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№ 6522

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September 1, 2021

Morpho-syntactic processing in Primary Progressive Aphasia and stroke-induced aphasia: comparison of ERP response patterns

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Introduction

People with the agrammatic variant of Primary Progressive Aphasia (PPA-G) and people with stroke-induced agrammatic aphasia (StrAph) both present with morpho-syntactic impairments and non-fluent speech with grammatical deficits in the presence of spared semantic processing [1]. However, in PPA-G, grammatical deficits gradually emerge over time due to neurodegenerative disease [2], while in StrAph, deficits occur suddenly due to cerebrovascular lesion. Only a few studies have directly compared language deficits in StrAph and PPA, and none have used on-line paradigms, although these may be more sensitive to detect language deficits [3]. In the present study, we compared on-line processing of subject-verb agreement violations in PPA-G and StrAph using ERP.

Methods

Sixteen healthy adults (age: 35-78 years) and two groups of people with aphasia: StrAph (n=7), ages 26-72 years; PPA-G (n=10), ages 52-76 years, completed a sentence acceptability judgment task while EEG was recorded from 32 scalp electrodes. Both patient groups presented with language impairments consistent with agrammatism. However, the StrAph group, compared to the PPA-G group, presented with more severe language deficits overall, were less fluent, and were more impaired on offline measures of sentence processing.

This study included (a) morpho-syntactic and (b) semantic conditions. For each, half of the sentences (n=50) contained a violation (Table 1). Data from each group were analyzed separately for both conditions using mixed-effects regression. For each regression model, the dependent variable was the mean amplitude of the EEG signal in pre-selected time windows, with *sentence type* (correct, violation) and *electrode region* (posterior left/right/midline, anterior left/right/midline) as fixed effects and *participant* as a random effect.

Results

Morpho-syntactic violations elicited a significant, posteriorly-centered P600 in the group of healthy adults (Figure 1). Compared to the healthy controls, the StrAph group showed a delayed P600 with an anterior shift, while the PPA-G group showed no response to

morpho-syntactic violations. Semantic violations elicited a significant, centro-parietally distributed N400 in all three participant groups.

Conclusions

Results indicate that the healthy participants undertake processes of re-analysis/repair after detecting violations of subject-verb agreement. In PPA-G, participants fail to detect such violations. Meanwhile, in StrAph, violations are detected, but re-analysis processes are delayed. In addition, the anterior shift of the scalp distribution in StrAph is in line with a previous study on older adults showing a more anterior distribution of the P600 in response to agreement violations in written sentences [4]. While the scalp distribution of ERP responses does not necessarily reflect activity of regions in the same area, this difference may reflect increased reliance on domain-general resources [5] supporting re-analysis processes. This suggests recruitment of more domain-general cognitive resources may be hindered in people with PPA-G due to the more widespread cognitive decline in this group (see also [6]).

Results from the semantic condition suggest semantic processing is preserved in both patient groups, in line with previous studies [7, 8]. Notably, no anterior shift of the N400 was noted in the StrAph group, suggesting that the abnormal P600 topography in this group does not simply reflect lesion-related shifts.

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Acknowledgments
This work was supported by the National Institutes of Health: R01-DC01948 (Cynthia Thompson) and R01-DC008552 (M-Marsel Mesulam).

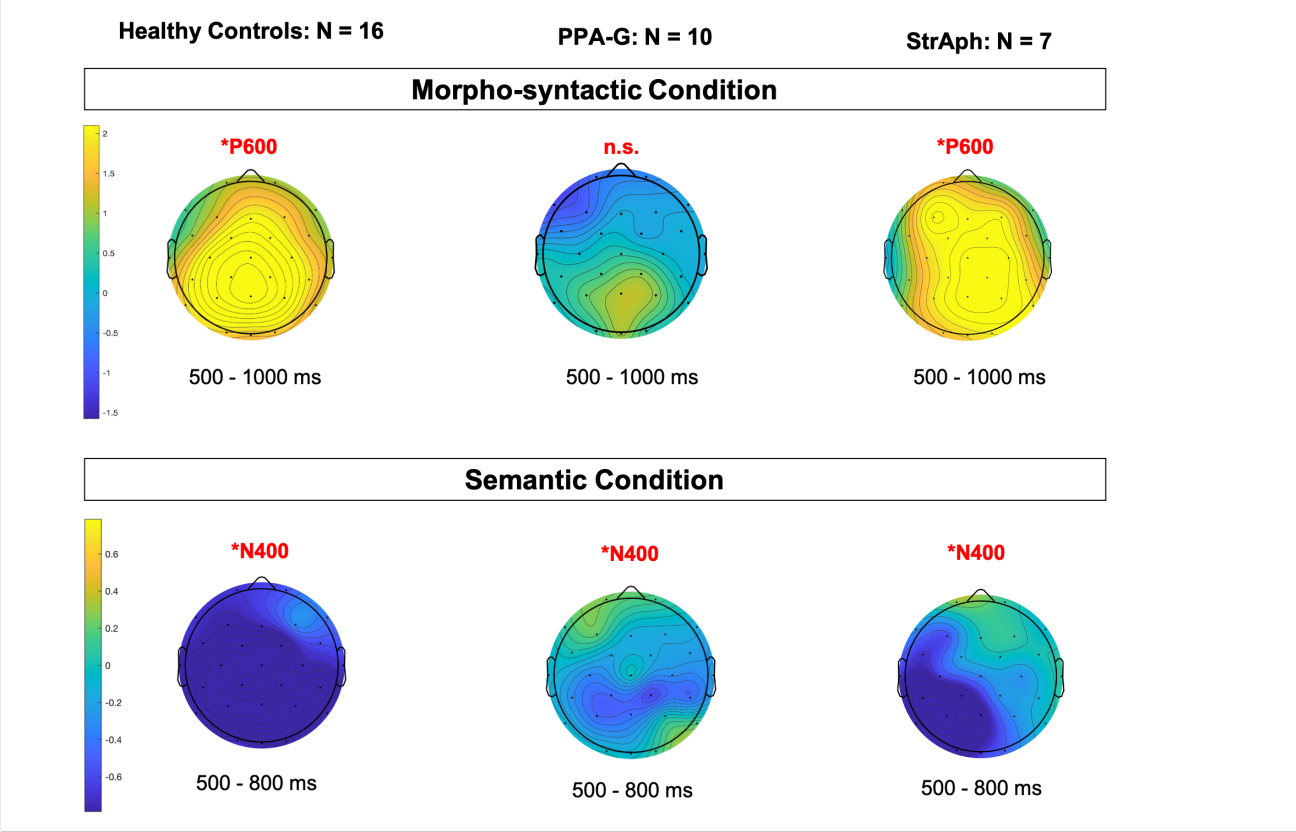

Figure 1. Difference waves obtained from violated minus correct sentences for each group for both conditions.

Table 1. Sentence Stimuli included two conditions (N = 100 sentences/condition), plus fillers (not analyzed). ERP was time-locked to onset of critical word (**bold**), with a 200ms pre-stimulus baseline.

Condition	Correct Sentences	Violated Sentences
Morpho-syntactic	The hiker **was** camping on the mountain.	*The hikers **was** camping on the mountain.
Semantic	Owen was carving **pumpkins** at the party	*Owen was mentoring **pumpkins** at the party