Anosognosia and self-correction of naming errors in aphasia

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Abstract

Background: There has been comparatively little research into anosognosia for aphasia (a lack of awareness of acquired language deficits). Direct assessments of metacognitive awareness tend to rely on high levels of verbal competence and are difficult for people with aphasia to complete. Therefore indirect measures of awareness have been considered, notably the person's self-correction of his or her naming errors. Different mechanisms for self-correction based in comprehension or production skills have been proposed. In addition, in other areas of cognition, the relationships between direct and indirect measures and underlying forms of awareness have not been clearly established.

Aims: The aims of this study were: a) to investigate the relationship between a direct and an indirect measure of awareness of aphasia, b) to examine the role of executive functioning in performance on both assessment types, and c) to examine the relationship between these measures and underlying language comprehension and production skills.

Methods & Procedures: Forty-eight people with aphasia participated, drawn from rehabilitation hospital caseloads. Participants were assessed on a language battery, a non-verbal test of executive function, a direct measure of awareness (ratings of difficulties), and had self-correction behaviour examined in a 40-item naming test.

Outcomes & Results: There was a trend relationship between performance on the direct and indirect measures. Both related to overall severity of language impairment, with more severely impaired people being less aware of their difficulties. The two measures, however, dissociated with respect to single-word production and comprehension scores: the direct measure related to production and not comprehension, while the indirect measure related to comprehension and not production. Executive functioning related only to the direct measure of metacognitive awareness. Within production scores, the rate of correction success rather than pre-correction naming rate was associated with metacognitive awareness.

Conclusions: This study revealed different underlying bases, in language processes and executive function, for two measures of anosognosia for aphasia. When used to assess awareness of deficits, direct and indirect methods should not be regarded as equivalent.

Keywords

Anosognosia, awareness, metacognition, executive function, self-monitoring, error detection

Anosognosia and self-correction of naming errors in aphasia

A lack of awareness of one's own deficits is known as anosognosia. This intriguing phenomenon has been studied in several areas of acquired neurological impairment, including motor, visuo-spatial and memory impairments (Prigatano, 2010). Anosognosia for aphasia has also been reported (Marshall, Robson, Pring & Chiat, 1998; Maher, Rothi & Heilman, 1994; Shuren, Hammond, Maher, Rothi & Heilman, 1995; for reviews see Al Banna, Redha, Abdulla, Nair & Donnellan, 2016; Kertesz, 2010; Lebrun, 1987). Such reports have been, however, infrequent due to the problem of using verbal indices, such as interviews, questionnaires or spontaneous comments, to assess the level of awareness of people with communication difficulties. These verbal indices are direct measures of metacognitive awareness, i.e. they tap the knowledge that a person holds about his or her own abilities and difficulties. People with aphasia may not understand the questions and/or may not be able to provide responses (McGlynn & Schacter, 1989).

A theoretical distinction has been made between metacognitive or 'intellectual' awareness, and 'emergent' awareness, which is the recognition of errors as they occur during a task. Different relationships between the two have been proposed. While Crosson et al. (1989) suggested that intellectual awareness provides the basis for emergent awareness, Toglia and Kirk (2000) suggested that instances of (emergent) error detection may lead to the development of intellectual awareness. Empirically, in studies of a variety of patient populations and cognitive domains, there has been little support for a relationship between the two forms of awareness (e.g.; O'Keeffe, Dockree, Moloney, Carton & Robertson, 2007; Hoerold, Pender & Robertson, 2013; Goverover, Genova, Griswold, Chiaravalloti & DeLuca, 2014; but see Dockree, Tarleton, Carton & FitzGerald, 2015). As well as a theoretical distinction between the two, metacognitive and emergent awareness are associated with direct and indirect methods of assessment.

