**Syntactic cueing of spoken naming in jargon aphasia**

Ruth Herbert, Dee Webster, Elizabeth Anderson

Affiliation: Department of Human Communication Sciences, University of Sheffield

Corresponding author:

Dr Ruth Herbert

Department of Human Communication Sciences. University of Sheffield, 362 Mushroom Lane, Sheffield, S10 2TS.

Tel: +44 (0) 114 222 2403

Email: [r.herbert@sheffield.ac.uk](mailto:r.herbert@sheffield.ac.uk)

Abstract

Background

Debate surrounds the relationships between the systems involved in spoken word production, the activation governing production, and the role of syntax in production. Jargon aphasia provides an opportunity to investigate the relationship between syntax and phonology as it often involves retained syntax, alongside phonological deficits shown through neologistic output. Models of spoken word production differ in terms of their accounts of the processing relationships between these two levels of representation, and the degree to which syntax is activated and affects phonology.

Aims

We aimed to complete a single case study investigation of the impact of syntactic cues on on spoken word production, and to compare data from this implicit task with data from an explicit syntax judgement task. The investigation aims to shed light on different theories of spoken word production, provide new evidence concerning the nature of the deficit in jargon aphasia, and identify potential intervention methods.

Methods & Procedures

The participant DP presented with transcortical sensory aphasia, with fluent neologistic output, a comprehension deficit, anomia, and preserved repetition. The investigations into DP’s noun syntax processing included syntactic cueing of naming, and a syntactic judgement task. The cueing task compared cued and uncued naming, where cues provided syntactic information relevant to count or mass noun targets. The judgement task investigated DP’s knowledge of potential determiner plus noun combinations.

Outcomes and results

Syntactic cues led to increased overall naming accuracy, increased numbers of nouns, more phonologically related errors, and fewer unrelated word errors. The cues had no effect on the proportion of lexical versus non-lexical responses, nor on rates of semantic errors. In contrast to the positive impact of cues, DP showed limited knowledge of the meanings of determiners via the explicit judgement task.

Conclusions

The evidence supports a spoken word production theory that has feedforward only activation from the syntactic to the semantic level, but allows interaction between syntactic and phonological representations. This account explains the lack of semantic errors, and the increase in phonologically related errors in the cued condition. DP’s difficulties completing the explicit judgement task provide more evidence of the need for online tasks which address language processing directly. New evidence of positive effects of syntactic cues on word retrieval informs future interventions for speakers with jargon aphasia.

Keywords:

Aphasia, jargon aphasia, spoken word production, syntactic cues

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**Introduction**

Investigations of language processing in speakers with jargon aphasia have concentrated on lexical productions including semantic errors (e.g. Perecman & Brown, 1985; Marshall, Pring, Chiat & Robson, 1995), and neologisms (Butterworth, 1979; Butterworth, 1985). Many speakers with jargon aphasia appear to retain relatively good syntactic knowledge (e.g. BF described by Buckingham & Kertesz, 1974), but this has been under-researched. The combination of retained syntactic knowledge with impaired phonology found in speakers with neologistic jargon presents a unique opportunity to explore the relationship between the two processing systems. In this study we explore spoken production with DP, a speaker with jargon aphasia, in order to inform existing theories of production, and to add to the clinical evidence base.

**Theories of spoken word production**

Theories of spoken word production agree that the architecture consists of three representational systems: semantic representations, syntax accessed via word or lemma nodes, and phonological representations (e.g. Caramazza, 1997; Dell, Martin, Saffran et al., 1997; Levelt, Roelofs & Meyer, 1999). There are significant disagreements regarding the means by which activation spreads within the architecture. Discrete theories propose completed activation at one level before activation starts at the next (e.g. Levelt et al., 1999). In contrast interactive activation accounts (e.g. Dell, Martin, Saffran et al., 1997) propose feedback and feedforward activation between levels.

Levelt et al. (1999) described the WEAVER ++ model which includes conceptual nodes, which map onto lemma nodes where syntax is retrieved, which in turn map onto phonological nodes or lexemes. Activation flows forward, and activation at one level is complete before subsequent activation commences at the next level, known as discrete processing. This theory assumes automatic and obligatory activation of lemma nodes, involving subsequent activation of syntactic nodes from the lemma, prior to phonological activation.

In contrast to discrete processing accounts the Interactive Activation (IA) model of Dell et al. (1997) involves feed-forward activation from one level to the next, and feedback from that level to the preceding level. Hence there is an influence of the semantic level on word selection and phonological processing, and of the phonological level on word selection and semantic processing. This account of spoken word production was devised to explain phenomena such as mixed errors (e.g. Dell & Reich, 1981; Harley, 1984). Mixed errors share both semantic and phonological features with the target, such as target *lobster* produced as error *oyster*.

As Goldrick and Rapp (2002) argue there are problems with both accounts. Discrete accounts cannot explain mixed errors, as semantically driven word selection is completed before phonological activation takes place. Hence semantic errors produced to a given target should have no necessary phonological relationship with the target. Lexical effects on phonological errors are also problematic for this account e.g. syntactic category preservation in phonologically related errors. Processing at the phonological level should be completely independent of lexical processing, which includes syntactic category information, and is governed by frequency (Kittredge, Dell, Verkuilen, & Schwartz, 2008). Finally, as there is no feedback from the phonological to the word level, the latter does not constrain selection to those phonemes activated by a word node i.e. produce lexical bias.

In contrast the challenges to highly interactive accounts are fewer. Goldrick and Rapp (2002) claim that such accounts predict phonological influences on semantic errors, with semantic errors being more likely to retain a phonological relationship with the target. They cite reports of speakers with aphasia who show no such effects. The lack of such errors in the aphasia data provides support for the notion of discrete semantic-lexical processing, free from the influence of subsequent phonological activation.

The Restricted Interaction Account or RIA proposed by Rapp and Goldrick (2000) and Goldrick and Rapp (2002) provides an alternative account. There is no feedback between their L-level (which corresponds to the word or lemma level) and the semantic level, and there is restricted feedback from the phonological to the word level. This was proposed to account for deficit and error data from two single case studies of language impairment in people with aphasia, which the alternative theories struggle to explain.

