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Word-finding in confrontation naming and picture descriptions produced by individuals with early post-stroke aphasia

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ABSTRACT

Objective: The present study aims to assess the relationship between quantitative measures of connected speech production and performance in confrontation naming in early post-stroke aphasia (8-14 days post-stroke). **Method:** We collected connected speech samples elicited by a picture description task and administered a confrontation naming task to 20 individuals with early post-stroke aphasia and 20 healthy controls. Transcriptions were made in compliance with the CHAT format guidelines. Several micro- (i.e. duration, total number of words, words per minute, mean length of utterances, ratio of open- to closed-class words and noun-to-verb ratio, VOC-D, repetitions, self-corrections, and phonological and semantic errors) and macrolinguistic (i.e. informativeness and efficiency) measures were extracted. **Results:** We provide evidence for the presence of impairments in an array of micro- and macrolinguistic measures of speech in individuals with early post-stroke aphasia. We show that in the patient group, confrontation naming abilities most strongly relate to informativeness in a picture description task. **Conclusion:** Our findings contribute to a better understanding of the relationship between performance in confrontation naming and in connected speech production in the first days after stroke onset and also suggest that discourse analysis may provide unique, possibly more complex information.

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Introduction

Post-stroke aphasia (PSA) is an acquired language impairment caused by a stroke, usually an ischemic stroke affecting the middle cerebral artery of the left hemisphere. This condition is present in approximately one-third of acute stroke patients (Engelter et al., 2006; Laska et al., 2001) and can affect language production and comprehension, as well as reading and writing abilities. Recovery from aphasia can be affected by various factors that include initial aphasia subtype, lesion location, and initial severity (Lazar & Antonello, 2008). While people with PSA, especially those with acute severe impairments, can exhibit highly variable language recovery, the greatest degree of improvement is generally observed in the first weeks after onset (Lazar & Antonello, 2008). One of the most frequent symptoms associated with early PSA is word-finding impairments (i.e. anomia), where individuals cannot efficiently retrieve even common, everyday words (Crystal, 2008), causing a major impact on verbal communication and social interaction. For this reason, word-finding impairments have received a great deal of attention in previous aphasia studies (e.g. Hillis et al., 2002; Larfeuil & Dorze, 1997; Lazar & Antonello, 2008). In clinical settings, the presence of word-finding difficulties in PSA is most often assessed at the single-word level using structured, standardized confrontation naming tasks during which participants are asked to correctly name various pictures. Common confrontation naming tests used in aphasia clinical evaluation include the Boston Naming Test (Goodglass et al., 2000), the Test of Adolescent/Adult Word-finding (German, 1990), and the DO80 (Deloche & Hannequin, 2007) and the TDQ-60 (Macoir et al., 2018) in French. Confrontation naming tests have numerous advantages, such as easy administration and scoring as well as high test-retest reliability (Herbert et al., 2008; Mayer & Murray, 2003). Moreover, the target words for confrontation naming are known beforehand, ensuring good interrater agreement when scoring for errors. However, these tasks have been criticized for lacking ecological validity and may not capture how word-finding impairments impact language production in everyday communication contexts (Herbert et al., 2008).

On the other hand, research on aphasia has highlighted the importance of assessing and treating word-finding impairments beyond the single-word level, and recent studies have increasingly relied upon connected speech tasks to assess language production in PSA (Boyle, 2014; Bryant et al., 2016). Connected speech samples elicited using picture descriptions or interviews can potentially be collected at bedside in the first days following stroke and can be analyzed with a variety of quantitative measures (Marini et al., 2011).