Cocchini, Gregg, Beschin, Dean and Della Sala (2010) produced a direct test of metacognitive awareness of aphasia. In the Visual-Analogue Test Assessing Anosognosia for Language Impairment (VATA-L), the person completes rating scales to indicate the extent that he or she experiences problems with a variety of language activities. Awareness is measured as the discrepancy between the person's own ratings and those made about them by carers. To minimise the impact of aphasia on following the test's instructions and providing responses, the test incorporates pictures to illustrate the activities in question, and responses are made by pointing to a non-verbal scale. The measure has been used to scope the incidence of anosognosia for aphasia (18.9% of those tested by Cocchini et al., 2010), and to explore the relationships between anosognosia and depression in people with aphasia (Cocchini, Crosta, Allen, Zaro, & Beschin, 2013), anosognosia and language difficulties in people with dementia (Savage, Piguet & Hodges, 2015), and awareness of aphasia and apraxia (Canzano, Scandola, Pernigo, Aglioti & Moro, 2014).

The measure of awareness in the VATA-L depends on both the person with aphasia and the caregiver's ratings for that individual, both based on subjective information and which may be affected by various personal factors (e.g., Prigatano, 2000). Studies have found agreement between these two sources of ratings (e.g. Rautakoski, Korpijaakko-Huuhka, & Klippi, 2008). Where differences exist, they tend to be in the direction of the person with aphasia producing ratings of better skills (e.g. Cocchini et al., 2010; Hesketh, Long, Bowen et al., 2011). Family and friends also tend to rate skills as superior to professional caregivers (e.g. De Jong-Hagelstein, et al., 2012). The inclusion of family members in establishing cut-off scores in the VATA-L therefore provides a conservative method for defining a lack of awareness. The VATA-L also includes 'check questions' with objectively correct responses, designed to eliminate people who have not understood the task requirements.

An alternative to a direct test, and one which side-steps the difficulty of designing accessible measures for people with communication difficulties, is to look for evidence in the person's behaviour that indirectly reveals his or her knowledge of deficits. In aphasia, the person's ability to self-correct errors in spoken language production has been proposed to this end (Marshall & Tomkins, 1982). Self-correction is therefore (potentially) a measure of emergent rather than metacognitive awareness, the correction being made at the time of an instance of difficulty (Toglia & Kirk, 2000). Two main mechanisms within language processes have been proposed to underlie the ability to self-correct.

The first is the Perceptual Loop hypothesis (Hartsuiker & Kolk, 2001; Levelt, 1989; Postma, 2000). According to this hypothesis, language output is monitored and errors detected by the person's own comprehension system. Output may be monitored after it is overtly produced, or at a pre-articulatory stage as 'inner speech' (Alderson-Day & Fernyhough, 2015). People with impaired comprehension fail to detect and thence correct errors, leading to phonologically and/or semantically errorful spoken output as occurs in fluent jargon aphasia. An alternative to the Perceptual Loop hypothesis is a mechanism in which errors are detected and correction is initiated within speech production processes themselves. Marshall et al. (1998) provided support for this approach in their study of a man with jargon aphasia and relatively good comprehension, attributing self-monitoring difficulties specifically to the process of accessing phonology from semantics, proposing that errors are detected by feedback mechanisms between these two layers of processing. Nozari, Dell and Schwartz (2011) described a model in which errors are detected by a different mechanism in production, namely due to conflict at the stage of selection between alternative responses. That this mechanism is feasible was supported when the model was applied to data from a group of people with aphasia. No correlation between error detection and comprehension skills was found.

Not all attempts at self-correction are the same. Schlenck, Huber and Willmes (1987) provided a useful taxonomy in a study of corrections made by people with aphasia during picture description with sentences. Correction behaviours, whether ultimately successful or not, included pauses, filled pauses or interjections, repetition of preceding utterances, phonemic approximations to the target, and circumlocutions or semantic approximations. Schlenck et al. (1987) made a distinction between repairs, which occur after an overt error and are attempts to modify it, and prepairs which are not preceded by an error but which relate to the following word. The majority of self-corrections seen in their study were prepairs, while repairs were not made by people with aphasia at a rate greater than that of control participants (despite people with aphasia making many more errors). The frequency of prepairs correlated significantly with comprehension scores at the level of the group. Examining individual participants, Schlenck et al. (1987) found relationships between both comprehension and production skills and the rate of prepair corrections. They concluded that there is evidence for both comprehension- and production-based monitoring.

