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Verb Tense Production in People With Nonfluent Aphasia Across Different Discourse Elicitation Tasks

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ABSTRACT

Purpose: Verb tense production is known to be impaired in people with nonfluent aphasia. Selective past tense impairment in this population has been reported, but results are inconsistent and lacking at the discourse level. In addition, language production can be affected by discourse elicitation tasks depending on the cognitive linguistic demands and instructions unique to each task. There is limited evidence regarding whether verb tense production in people with nonfluent aphasia is impacted by discourse task demands. Understanding this potential impact is important for clinicians and researchers who are interested in assessing and then identifying effective clinical goals for this population. Therefore, this study aimed to investigate the trends of verb tense production across various discourse elicitation tasks in people with nonfluent aphasia compared to people without aphasia.
Method: Language samples for 23 people with nonfluent aphasia and 27 people without aphasia were obtained for six discourse tasks from the AphasiaBank database. We calculated ratios of past tense, present tense, future tense, imperative, and unknown verb types to compare which tense was used most frequently within and across the tasks and groups.
Results and Conclusions: Our findings revealed evidence of verb tense production deficits and a selective past tense impairment in people with nonfluent aphasia. Discourse task effects were shown for people without aphasia but were scarce in people with nonfluent aphasia. This finding could be explained by an overall reduction of verb production and overreliance on present tense production in nonfluent aphasia. These results suggest the potential methodological implications of using different discourse tasks to evaluate verb tense production in people with nonfluent aphasia. Future studies need to evaluate discourse task effects on other aspects of verb production (e.g., moods) and specific task factors (e.g., presence or absence of visual stimulus).
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People with nonfluent aphasia often exhibit agrammatism, which is characterized by decreased use of function words, impaired syntactic and morphological skills, and difficulty with verb inflection. Studies in this area have spanned across different languages, including English (e.g., Dickey et al., 2005; Faroqi-Shah & Thompson, 2003, 2004, 2007; Goodglass et al., 1993), Greek (e.g., Nanousi et al., 2006), German (e.g., Penke & Westermann, 2006; Penke et al., 1999), Catalan (e.g., Rofes et al., 2014), and Dutch (e.g., Kok et al., 2007).

Production of verb tense, in particular, is often more impaired in this population than other morphological markers (e.g., number agreement and mood) because tense markers are more complex semantically, syntactically, and conceptually and therefore are harder to encode and retrieve during speech (Arabatzi & Edwards, 2002; Clahsen & Ali, 2009; Duffield, 2016; Faroqi-Shah & Thompson, 2007; Kok et al., 2007; Patterson et al., 2001). Research

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has shown that people with nonfluent aphasia often perform poorly on tasks related to tense, whether in spontaneous speech, grammatical judgment tasks, or sentence completion (Arabatzi & Edwards, 2002). For example, Clahsen and Ali (2009) found that people with nonfluent aphasia struggled with recognizing and producing inflectional morphemes, which is indicative of a general impairment in tense processing.

Evidence suggests that people with nonfluent aphasia may demonstrate a selective past tense impairment (Bastiaanse, 2008; Rofes et al., 2014; Tsiwah et al., 2021). There are several theories to explain why this might be the case, including (a) a reduced ability to select the correct inflectional markers to denote temporal information, known as diacritic encoding and retrieval (Faroqi-Shah & Thompson, 2007); (b) a reduced reliance on co-occurrence of grammatical features to produce accurate markers (Duffield, 2016); and (c) the increased semantic and conceptual complexity of tense markers (Abuom et al., 2011; Arabatzi & Edwards, 2002; Bos & Bastiaanse, 2014; Clahsen & Ali, 2009; Duffield, 2016; Faroqi-Shah & Thompson, 2007; Kok et al., 2007; Marini et al., 2011; Patterson et al., 2001; Rofes et al., 2014). The Past Discourse Linking Hypothesis (Bos & Bastiaanse, 2014) is an example of one hypothesis that suggests the selective past tense impairment is a result of the semantic and conceptual complexity of past tense production. This hypothesis suggests that past referencing is particularly difficult in that it takes more cognitive effort to link current discourse with a past event (Bos & Bastiaanse, 2014; Bos et al., 2014). The hypothesis further posits that this increased effort leads to difficulties in accurately producing morphological markers for the past tense.

Other studies, however, have found equivalent impairments in tense production in people with nonfluent aphasia or an interaction between tense production and task demands (e.g., Clahsen & Ali, 2009; Faroqi-Shah & Friedman, 2015; Faroqi-Shah & Thompson, 2007; Fyndanis et al., 2012; Jonkers & de Bruin, 2009; Khaledi, 2017; Kok et al., 2007; Nerantzini et al., 2020; Patterson & Holland, 2014). It is possible that task and stimulus type influenced these findings, adding another layer of complexity to our understanding of tense impairments in nonfluent aphasia. For example, Faroqi-Shah and Friedman (2015) found that people with nonfluent aphasia performed worse on verb production tasks than on verb selection tasks. The authors argued that the additional conceptual-semantic representations required in production tasks can interfere with morphosyntactic processing and make it more difficult to produce past tense. They also suggested that discourse tasks, which require robust lexical retrieval processing, could be a useful tool for evaluating past tense impairments in people with nonfluent aphasia. However, they also identified the methodological challenges associated with evaluating verb tense in discourse, such as the impact of discourse genres (i.e., specific category of spoken or written communication, e.g., conversation, personal narrative, expository) and tasks on verb tense production.

Discourse Task Effects on Tense Production

Discourse can be defined as "continuous stretches of language that convey a message" (Cherney et al., 1998, p. 2). Discourse often involves multiple words or sentences, although a single word can also deliver a message that would be considered discourse (Ulatowska et al., 1990). Discourse is considered the most natural, functional, and thus ecologically valid level to evaluate language since it encompasses abilities such as storytelling, conversation, and giving directions. Because of this, a variety of language measures (e.g., mean length of utterance [MLU], type–token ratio [TTR], lexical diversity, core lexicon, and so forth) have been used to evaluate the effects of treatment for people with neurogenic communication disorders (Boyle, 2011, 2014) or as an assessment tool to capture cognitive–linguistic deficits (Fleming & Harris, 2008). The increasing use of discourse in research has pointed out some of the methodological weaknesses and the lack of reference data for many discourse analysis methods (Bryant et al., 2016; Linnik et al., 2016; Pritchard et al., 2017; Wallace et al., 2018). For example, previous work has evaluated the impact of discourse genre or elicitation instructions on language performance in areas such as syntactic complexity (Glosser et al., 1988; Stark, 2019), lexical diversity (Fergadiotis & Wright, 2011; Stark, 2019), heavy and light verb production (Park et al., 2023), and gesture (Stark & Cofoid, 2022). Additionally, research suggests that genre and other characteristics of discourse tasks (e.g., topics, instructions, visual stimulus) can interact with the cognitive–linguistic abilities of people with aphasia and thus influence their language production (Fergadiotis & Wright, 2011; Stark, 2019; Stark & Cofoid, 2022; Stark & Fukuyama, 2021) including verb tense production (Armstrong, 2000).