In general, quantitative analysis of connected speech samples can inform us about micro- and macrolinguistic measures of discourse (Marini et al., 2011). Microlinguistic abilities relate to phonological, syntactic, and lexico-semantic variables. Previous studies have shown that these refined linguistic analyses are crucial when documenting language performance of individuals with PSA, especially when language deficits are more subtle (Dalton & Richardson, 2015; Fromm et al., 2017). Macrolinguistic abilities, on the other hand, refer to more global discourse organization and include measures of coherence, informativeness, and efficiency. While several studies focusing on these

two types of measures have revealed impairments in connected speech of individuals with chronic PSA relative to speech of neurologically healthy older adults (e.g. Andreetta et al., 2012; Behrns et al., 2009; Fergadiotis & Wright, 2016; Jaecks et al., 2012; Marini et al., 2007; Pashek & Tompkins, 2002; Shewan, 1988), only a few have studied the micro- and macrolinguistic aspects of connected speech of individuals with PSA in acute or subacute stages.

Yagata et al. (2017) showed that two patients with aphasia following infarction of Wernicke's area demonstrated overall improvements within the first three months post-stroke in multiple language domains including fluency, lexical access, phonological retrieval and encoding, and syntactic complexity, with the largest improvements occurring early after stroke. In their study, Furlanis et al. (2018) recruited forty individuals with PSA who underwent a language screening test at baseline, 24 hours, and 72 hours post-stroke. They showed that amongst all the investigated measures (e.g. spontaneous speech, oral comprehension of words, reading aloud and comprehension of written words, naming), the 'spontaneous speech' score, which was calculated in terms of number of semantic units conveyed in a picture description task, was the only variable that significantly improved during the first 72 hours. Shewan (1988), using a picture description task, showed that patients with various types of aphasia improved between 2-4 weeks post-stroke and the chronic stage for most connected speech measures, namely speech rate, communication efficiency, production of content units, and production of word errors. Recently, our team reported a significant improvement between the acute (3 days post-stroke) and subacute stage following stroke (10 days post-stroke) in measures related to the informativeness and efficiency of informativeness in a picture description task (Brisebois et al., 2019). More recently, Ding et al. (2020), using a story-telling procedure, showed that as a group, patients with early PSA (4 days post-stroke) were significantly impaired on most measures of connected speech production, producing significantly fewer narrative words, required determiners, embeddings, well-formed sentences, and proportionally more pronouns than nouns, and that they had an overall slower speech rate than healthy controls. Several other studies have documented connected speech in post-stroke aphasia later in the subacute stage (e.g. Larfeuil & Dorze, 1997; Marini et al., 2007).

In sum, these findings suggest that during the early stages of the disease, individuals with PSA exhibit impairments in several measures of connected speech. However, to date, studying word-finding impairments in decontextualized tasks such as confrontation naming has still received considerably more attention than more ecological connected-speech eliciting tasks in early PSA. Confrontation naming tasks are well validated (i.e. Deloche & Hannequin, 2007; Macoir et al., 2018) and can be useful tools with which to assess single-word naming in aphasia. However, while we generally assume that the performance in confrontation naming reflects the ability to produce words in real-life settings, very few studies on aphasia have directly assessed whether various measures of connected speech production relate – or not – to confrontation naming abilities. Moreover, the limited research conducted on the matter almost exclusively regarded the chronic stage of PSA.

A number of studies suggest that the performance on confrontation naming and some measures of connected speech production are significantly correlated, though

the strength of the relationship varies from one study to another. For instance, Fergadiotis and Wright (2016) showed that a naming accuracy score based on three different tests was correlated to informativeness as measured by correct information units in three speech-eliciting tasks (i.e. free speech, event casts, and story retell; $r = .68$), in 98 individuals with various types of chronic PSA. Similarly, Kong (2011) and Richardson et al. (2018) found significant correlations between the performance of chronic PSA speakers on naming tasks and the number of main concepts conveyed during speech production using a picture description task (Kong, 2011: $r = .89$, $r = .92$) and a combination of picture sequence, story-telling, and procedural narratives (Richardson et al., 2018: $p = .68$, $p = .70$). Another study also reported a strong correlation ($r = 0.81$) between the proportion of nouns produced in a conversational task and performance on a confrontation naming task in eight chronic PSA patients (Hickin et al., 2001). More recently, though this was not the main focus of their study, Hillis et al. (2018) reported a significant relationship ($r = .72$) between performance on a confrontation naming task and content units conveyed in a picture description task in a longitudinal cohort of 19 individuals with various types of aphasia, within 48 hours and 6 months after stroke onset.