The relationship between direct and indirect measures of awareness for aphasia, such as self-reports and self-correction rate, remains uncertain. The tests may, despite being different methods, reflect a single form of awareness, or may alternatively tap different (metacognitive and emergent) forms of awareness, deriving from different aspects of language processing to different degrees. The aims of the present study are threefold. First, we investigated the relationship between a direct measure of awareness of language difficulties (the VATA-L) and an indirect measure (self-correction in naming). Secondly, we examined these measures in terms of participants' language comprehension and production skills. A relationship with comprehension skills would be consistent with the Perceptual Loop hypothesis for error detection, while a relationship with production skills would be consistent with production-based mechanisms of error detection. Finally, we examined the role of executive functioning in performance on the two measures of awareness. Metacognitive awareness (in domains of cognition other than language) has typically been described as conscious (McGlynn & Schacter, 1989; Koriat, 2007) and dependent on executive functioning (Bivona et al., 2008; Goverover et al., 2014; Shimamura, 2000). An association between tests of metacognitive awareness and tests of executive function has not, however, been clearly established by experimental studies (e.g., Gasquoine, 2016). The Perceptual Loop account of self-correction in aphasia has been characterised as conscious and demanding of attentional resources (Levelt, 1989; Postma, 2000), whereas, production-based monitoring has been described variously as automatic, with autonomous resources (Postma, 2000) or as requiring central cognitive control (Gauvin, De Baene, Brass & Hartsuiker, 2016).

Method

Participants

Forty-eight people with aphasia participated in this study. Participants were recruited as volunteers from in-patient and community neurological rehabilitation caseloads in Italy and the UK according to the following inclusion criteria: they were over 18 years of age, each had left hemisphere acquired brain injury confirmed by CT or MRI scan, and each had a diagnosis of aphasia as conferred by his or her healthcare teams following routine clinical assessment. Demographic and aetiological information is presented in Table 1. For the three individuals with bilateral injuries, these were sustained simultaneously. No participant had a previous neurological condition.

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

Thirty-eight participants were tested in Italy and had Italian as their first language; 10 tested in the UK had English as their first language. Participants were tested individually, either within one session or in two sessions separated by no more than 7 days. All participants gave informed consent prior to participating in the study according to the Declaration of Helsinki. The study was approved by the Italian and the UK NHS Ethical Committees.

Assessments

Language assessment. All participants completed the Aachen Aphasia Test (AAT), a battery of language assessments standardised in Italian and English versions (Luzzatti, de Bleser, & Willmes, 1991; Miller, Willmes & de Bleser, 2000). The AAT includes various sub-tests of comprehension (auditory comprehension, reading comprehension) and language production (spontaneous speech, repetition, naming, and writing). Each sub-test score (with the exception of the spontaneous speech scales) is converted to a percentile (where higher percentiles indicate better performance) and compared with normative data to indicate the possible degree of impairment, from 1 (very mild) to 4 (severe).

Awareness of language difficulties. The Visual-Analogue Test Assessing Anosognosia for Language Impairment (VATA-L; Cocchini et al., 2010) is a 14-item questionnaire in which individuals rate the ease or difficulty they experience in a number of different communication activities, from 0 (no problem) to 3 (major problem). The questionnaire is made accessible to people with aphasia through use of pictures to support understanding of the items, and through use of a visual-analogue scale as a means to respond. The overall score can range from 0 to 42. Four additional check questions elicit responses made at either end of the responses scale. The rating of the check questions is not included in the final VATA-L score; however participants who fail to provide the expected response to any of the check questions are excluded as their use of the measure cannot be considered reliable. As well as participants with aphasia completing the questionnaire about themselves, a family member and/or a professional carer (e.g. a therapist, medic, nurse, or psychologist) also completed the questionnaire about them. Five of the participants had ratings provided by family members only, 9 by professional carers only, and 34 by both. Where two carer ratings were obtained, an average value was taken. Discrepancies between participants' and carers' ratings were compared with norms (Cocchini et al., 2010). Discrepancies higher than 13 points indicate lack of awareness of language difficulties, scores between 12 and 13 indicate borderline performance, and discrepancies equal to or lower than 11.9 indicate preserved awareness. Family members and professional caregivers give similar ratings, and test-retest reliability for the VATA-L is high (Cocchini et al., 2010). There is an absence of validity data as there are not, to our knowledge, other direct tests of awareness of language deficits in aphasia. Direct tests of awareness for other cognitive and for motor deficits have adopted similar methods (e.g. Della Sala, Cocchini, Beschin & Cameron, 2009; Smith, Della Sala, Logie & Maylor, 2000).