Previous research has examined some aspects of verb tense production in people with nonfluent aphasia. One of these aspects regards the degree of temporal organization elicited by a discourse genre (Armstrong, 2000). Recount and storytelling focus on the characters in the story and contain narrative elements such as setting and events (Ulatowska et al., 1983). This requires temporal organization to convey the relationship between episodes, which results in more past tense production (Armstrong, 2000). On the other hand, an expository procedure is meant to convey actions required to complete a task and can simply list those actions in a sequence, so it is unlikely to elicit causal relationships. Thus, more present tense verbs are likely produced (Armstrong, 2000). Additionally, the temporal organization of discourse along with past tense production can be facilitated by specific elicitation instructions. Olness (2006) and Wright and Capilouto (2009) evaluated the impact of discourse task instructions on language performance in people without aphasia (Wright & Capilouto, 2009) and people with aphasia (Olness, 2006). In both studies, a picture description task was used, but task instructions were varied to compare performance when participants were instructed to "describe" or to "tell a story." The results in both studies showed the same pattern between people with and without aphasia. Both groups produced significantly more past tense verbs (but similar present verbs) when instructed to tell a story than to describe the picture stimuli. The findings from Olness (2006) suggested that requesting a "description" resulted in output without temporal organization and with more present tense verbs than past tense verbs. Whereas, requesting that participants "tell a story" resulted in more temporal sequencing and use of past tense verbs. Such variations in discourse tasks and genres can, therefore, elicit different patterns of tense usage.

Furthermore, the cognitive–linguistic demands of a discourse task can impact verb tense production. The level of task difficulty can be impacted by the complexity of the story grammar for the stimuli, presence or absence of visual stimulus, and familiarity to the topic, and so forth, and therefore, each discourse task is associated with different levels of cognitive and linguistic demands. For example, telling the Cinderella story is considered a cognitively and linguistically demanding task because it requires long-term memory to recall the story and working memory to construct the story grammar including the many characters and episodes. On the other hand, simple picture description tasks would be considered less cognitively and linguistically demanding because they contain few characters, a small number of depicted events and the visual stimulus is present throughout the discourse production, which can provide scaffolding for the story and semantic cues for lexical retrieval. These differences in elicitation task and stimuli are relevant since speakers with cognitive and/or linguistic deficits such as aphasia are more sensitive to tasks with higher cognitive demands. Fergadiotis and Wright (2011) reported that people with aphasia showed similar lexical diversity in storytelling and sequential picture description, while people without aphasia produced more lexical diversity in storytelling. The researchers interpreted this group difference by suggesting that sharing resources between the low-level cognitive process of lexical access and the higher order cognitive processes required for discourse organization impacted the ability for people with aphasia to produce diverse lexical items. If the same explanation applies, we expect that the phenomenon of selective past tense impairment would be more prominent in discourse tasks that are more cognitively and linguistically demanding for people with nonfluent aphasia. It is clinically important to understand potential discourse task demands related to verb tense production in people with nonfluent aphasia so that clinicians and researchers can accurately evaluate performance related to these tasks.

Current Study

The purpose of this study was to investigate how people with nonfluent aphasia produce verb tense compared to people without aphasia in various discourse tasks. Particularly, this study sought to evaluate evidence of selective past tense impairment in nonfluent aphasia. Previous research has investigated verb tense production in people without aphasia (Wright & Capilouto, 2009) and people with aphasia (Olness, 2006) independently and explored how discourse task instructions impact verb tense production. Therefore, the current study will add to this literature by completing group comparisons to evaluate the degree of task effects on verb tense production. In addition, there is a gap in our understanding of how verb tense production is impacted by the type of discourse being elicited. Because each discourse task has different cognitive–linguistic demands, it is likely that speakers with cognitive–linguistic impairments will be affected differently by these task demands. Therefore, another purpose of the study was to address this gap by comparing the tense production of people with and without aphasia on a variety of discourse tasks and investigate whether selective past tense impairment is most prominent in cognitively demanding tasks (such as Cinderella). Below, our specific research questions (RQs) and hypotheses are listed.

1. Do people with nonfluent aphasia produce fewer verb tenses compared to people without aphasia in discourse?
   a. Are people with nonfluent aphasia disproportionately impaired in the production of past tense verbs when compared to other verb tenses in discourse?
   b. Is selective past tense impairment in people with nonfluent aphasia prominent in specific discourse tasks?

   Hypothesis: We expected an overall reduction of verb tense production, but with a greater reduction in past tense verbs than other verb tenses in people with nonfluent aphasia due to their limited morphosyntactic skills and the mismatch of temporal relationship between speaking time and the event. Also, this selective impairment of past tense would be prominent for tasks with greater cognitive–linguistic demands (e.g., Cinderella).
2. Is verb tense production in people with and without nonfluent aphasia different across discourse tasks?

Hypothesis: We hypothesized that people without aphasia would purposely select verb tenses based on the task demands. However, people with nonfluent aphasia would show a reduction in verb tense variations, and this would be prominent for tasks with greater cognitive–linguistic demands in the group with nonfluent aphasia (e.g., Cinderella).

Method

Participants

This study received an exempt approval from the institutional review board at the University of Mississippi.

G*Power analysis suggested a total sample size of 44 to complete an *F* test for two between groups and six repeated measures with a power of 0.7, effect size of 0.30 (medium effect), and alpha error probability of 0.05. We included 23 people with nonfluent aphasia from the AphasiaBank, which is a large language sample database of individuals with and without aphasia (MacWhinney et al., 2011; https://aphasia.talkbank.org) made up of various subdatasets (i.e., ACWT, Adler, BU, Elman, Kurland, Fridriksson, Kansas, Kempler, UNH, MSU, Scale, TAP, and Tucson). Participants with nonfluent aphasia (17 Broca's aphasia and six transcortical motor aphasia) were selected based on the results of Western Aphasia Battery–Revised (WAB-R; Kertesz, 2006) and their aphasia quotients (AQs) ranged from 25 to 75 ($M = 58.39$). All participants were monolingual English speakers with normal vision and hearing with or without aids.