These studies suggest an association between accuracy in confrontation naming and measures of informativeness in connected speech. However, other studies failed to replicate these associations with other connected speech measures. Using conversational analysis, Mayer and Murray (2003) reported that although confrontation naming scores were strongly associated with overall aphasia severity, they did not predict the proportion of word-finding and self-corrected errors in conversation. Similarly, in a study conducted in 18 individuals with chronic aphasia, Angelopoulou et al. (2018) revealed that while long pause rate was associated with speech rate ($p = -.78$) and mean length of utterances ($p = -.89$) in a semistructured interview, it was not significantly correlated to confrontation naming scores. Finally, Pashek and Tompkins (2002) showed that out of 20 participants with various types of chronic aphasia, 13 demonstrated fewer word-finding difficulties during video narration than during confrontation naming.

Thus, a review of previous studies shows that a relationship between performance in various picture naming tests and some connected speech variables, mainly measures of informativeness, have been observed at the chronic stage. However, variability across studies, including differences in discourse analysis procedures, discourse-elicitation method, confrontation naming test used, statistical analyses, and participant samples could have contributed to some of the inconsistencies found between studies. Also, it remains unclear whether the relationship between performance in confrontation naming tests and connected speech measures is valid in more acute stages of PSA. This is of particular importance given that some studies (e.g. Wilson et al., 2019) suggest that connected speech samples of patients with PSA may be too impoverished to allow a valid assessment of language impairments when collected very early after stroke onset.

In sum, confrontation naming tasks are often used in the early stages of PSA to make predictions about more functional communication abilities. However, previous research has shown that tasks involving connected speech production may provide valuable, possibly unique information about the impact of language impairments in everyday communication contexts, early after stroke onset (e.g. Furlanis et al., 2018;

Shewan, 1988). Moreover, the association between more ecological measures (i.e. measures of connected speech production) and a well-accepted and validated measure such as confrontation naming needs to be investigated at this stage. This represents a necessary step in order to legitimate the use of these measures at an early stage.

Thus, the current study aims to assess the strength of the relationship between confrontation naming and several micro- and macrolinguistic measures of connected speech in a group of participants with early PSA. To address this aim, we collected connected speech samples elicited by the Picnic scene of the Western Aphasia Battery (Kertesz, 2006) and assessed confrontation naming using the DO80 (Deloche & Hannequin, 2007) in a group of individuals with various types of PSA, between eight and fourteen days following a first ischemic left hemisphere stroke, and a group of healthy controls. While several tasks can be used to elicit connected speech samples (e.g. structured and semistructured interviews, story-retelling procedures, procedural narratives), we used a picture description task, which consists of the detailed description of a standardized pictorial stimulus representing a complex scene and is the most frequently used connected speech-eliciting task in aphasia studies (Bryant et al., 2016). This task presents the advantage of providing a relatively constrained discourse sample with expected topics, which allows a standardized approach to eliciting connected speech and facilitates performance comparison over time and across groups (Chenery & Murdoch, 1994). From connected speech transcripts, we semi-automatically extracted microlinguistic measures included in the CLAN software (i.e. duration, total number of words, words per minute, mean length of utterances, ratio of open- to closed-class words and noun-to-verb ratio, VOC-D, repetitions, self-corrections, and phonological and semantic errors) and hand-scored for informativeness and efficiency. We first contrasted the performance of individuals with early PSA and healthy controls for the picture description and the confrontation naming task. Then, we examined, in the PSA group, the extent to which the connected speech measures for which we found significant group differences related to confrontation naming scores.