Self-correction behaviours in naming. Participants named 40 line drawings of objects (PALPA subtest 53; Kay, Lesser & Coltheart, 1992). No time constraints or limits on the number of naming attempts were made. Participants indicated when they wished to end their naming attempt and move on to the next item via pointing to a choice of card (illustrating a thumb up and the word 'Correct' or an arrow and the word 'Pass'). They received no feedback as to whether the response was in fact correct or incorrect. Responses were all audio recorded for later analyses.

Performance was scored for accuracy of the initial naming attempt, and for the presence of subsequent self-correction behaviours derived from the set proposed by Schlenck et al. (1987). These included subsequent naming attempts (whether correct or not) and also phonemic approximations, circumlocutions or semantic approximations to the target, and comments on own performance. ‘Pass’ responses were considered as comments, equivalent to stating “No, I can’t get this one”. Pauses of 2 or more seconds after a response were also counted as self-corrections if terminated by a subsequent naming response, self-correction behaviour or use of the correct/pass card. Filled pauses, or interjections, were similarly classified as self-corrections. We excluded, however, all trials that started with a pause or filled pause as, for these trials, we do not know whether (a) the participant produced a naming attempt after covert correction, or (b) the pause reflects slowed lexical retrieval (Nickels & Howard, 1995). Examples of each type of correction are given in Table 2. For the sake of clarity, we adopt the expression ‘Self-correction behaviours’ to refer to all types of responses discussed above.

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

For each object picture, participants were assigned a pre-correction naming accuracy score based on the initial component of their response (0= incorrect; 1= correct), a self-correction behaviour score (0= no self-correction behaviours; 1= self-correction behaviours) and a post-correction naming accuracy score (0= incorrect; 1= correct). Across the 40 items, the two naming scores were used to calculate a pre-correction and a post-correction naming rate. A self-correction behaviour rate was calculated as the proportion of initially incorrect responses that were followed by one or more self-correction behaviours (regardless of whether this correction was successful or not.) A self-correction success rate was calculated as the proportion of initially incorrect responses that were subsequently successfully corrected to the target response.

Executive functioning. Executive functioning was assessed using the Brixton spatial anticipation test (Burgess & Shallice, 1997). In this test, participants are presented with a series of pages, each of which displays an array of dots, one of which is coloured. Participants respond by indicating the location that they anticipate the coloured dot will occupy on the next page. Over the series, the location of the dot changes within the array according to pre-determined sequences and sequence changes. The test is therefore one of rule detection and application. It is scored in terms of number of errors over 55 trials, with a maximum error score of 54. The Brixton test is a suitable assessment of executive function for people with aphasia due to its non-verbal stimuli and response options (Strauss, Sherman & Spreen, 2006). The test instructions, which are spoken, also contain a modelled sequence of pointing responses. It is difficult to ensure unequivocally that instructions have been understood in the case of pathological performance, however, failure to understand the task requirements would lead to non-responding or chance level scores (48/54 errors), which were not seen in our sample.

Results

Assessment of language difficulties and executive functioning

The average total AAT percentile score for the group of people with aphasia was 57.1 (sd= 28.4). There was a wide range of overall production scores (range 0-91.9) and of comprehension scores (range 16.1-99.3). The aphasia subtypes of the group are shown in Table 3, based on their pattern of performance across tests in the AAT.

---Table 3 about here---

In the following analyses, the AAT auditory word-to-picture matching subtest score was used as the measure of each participant's comprehension rather than the composite scores of the AAT, and the PALPA object naming subtest score was used as the measure of production skills. The processing demands of these single word tasks most closely reflect the demands of single object naming and error detection which were the focus of our study, whereas the AAT composite score incorporates sentence-level processing.