A total of 27 participants without aphasia (15 males and 12 females) were also included from AphasiaBank (22 from Capilouto and five from UMD subset). These participants were matched to the group of people with aphasia for age, $t(48) = 1.180$, $p = .244$, and years of education, $t(48) = 1.678$, $p = .074$. The inclusion/exclusion criteria for all control participants were (a) native English monolingual speakers, (b) no history of neurogenic disorders, (c) no history of developmental disorders, (d) normal vision and hearing with or without aids, and (e) Mini-Mental State Examination (Folstein et al., 2010) score within normal limits based on age and years of education (Crum et al., 1993). Table 1 includes demographic information for the two groups. Additionally, detailed demographic information for each participant with nonfluent aphasia is reported in Appendix.

Materials and Data Management

Transcriptions of the language samples from six discourse elicitation tasks were obtained from AphasiaBank: (a) generating an important event from the participants' personal life (Event), (b) sequential picture description of four sequenced scenes (Window), (c) sequential picture description of six sequenced scenes (Umbrella), (d) single picture description (Cat; Nicholas & Brookshire, 1993), (e) story telling obtained via the Cinderella story (Cinderella), and (f) procedure obtained by explaining how to make a peanut butter jelly sandwich (PJS). The recount task (Event) requested that participants "tell a story about something important that happened to you in your life." For the three picture descriptions (Window, Umbrella, Cat), participants were provided a picture stimulus and instructed to "tell a story with a beginning, a middle, and an end." For the storytelling (Cinderella), participants were provided a wordless book of Cinderella to review the story. After the book was taken away, they were asked to "tell as much of the story of Cinderella as you can. You can use any details you know about the story." Lastly, the procedure task (PJS) asked participants to "tell how you would make a peanut butter and jelly sandwich." The detailed instructions and stimuli for each task can be found at https://aphasia.talkbank.org. According to AphasiaBank, the language samples were transcribed by trained researchers, and each utterance was parsed based on a hierarchy of indices: syntax, intonation, pause, and semantic content following the guidelines by Saffran et al. (1989).

After obtaining each transcription, we excluded verbs that were produced in automatic speech (e.g., "you know," "I mean"), as commentary (e.g., "that's it"), or that were immediately repeated, revised, or interrupted (e.g., "this could be // this could fit"), and as nonfinite verbs (e.g., "I wanted to go"). All finite verbs used in both

Table 1. Demographic information of people without aphasia and people with nonfluent aphasia.

Demographic	People without aphasia (*n* = 27)	People with nonfluent aphasia (*n* = 23)
Age	67.69 ± 7.85 years old	65.02 ± 8.11 years old
Sex	15 males and 12 females	15 males and 8 females
Years of education	15.63 ± 2.53 years	14.17 ± 2.50 years
WAB-AQ	—	58.39 (ranged 30.5 to 74.6)
MMSE	29.66 ± .620	—

Note. WAB-AQ = Western Aphasia Battery–Aphasia Quotient; MMSE = Mini-Mental State Examination.

main and subordinate/coordinate clauses were included in our data set. Those finite verbs were then coded for tense categorization of either past, present, future, imperative, or unknown. We followed the morpheme (e.g., −*ed*, "will") indicator or irregular tense form (e.g., "wrote") of each tense. Imperative is in a present form but was considered separately because it is distinctly used to command and is usually missing a subject in the sentence (e.g., "*Spread* it on the bread") and does not carry temporal information as a tense. Unknown was categorized (a) when the verb form did not indicate specific tense (e.g., "They *put* it down"), (b) when the verb tense was produced in error such as missing a tense morpheme (e.g., "He *pick* it"), or (c) in the case of a mismatched tense morpheme and subject (e.g., "They *takes* it").

The four authors were trained based on the developed criteria for verb inclusion/exclusion and tense categorization. After completion of verb tense coding for all transcriptions, transcripts for 25% of people without aphasia (n = 7) and 39% of people with nonfluent aphasia (n = 9) were randomly selected to evaluate interrater reliability between the first author and the three raters. The average item-by-item agreement comparison was 94.05% for verb inclusion/exclusion determination and 95.42% for verb tense categorization. The disagreed items were discussed between raters to reach consensus.

Statistical Analysis

First, to conceptualize the participants' general language production skills, the following measures were obtained from the Computerized Language Analysis (CLAN) eval function:

$$\text{eval @} + \text{t}\text{"PAR: } +\text{g"each task (e.g., Important\_Event)"} \quad +\text{u} \tag{1}$$

The variables included the total number of utterances, MLU, TTR, verbs per utterance, density, and percentage of word errors in each discourse task for each group. Each variable in each task was compared between groups using repeated mixed analysis of variance (ANOVA; 2 group × 6 discourse tasks) with Bonferroni corrections (adjusted p values were reported).

In order to control for variance in the number of verbs produced across participants and discourse tasks, a ratio was calculated for each type of tense by dividing the total number of each type of verb tense produced in each task by the total number of finite verbs included in each task. Therefore, the past ratio, present ratio, future ratio, imperative ratio, and unknown ratio were calculated as dependent variables for all six discourse tasks. We conducted a generalized linear mixed model (GLMM) with pairwise comparisons for each dependent variable (i.e., each tense ratio). GLMM is an extension to the generalized linear model and considered a more powerful analysis as the linear predictor contains random effects in addition to the fixed effects (Rabe-Hesketh & Skrondal, 2010; Schielzeth et al., 2020). In the current study, group and task effects were included as fixed effects and individual participants were included as a random effect to factor in individual variations. To provide contextual perspectives of verb tense production, the raw frequency of each verb tense was compared by two-way ANOVA (group by task) with Bonferroni corrections.

In addition, secondary analyses were conducted for further comparisons to contextualize verb tense production for both groups. First, the past, present, and future ratios within each group were compared using repeated measures ANOVA with Bonferroni corrections. Then, the tense ratio discrepancy between the past and present ratios and between past and future ratios within each group was calculated by subtracting present or future ratio from past ratio. Below are the equations:

$$\begin{aligned} &\textit{Past–Present discrepancy} = \textit{Past ratio} \\ &\textit{subtracted by present ratio in each group} \\ &\textit{Past–Future discrepancy} = \textit{Past ratio} \\ &\textit{subtracted by future ratio in each group} \end{aligned} \tag{2}$$

The past–present discrepancy and past–future discrepancy between groups were then compared using independent sample t tests.