Material and methods

Participants

Twenty participants with PSA, recruited in the stroke unit of *Hôpital du Sacré-Coeur de Montréal*, and 20 healthy controls, recruited in the participant bank of the *Centre de recherche de l'Institut Universitaire de Gériatrie de Montréal*, were evaluated between May 2015 and August 2018. All participants were right-handed. Participants in the PSA group had suffered from a single ischemic stroke in the middle cerebral artery of the left hemisphere. They were assessed between eight and fourteen days post-stroke ($M = 10.39$), and no criteria for aphasia severity or type were used. Only patients who had been fluent speakers of French-Canadian before the stroke were included. For both groups, participants with a history of psychiatric disorders, learning disabilities, or perceptual deficits were not included. Sociodemographic data are presented in Table 1; the two groups did not differ significantly in age ($t(38) = 1.54$, $p = .131$), sex ($\chi^2 = 1.16$, $p = .204$), or education level ($t(38) = -1.67$, $p = .102$). The study was approved by the ethics review board of the *Centre intégré universitaire de santé et de*

Table 1. Sociodemographic characteristics of sample.

	HC (<i>n</i> = 20)	PSA (<i>n</i> = 20)
Female/Male ratio	13/7	9/11
Age	65.05 (6.79)	69.85 (12.14)
Education (years)	13.70 (2.11)	12.05 (6.79)

Note. HC = healthy controls.

Table 2. Patients' characteristics.

Participant ID	Sex	Age	Education (years)	Aphasia type (WAB)	Aphasia severity (BDAE)
A1502	male	52	9	anomic	mild
A1503	male	74	6	wernicke	moderate-severe
A1515	female	75	9	global	moderate-severe
A1601	male	61	10	broca	moderate-severe
A1701	male	49	9	anomic	mild
A1702	male	73	19	wernicke	moderate-severe
A1703	female	70	14	global	moderate-severe
A1706	female	73	7	sensory transcortical	moderate
A1707	male	65	11	anomic	mild
A1709	male	72	15	anomic	mild
A1710	male	55	11	global	moderate-severe
A1801	male	73	11	wernicke	moderate
A1802	male	64	15	conduction	mild
A1804	female	95	6	broca	mild-moderate
A1806	female	60	12	anomic	mild-moderate
A1807	male	91	19	anomic	mild
A1808	male	61	15	wernicke	moderate-severe
A1810	female	85	16	anomic	mild-moderate
A1815	female	81	15	anomic	mild
A1816	female	68	12	anomic	minimal

services sociaux du Nord-de-l'Île-de Montréal (Project #MP-32-2018-1478), and written informed consent was obtained from all participants. Three participants presented with dysarthria. Detailed patient characteristics are presented in Table 2.

Language assessment

For all participants, connected speech samples were elicited by the Picnic scene picture description task (Western Aphasia Battery; Kertesz, 2006). Confrontation naming abilities were assessed using the DO80, a standardized test of picture naming in French (Deloche & Hannequin, 2007).

Transcription

Recordings of connected speech samples were transcribed by a trained speech-language pathologist and a student in speech-language pathology using ELAN (Sloetjes & Wittenburg, 2008) and CHAT conventions (MacWhinney & Wagner, 2010). Transcriptions were submitted to detailed linguistic analysis, and all microlinguistic variables were extracted using EVAL of CLAN software. Utterance segmentation, transcription, and scoring were conducted following the CHAT manual guidelines (<https://>

talkbank.org/manuals/CLAN.pdf), with additional guidance of French users of this program (Colin & Le Meur, 2016).

Connected speech measures

Microlinguistic measures

Duration. Total number of seconds during which the participant is speaking.

Total number of words. Total number of words produced by the participant.

Speech rate. Number of words per minute.

Mean length of utterance. Total number of words produced by the participant/total number of utterances. An utterance was defined as a main clause along with its dependent (subordinate or coordinate) clauses.

Lexical diversity. Lexical diversity measure was estimated using the VOC-D program in CLAN. It provides a measure of lexical diversity that is considered more robust to differences in sample length (number of words) than the type-token ratio is (Capilouto et al., 2016). This measure is calculated by comparing randomly sampled data from the transcript to a mathematical model representing how the type-token ratio varies with token size (see McKee et al., 2000 for a detailed description).