**Activation of syntax in production**

All of the theories outlined above propose a syntactic level of representation mediating between the semantic and phonological levels. Access to syntax is therefore obligatory in production, regardless of the demands of the speech task. For phrase and sentence production to proceed, where the syntactic role of the target word is essential, syntax must be activated. In naming single nouns however, where no explicit knowledge of syntax is required, its role is more controversial. Caramazza (1997: 188) labelled the lemma a ‘contentless waystation’ in this context, as the level of representation had to be passed through, but for no explicit purpose.

The evidence for the involvement of syntax in noun production comes from studies with neurotypical speakers and those with aphasia. One form of investigation is gender priming conducted with healthy speakers, a second is the analysis of syntactic knowledge in speakers with anomia in aphasia. In addition there is a small body of work using cueing and grammatical judgement tasks to investigate the phenomenon in English, using the fact that mass and count nouns inhabit different determiner frames with *a cat* being in common use and *some cat* being less common, whereas the opposite is the case for mass nouns such as *petrol.*

Gender priming experiments investigate the activation or otherwise of grammatical gender in spoken word production tasks. A typical task involves the presentation of a picture to name, while simultaneously presenting a second stimulus which is either gender congruent or gender incongruent with the target word. The second stimulus may be a written word such as a determiner, or another picture. For example, the French word for apple is ‘la pomme’. The picture of an apple would be presented along with either the congruent gender article ‘la’ or the incongruent article ‘le’. The response required may be the target name, or a phrase such as determiner plus noun. The difference in response latencies between the two conditions is then compared. Research into the effects of gender priming with neurotypical speakers is inconclusive with regard to the degree to which syntactic processing is involved in bare noun production e.g. ‘pomme’. Several studies claim that gender priming in production is found only when the gender information is explicitly required in the morpho-syntax of the response, such as on a gender marked adjective e.g. ‘la belle pomme’ (e.g. Pechmann & Zerbst, 2002; Pechmann et al., 2004; Akhutina et al., 1999; LaHeij et al., 1998; Schriefers, 1993; Schriefers & Teruel, 2000; Starreveld & La Heij, 2004; Vigliocco et al., 2002). There is however a second smaller group of studies which has identified positive effects of gender priming in bare noun responses, i.e. when no explicit knowledge of the grammatical gender of the target is required in the response (e.g. Alario et al., 2004; Cubelli et al., 2005; Akhutina et al., 2001; Paolieri et al., 2011).

In English the mass and count distinction maps in a quasi-regular fashion onto syntax, and hence investigations into mass and count noun syntax have added to the evidence base. Gregory, Varley and Herbert (2012) investigated the impact of spoken cues on noun production latencies with neurotypical speakers. They found priming of bare noun naming of English nouns, with faster response times to target words presented with a clause + determiner cue, such as *this is some*\_, than when presented with no cue or a determiner cue. This evidence and that from gender priming shows that grammatical cues can speed noun production, providing support for theories which include syntactic information as an essential component in the production system, and argue that syntax is activated in production regardless of whether it is explicitly required in spoken production.

Further evidence comes from studies of speakers with aphasia, where participants with anomia are asked to judge the syntactic properties of words they cannot produce. Typically participants are asked to point to one of a choice of two cards depicting the grammatical gender of the target. Two single case reports provide evidence that participants retained grammatical gender knowledge of words they were unable to name (Dante reported by Badecker et al., 1995; GM reported by Henaff-Gonon et al., 1989). Avila et al. (2001), Bachoud-Lévi and Dupoux (2003), Macoir and Béland (2004) report similar findings, and Scarnà and Ellis (2002) demonstrated similar retained syntactic knowledge using a translation task.

There is limited evidence from speakers of English. Vigliocco et al. (1999) report data from participant MS who had anomia, and who accurately judged the syntax of mass and count nouns which he could not produce. Herbert and Best (2005; 2010) report data from participant MH who showed a significant effect of syntactic cues in naming mass nouns. In a larger study involving 13 speakers with aphasia, Herbert, Anderson, Best and Gregory (2014) explored participants’ knowledge of the syntax of nouns, using mass and count nouns. They found accurate syntactic judgements for most accurately named nouns, but no relationship between naming accuracy and syntactic knowledge, indicating that noun syntax was available but was not essential for naming.

**Jargon aphasia**

The term jargon aphasia is used to refer to fluent and often largely unintelligible spoken language production in connected speech, which occurs in certain speakers with aphasia (see Marshall, 2006, 2017). The typical profile of neologistic jargon is of fluent and syntactically accurate or at least recognisable sentence structure, with lexical content fairly consistently replaced by errors including lexical errors, non-word errors and perseverations (e.g. Butterworth, 1979; Butterworth, 1985). Awareness and correction of errors is usually impaired, often totally (Kinsbourne & Warrington, 1963; Marshall, Robson, Pring & Chiat, 1998).

Various subtypes of jargon have been identified, based on the profile of word errors produced, in particular semantic and non-word errors. Semantic jargon consists of well-formed syntactically accurate sentences in which lexical content is replaced by semantic errors and other lexical terms. In other forms of jargon lexical content is replaced more or less entirely with non-words, resulting in neologistic output, which Alajouanine (1956) termed undifferentiated jargon. Marshall (2017:74) makes a further distinction between neologistic jargon, which contains many non-word errors but also contains words and word errors, and phonemic or undifferentiated jargon which contains few if any real words. In all types of jargon content words appear to be more affected than function words. Marshall (2017) also notes that jargon occurs in both Wernicke’s aphasia and transcortical sensory aphasia.

Investigations of jargon aphasia have largely concentrated on explanations for the neologistic or non-word productions (e.g. Butterworth, 1979; Robson et al., 2003). The nature of these errors has been extensively debated, with some researchers labelling phonemic strings which are not words but which have a relationship to the target as phonemic paraphasias, and labelling those with no relationship neologisms or abstruse errors (e.g. Buckingham, 1987). Other researchers have labelled all such strings as neologisms. More recently researchers have used quantitative criteria to differentiate phonemic paraphasias, which share more than 50% of phonemes with the target, from neologisms which share fewer than 50% (e.g. Olson, Halloran & Romani, 2015; Schwartz, Wilshire, Gagnon & Poliansky, 2004). The debate has centred around the source of the non-word errors, with proposals of one or two sources proposed. Olson et al. (2015) used statistical modelling to explore word and non-word errors with speakers with jargon aphasia, and found greater support for a model incorporating only phoneme selection errors than for a combined model with errors at word selection and phoneme selection. They also found fewer non-word errors in reading and in repetition than in naming, which is accounted for easily by the single error source, in which phonological selection benefits from the phonological input which is available in these tasks but not in picture naming.

