient had occipital lobe lesions. The authors suggest problems with sign execution cannot be explained solely with temporal lobe lesions. The patient had trouble reading and writing English words. The occipital lobe is activated in visual processing, therefore these problems could arise from lesions here and indeed sign production and finger spelling could be affected by this also. The authors did not confirm the patient's fluency with English hence cultural differences could account for this. Involvement of multiple regions has huge implications for sign language aphasia as the language relies heavily on a visual element, whereas this may not be so in English.

3.7 Semantic errors

A single case study of a deaf signer with left hemisphere stroke, presented with semantic errors comparable to spoken languages for example mistaking DOG for CAT Marshall, Atkinson, Woll, and Thacker (2005). The patients was shown a sign and asked to point to the corresponding picture from 5 options (the target or a semantic, phonological, visual or unrelated distractor) Atkinson et al. (2004). A challenge in BSL aphasia assessment is iconicity, for example the sign for CIGARETTE mimics how one would use it. Therefore, use of gesture may be misinterpreted as comprehension. The test removes this possibility by using 20 iconic and 20 non-iconic signs, thus identifying if a patient truly understands a sign. The patients showed no difference between iconic or non-iconic signs but made primarily semantic errors scoring only 25/40 (control average: 39.15). The patient was bilingual in BSL and English. Similar tests in English would ascertain whether the patient's aphasia is similar between both languages, supporting the hypothesis. Indeed, the patient scored 23/40 in a similar English test, with largely semantic errors.

3.8 Key differences between aphasia between BSL and spoken language

Anterior left hemisphere damage induces agrammatism in users of BSL Marshall et al. (2003). BSL relies on space for grammatical structures and uses multiple body parts, for example moving the torso forward and backward to indicate tenses Marshall et al. (2005). Apraxia post-stroke due to lesions of the motor cortex may prevent proper sign formation and grammar production. Apraxia (outside orofacial/bulbar muscles) would not affect spoken language. Although deaf signers can switch dominance and communicate with one hand, hemiplegia may affect communication, particularly as speaking whilst performing tasks will become affected.

Another difference is the potential for visual errors in sign language. For example, the sign for DOG may be mistaken for a knife and fork gesture, as the sign resembles the action of using these items (first two fingers of both hands pointing downwards, palms facing towards the speaker) Marshall et al. (2005). This error could indicate a patient is relying on iconicity or gesture to communicate rather than truly comprehending signs.

4 Conclusions

Despite only a small number of existing studies compromising a small patient population, there is clear evidence sign language aphasia presents similarly to spoken languages and could be given parallel diagnosis of aphasia subtypes. Recognition of this alone will ensure better access to therapy. Moreover, risks for aphasia post-stroke are well recognized such as age, previous stroke and urinary problems Plowman, Hentz, and Ellis (2012). A clinician should be made aware aphasia is a possibility in a deaf patient presenting with these risk factors and be monitored closely, particularly where communication between patient and clinician is limited. Future studies should aim to elucidate how lesions of the motor cortex and visual cortex influence aphasia and any other potential differences to administer appropriate, high quality therapy.

Author statements

Conflicts of interest statement

No conflicts of interest have been declared by any authors.

Authorship statement

All authors fulfill ICMJE authorship criteria, which can be accessed at http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html. All authors have read and approved the final version, and accept responsibility for information published.

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Authors declare that no ethical approval was required for this article.

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