Noun-to-verb ratio. Total number of nouns produced/total number of verbs produced computed by the EVAL program.

Ratio of open- to closed-class words. Total number of open-class words (i.e. nouns, verbs, adjectives, and adverbs)/total number of closed-class words produced computed by the EVAL program.

Repetition. A repetition is manually coded and then counted by the CLAN program every time a word is inappropriately uttered more than once.

Self-correction. A self-correction is manually coded and then counted by the CLAN program every time a modification is made to one or more previous words (Schmitter-Edgecombe et al., 2000).

Phonological and semantic errors. Number of phonological and semantic errors. Phonological errors included phonemic paraphasias, false starts, and neologisms. Semantic errors included verbal and semantic paraphasias.

Macrolinguistic measures

Informativeness: information content units (ICUs). Prespecified unit of accurate and relevant information conveyed by the speaker (Cooper, 1990). Picture descriptions were scored twice for ICUs, by three independent examiners (J. B., A. B., and a

research assistant), using a list of 30 predefined ICUs, consisting of places (e.g. on the lake), people (e.g. the mother), objects (e.g. a kite) and actions (e.g. pouring [a drink]), adapted from Jensen et al. (2006). The mean interrater agreement for this measure reached 99%.

Efficiency. Duration/number of ICUs.

Interrater reliability

Interrater reliability (IRR) was calculated based on the transcriptions of ten participants (randomly selected within the PSA group) that were transcribed and coded by a second rater, who was a student in speech-language pathology. Two-way random-effects intraclass correlation coefficients (ICC) were calculated to determine the consistency between raters (as in Marcotte et al., 2017). Most microlinguistic variables met the threshold for high reliability, $ICC > .80$ (Norman & Streiner, 2008): duration ($\alpha = .895$), total number of words ($\alpha = .958$), mean length of utterance ($\alpha = .893$), ratio of open- to closed-class words ($\alpha = .895$), noun-to-verb ratio ($\alpha = .854$), VOC-D ($\alpha = .975$), and self-corrections ($\alpha = .900$). IRR scores were lower for repetitions ($\alpha = .675$) and semantic ($\alpha = .274$) and phonological ($\alpha = .590$) errors.

Statistical analysis

Participants' z scores for each connected speech measure were first calculated to detect extreme scores and assumptions of normality were verified. We contrasted the performance of PSA participants and healthy controls on the confrontation naming score and the connected speech measures using independent-samples t -tests. Then, for the connected speech measures for which we found significant differences between the PSA and healthy control groups, we conducted correlation analyses to identify the connected speech measures that related to accuracy on the confrontation naming task.

Results

Impact of PSA on language measures

Mean and standard deviation scores for the confrontation naming task and connected speech measures are presented in Table 3. The PSA group showed significantly lower accuracy than the controls on the DO80 confrontation naming task ($t(38) = -3.86$, $p < .001$, $d = -1.22$). For the picture description task, the PSA group produced a significantly lower number of words ($t(38) = -2.57$, $p = .014$, $d = -.81$), shorter utterances ($t(38) = -3.54$, $p = .001$, $d = -1.12$), and more errors ($t(38) = 3.70$, $p = .001$, $d = 1.17$) and had a slower speech rate ($t(38) = -4.03$, $p < .001$, $d = -1.28$) than the control group. The picture descriptions of individuals with PSA were characterized by reduced lexical diversity (Voc-D; $t(32) = -3.27$, $p = .003$, $d = -1.16$), informativeness ($t(38) = -5.19$, $p < .001$, $d = -1.64$), and efficiency ($t(37) = -2.16$, $p = .037$, $d = -.70$). No significant group differences were observed for the duration of speech sample ($t(38)$

Table 3. Means and standard deviations for confrontation naming and connected speech measures.

