The Stability of Individual ERP Response Dominance Within and Across Conditions

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Introduction. Prior research shows individual differences in ERP responses, specifically in the relative prominence of the N400 and P600 components to agreement violations [1, 2]. Participants exhibited stability in their response dominance across conditions—reflecting a systematic positive, negative, or biphasic response to the agreement violations [1]. A significant question is whether response dominance is systematic within participants across other constructions that traditionally elicit a P600 response. If participants show a positive response dominance in one condition, will the response dominance remain positive in another condition. So, using magnitude and Response Dominance Index (RDI) [1], we explored (1) whether the dominance effect is stable across the different violations that traditionally elicit a P600 response and (2) if the dominance effect remains stable within participants across different violations? Preliminary results show that within a single condition the participants do show stable dominance effects to violations that are known to traditionally elicit a P600 response; however, within individual participants, this dominance effect is not stable across the other violations.

Methods. 520 sentence stimuli were divided into target (160), control (120), and filler (240) conditions. The stimuli were separated into two lists, such that each participant read and rated the acceptability of 260 American English sentences. The target word is bolded, and predicted violations (e.g., ungrammatical, dispreferred, or infelicitous) are marked with an asterisk (1).

(1) Example Stimuli from the Target, Control, and Filler Conditions [3,4]
a. Complementizer: The belief **that Ø$_{Det}$** seven baristas are coffee snobs is widely accepted.
b. Without Comp: The belief **Ø$_{comp}$ these** seven baristas are coffee snobs is widely accepted.
c. Subject-Verb Agreement: The cats **meow/*meows** by the window watching the birds.
d. Gender Reflexive: The elderly gentleman fixed **himself/ *herself** up for the dance.
e. Lexical Semantic: The child borrowed some **books/*conversations** from the library.

Procedure & Analysis. EEG data recorded from 22 adults is presented. Participants read sentences word-by-word (300ms word presentation, 200ms ISI) using the Rapid Serial Visual Presentation paradigm [1]. At the end of each trial, participants rated sentence acceptability using a four-point Likert-scale (1 *unacceptable* - 4 *acceptable*) [5]. Raw EEG data sampled at 500 Hz was band-pass filtered between 0.5–40 Hz and divided into 1300ms epochs around each target word in a sentence. Ocular signals were removed with ICA, and other artifacts were visually identified and excluded [6]. Two averaged amplitude time points were extracted—an N400 (300-500ms) and a P600 (500-800ms) timeframes—from a large centro-parietal ROI (C3, Cz, C4, CP1, CP2, P3, Pz, P4) [1]. Effect magnitudes were then calculated for the N400 (grammatical minus ungrammatical) and the P600 (ungrammatical minus grammatical) (Fig 1A). Using these effect magnitudes, the RDI metric was calculated [((P600 mag- N400 mag)/ (sqrt 2))], which assesses the relative prevalence of the ERP response (Fig 1B) [1, 2, 7].

Results. The results indicate a stable response within a single condition, such that individuals who show a large P600 effect in one condition tend to show little negativity in that same condition and vice versa. As shown in Fig 1(A), the correlations in all 4 conditions are negative and statistically significant (between -0.73 and -0.89; p< 0.0001). However, the results across conditions do not show the same stability. Fig 1(B) indicates that participants may not always show the same RDI across the conditions, which traditionally elicit a P600 response. Some participants remain positive-going, negative-going, or switch dominance responses as represented by the 4 symbols in select participants. Fig 1(C) shows the grand average ERP waveforms for all participants and the 3 separate RDI groupings for each condition. Graph C2 (P600 dominant) shows a statistically significant difference as compared to A2 (all participants), where the statistically significant effect has disappeared. **Conclusion.** More work is needed to understand the different processing strategies participants employ to process the "traditional P600 violations" to explain why the neural response differs from the "traditional" predictions.

A.

B.