In contrast to phonological processing, syntactic processing has been viewed as an area of comparative strength and retained function in speakers with jargon. Some speakers, especially those with semantic jargon, demonstrate complex syntax in production (e.g. BF: Buckingham & Kertesz, 1974; RG: Marshall et al., 1996). The likely presence therefore of impaired phonological processing in the presence of intact syntactic knowledge led us to investigate spoken word production in a speaker with jargon aphasia.

**This study**

We investigated noun syntax knowledge with DP who has jargon aphasia, using explicit and implicit processing tasks first used by Herbert and Best (2005; 2010). We completed a cued picture naming task which arguably involved implicit processing, and an explicit syntactic judgement task. Following Scarnà and Ellis (2002), who found a difference between explicit and implicit processing tasks, we used both forms of investigation.

The tasks capitalised upon the fact that in English count and mass status of nouns is represented systematically in syntax, with certain nouns being more likely to be preceded by a quantifying determiner such as *a* for example *a diamond*, whilst other noun types are infrequently produced in that context e.g. *a pasta.* In the latter case non-quantifying determiners are more frequently paired with the noun, such as *some pasta*.

For the cued naming task we used phrase + determiner frame cues: *this is a*\_ to cue count nouns and *this is some*\_ to cue mass nouns (e.g. Gregory et al., 2012; Herbert & Best, 2010). It has been proposed that such syntactic information can act as scaffolding for production (e.g. Linebarger McCall & Berndt, 2004), preparing the noun phrase for noun insertion. Cues should therefore lead to greater accuracy, and more nouns in production. The various theories predict different effects in terms of errors, which we address in full in the discussion.

**Methods**

***Participant details***

DP[[1]](#footnote-1) is a right-handed 76 year old female, who sustained a single left CVA three years prior to her involvement in the study. Following her CVA she presented with a right upper limb hemiparesis and neologistic jargon aphasia. DP is a monolingual native speaker of British English. She has no known hearing difficulties, wears glasses for reading, and has no other significant medical history. She left school at 16 and entered employment in an administrative role. At the time of the study she was living at home with her family. She was recruited to the study after the family approached researchers. Ethical approval for the study was obtained from the University of Sheffield Research Ethics Committee. Informed consent to participate in the research was obtained by means of an aphasia-accessible information sheet and accessible consent form.

***Language and cognitive assessment***

DP underwent language and cognitive assessments to identify the nature of her aphasia, and any concomitant cognitive difficulties. Details of the language tests are shown in Table 1.

Table 1 here

*Language sample*

A sample of DP’s connected speech in describing the Cinderella story is provided in table 2. DP produced determiners *a, his, the, this* and numerals in this narrative, with *the* being the most commonly produced. She produced 15 accurate determiner plus noun combinations, 11 involving *the*, and 15 incorrect attempts at noun phrases which involved either a determiner or a noun in isolation. She did not produce determiner *some* in this narrative.

Table 2 here

*Aphasia profile*

Sentence processing

DP’s spoken production is fluent and consistent with descriptions of neologistic jargon aphasia (e.g. Buckingham, Whitaker & Whitaker, 1978). She produced sentence structure with recognisable syntactic phrases, but content words were typically neologistic. DP produced target-related nonword errors, such as // for target horses, and apparently unrelated errors, such as // for an unidentified target. DP showed no awareness of errors nor any attempts to correct errors or seek help with production. Syntactic phrases were decipherable through the presence of function words such as determiners and auxiliary verbs, and inflections (see table 2). Sentence syntax appeared limited with no evidence of complex syntax such as moved argument structures. Sentences were typically short in length, consisting of possible noun and verb phrases, with conjunction ‘and’ used to link structures.

Nouns and verbs inserted into sentence frames were realised in many instances as phonologically related or unrelated non-words, with a tendency for high frequency words such as *get* to maintain phonological integrity. DP also produced some high frequency constructions such as ‘I don’t know’ accurately. In comparison to the phonological degradation typifying the content word production, function words and inflectional morphology were phonologically intact. DP’s impaired syntactic processing was evident in production as outlined above, and in sentence comprehension, where her errors consisted mainly of selection of the reverse distracter for reversible targets.

Single word processing

DP presented with difficulties in semantics and phonology, evident across a range of tests. Her performance was outside the normal range on spoken and written word to picture matching, and on Pyramids and Palm Trees. Her errors in spoken word to picture matching were largely semantic, and in written word to picture matching she made semantic and phonological/visual errors. In picture naming she produced semantic errors, phonologically related real and non-words, phonologically unrelated real words and non-words (neologisms), and no responses. Her performance in minimal pair judgements was at chance. Repetition scores were extremely good in contrast, with minor phonological errors both for words and non-words, despite apparent auditory processing difficulties as demonstrated in the minimal pairs task[[2]](#footnote-2).

Reading aloud was severely impaired. DP omitted or substituted the initial letters of words and non-words (table 3), which is indicative of left neglect dyslexia (see Vallar, Burani & Arduino, 2010). She was able to produce some regular and some irregular words successfully however, indicating some retained access to the orthographic lexicon.

Table 3 here

In summary DP presents with fluent neologistic output, a comprehension impairment, anomia, and good repetition, which leads to a diagnosis of transcortical sensory aphasia. There is evidence of impairment at all three levels identified within spoken word production models, with marked semantic and phonological deficits, and a less marked syntactic deficit. Repetition is retained and provides evidence of an alternative route to spoken output which is not semantically driven.

*Tests of non-linguistic cognition*

The Cognitive Linguistic Quick Test (CLQT: Helm Estabrooks, 2001) and subsections of the Birmingham Object Recognition Battery (BORB: Riddoch & Humphreys, 2002) were used to investigate DP’s cognitive and visual processing. The results of the cognitive tests are shown in Table 4.

Table 4 here

In the subtests of the CLQT DP demonstrated a severe attention deficit, and moderate impairments of memory, executive function and visuo-spatial processing. DP had difficulty with planning and understanding tasks, and demonstrated some impulsivity. She was within normal limits in BORB Picture Judgements, which assesses visual and semantic processing of line drawings. Line bisection showed no impairment.