	Healthy Controls				Post-stroke Aphasia				<i>p</i>
	M	SD	Min	Max	M	SD	Min	Max	
DO80 (/80)	78.15	1.81	73.00	80.00	52.10	30.13	0.00	79.00	***
Total number of words	231.45	143.06	72.00	572.00	126.35	113.82	4.00	406.00	
Duration	89.90	63.32	18.00	291.00	58.15	42.17	4.00	132.00	
Words per minute	171.14	43.69	78.00	247.00	111.65	49.41	34.00	185.00	***
Mean length of utterance	9.97	2.68	6.40	15.20	6.14	4.03	1.00	14.57	*
Information content units (/30)	24.85	2.66	17.00	29.00	13.30	9.59	0.00	26.00	***
Information content units/duration	0.40	0.22	.10	.94	0.26	0.17	0.00	0.69	
Open- to closed-class word ratio	0.51	0.09	.39	.72	0.41	0.20	0.00	0.68	
Noun to verb ratio	6.95	3.43	3.20	15.00	7.10	6.27	2.00	26.00	
Voc-D	45.09	11.93	28.60	67.50	32.24	10.27	12.29	45.39	*
Repetitions	2.05	2.48	0.00	8.00	3.65	4.70	0.00	17.00	
Self-corrections	2.35	1.98	0.00	8.00	2.35	2.87	0.00	10.00	
Word errors	0.25	0.55	0.00	2.00	3.30	3.64	0.00	10.00	*

Note. * $p < .05$; ** $p < .01$; *** $p < .001$.

= -1.77 , $p = .085$, $d = -.56$), noun-to-verb ratio ($t(33) = .09$, $p = .928$, $d = .03$), ratio of open- to closed-class words ($t(38) = -2.01$, $p = .051$, $d = -.64$), repetitions ($t(38) = 1.35$, $p = .186$, $d = .43$), and self-corrections ($t(38) = .00$, $p = 1.000$, $d = .00$). After adjusting for multiple comparison using Bonferroni correction, only group differences for mean length of utterances ($p = .012$), word errors ($p = .012$), speech rate ($p < .001$), lexical diversity ($p = .036$), and informativeness ($p < .001$) remained significant.

Examination of the correlations between connected speech variables and confrontation naming performance in the PSA group

We conducted correlation analyses between DO80 scores and the connected speech measures for which we found significant differences between groups. Informativeness was the connected speech variable that most strongly related to performance on the confrontation naming task ($r(18) = .86$, $p < .001$), followed by speech rate ($r(18) = .80$, $p < .001$). Performance on the confrontation naming task was also correlated to the mean length of utterances ($r(18) = .76$, $p < .001$), and lexical diversity ($r(18) = .64$, $p = .014$). Performance on the confrontation naming task did not significantly relate to the number of semantic and phonological errors produced by individuals with PSA ($r(18) = .09$, $p = .693$). After adjusting for multiple comparisons using Bonferroni correction, only informativeness ($p < .001$), speech rate ($p < .001$), and mean length of utterances ($p < .001$) remained significantly associated with performance on the confrontation naming task.

Discussion

The present study aimed to establish how word-finding abilities in a confrontation naming task relate to measures of connected speech production in early PSA (8–14 days post-stroke). We first provided evidence for the presence of impairments in an array of micro- (i.e. mean length of utterances, number of errors, speech rate, and lexical diversity) and macrolinguistic measures of connected speech (i.e. informativeness). As expected, individuals with early PSA performed worse on confrontation naming

than healthy controls, but critically, that correlated with measures of connected speech, specifically informativeness, speech rate, and mean length of utterances in the picture descriptions.