Direct and indirect measures of awareness

Thirty-four out of 48 participants (71%) were fully aware of their language impairment in the direct measure, according to the VATA-L scoring system. Three (6%) were considered as borderline, and 11 (23%) were classified as unaware. There were no reliable differences between the aware and unaware groups in terms of the age of participants (t=0.31, df=41, ns) or the time post-onset of injury (t=0.37, df=41, ns). Table 3 presents the breakdown of the VATA-L sub groups in terms of the type and severity of aphasia as determined by the AAT. A series of chi-square analyses investigated whether any sub-type of aphasia was more often associated with unawareness; no significant effects were found.

Self-correction behaviour rate was calculated from analysis of the 40 item PALPA naming task. Data from 2 participants (one aware, one unaware on the VATA-L), were excluded as these participants scored zero correct by indicating ‘pass’ to all 40 items as their initial and only response. They were excluded because we cannot determine whether they covertly attempted each item and subsequently indicated that they could not name it, or whether they were immediately making a pass response without considering the item. Of the 46 participants entering subsequent analyses, eight also scored zero on the naming task and made some pass responses, but did also make overt responses indicating an attempt at naming. For these participants, we scored the pass responses as comments (see above).

Overall, the proportion of errors that were followed by self-correction behaviours was .56 (sd= 0.36). Self-correction behaviour rate was not associated with age of the participants (Spearman's r=-.12, ns) nor with the time since onset of their difficulties (r=-.14, ns).

Table 4 contains summary data for the whole group and the VATA-L awareness sub-groups.

---Table 4 about here---

Relationship between direct and indirect measures of awareness

An independent samples t-test found a trend for the VATA-L aware group to produce self-correction behaviours at a higher rate (mean=.60) than the VATA-L unaware group (mean=.38; t=1.712, df=41, p<.10). As the unaware group is small in this comparison, we also used the VATA-L discrepancy score as a continuous measure of awareness; there was again a trend for more aware participants on this direct measure to produce self-correction behaviours at a higher rate (Spearman's r=.250, p<.10).

Relationships between measures of awareness, language production and comprehension, and executive functions

The VATA-L aware and unaware groups differed with respect to overall severity of aphasia, with the aware group scoring higher on the AAT (mean percentile=64.8) than the unaware group (mean=34.1; t=3.53, df=41, p<.01). Examining component language scores, the aware group were better at naming (mean PALPA object naming=24/40 vs 12/40 correct respectively; t=2.50, df=41, p<.05). The groups did not however differ in comprehension

($t=0.20$, $df=41$, ns). A higher proportion of the aware group were classed as impaired on the Brixton test (.44 vs .30), however this was not a reliable difference (Fisher's Exact Test, $p=.44$).

This pattern was confirmed when the VATA-L discrepancy score was used as the direct measure of awareness. As production (PALPA object naming) and comprehension (AAT auditory word-to-picture matching) scores themselves correlate (Spearman's $r=.48$, $p<.01$), multiple regression was used to estimate the unique effect of each language variable and executive function (number of errors) on the measure of awareness. This revealed a significant effect of production ($\beta=-.35$, $t=-2.22$, $p<.05$) and no reliable effect for comprehension ($\beta=.11$, $t=.68$, ns). There was a trend effect for executive function ($\beta=-.26$, $t=-2.73$, $p<.10$), with more errors on the Brixton test relating to greater discrepancy between participants and their carers' ratings of language difficulties.

For the indirect measure self-correction behaviour rate, there was also a correlation with overall severity of aphasia, with those more likely to correct being less severely impaired ($r=.350$, $p<.05$). The single-word language test and executive function test scores were entered into a multiple regression analysis; this revealed an effect of comprehension only ($\beta=.48$, $t=3.09$, $p<.01$), with no effect of production ($\beta=.02$, $t=0.12$, ns), nor of executive function ($\beta=.10$, $t=0.71$, ns).