***Tests of noun syntax***

Noun syntax knowledge was investigated via two tasks: Cued naming of mass and count nouns, and Determiner judgement task with pictures of mass and count nouns. The same picture naming stimuli were used for both tasks, hence DP named the items three times in total. The Determiner Judgement task was completed after the cued naming task.

*Cued naming of mass and count nouns*

We tested lexical retrieval of a set of mass and count nouns in an uncued condition, where simple naming of pictures was conducted, and a cued condition where an auditory cue consisting of a short phrase with a determiner was presented.

*Design, materials and procedure*

The target words consisted of 40 count nouns and 40 mass nouns presented once in each of the two conditions. We used an ABBA design, where half the items were presented first in the no cue condition, and half were presented first in the cued condition. There was a four-week gap between the two presentations of the full set. Items in the two lists were organised in blocks of ten mass or ten count nouns, with four blocks in each condition in each list. Within those blocks items were randomly ordered with the constraint that items that were either semantically or phonologically related to each other were separated by at least three items.

The count nouns and mass nouns were matched for key variables including imageability, concreteness, familiarity, age of acquisition, frequency and word length. All nouns depicted everyday objects or substances, and there were no living things. The nouns were singletons, and none were compounds or superordinate terms. One photograph depicted each noun, and naming from 15 adult healthy controls gave 93% or greater name agreement[[3]](#footnote-3). The count nouns were presented with the spoken cue ‘this is a/an’ (depending on the onset of the word), and the mass nouns were presented with the spoken cue ‘this is some’.

DP was seen individually in a quiet room. The pictures were presented on a laptop computer. DP was instructed to say aloud one word in response to each picture. In the uncued condition all pictures were presented for naming with no cue. In the cued condition the count nouns were presented at the same time as the spoken cue. DP was given up to ten seconds to respond.

*Response recording and coding*

The responses were recorded to audio-files on the computer and on an audio-recorder. The researcher also transcribed all responses in situ, using standard orthography and broad phonemic transcription as necessary. All transcriptions were checked later against the audio-recordings. Responses to naming were then coded.

The coding is based on the criteria outlined in Dell et al. (1997) detailed in table 5. For all attempts the first CV or VC response containing an unreduced vowel was treated as the response. Only exact matches to the target word were coded as correct. In cases where DP produced a determiner plus a noun such as ‘the tree’ the noun was credited as the response. If DP produced no verbal response within the ten second cut-off this was coded as no response. In terms of non-word production we distinguished between those related to the target and those unrelated to the target. The former we refer to as phonologically related non-words and the latter as neologisms (following Olson et al., 2015). To ensure the reliability of the coding two researchers coded all responses agreeing the final coding by consensus.

Table 5 here

*Determiner judgement task*

*Design materials and procedure*

Prior to undertaking the Determiner Judgement task DP completed a test of visual lexical decision of determiners to ensure that she was able to process functors, which included ten items, and on which she was 100% accurate. The same 80 photographs from the naming tests were used, sorted into four lists of 20 items. Within each list mass and count nouns were pseudo-randomly ordered so that no more than three items in succession were from the same set. Each image was presented on a computer screen for naming, then after the naming trial, presented with two written words, *a* and *some*, positioned top left and top right, or *an* and *some* for words beginning with a vowel. For all target words whose initial phoneme was a vowel (e.g., axe, ink), the choice of words was *an* or *some.* All written words were presented in bold lower case 36 point font. Pre-recorded auditory files of the words were also played. The correct written response was placed on the left or the right pseudo-randomly ordered, so that no more than three consecutive correct items succeeded each other on the same side. DP was asked to name each item then judge the determiner by pressing a button on the left or the right of the keyboard. Instructions for the task were provided in written aphasia accessible format and supported by spoken explanations, and DP completed the task under instruction with practice items. Once she signalled she was happy to commence the task began. The computer recorded all naming attempts and the accuracy of the syntax judgement task[[4]](#footnote-4).

**Results**

*Cued naming of mass and count nouns*

Overall accuracy and the three main categories of lexical, non-lexical and other response, are shown in table 6.

Table 6 here

*Relatedness and lexical status of responses*

Analysis of accuracy showed a significant difference between uncued and cued conditions, with higher accuracy in the cued than in the uncued condition (Fisher’s Exact test z=2.1447, two-tailed p=0.0320).

Analysis of the distribution of the three categories of response types (lexical, non-lexical and other) showed no significant differences between conditions. We ran two analyses, including correctly named in the lexical category in the first analysis and excluding correctly named in the second analysis. There was no significant difference in either case (first analysis including correctly named: Chi square = 2.29, df=2, p=0.318; second analysis excluding correctly named: Chi square=0.95, df=2, p=0.621).

Within the overall category of *lexical responses* there were significant differences in the distribution of error types between the conditions. In the uncued condition the majority of responses were unrelated words. In the cued condition the majority of responses were correct and formal errors. Comparison of the number of correct, semantic, formal, mixed and unrelated errors across conditions was significant (Chi square=19.84, df=4, p=0.001).

The distribution of related vs unrelated lexical errors between the conditions was analysed by comparing the total number of semantic, formal and mixed errors to the total number of unrelated errors. This comparison was significant, with more unrelated errors in the uncued condition and more related errors in the cued condition (Fisher’s Exact test two tailed p=0.0005).

The impact of syntactic cues on the *semantic* relationship between targets and errors was analysed by comparing the number of lexical errors with a semantic relationship to the target (semantic and mixed errors) with the number of lexical errors with no semantic relationship to the target (formal and unrelated errors), and this comparison was not significant (Fisher’s Exact Test, two tailed p=0.2641).

The impact of syntactic cues on the *phonological* relationship between targets and errors was analysed by comparing the number of lexical errors with a phonological relationship to the target (formal and mixed errors) with the number of lexical errors with no phonological relationship to the target (semantic and unrelated errors). Syntactic cues elicited more lexical errors with a phonological relationship to the target (Fisher’s Exact test two tailed p=0.0007).

No effect of cues was found in the non-lexical responses. Within the category of non-lexical responses there were very few non-words in either cue condition whose hypothesised corresponding real word had a semantic relationship to the target, so no analysis was possible, and there were similar rates of phonogically related non-words in the two conditions (12 uncued and 9 cued).