Results

Overall Language Production Between Groups

Although it is not within the scope of the current RQs, we provided descriptive data of language output to contextualize the participants' language production. Additionally, statistical comparisons were conducted to compare groups. Overall lexical production was reduced in people with nonfluent aphasia compared to people without aphasia. More specifically, compared to people without aphasia, people with nonfluent aphasia produced significantly fewer utterances and had shorter MLU in Event and Cinderella tasks, and had reduced TTR in all tasks except for the two sequential description tasks. Lexical density and the number of verbs per utterance were reduced in all tasks in people with nonfluent aphasia compared to people without aphasia. The proportion of word errors was greater for people with nonfluent aphasia in all tasks except Event and PJS when compared to people without aphasia (see Table 2).

Table 2. Language production of people without aphasia and people with nonfluent aphasia.

Parameter	Task	People without aphasia	People with nonfluent aphasia	Adjusted *p* value
Total number of utterances	Overall	20.30 ± 21.182	11.32 ± 9.249	**< .001***
	Event	27.41 ± 29.752	17.83 ± 11.653	**.010***
	Window	8.44 ± 2.979	6.30 ± 2.899	.562
	Umbrella	15.33 ± 5.758	9.91 ± 4.535	.147
	Cat	11.48 ± 4.510	9.70 ± 4.258	.628
	Cinderella	48.89 ± 23.162	17.52 ± 13.180	**< .001***
	PJS	10.22 ± 5.938	5.28 ± 3.286	.212
MLU per utterance	Overall	20.25 ± 21.134	10.91 ± 8.77	**< .001***
	Event	27.37 ± 29.774	17.35 ± 11.773	**.007***
	Window	8.44 ± 2.979	6.04 ± 2.804	.513
	Umbrella	15.33 ± 5.758	9.55 ± 4.217	.120
	Cat	11.48 ± 4.510	9.39 ± 4.197	.569
	Cinderella	48.70 ± 23.081	16.65 ± 12.507	**< .001***
	PJS	10.15 ± 5.921	5.17 ± 3.330	.206
TTR	Overall	.503 ± .118	.599 ± .192	**< .001***
	Event	.507 ± .131	.589 ± .188	**.039***
	Window	.600 ± .068	.662 ± .147	.120
	Umbrella	.526 ± .071	.521 ± .153	.899
	Cat	.523 ± .082	.606 ± .188	**.038***
	Cinderella	.356 ± .067	.511 ± .201	**< .001***
	PJS	.504 ± .121	.734 ± .198	**< .001***
Verbs per utterance	Overall	1.498 ± .425	.477 ± .395	**< .001***
	Event	1.441 ± .537	.493 ± .353	**< .001***
	Window	1.547 ± .417	.423 ± .337	**< .001***
	Umbrella	1.484 ± .344	.500 ± .412	**< .001***
	Cat	1.624 ± .449	.526 ± .474	**< .001***
	Cinderella	1.569 ± .269	.542 ± .419	**< .001***
	PJS	1.324 ± .454	.355 ± .371	**< .001***
Density	Overall	.487 ± .045	.356 ± .156	**< .001***
	Event	.505 ± .043	.383 ± .128	**< .001***
	Window	.493 ± .057	.381 ± .152	**< .001***
	Umbrella	.506 ± .041	.360 ± .183	**< .001***
	Cat	.460 ± .038	.290 ± .170	**< .001***
	Cinderella	.493 ± .020	.392 ± .153	**.001***
	PJS	.463 ± .044	.321 ± .134	**< .001***
Percentage of word errors	Overall	0.006 ± 0.038	12.318 ± 25.536	**< .001***
	Event	0.000 ± 0.000	5.035 ± 7.822	.302
	Window	0.000 ± 0.000	12.667 ± 15.238	**.010***
	Umbrella	0.000 ± 0.000	17.850 ± 50.637	**< .001***
	Cat	0.000 ± 0.000	16.120 ± 22.745	**.001***
	Cinderella	0.036 ± 0.090	12.654 ± 20.371	**.010***
	PJS	0.000 ± 0.000	9.130 ± 11.370	.081

Note. Bold *p* values with an asterisk indicate significant difference between groups. PJS = peanut butter jelly sandwich; MLU = mean length of utterance; TTR = type–token ratio.

RQ1: Group Comparisons for Each Tense Ratio

Verb Tense Production

To address RQ1 regarding group differences on verb tense production, the parameters of the fixed and random effects of the linear model for each tense ratio were reported in Supplemental Materials S1 and S2. The model indicated a significant group effect for past ratio, $F(1, 266) = 8.954$, $p = .003$; future ratio, $F(1, 266) = 9.781$, $p = .002$; and imperative ratios, $F(5, 266) = 5.661$, $p = .018$, where people with nonfluent aphasia showed a lower ratio of the three tenses than people without aphasia. The group effects were also significant for the unknown ratio, $F(1, 266) = 7.218$, $p = .008$, but the unknown ratio was higher for people with nonfluent aphasia than people without aphasia. Differences between present ratios in the two groups were not statistically significant, $F(1, 266) = 0.011$. See Table 3 for the means and standard deviations of each tense ratio for the two groups.

Tense Ratio Discrepancy Comparisons

In order to evaluate selective past tense impairment for RQ1a, the overall past ratio was compared to present and future ratios in each group. Both groups had lower past ratios compared to present ratios but higher past ratios than future ratios. The mean past–present discrepancy, $t(270.448) = 2.576$, $p = .011$, and the past–future discrepancy, $t(271.048) = 44.607$, $p < .001$, between groups

Table 3. Verb tense ratio in specific tasks between groups.