The analysis of picture descriptions produced by the patient group also revealed significant impairments in several microlinguistic measures. Most of these findings are consistent with the results from a previous study conducted with individuals in the acute stage. Ding et al. (2020), using a story-telling procedure, showed that patients with early PSA (4 days post-stroke), when compared to healthy controls, were significantly impaired on most microlinguistic measures of connected speech production, including number of narrative words produced and speech rate. Furthermore, several studies focusing on the chronic stage of aphasia showed that connected speech samples of individuals with chronic PSA were characterized by the production of shorter utterances (e.g. Andreetta et al., 2012; Behrns et al., 2009) and slower speech rate (e.g. Andreetta et al., 2012; Shewan, 1988) compared to the samples of neurologically healthy controls. Finally, in line with studies conducted in the chronic stage of PSA (Fergadiotis & Wright, 2016; Kavé & Goral, 2017), the picture descriptions of individuals with early PSA were more lexically impoverished than those of healthy controls.

Our results also suggest that early PSA is accompanied by significant impairments in the macrolinguistic aspects of speech, namely informativeness. Similarly, Agis et al. (2016) showed that individuals with left hemisphere stroke tested within 48 hours of stroke onset produced significantly fewer content units than neurologically healthy controls during a picture description task. Similar findings were observed in studies conducted in the chronic stages of PSA (e.g. Boyle, 2014; Gordon, 2008; Nicholas & Brookshire, 1993; Shewan, 1988), reflecting the difficulties that aphasic speakers may experience in conveying relevant information.

The number of information content units produced was the connected speech measure that most strongly related to performance in confrontation naming ($r = .86$). Individuals with early PSA who scored higher in confrontation naming also produced more information content units, and those performing poorly on this task experienced greater difficulty in conveying the information content units in the picture description task. Hillis et al. (2018) had reported a similar relationship ($r = .72$) between performance on a confrontation naming task and number of content units conveyed in a picture description task in a cohort of 19 individuals with various types of aphasia, within 48 hours and 6 months after stroke onset. While informativeness may not target a single, isolated aspect of language production, it appears to be largely related to the ability to find the correct words in a single-word production task. Thus, the amount of information an individual with early PSA is able to successfully convey in more ecological tasks could represent a good indicator of the extent to which he/she experiences word-finding difficulties. Interestingly, the association between informativeness and confrontation naming scores was similar to that of previous studies conducted in the chronic stage of PSA using picture descriptions (e.g. Kong, 2011), and thus greater than some studies using other speech-eliciting tasks, such as interviews or story-retelling (e.g. Fergadiotis & Wright, 2016). This difference may likely occur because picture description, as a speech elicitation method, involves cognitive demands (i.e. identifying

and naming various objects or people) that are much more similar to those required during confrontation naming than do methods that do not involve pictorial stimuli.

Our results indicate that confrontation naming abilities in early PSA are also strongly related to speech rate during the picture description. The relationship between speech rate and naming abilities has not been extensively explored in the aphasia literature, regardless of the stage. However, one interpretation is that the decreased speech rate in picture description may represent an indicator of the presence of word searching behaviors, such as insertion of pauses or filler words during speech production (Falconer & Antonucci, 2012; Pashek & Tompkins, 2002). In fact, Angelopoulou et al. (2018) showed that long pause rate and speech rate during a semistructured interview were significantly associated ($p = -.78$) in individuals with chronic PSA. However, the present study did not examine number or length of pauses. This is an area of future interest.

Notably, other comorbid speech disorders are also quite prevalent in the early stages following stroke (Ali et al., 2015). However, only three of our patients experienced dysarthria. As these participants were not excluded from the sample, this could have slightly contributed to the reduced speech rate (Mahler & Ramig, 2012).

When we investigated the relationship between confrontation naming and other measures of connected speech in early PSA, scores on the confrontation naming task were also significantly correlated to the mean length of utterances. However, almost half of the variance on these measures remained unaccounted for, suggesting that this measure of connected speech production might not be as useful to draw inferences about the severity of word-finding impairments. While this measure is partly related to confrontation naming abilities, it is most likely multifaceted and reflects other impairments associated with PSA (Angelopoulou et al., 2018), such as sentence planning, grammatical processing, or even global aphasia severity.