Further analysis investigated the degree of phonological relatedness between targets and formal errors, and found no differences between conditions for any of the factors investigated (number of shared phonemes in target and error, proportion of errors sharing initial phoneme of target, and total phonemes shared in same position).

*Interim summary*

The above analyses indicate that the syntactic cues led to greater overall accuracy in naming. Within the lexical category there were more related errors in the cued condition and more unrelated errors in the uncued condition, and the related errors were largely formal errors. Non-word error rates showed no effects of cues.

Within the set of formal errors the relationship between targets and errors was similar across uncued and cued conditions, with no evidence of a closer relationship due to the cues. Errors showed a tendency to be shorter in length and less phonotactically complex, although the differences were not significant. The type of phonological overlap was the same across conditions, and was varied, with no clear pattern of retained or not retained phonemes being discernible in either condition.

It is possible that the cues limit the field of possible errors to that of the grammatical class of noun. In order to explore this proposal the next analysis investigated the grammatical class of the lexical errors.

*Grammatical status of errors*

Lexical error responses in the two conditions were coded according to their grammatical class. Coding was conducted by two researchers independently. Disagreements were resolved by discussion to reach a consensus. A number of responses were ambiguous with regard to grammatical class, in particular many responses could be either a noun or a verb, for example /si/. To resolve the status of the ambiguous responses the frequency values of the noun and the verb in each case were derived from the British National Corpus (Davies, 2004), and the higher frequency response credited. The resulting data are shown in table 7. Table 7 shows a significant difference between conditions with more noun responses in the cued than the uncued condition (Fisher’s Exact Test, z=2.4914, p=0.0127).

Table 7 here

*Count mass status of responses*

As for grammatical class, the word level potentially constrains production, ensuring the count or mass status of the target is maintained. We therefore analysed the number of responses sharing the mass or count status of the target. DP named more count than mass nouns correctly. The proportions of responses produced in the categories of lexical, non-lexical and other responses were similar across count and mass, as shown in table 8.

Table 8 here

*Count and mass status of errors*

All targets to which DP produced a noun as an error were included i.e. 19 in the uncued and 29 in the cued condition. All responses were coded as either count or mass nouns. The proportion of responses which retained the mass or count status of the target are shown in table 9. Count nouns predominate in DP’s error responses, regardless of the status of the target, or of the cue condition. For example presented with a picture of *butter* and the cue *This is some*\_\_ DP produced the count noun *pea*. Most responses were singular nouns. There were significantly more count than mass nouns (binomial test: uncued p=0.0192; cued p=0.0023). The distribution of count nouns vs mass nouns was similar across the four conditions of mass and count, cued and uncued (Chi square=2.9404, df=3, p=0.40091).

Table 9 here

*Summary of syntactic effects*

The analysis of grammatical class effects of the syntactic cues showed 50% of DP’s error responses in uncued condition were nouns, the remainder being verbs or adjectives. In the cued condition significantly more of the responses were nouns. Analysis of mass and count status showed there was no effect of syntactic cues on the count or mass status of errors. DP produced mainly count nouns, regardless of the cue condition and of the target noun’s status.

*Impact of variables on naming in the cued condition*

This analysis investigated the impact of psycholinguistic variables on DP’s naming using only the cued responses (as there were insufficient correct responses in the uncued condition). Number of phonemes, frequency, and familiarity all predicted naming success. The mean values for each variable for items named correctly vs items named incorrectly are shown in table 10 along with the values for Pearson’s R.

Table 10 here

Logistic regression was then performed to determine the impact of the variables on accuracy. As frequency and familiarity were highly inter-correlated (Pearson’s R=0.712, p<0.001), frequency was entered, along with number of phonemes. The model was statistically significant (Chi square =13.516, df=2, p=0.001). The model explained 25% (Nagelkerke R2 ) of the variance in naming accuracy, and correctly classified 81% of cases. Thus shorter words and more frequent words were associated with more accurate naming.

Frequency of targets differed significantly between response categories in the cued condition, with mean frequencies as follows: correctly named 1.81; lexical errors 1.46; non-lexical errors 1.34 and other responses 1.15. Kruskal-Wallis test was significant (K(3)=10.30, p=0.016).

*Determiner judgement task*

DP’s accuracy in the syntax judgement task is shown in table 11. The data show the accuracy of DP’s responses to determiner selection for the target nouns, both for nouns named correctly (n=18) and those named incorrectly or not named (n=42). For all sets, i.e. count and mass nouns and correctly and incorrectly named, syntax judgements were at chance (2-tailed Binomial test values - correct count nouns: p=1.00; incorrect count nouns: p=0.8555; correct mass nouns: p=0.0703; incorrect mass nouns: p=0.5966). Correct mass nouns showed better syntax judgements than all other sets but small numbers in the dataset mean the result is not significant.

Table 11 here

**Discussion**

In this study we analysed the language processing of DP, who presented with transcortical sensory aphasia with fluent neologistic jargon aphasia, comprehension deficit, anomia, and relatively retained repetition. In her connected speech she retained simple syntactic structures at phrase and sentence level, but inserted neologistic content into content word slots. The investigation of noun syntax showed an impact of syntactic cues on accuracy of noun production, and on the types of errors. DP produced more nouns and more formal errors following cues. In contrast DP showed almost complete impairment on the explicit test of syntax judgement. This is the first study to investigate noun syntax in a speaker with jargon aphasia. The data add to knowledge of the spoken word production system and add new insights into jargon aphasia.

*Cued naming*

The data show positive effects of syntactic cues on spoken word production. The syntactic cues facilitated a higher number of accurate responses, more word errors with a phonological relationship to the target, and fewer unrelated word errors. This was despite DP showing little to no explicit awareness of the syntax of the cues in the syntax judgement task. The cues did not impact on rates of words vs non-words, or the proportion of errors which were semantically related to the target. The degree of phonological relationship between targets and errors was similar across conditions. The cues led to more nouns than other grammatical classes as errors, but had no impact on the count or mass status of errors, with count noun errors predominating, regardless of the target word, or the cue condition. Word length and frequency were significant predictors of naming accuracy in the cued condition.