A final set of analyses considered production scores and their relationship with the VATA-L more closely. The score on the PALPA naming test reflects the accuracy of the initial attempt ('pre-correction naming') plus any additional items that were successfully corrected. We carried out an analysis in which these two components of the naming score were separately examined. Self-correction success rate was calculated as the proportion of errors on this task that were subsequently corrected to the target response. Correlation analyses revealed that participants with better pre-correction naming were not reliably more likely to attempt self-correction (Spearman's r=-.05, ns); they were, however, more likely to be *successful* in the correction attempts they made (Spearman's r= .347, p<.05). A multiple regression analysis including the two component production scores (pre-correction naming and self-correction success rate), along with comprehension and executive function, against VATA-L discrepancy scores revealed no effect for pre-correction naming (β=-.06, t=.33, ns) but a reliable effect for self-correction success rate (β=-.47, t=-2.36, p<.05) and for executive function (β=-.30, t=-2.02, p=.050).

Discussion

We add to the literature on anosognosia by demonstrating dissociation between direct and indirect measures of awareness in the domain of language, and further characterise the underlying processes. This study employed two measures: a direct, questionnaire-based metacognitive measure (the VATA-L; Cocchini et al., 2010) and an indirect, online measure, namely the rate at which self-correction of naming errors was attempted. We found a trend but not a statistically reliable relationship between the two. This finding is consistent with studies that have not found strong associations between metacognitive and indirect measures of awareness in other domains of cognitive impairment and following different types of acquired brain injury (e.g., Hoerold, Pender & Robertson, 2013; O'Keeffe et al., 2007; Cocchini, Beschin, Fotopoulou & Della Sala, 2010; Moro, Pernigo, Zapparoli, Cordioli, & Aglioti, 2011).

Performance on both direct and indirect measures of awareness related to overall severity of language impairment. Importantly, however, the two measures dissociated with respect to the participants' production and comprehension skills when the unique contribution of these was examined in multiple regression analyses. The direct measure of metacognitive awareness related to production and not comprehension scores, while the indirect measure related to comprehension and not production scores. This pattern of results challenges the conclusion that the two measures have the same underlying basis, with one of the measures being more sensitive to impairment than the other, which could lead to a single but not the double dissociation (Gasquoine, 2016). Rather, the two measures have different underlying bases in language processes. In other domains of impairment, such as hemiplegia, visuo-spatial neglect and amnesia, researchers have also been led to conclude that directly and indirectly assessed forms of awareness have different bases (Berti, Làdavas, Della Corte, 1996; Fotopoulou, Pernigo, Maeda, Rudd, & Kopelman, 2010; Schacter, 1990; Mograbi, & Morris, 2013; see Nurmi & Jehkonen, 2014, for a review). While our findings support this distinction, they do not support the notion that one form of awareness is predicated on the other (Crosson et al., 1989; Toglia & Kirk, 2000).

At the whole group level, we found an association between self-correction behaviour rate and comprehension scores (see also Schlenk et al., 1987). This is consistent with the Perceptual Loop hypothesis, which proposes that speakers monitor their output and detect errors using their comprehension system (Hartsuiker & Kolk, 2001; Levelt, 1989). We did not find a relationship between self-correction behaviour and production skills and so found no evidence to support a production-based mechanisms of error monitoring (Marshall et al., 1998; Nozari, Dell & Schwartz, 2011). We did, however, find a relationship between metacognitive awareness and production scores. The fact that it was the contribution of successful corrections to the naming score rather than the pre-correction naming rate that bore this relationship is a novel finding. This suggests either (a) that metacognitive awareness moderates attempts at self-correction, such that they are made when the speaker knows that he or she will be successful, or alternatively (b) that metacognitive awareness arises through the experience of successful correction (cf. Toglia & Kirk's (2000) proposal that intellectual awareness develops through instances of emergent awareness).

Metacognitive awareness has been described as a controlled process, dependent on central resources (e.g., Shimamura, 2000). Our finding of a relationship between performance on the Brixton test of executive function and the direct test of metacognitive awareness provides support for this view in the domain of language, with those participants showing better executive function making more objective ratings of their own skills. No role for executive function (at least as measured by the Brixton test) in determining the rate of self-correction was found, providing no support for characterisation of the Perceptual Loop as a centrally controlled mechanism.