Task	People without aphasia	People with nonfluent aphasia	Adjusted *p* value
Past ratio			
Overall	0.369 ± 0.345	0.188 ± 0.286	**.003***
Event	0.720 ± 0.195	0.329 ± 0.364	**< .001***
Window	0.178 ± 0.233	0.166 ± 0.295	.873
Umbrella	0.101 ± 0.125	0.138 ± 0.221	.719
Cat	0.391 ± 0.346	0.150 ± 0.260	**.010***
Cinderella	0.530 ± 0.391	0.296 ± 0.302	**.013***
PJS	0.294 ± 0.294	0.010 ± 0.042	**.005***
Present ratio			
Overall	0.552 ± 0.354	0.563 ± 0.373	.915
Event	0.252 ± 0.200	0.537 ± 0.392	**.024***
Window	0.815 ± 0.231	0.572 ± 0.325	**.032***
Umbrella	0.870 ± 0.127	0.631 ± 0.360	**.032***
Cat	0.582 ± 0.342	0.608 ± 0.369	.907
Cinderella	0.425 ± 0.366	0.588 ± 0.349	.204
PJS	0.371 ± 0.309	0.412 ± 0.459	.844
Future ratio			
Overall	0.009 ± 0.022	0.002 ± 0.012	**.002***
Event	0.007 ± 0.025	0.004 ± 0.016	.565
Window	0.000 ± 0.000	0.000 ± 0.000	1.000
Umbrella	0.014 ± 0.029	0.000 ± 0.000	**.015***
Cat	0.013 ± 0.028	0.000 ± 0.000	**.018***
Cinderella	0.012 ± 0.014	0.006 ± 0.025	.229
PJS	0.006 ± 0.018	0.000 ± 0.000	.283
Imperative ratio			
Overall	0.054 ± 0.162	0.083 ± 0.254	**.018***
Event	0.004 ± 0.012	0.000 ± 0.000	.936
Window	0.000 ± 0.000	0.025 ± 0.112	.563
Umbrella	0.010 ± 0.028	0.000 ± 0.000	.839
Cat	0.000 ± 0.000	0.033 ± 086	.437
Cinderella	0.006 ± 0.014	0.003 ± 0.011	.964
PJS	0.302 ± 0.290	0.525 ± 0.475	**< .001***
Unknown ratio			
Overall	0.017 ± 0.042	0.160 ± 0.290	**.008***
Event	0.016 ± 0.030	0.130 ± 0.302	.109
Window	0.009 ± 0.027	0.237 ± 0.305	**.002***
Umbrella	0.005 ± 0.017	0.226 ± 0.345	**.002***
Cat	0.014 ± 0.040	0.208 ± 0.325	**.007***
Cinderella	0.026 ± 0.031	0.088 ± 0.231	.360
PJS	0.034 ± 0.078	0.052 ± 0.145	.760

Note. Bold *p* values with an asterisk indicate significant difference between groups. PJS = peanut butter jelly sandwich.

were higher in people without aphasia than people with nonfluent aphasia (see Table 4).

RQ2: Discourse Task Effects on Verb Tense Production

Group Comparisons in Each Discourse Task

The group differences in verb tense production were evaluated in each specific task as well. Compared to people without aphasia, people with nonfluent aphasia produced fewer past tense verbs in all tasks except for the two sequential picture descriptions (Window and Umbrella). In contrast, people with nonfluent aphasia had significantly lower present ratios in only two tasks (Window and Umbrella) and higher present ratios in Event. Future ratios in Umbrella and Cat were significantly lower in people with nonfluent aphasia than people without aphasia. However, unknown ratios in Window, Umbrella, and Cat were higher in people with nonfluent aphasia than people without aphasia (see Table 3 for all comparisons).

Table 5 reports the raw frequency data of each tense production. The group comparisons for raw frequency data differed somewhat from the ratio data; however, the main patterns remained. People with nonfluent aphasia less frequently produced past verbs in Event and Cinderella, and present verbs in Window and Umbrella than people without aphasia. Also, people with nonfluent aphasia produced more unknown verbs in Window, Umbrella, and Cinderella than people without aphasia. Both groups produced future and imperative verbs minimally.

People Without Aphasia

The task effect was evaluated by comparing the tense ratios of each task within group. In this group, the highest past ratio was shown in Event, followed by Cinderella, Cat, and PJS. Window and Umbrella had the lowest past ratios in people without aphasia. Conversely, their present ratios were higher in Umbrella and Window than other discourse tasks. The present ratio for Cat was higher than Event and PJS. The imperative ratio for PJS was significantly greater than all other tasks. Lastly, the future ratios and unknown ratios between tasks were not significantly different (see Table 6).

People With Nonfluent Aphasia

The task effects on the past ratios were rarely reported in people with nonfluent aphasia, and only a few task comparisons were significantly different (Event vs. PJS and Cinderella vs. PJS). The imperative ratio for PJS was significantly greater than all other tasks. The past, future, and unknown ratios for all tasks were not significantly different (see Table 7).

Discussion

This study aimed to investigate verb tense production and the possibility of selective past tense impairment in people with nonfluent aphasia in various discourse tasks compared to people without aphasia by measuring verb tense ratios. With respect to RQ1 (group differences in verb production and selective past tense impairment), we found evidence of a selective past tense impairment in people with nonfluent aphasia. This group produced significantly fewer past and future tense verbs but a similar amount of present tense verbs compared to people without aphasia. In addition, they showed greater past–present and past–future discrepancies than people without aphasia, indicating greater reduction of past tense than other tenses. For RQ2, discourse task effects on tense production were found in people without aphasia (i.e., certain types of verb tenses were produced more or less depending on the characteristics of the discourse tasks). However, discourse task did not have a measurable effect in the group with nonfluent aphasia, with only few significantly different task comparisons.

Overall Reduction of Verb Tense Production

As expected, the overall language production skills of people with nonfluent aphasia were significantly reduced compared to people without aphasia. The overall total number of utterances, MLU, and TTR in people with nonfluent aphasia was smaller than people without aphasia, although there were variations across tasks. The verbs per utterance and density were reduced in people with nonfluent aphasia in all tasks.

Evidence of Selective Past Tense Reduction in People With Nonfluent Aphasia

With respect to tense production, people with nonfluent aphasia had similar present tense ratios, but significantly reduced past and future tense ratios compared to people without aphasia. In addition, although both groups produced fewer past tense than present tense, the tense discrepancy analyses indicated greater reduction of past tense in people with nonfluent aphasia than people without aphasia. The current study, therefore, supports a selective past tense impairment (Bastiaanse, 2008; Faroqi-Shah & Thompson, 2007; Marini et al., 2011; Rofes et al., 2014; Tsiwah et al., 2021). Although we hypothesize prominent past tense impairment in cognitively–linguistically demanding tasks such as Cinderella, when evaluating the individual tasks, the trend of selective past tense impairment was consistent in most tasks (except for Window and Umbrella, where we discuss further with the task effects for the reason). Difficulty with past tense production in the group

Table 4. Verb tense raw frequency data in people with and without aphasia.