An Interactive Activation account of production

Highly interactive accounts such as that of Dell et al. (1997) propose feedforward and feedback of activation between semantic-word levels and between word-phoneme levels. Within this theory the proposal that the cues activated all nouns more highly at the word level accounts for many of the findings. DP’s profile indicates damage at the semantic, the word and the phoneme level. This affects lexical selection through impaired semantic-word processing, leading to semantic, mixed and unrelated word errors, and words other than nouns. Second stage damage affecting word-phoneme processing results in formal errors and phonologically related non-word errors.

Provision of the syntactic cues will affect both stages of processing via the boost of activation to nouns at the word level. Increased semantic-word level activation would lead to greater accuracy, more nouns, and more semantically related responses. Increased word-phoneme level activation would mean greater accuracy, more nouns, more formal errors and more phonologically related non-word errors. We found evidence to support interactive processes between word-phoneme levels including more nouns and more formal errors – although no increase in phonologically related non-word errors - but no evidence to support claims of any effect on semantic level processing from the cues. An alternative account, as proposed by Goldrick and Rapp (2002) proposes that there is no feedback from the word level or L-level to the semantic level in the course of lexical selection, and we now consider this account as a possible explanation.

A Restricted Interactive Activation account

Rapp and Goldrick (2000) and Goldrick and Rapp (2002) proposed feed-forward only activation from semantics to syntax represented at the word level. This activates the target and its semantically and syntactically related neighbours. Activation then feeds forward to phonological representations, resulting in activation of the phonology of the target and its neighbours. Restricted feedback of activation from the phoneme level to the word level results in increased activation to words which are formally related to the target. According to these authors this explains the patterns of errors seen in healthy speakers and in specific single case data from aphasia. This account explains many aspects of DP’s data. Damage to the semantic-word and word-phoneme processes mean many unrelated and non-noun responses, unrelated lexical responses, and phonological related non-word errors.

This account arguably explains the effects of cues more easily than does the IA account. The syntactic cues lead to increased activation to syntactic nodes for nouns via the word level, resulting in greater accuracy and more nouns in the response set. There is no increase in semantically related errors as there is no influence on semantic processing from the word level. The increase in formal errors is explained in terms of damage to the processes operating between word-phoneme levels. The syntactic cues mean more correct items are activated effectively at the word level, and activation feeds forward to the phoneme level then back to the word level activating formal neighbours of the target enabling their possible selection in place of the target word.

This theory predicts also a decrease in the rate of phonologically related non-word errors as a result of the cues, but this was not found. The rate of production of these errors was the same across conditions, which is problematic for this account as it predicts an influence on the production of words. This could be explained by frequency however, as analysis of the frequencies of the four response categories of correct, lexical, non-lexical and other showed decreasing mean frequencies across categories in a linear relationship, with non-lexical errors occurring to lower frequency targets than targets eliciting correct or lexical responses. Frequency is assumed to operate at the lexical or word level (e.g. Kittredge, Dell, Verkuilen & Schwartz, 2008).

Repetition

DP’s repetition is noteworthy in the context of the severe phonological output deficit. DP was able to repeat words at near 100% accuracy and is similar in this respect to JH (Olson et al., 2015) who also had jargon aphasia with retained repetition. The impaired phonological processing evident in semantically driven speech tasks such as picture naming, coupled with the retained phonological processing evident in repetition require a further mechanism for spoken production. Hillis and Caramazza (1991) proposed two routes to production, lexical and nonlexical. In repetition both routes are activated and act in summation to produce a response, and can override impairment to one route. The nonlexical route is activated by incoming auditory stimuli and hence does not support picture naming. Recent modelling of separate lexical, sublexical, and combined lexical and sublexical accounts revealed the superiority of the latter in accounting for reading and repetition data in jargon aphasia (Olson et al., 2015).

*Processing of mass and count nouns and syntax*

There was no difference in DP’s accuracy in naming mass and count nouns, but she produced more count nouns than mass nouns as errors in the naming task. This suggests that DP’s processing of the meaning conveyed by the different determiners *some* and *a* was impaired. This is supported by data from the syntax judgement task which showed mainly chance responses to determiner-noun combinations apart from some slight evidence that she correctly judged *some* to combine with mass nouns. With this exception, there is little evidence that DP processed determiner meanings. It is worth noting however that the judgement task required attention, planning, and decision-making however all of which are impaired for DP, so these data may not accurately reflect her knowledge of determiner meanings.

The inability of the cues to promote more count or mass nouns as errors does not directly address either the IA or the RIA accounts. Regardless of the target’s intended status of count or mass, or of cue condition, DP produced mainly count nouns in response. This could be due simply to there being more count nouns in English, and count nouns being of average higher frequency. An alternative account is that nouns are not mentally represented as count or mass, but rather the sense in which they are used in particular contexts determines their count or mass status, in that context. Most nouns can be used in both count and mass senses, and this meaning is achieved by the determiner frame. Determiner *a + noun* refers to a single quantifiable entity such as ‘a duck’. Determiner *some + noun* has several meanings including a quantity of a substance such as ‘some duck’. Single quantifiable entities such as objects are referred to more often in that sense, hence combine with determiner ‘a’ frequently. It is this statistical frequency that leads to them being termed count nouns. This account of mass and count nouns views nouns as just being *more likely* to be used in one sense than the other. The frequency of the different determiner + noun combinations may therefore contribute to processing ease, for example ‘a cat’ is a higher frequency combination than ‘some cat’ so ‘a’ is likely to cue cat more easily. The frequency of combinations of words as well as lexical frequency itself therefore needs to be controlled for in future experiments.

DP was sensitive to the information in the cue phrases *this is a\_* and *this is some\_* in that both enabled her to access more related words, and more nouns. Hence the cues enabled syntactic processes to operate more efficiently generally. DP did not discriminate between the meaning of the determiners however - both types of cue facilitated noun production and mainly cued production of count nouns. It is possible that DP may have processed only this first part of the cue ‘*this is’,* which enabled her to access nouns in general, with no regard to the semantic information encapsulated in the determiners *a* and *some*. The phrase *this is\_* presents a noun slot in itself however, and Gregory et al. (2012) showed significant cueing effects using this with neurotypical adults. The semantics of determiners are extremely difficult to investigate, but future experiments could compare different phrasal contexts to explore this issue in more depth.