Interestingly, our results showed that performance in confrontation naming was not related to connected speech performance when it comes to the production of phonological and semantic errors. Some participants did not produce any phonological and semantic error in the picture description task, despite impairments on the confrontation naming task. Paraphasias may be under-detected in connected speech because the target is less predictable, which is reflected in the poor inter-rater reliability. Another limitation of the present study is that we did not further categorize errors into phonemic and semantic paraphasias. Nonetheless, our findings were consistent with previous work on patients with chronic aphasia showing that the production of errors in connected speech tasks does not significantly relate to the performance in confrontation naming (Mayer & Murray, 2003; Pashek & Tompkins, 2002). Thus, we suggest that alone, measures of word errors may not be robust indicators of the severity of word-finding difficulties in connected speech production.

Word-finding impairments being one of the main and persistent problems experienced by patients with PSA (Larfeuil & Dorze, 1997), confrontation naming tasks are often used to make predictions about their everyday communication abilities. However, while several micro- and macrolinguistic measures have been proposed to characterize connected speech production in individuals with PSA, it remained unclear how those relate to confrontation naming abilities early after stroke onset. Here, we

show that performance in confrontation naming is strongly related to the ability to successfully convey relevant information during a picture description in individuals with early PSA. Nonetheless, a substantial part of the variance in information content units remains unaccounted for. This highlights the fact that aside from word-finding difficulties, additional factors may determine performance on this measure of connected speech production. Therefore, direct generalization from confrontation naming to information content units should not be made.

From a theoretical standpoint, potential discrepancies between confrontation naming and performance in connected speech production could partly be explained by the differential nonlinguistic demands (e.g. attention, executive functioning) placed on the person with aphasia (Mayer & Murray, 2003). Also, in contrast with confrontation naming, which requires the selection of a specific lexical item, connected speech tasks allow patients to select their own words (Kavé & Goral, 2017). Moreover, the DO80, which was used in the present study, only includes object and person naming (e.g. *Père Noël* [Santa Claus]), whereas picture description tasks involve the description of people, objects, places, and actions using various word classes. Our findings highlight the need to explore how different tasks affect the expression of word-finding impairments.

Further research is needed to establish which way is best to quantify word-finding difficulties. On the one hand, confrontation naming tasks present the advantage of offering a priori target words, ensuring easy scoring and high test-retest reliability (Herbert et al., 2008; Mayer & Murray, 2003). However, these tasks may lack ecological validity and can be tiring for patients with acute or subacute stroke. On the other hand, while connected speech samples are quick and easy to obtain and may be considered more similar to real-life communication contexts, their analysis is time-consuming and can be associated with consistency issues. Nevertheless, our findings provide support for the validity of the assessment of informativeness in more ecological settings early after stroke and suggest that this measure could be sensitive to word-finding abilities at different time-points during recovery or in response to treatment.

Conclusion

In sum, the present study suggests that the informativeness of speech during picture descriptions is strongly associated to confrontation naming abilities in individuals with early PSA, thus contributing to a better understanding of how word-finding difficulties can manifest in more ecological communication settings early after stroke onset. This is of particular importance given that aphasia severity in the early stages of the disease may serve as one of the most useful predictor of recovery after stroke (e.g. Benghanem et al., 2019; Hillis et al., 2018; Lazar et al., 2010; Osa García et al., 2020). Therefore, having accurate and specific tools to evaluate language abilities is necessary to advance research on early predictors of language performance and implement early interventions that are the best suited for the patients' needs. Moreover, our findings suggest that studying connected speech production may provide unique, possibly more complex information about early impairments that is not entirely captured by single-word production tasks and may be clinically relevant. As in any stage of post

stroke language recovery, a valid picture of expressive language impairments should ideally include both connected speech analysis and more structured tasks. However, despite the widespread use and clinical utility of the picture description task, the transcription and analysis of connected speech samples can be time-consuming, limiting its applicability in clinical settings. Future directions could thus include automating the analysis of connected speech samples to make it more suitable for assessing word-finding difficulties in clinical settings.

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