Task	People without aphasia	People with nonfluent aphasia	Adjusted *p* value
Past ratio			
Overall	11.340 ± 17.433	1.275 ± 2.588	**< .001***
Event	23.000 ± 20.443	2.565 ± 3.231	**< .001***
Window	1.926 ± 2.352	0.609 ± 1.270	.631
Umbrella	1.926 ± 2.319	0.783 ± 1.536	.677
Cat	5.519 ± 5.214	0.565 ± 0.896	.072
Cinderella	32.222 ± 23.047	3.087 ± 4.295	**< .001***
PJS	3.444 ± 4.089	0.043 ± 0.209	.215
Present ratio			
Overall	12.994 ± 16.933	3.225 ± 4.331	**< .001***
Event	8.519 ± 13.265	4.304 ± 6.270	.186
Window	8.741 ± 3.727	1.826 ± 1.497	**.030***
Umbrella	15.852 ± 5.934	3.565 ± 3.975	**< .001***
Cat	8.370 ± 5.969	3.087 ± 2.843	.098
Cinderella	31.111 ± 31.548	5.652 ± 5.781	**< .001***
PJS	5.370 ± 6.929	0.913 ± 1.676	.162
Future ratio			
Overall	0.327 ± 0.763	0.014 ± 0.120	**< .001***
Event	0.259 ± 0.764	0.043 ± 0.209	.274
Window	0.000 ± 0.000	0.000 ± 0.000	.775
Umbrella	0.259 ± 0.594	0.000 ± 0.000	.465
Cat	0.259 ± 0.594	0.000 ± 0.000	.475
Cinderella	1.000 ± 1.177	0.043 ± 0.209	.293
PJS	0.185 ± 0.622	0.000 ± 0.000	**< .001***
Imperative ratio			
Overall	0.654 ± 1.710	0.181 ± 0.570	0.823
Event	0.333 ± 0.920	0.000 ± 0.000	.082
Window	0.000 ± 0.000	0.087 ± 0.417	**.027***
Umbrella	0.222 ± 0.641	0.000 ± 0.000	**.009***
Cat	0.000 ± 0.000	0.217 ± 0.600	.163
Cinderella	0.407 ± 0.888	0.087 ± 0.288	**< .001***
PJS	2.963 ± 3.044	0.696 ± 1.020	.417
Unknown ratio			
Overall	0.549 ± 1.266	0.522 ± 0.976	.823
Event	0.963 ± 2.009	0.435 ± 0.788	.082
Window	0.111 ± 0.320	0.783 ± 1.166	**.027***
Umbrella	0.111 ± 0.320	0.913 ± 1.505	**.009***
Cat	0.185 ± 0.483	0.609 ± 0.891	.163
Cinderella	1.593 ± 1.716	0.304 ± 0.559	**< .001***
PJS	0.333 ± 0.784	0.087 ± 0.288	.417
Total verbs			
Overall	25.852 ± 27.386	5.225 ± 5.736	**< .001***
Event	33.074 ± 33.641	7.348 ± 7.303	**< .001***
Window	10.741 ± 3.312	3.304 ± 2.439	.076
Umbrella	18.370 ± 6.215	5.304 ± 4.547	**.002***
Cat	14.333 ± 5.974	4.478 ± 3.217	**.019***
Cinderella	66.333 ± 31.291	9.174 ± 8.489	**< .001***
PJS	12.259 ± 8.198	1.739 ± 2.094	**.012***

Note. Bold *p* values with an asterisk indicate significant difference between groups. PJS = peanut butter jelly sandwich.

Table 5. Tense ratio discrepancy comparisons.

Tense comparison	People without aphasia	People with nonfluent aphasia	Adjusted *p* value
Past ratio vs. Present ratio	$p < .001$	$p < .001$	
Past ratio vs. Future ratio	$p < .001$	$p < .001$	
Past ratio – Present ratio	−.183 ± .680	−.375 ± .561	.011
Past ratio – Future ratio	.360 ± .346	.186 ± .283	< .001

with nonfluent aphasia resulted in an overreliance on present tense. In the group with nonfluent aphasia, more than 50% of the verbs produced were in the present form (41% of verbs produced in present tense in PJS; however, combining the imperative ratio of PJS, because imperatives are morphologically formed as present tense, the ratio rises to approximately 94%). In addition, this yielded an unexpected result of a higher present ratio in the Event task, where people with nonfluent aphasia produced present tense more frequently (53.7%) than people without aphasia (25.2%).

The findings of the current study support Faroqi-Shah and Friedman's (2015) assumption where discourse tasks could be a useful tool to support selective past tense impairment in nonfluent aphasia, due to the robust lexical processing required for discourse production. In addition, discourse is considered a challenging level of language production where speakers need to appropriately formulate the micro- and macrostructure of language and consider pragmatics such as social appropriateness. Those behaviors require a higher level of cognitive–linguistic processing which can be particularly difficult for people with nonfluent aphasia due to the nature of their impairments (Murray, 2000; Purdy, 2002; Vallila-Rohter & Kiran, 2013) compared to the tasks in previous studies (e.g., sentence production priming task; Faroqi-Shah & Thompson, 2004; Nanousi et al., 2006). The cognitive and linguistic challenges of people with nonfluent aphasia limit the resources available in discourse production, which could lead them to sacrifice verb tense variations, in order to complete other linguistic functions required for discourse production (e.g., lexical access, story grammar generation, and so forth). Thus, this may result in an increased difficulty of past tense production.

Discourse Task Effect on Verb Tense Production

Task Effects in People Without Aphasia

The discourse elicitation task effects on tense production were evident in people without aphasia. This group had flexibility in producing past or present tense verbs, based on the purpose of the task. Earlier, we explained that recounts and storytelling could elicit more past tense verbs than other tasks because the tasks require a temporal organization to construct the relationship between episodes and events. Additionally, recounts require a recall of past personal memory, which also results in more past tense production than other tasks. Our results supported this

Table 6. Verb tense ratio comparisons between tasks in people without aphasia.