Task differences

It is notable that DP responded positively to cues but showed little explicit awareness of syntax in the judgement task. This is similar to the data reported by Scarná and Ellis (2002) from ED who is a bilingual English-Italian participant with aphasia. ED showed no explicit knowledge of noun syntax in explicit tasks probing grammatical gender, but she was able to translate adjective-noun phrases from English to Italian. This finding indicates that selection of task is critical to ensure data are representative of processing ability, as offline explicit tasks which measure meta-knowledge of language are arguably probing different and/or additional cognitive functions to real-time language processing capacity and function.

Limitations of this study

Several assumptions underlie our reporting of the data from DP. She was three years post-onset of her stroke when she participated, hence significant cortical reorganisation will have taken place, and what we witnessed with her was the result of the damage caused by the stroke and the results of these processes (Kleim, 2011; Hartwigsen & Saur, 2017). DP’s data represent a snapshot in a window of time, with prior and subsequent cortical changes being unknown. Without this information we cannot state with certainty the status of the findings. Related to the above is the fact that we have no imaging data from DP and so cannot make any claims about the involvement of specific cortical regions in her performance and in her recovery. Marshall (2017: 73) states that jargon aphasia usually arises after posterior brain lesions and that motor cortex is unimpaired. DP presented with right hemiparesis however. In addition DP presented with neglect dyslexia, which is associated with right hemisphere damage (Vallar et al., 2011). The combined set of symptoms are not coherent with current knowledge of the various neuropathological bases, and as such challenge existing knowledge. Without imaging data we cannot comment on this aspect of the research.

We have treated all the data as representative of domain-specific language function only, yet, as many studies and their consequent theories now attest, numerous other cognitive functions support language processing, including memory, attention and executive functions such as planning and decision-making (see e.g. Brownsett, Warren, Geranmayeh et al., 2013; Jefferies & Lambon Ralph, 2006). One hypothesis is that language itself may remain less impaired than tests suggest in aphasia, and slow and errorful performance on language tests is due instead to the demands placed on domain-general systems by resource-hungry complex tasks. This haunts research using neuro-imaging to locate language function, as activated areas cannot be confidently attributed solely to the language function under examination. Brownsett at al. (2013) cite Wise (2003) who argued that most language tasks differ markedly from normal language use, with increased task demands on domain-general functions such as attention, and it is this upregulation that is identified in imaging studies. DP experienced particular difficulties with two tasks which diverge markedly from natural language use, the minimal pairs test and the syntactic judgement task. What we witnessed here was likely the result of impoverished domain-general function in attention and decision-making, and again argues for tasks to mimic natural language use as closely as possible, and for data relating to other cognition to be presented along with language data.

Insights into jargon aphasia

The data from DP offer new information concerning the retained linguistic knowledge in a speaker with neologistic jargon aphasia. This condition has long perplexed researchers and clinicians, being described as ‘clinically intractable’ (Marshall 2006: 387) which reflects the puzzlement with which we view jargon, and the difficulties clinicians encounter in their attempts to help people improve their language via therapy. Assessment of DP’s language found evidence of retained knowledge of syntax demonstrated through connected speech production and via the cueing experiment. Critically for the rehabilitation chances of people with jargon aphasia we found positive effects of syntactic cues on lexical retrieval. This opens the door to extending the cueing method into an effective form of intervention for noun retrieval and to extending the cues to other syntactic structures including verb phrases (see related data from DP in Herbert et al., 2012). Given the lack of evidence of effective interventions for jargon aphasia these findings are extremely positive.

Conclusion

Evidence from people with such complex and severe damage to their linguistic system must be viewed with care. Traditionally, theory building within the cognitive neuropsychological approach has proceeded on a case by case basis with evidence from individuals with specific impairments providing support for or challenging an existing position. The data from DP are presented within this tradition, in the spirit of challenging some previous assumptions regarding the architecture and workings of the language system, and regarding our conceptualisation of particular elements within linguistics.

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Disclosure of interest

The authors report no conflict of interest

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Table 1. Language assessment data

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Assessment details | Composite test score | Proportion correct | Control mean (st dev) | Control range |
| Oral Naming |  |  |  |  |
| CAT Picture naming (n=48) | 5 | 0.13 | 46.37 (1.6) | 42-48 |
| CAT Naming Actions (n=10) | 4 | 0.40 | 9.88 (0.43) | 8-10 |
| Auditory analysis |  |  |  |  |
| Auditory Minimal pairs (ADA) (version P2) (n=40) | 24 | 0.60 | - | - |
| Semantic processing |  |  |  |  |
| Pyramids and Palm Trees (three pictures) (n=52) | 43 | 0.83 | - | 49-52 |
| Spoken word to picture matching (CAT x) (n=30) | 23 | 0.77 | 29.15 (1.35) | 25-30 |
| Written word to picture matching (CAT x) (n=30) | 26 | 0.87 | 29.63 (0.79) | 27-30 |
| Sentence processing |  |  |  |  |
| Auditory sentence comprehension (CAT 9) (n=32) | 11 | 0.69 | 30.17 (1.85) | 26-32 |
| Reading and repetition |  |  |  |  |
| Word repetition (PALPA 53) (n=40) | 38 | 0.95 | 39.79 (0.83) | - |
| Word repetition (CAT 12) (n=32) | 30 | 0.94 | 31.73 (0.67) | 30-32 |
| Non-word repetition (n=26)a | 24 | 0.92 | - | - |
| Read aloud simple words (CAT 20) (n=48) | 19 | 0.40 | 47.42 (1.06) | 44-48 |
| Read aloud non-words a (n=26) | 0 | 0.00 | - | - |

CAT: Comprehensive Aphasia Test (Swinburn, Porter & Howard, 2005); ADA: Action for Dysphasic Adults; a Test produced by David Howard, personal communication; PALPA: Psycholinguistic Assessment of Language Processing in Aphasia (Kay, Lesser & Coltheart, 1992); The Pyramids and Palm Trees Test (Howard & Patterson 1992)

Table 2. Cinderella narrative sample

well there’s six . white. /d/ and // the same // thing and the thing the fat...I don’t know // the similar all last fat yes and beautiful and yes oh there ///k/ // this // happiness has been / / of him and he er and he / / the // and today oh he // he // he wafted home home to his /j / and // I don’t know what it is