The obvious caveats should be raised in drawing conclusions from non-significant results, where the lack of effects may be due to aspects of methodology. Our study was limited in its use of a single test of executive function, chosen because of its suitability for assessing people with language difficulties. Executive functioning is known to fractionate (Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000; MacPherson & Della Sala, 2005; Logie, 2016) and we did not explore which of its component processes may be involved in the different aspects of awareness for language difficulties. Related to this point, it would have been useful to have included measures of attention and prospective memory in the study, as these are implicated in some accounts of error monitoring in other domains of cognition (Dockree et al., 2015; O'Keeffe et al., 2007; Maher et al., 1994). Another potential methodological limitation relates to the size of the unaware subgroup as determined by the VATA-L. The subgroup comprised only 11 participants (of 48 in the study). This may have impacted on power in statistical tests that compared the awareness subgroups. This possibility motivated our use of the VATA-L discrepancy score as a continuous variable across all participants in the study, to explore relationships with self-correction rate and language production and comprehension scores. Interestingly, in doing so, we found the same pattern of significant effects as with the two groups defined by a cut-off score.

There are currently no other direct tests of awareness of language difficulties against which to establish the VATA-L's validity. It is a composite measure, assessing awareness of a range of language difficulties, including both comprehension and production of auditory and written verbal information that may be experienced in everyday life. As such, it is possible that its sub-components behave differently and have different sensitivity with respect to other variables. This may include different relationships with self-correction behaviours in other contexts such as sentence production (as used in Schlenck et al.'s 1987 study), discourse or in conversation, where the opportunities to avoid errors through choice of words and decisions about whether to correct or not (such as there are consciously made) may be different.

Though test-retest reliability of the VATA-L is high (Cocchini et al., 2010), we do not have test-retest nor inter-rater reliability measures for our self-correction behaviour measure. This is a methodological limitation that would benefit from future study.

No direct nor indirect measures of awareness are routinely used in the clinical management of people with aphasia. This matters, given the poorer rehabilitation outcomes for people with anosognosia for a range of acquired difficulties as identified by direct measures (Jenkinson, Preston & Ellis, 2011; Gialanella & Mattioli, 1992; Rüsch & Corrigan, 2002; Fillingham, Sage & Lambon Ralph, 2006; Appelros, 2007). The predictive value of indirect measures such as self-correction rates on rehabilitation outcomes has not been established. It is worth noting that self-correction is itself an adaptive behaviour, contributing to communicative success. An attempt at correction may lead to the correct target item being produced. Even if not successful, an attempt at correction may convey to a communication partner that an error has been made. Tompkins, Scharp and Marshall (2006) dubbed the behaviours produced following word finding difficulties "self-cues", making a distinction between behaviours which lead to improved word finding and those that enhance communication of the speaker's intended message. In the conversation analysis literature, attempts at self-correction have been termed "trouble-indicating behaviours", and while the correction itself may be difficult for the person with aphasia to complete (e.g., Wilkinson, 2007), a repair to communicative breakdown may be made by the conversation partner after it has been indicated (e.g., Barnes & Ferguson, 2014). Self-corrections therefore belong to a broad class of pragmatic abilities (see, e.g. Hernández-Sacristán, Rosell-Clari, Serra-Alegre & Quiles-Climent, 2012). Our study highlights the importance of considering both direct and indirect measures in investigations of language presentation and rehabilitation, as they cannot be regarded as tapping some unitary 'awareness' of deficit.