Task comparison (a vs. b)	Past ratio difference (a–b)	Present ratio difference (a–b)	Future ratio difference (a–b)	Imperative ratio difference (a–b)	Unknown ratio difference (a–b)
Event vs. Window	**.542*** **	**−.563*** **	.007	.004	.007
Event vs. Umbrella	**.619*** **	**−.618*** **	−.007	−.006	.011
Event vs. Cat	**.329*** **	**−.329*** **	−.006	.004	.002
Event vs. Cinderella	**.190** **	−.173	−.005	−.002	−.010
Event vs. PJS	**.426*** **	−.119	.000	**−.298* **	−.017
Window vs. Umbrella	.077	−.055	−.013	−.010	.004
Window vs. Cat	**−.213* **	**.234* **	−.013	.000	−.005
Window vs. Cinderella	**−.352*** **	**.390*** **	−.012	−.006	−.017
Window vs. PJS	−.117	**.444*** **	−.006	**−.302*** **	−.025
Umbrella vs. Cat	**−.290** **	**.288** **	.001	.010	−.009
Umbrella vs. Cinderella	**−.429*** **	**.445*** **	.001	.004	−.021
Umbrella vs. PJS	**−.193** **	**.499*** **	.007	**−.292*** **	−.028
Cat vs. Cinderella	−.139	.157	.001	−.006	−.012
Cat vs. PJS	.097	**.211* **	.006	**−.302*** **	−.019
Cinderella vs. PJS	**.235*** **	.054	.006	**−.296*** **	−.008

Note. Bold *p* values indicate significant difference between tasks. PJS = peanut butter jelly sandwich.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 7. Verb tense ratio comparisons between tasks in people with nonfluent aphasia.

Task comparison (a vs. b)	Past ratio difference (a–b)	Present ratio difference (a–b)	Future ratio difference (a–b)	Imperative ratio difference (a–b)	Unknown ratio difference (a–b)
Event vs. Window	.167	–.039	.004	–.025	–.103
Event vs. Umbrella	.193	–.093	.004	< –.001	–.100
Event vs. Cat	.183	–.074	.004	–.033	–.077
Event vs. Cinderella	.040	–.055	–.002	–.003	.039
Event vs. PJS	**.318***	.126	.004	**–.525****	.074
Window vs. Umbrella	.026	–.053	< –.001	.025	.002
Window vs. Cat	.016	–.035	< –.001	–.008	.025
Window vs. Cinderella	–.127	–.016	–.006	.022	.142
Window vs. PJS	.151	.165	< .001	**–.500****	.176
Umbrella vs. Cat	–.011	.018	< .001	–.033	.023
Umbrella vs. Cinderella	–.154	.038	< –.001	–.003	.139
Umbrella vs. PJS	.125	.218	< .001	**–.525****	.174
Cat vs. Cinderella	–.143	.020	–.006	.030	.116
Cat vs. PJS	.135	.200	< .001	**–.492****	.151
Cinderella vs. PJS	**.279***	.180	.006	**–.522****	.035

Note. Bold *p* values indicate significant difference between tasks.#PJS = peanut butter jelly sandwich.
*$p < .05$. **$p < .001$.

assumption and showed dominant past tense production in the two tasks (Event and Cinderella). This is consistent with Armstrong (2000) who also reported dominant past tense production in recount tasks.

We expected similar tense production for the single and sequential picture description tasks as storytelling. That was because the single and sequential picture description tasks have methodological similarities, and we used the instructions of "tell a story," which potentially request temporal organization. However, the results were different between the single and sequential picture description tasks. People without aphasia produced past tense in the Cat single picture description task as often as the Cinderella storytelling task, and more than sequential picture descriptions. On the other hand, this group produced significantly more present tense in sequential picture description (more than 80% in Window and Umbrella) than other tasks. One difference between the two tasks is whether or not the task displays the causal and consequential events in the picture stimulus. Because sequential picture description tasks lay out scenes of causal and consequential events, speakers can conceptualize the causal and consequential events as the moment of speaking, which could result in the use of present tense verbs. In contrast, if the causal and consequential events are not presented (such as the single picture description), speakers organize these events into a timeline and use past tense to describe the causal events that were not displayed in the current picture scene.

Lastly, higher imperative ratios in PJS were expected because procedural discourse often employs imperative utterances to convey the steps required to complete the task. Armstrong (2000) previously reported dominant present tense for procedures. Considering Armstrong included imperatives in the category of present tense, our results are consistent in reporting higher imperative ratios in PJS.

Task Effects in People With Nonfluent Aphasia

Despite the discourse task-related effects on verb tense production in people without aphasia, this variation was less apparent in people with nonfluent aphasia. Similar to people without aphasia, this group also showed a tendency of using more past tense in Event and Cinderella, but their ratios were not significantly greater than other tasks, except for PJS. The only significant task effect was reported in PJS for the imperative ratio, similar to people without aphasia. No other tense ratios were significantly different between tasks. This limited variation of verb tense usage is possibly related to the selective past tense impairment in people with nonfluent aphasia or their limited resources to purposely vary the type of tense based on the characteristics of tasks as discussed earlier.

The results of limited variation of verb tense production are inconsistent with Olness (2006). This can be explained by the characteristics of participants in the two studies. Participants with aphasia in Olness (2006) had mild-to-moderate aphasia (AQ ranged from 77.2 to 99.7, M = 86.2) with no report of their aphasia types. Considering the relatively high AQ, those participants may have demonstrated a better ability for tense manipulation depending on the task characteristics (e.g., instructions, topics) similar to people without aphasia. The results of the current study are based on participants who were classified as nonfluent aphasia and their AQ scores ranged between 25 and 75 with an *M* of 58.39. Therefore, our findings suggest that these participants are less sensitive to task effects possibly due to a limitation in ability to purposely manipulate the verb tense depending on discourse tasks.

The future tense was minimally produced in all tasks in both groups; therefore, it was difficult to evaluate the task effects. The discourse tasks and topics included in the study did not provide many opportunities to produce future events for speakers. A discourse task such as describing plans for a future trip, for example, could elicit more future tense verbs.

Collectively, our results suggest that the genre and topics of discourse elicitation task impact verb tense production in people without aphasia but rarely in people with nonfluent aphasia. Similar trends of discourse task effects on verb production have been previously reported (Park et al., 2023), although Park and colleagues focused on the semantic weight of verbs. These two studies consistently showed a possible discourse task impact on verb production where people, who have the ability, purposefully select verb lexicons and manipulate the form based on the purpose and type of the specific task. However, the task effect may not be shown in people who have difficulty with this processing.