Table 3. Reading aloud errors

|  |  |
| --- | --- |
| worm → ‘some’ | plead → ‘lead’ |
| bows → ‘cows’ | shone → ‘lone’ |
| fox → ‘box’ | position → [] |
| yacht → ‘at’ | asbestos → [] |

Table 4. Cognitive tests

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Task | Raw score | Proportion correct | Control mean  (st dev) | Control range |
| Digit span | 5.5 |  | - | 5-9 |
| Cognitive Linguistic Quick Test | | | | |
| Attention (n=215) | 39a | 0.18 | - | 160-215 |
| Memory (n=185) | 83b | 0.45 | - | 141-185 |
| Executive Function (n=40) | 10b | 0.25 | - | 19-40 |
| Visuospatial skills (n=105) | 36b | 0.34 | - | 62-105 |
| BORB Picture judgment | | | | |
| Picture judgement Easy (n=32) | 28 | 0.88 | 30.5 (1.4) | 28-32 |
| Picture judgement Hard (n=32) | 25 | 0.83 | 27.0 (2.2) | 22-30 |

aSevere bModerate

Table 5. Naming response categories and criteria

|  |  |
| --- | --- |
| Lexical errors |  |
| Semantic | Synonym, category coordinate, category superordinate, category subordinate or associate |
| Formal | The response is phonologically similar to the target, i.e. The target and response starts or ends with the same phoneme, has a common phoneme in another corresponding syllable or word position, or has more than one common phoneme in any position. Proper nouns and plural morphemes do not contribute to phonological similarity |
| Mixed | The response meets the criteria for both semantic and formal errors |
| Unrelated | The response meets neither semantic nor formal errors and is not visually related to the target |
| Sublexical errors |  |
| *Phonologically related non-word* | Criteria as for Formal but resulting in a non-word |
| *Semantically related or semantically and phonologically related non-word* | The response differed by one phoneme from a word that was a semantic coordinate of the target e.g. response ‘babbit’ for target ‘squirrel’ |
| *Neologism - Unrelated non-word* | No relationship to the target and not a real word |
| Other |  |
| *No response* | No spoken production apart from comments such as ‘Oh what’s the word’ |
| *Description* | The response is a multiword utterance or single adjective or adverb that characterizes the target object or explains its function or purpose. |
| *Miscellaneous* | e.g. named a part of the target object such as response ‘sleeve’ for target ‘jumper’ |

Table 6. Cued and uncued naming responses

|  |  |  |
| --- | --- | --- |
| Response | Uncued naming responses | Cued naming responses |
| **Lexical responses** |  |  |
| Correct | 5 | 15 |
| Semantic | 5 | 4 |
| Formal | 7 | 17 |
| Mixed | 1 | 6 |
| Unrelated | 25 | 9 |
| **TOTAL** | **43** | **51** |
| **Non-lexical responses** |  |  |
| Phonologically related non-word | 12 | 9 |
| Semantically or semantically and phonologically related non-word | 1 | 2 |
| Neologism – Phonologically unrelated non-word | 5 | 6 |
| **TOTAL** | **18** | **17** |
| **Other** |  |  |
| No response | 11 | 9 |
| Description | 3 | 2 |
| Miscellaneous | 5 | 1 |
| **TOTAL** | **19** | **12** |

Table 7. Lexical errors by grammatical class – ambiguous responses resolved by word frequency

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Noun | Verb | Adjective | Other | Total | % nouns |
| Uncued | 19 | 9 | 9 | 1 | 38 | 0.50 |
| Cued | 29 | 3 | 3 | 1 | 36 | 0.81 |
|  |  |  |  |  |  |  |

Table 8. Categories of responses to count vs mass noun targets

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Response category** | **Uncued naming responses** | | **Cued naming responses** | |
|  | **Count targets** | **Mass targets** | **Count targets** | **Mass targets** |
| Lexical responses | 22 | 21 | 25 | 26 |
| Non-lexical responses | 11 | 7 | 8 | 9 |
| Other responses | 7 | 12 | 7 | 5 |

Table 9. Count and mass status of noun errors in relation to status of targets

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Uncued | Uncued | Cued | Cued |
|  | count targets | mass targets | count targets | mass targets |
|  |  |  |  |  |
| Number of errors | 8 | 11 | 14 | 15 |
| Number of errors maintaining target’s mass-count status | 5 | 1 | 12 | 4 |
| % maintaining target’s status | 0.63 | 0.09 | 0.86 | 0.27 |

Table 10. Values for key variables and results of Pearson’s correlation analyses

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Values for variables | | Correlation with naming | |
|  | Mean of items named correctly  (n=15) | Mean of items failed to name (n=25) | Value of Pearson’s R | P value |
| Word length phonemes | 3.27 (1.44) | 4.18 (1.25) | 0.310 | 0.005 |
| Celex frequency | 1.81 (0.52) | 1.36 (0.55) | 0.311 | 0.005 |
| Familiarity | 582 (34) | 548 (50) | 0.269 | 0.016 |

Table 11: Accuracy in syntax judgement task

|  |  |  |  |
| --- | --- | --- | --- |
|  | Correctly named | Incorrectly named | Total |
| Count nouns (n=40) | 5/10 (0.50) | 16/30 (0.53) | 21/40 (0.53) |
| Mass nouns (n=40) | 7/8 (0.88) | 14/32 (0.44) | 21/40 (0.53) |
| All nouns (n=80) | 12/18 (0.67) | 30/62 (0.48) | 42/80 (0.53) |

1. Some of the background data concerning DP were published originally in Herbert, R., Webster, D., & Dyson, L. (2012). Effects of syntactic cueing therapy on picture naming and connected speech in acquired aphasia. *Neuropsychological Rehabilitation, 22*(4), 609-633. See [www.tandfonline.com](http://www.tandfonline.com). [↑](#footnote-ref-1)
2. DP struggled to understand what was required of her in this task however and we are not confident that it accurately reflects her auditory processing, given the repetition data. [↑](#footnote-ref-2)
3. The same set of materials was used in Herbert and Best (2010) and in Herbert, Anderson, Best and Gregory (2014). [↑](#footnote-ref-3)
4. The naming responses were coded for accuracy to compare against the syntax judgement accuracy but were not analysed further. [↑](#footnote-ref-4)