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Table 1. Demographic details and aetiology of injury for whole group and VATA-L awareness subgroups

					Lesion (N)		Aetiology (N)			
	N	Proportion male	Age/years (mean; sd; range)	Education/years (mean; sd; range)	Unilateral left hemisphere	Bilateral	Vascular ischaemic	Vascular haemorrhagic	Traumatic	Time since onset/months (mean; sd; range)
Whole group	48	.69	58.0	10.0	45	3	30	13	5	10.8
			15.4	4.3						22.0
			19-84	4-18						0.2-130.3
<u>VATA-L subgroup</u>										
Aware	34	.62	58.7	10.3	32	2	21	9	4	8.9
			17.0	4.4						14.6
			19-84	4-18						0.2-69.8
Unaware	11	.82	57.1	9.6	11	0	7	4	0	7.3
			11.3	4.8						10.4
			40-77	4-18						0.4-36.0
Borderline	3	1.0	54.0	8.0	2	1	2	0	1	45.1
			13.5	0						73.8
			41-68	-						1.2-130.3

Table 2. Examples drawn from the present study of types of self-correction behaviour following an initial attempt at naming. Based on Schlenck et al. (1987).

Correction type	Target	Response
Successful correction	elephant	begins with an 'a' and it's…*elephant*
Silent pauses of 2 or more seconds	glass	/ˈsɜlə/…[3 seconds*]*…/ˈsɜləbæd/
Pauses of 2 or more seconds with non-lexical fillers (interjections)	swing	ehm, ehm... swing
One or more phonemic approximations	montagne [mountain]	/mə/…/mɒn/… *monte*
Repetition of immediately preceding utterance (whole or part word)	scarpa [shoe]	la scalpa… scalpa
Circumlocutions or semantic approximations	anchor	short… raise and lower the sea
Comments	monkey	carrot…I can't think I can't think

Table 3. Type and severity of aphasia (Aachen Aphasia Test) for whole group and VATA-L awareness subgroups

		Aphasia classification					
		Broca	Wernicke	Amnesic	Global	Not classifiable	Total
Whole group	N. participants	11	7	14	11	5	48
	Severity[1] mean	2.9	3.1	2.8	3.9	1.2	3.0
	sd	0.9	0.7	0.7	0.3	0.5	1.0
	range	1-4	2-4	2-4	3-4	1-2	1-4
VATA-L subgroup							
Aware	N	9	7	11	4	3	34
	Severity mean	2.8	3.1	2.9	4	1	2.9
	sd	1.0	0.7	0.7	0	0	1.0
	range	1-4	2-4	2-4	-	-	1-4
Borderline	N	0	0	1	0	2	3
	Severity mean	-	-	2	-	1	2
	sd	-	-	0	-	0	0
	range	-	-	-	-	-	1-2
Unaware	N	2	0	2	7	0	11
	Severity mean	3.5	-	2.5	3.9	-	3.6
	sd	0.7	-	0.7	0.4	-	0.7
	range	3-4	-	2-3	3-4	-	2-4

[1] 1=very mild; 2=mild; 3=moderate; 4=severe

Table 4. Assessments and measures of awareness for whole group and VATA-L awareness subgroups

		Naming /40	Auditory word-to-picture matching/30	Brixton No. errors/54	VATA-L discrepancy	Self-corrections: Pre-correction naming/40	Self-corrections: Self-correction behaviour rate	Self-corrections: Self-correction success rate
Whole group	Mean	21.79	24.15	25.73	5.82	14.95	.56	.35
	sd	13.75	3.76	8.94	9.12	12.45	.36	.27
	range	0-39	16-30	10-42	-18-22	0-36	0-1.0	-.03[a]-.93
VATA-L subgroup								
Aware	Mean	23.82	23.97	27.09	1.72	16.11	.60	.37
	sd	11.93	3.86	9.09	7.17	11.92	.34	.26
	range	0-39	16-30	10-42	-18-11	0-36	0-1	-.03-.93
Unaware	Mean	12.00	23.70	21.78	17.40	8.30	.38	.22
	sd	16.69	3.50	8.60	2.86	12.77	.40	.31
	range	0-37	18-28	10-33	13.25-22	0-32	0-1	0-.74
Borderline	Mean	32.00	27.67	22.67	12.25	24.33	.84	.48
	sd	4.58	2.08	4.93	0.25	10.02	.06	.05
	range	27-36	26-30	17-26	12-12.5	13-32	.80-.89	.42-.52

[a]This negative value reflects correct naming responses that were followed by self-correction behaviours to give an incorrect final response