Limitations and Clinical Implications

Our study categorized verb tense based on morphological markers in order to implement clear and specific methodology. Therefore, we did not consider different aspects (e.g., perfective, progressive) or moods (e.g., possibility, necessity) of the action that can be associated with the verb forms except for imperative, which was clearly determined based on grammatical judgment. Previous studies discussed disproportionate impairment on not only tense types but also moods and aspects in people with nonfluent aphasia (e.g., Binnick, 2012; Gilead et al., 2013; Magliano & Schleich, 2000). However, findings have been inconsistent across studies. Also, none of previous studies have compared production of verb aspect and mood in people with nonfluent aphasia across various discourse tasks. Therefore, future studies should identify specific aspects and moods of verbs to evaluate comprehensive patterns of verb use in various types/genres of discourse. In addition, the current study reported the unknown ratio, which included errors and verb tense without morphological variation (e.g., "put") in one category due to potential ambiguity when identifying tense. It was beyond the scope of the current study to investigate errors and analyze the types of errors. However, in-depth error analysis on verb tense in future studies would provide more insight on how discourse tasks may affect verb tense production. There are also limitations related to the use of secondary data from AphasiaBank. Because AphasiaBank provides one-speaker monologue type discourse, those were the only discourse genres included in the current study. Other discourse genres such as conversational dialogue were not evaluated. Conversations require other types of cognitive–linguistic resources such as language comprehension, pragmatics, and auditory attention, and so forth. Therefore, this is an important discourse genre that needs to be included in future studies examining verb production in conversations. Additionally, when collecting discourse samples, one may concern about an order effect that impacts language production. AphasiaBank provides a protocol for language sample data collection procedures (Event ➔ Window ➔ Umbrella ➔ Cat ➔ Cinderella ➔ PJS). Therefore, the order of the discourse samples used in the current study was not randomized. It is possible that verb production practice in earlier tasks impacted the later tasks, or later task performance may have been affected by mental and physical fatigue.

The current study included discourse elicitation tasks commonly used in clinic and research without experimental manipulation of task instructions or materials (e.g., telling the same topic with and without a picture). Although this was done to increase the ecological validity and clinical relevance of our research, our findings may be confounded with other issues such as the topic of tasks. The current study represents an early attempt to raise researchers' and clinicians' awareness of methodological issues that could affect language production, including verbs in discourse. Bryant et al. (2016) reported that most clinicians use one task to evaluate the discourse of people with aphasia (most commonly picture descriptions because they are included in standardized tests, e.g., WAB), which is not surprising considering the time restrictions that clinicians face. However, one task may provide a biased diagnosis of verb production in people with aphasia since it is possible for specific tasks to facilitate certain verb tense production. Instead, literature suggests using multiple tasks or purposefully selecting a task (e.g., Stark & Fukuyama, 2021). For example, this study suggests that picture descriptions facilitated more present tense verb production and less past tense than recount and storytelling. Therefore, picture description may not be the best choice if a clinician or researcher is interested in evaluating past tense verb production; recount or storytelling could be better options. In addition, because the results of this study showed limited tense variation in people with nonfluent aphasia, improving tense variation depending on the purpose of the discourse tasks could be a potential target for intervention in this population.

Our study advanced methodological specification since we limited our participant pool to include a specific type (nonfluent) of aphasia and severity level so that there were fewer confounds created by the potential variations in aphasia characteristics. We included participants with WAB-AQs that ranged from 25 to 75. Although this range still represents wide variability, it reduced the likelihood of including participants whose aphasia severity may result in discourse samples that could not be analyzed (or participants who could not produce discourse), and participants with mild impairments. Also, unlike previous studies that included only one or two types of discourse tasks (picture descriptions in Olness, 2006; Wright & Capilouto, 2009; e.g., recounts in Kynette & Kemper, 1986), the current study provides evidence of task effects on verb tense production in various discourse elicitation tasks and showed that the task effects could affect speakers based on their cognitive–linguistic abilities. Recent research in aphasiology has called for an increase in the methodological rigor associated with evaluating discourse outcomes (Stark et al., 2021; Wallace et al., 2018). Although the current study showed limited task effects on people with nonfluent aphasia, the result may differ for other types of aphasia and severity levels. Therefore, more studies are needed to fully understand the discourse task effects, and the task should be considered an important variable in both clinical and research environments.

Data Availability Statement

The data sets generated and/or analyzed during the current study are available in the AphasiaBank repository, https://aphasia.talkbank.org/.

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Appendix

Demographic Information of People With Nonfluent Aphasia

Pt	WAB-AQ	Age	Aphasia duration (years)	Handed-ness	Lesion side	Lesion location	WAB type	Previous stroke	Apraxia of speech	Dysarthria
01	74.6	53.1	3.3	R	L	U	TransMotor	No	Yes	No
02	59.8	71.5	5.75	R	U	U	TransMotor	No	Yes	Yes
03	63.5	66.3	1.2	R	L	U	TransMotor	No	No	No
04	45.5	76.9	1.9	R	L	U	Broca	No	Yes	No
05	67	52.2	5.1	R	L	U	Broca	No	Yes	No
06	36.2	80	0.7	R	L	Frontal, temporal	Broca	No	Yes	No
07	61.2	64.8	7.16	R	L	U	Broca	Unknown	Yes	U
08	60	57.2	5.7	R	L	U	Broca	No	Yes	Yes
09	71.9	54.6	1	R	L	U	TransMotor	No	No	No
10	60.7	64.5	16	R	L	Frontal, temporal	Broca	No	Yes	No
11	54.6	60.3	3.3	R	L	Subcortical	Broca	No	No	No
12	67.2	70.5	8.8	R	L	Frontal, temporal, parietal	Broca	No	No	No
13	50.8	65.9	4.1	R	L	U	Broca	No	No	No
14	68.2	72.9	7.2	R	L	U	Broca	No	Yes	No
15	52.5	78.3	25.75	R	L	Frontal, temporal, parietal	Broca	No	Yes	No
16	73.2	63.7	5.7	R	L	Frontal, subcortical	TransMotor	Yes*	Yes	Yes
17	64.8	58.8	11.25	L	L	U	Broca	No	Yes	No
18	43.3	71.8	1	R	U	U	Broca	No	Yes	No
19	66.3	55.2	3.2	R	L	U	Broca	No	Yes	No
20	30.5	69.9	0.9	L	L	U	Broca	No	No	No
21	59.5	65.5	2.3	R	L	U	Broca	No	Yes	No
22	39.7	64.6	9.2	R	L	U	Broca	No	No	No
23	72	57	5	R	L	U	TransMotor	No	U	No

Note. WAB-AQ = Western Aphasia Battery–Aphasia Quotient; U = Unknown; R = Right; L = Left; Participants were drawn various depositories in AphasiaBank including: ACWT (*n* = 1), Adler (*n* = 1), BU (*n* = 2), Elman (*n* = 2), Kurland (*n* = 2), Fridriksson (*n* = 1), Kansas (*n* = 2), Kempler (*n* = 2), UNH (*n* = 2), MSU (*n* = 1), Scale (*n* = 5), TAP (*n* = 1), Tucson (*n* = 1).

*Also reported other neurological condition: moderate atherosclerosis of both internal carotid and vertebral arteries.