C.
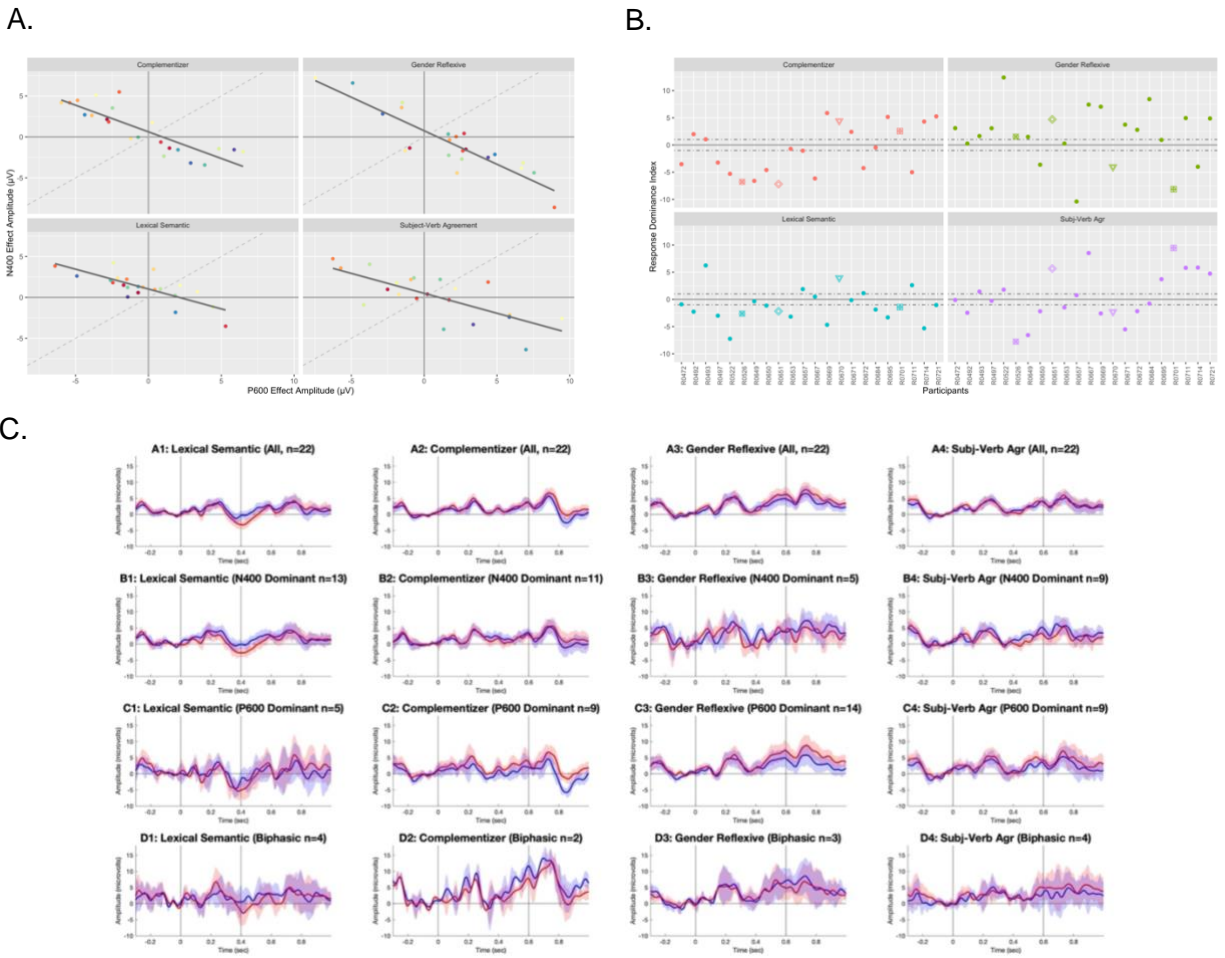
Figure 1. (A) *N400 & P600 Magnitude Effects in each Condition.* Participants are represented by the different colored dots. Dots above/to the left of the dashed line are individuals who show a primarily N400 effect, while dots below/to the right of the dashed line are individuals who show a primarily P600 effect. **(B)** *Individual Response Dominance Index (RDI) by Condition for each Participant.* Participants above 1 show a positive response, below -1 show a negative response, and between 1 and -1 show a biphasic response. 4 participants are shown in different symbols to show different dominances across conditions. **(C)** *ERP waveforms grouped by all, N400 dominant, P600 dominant, and biphasic.* The preferred conditions are shown in red (e.g., predicted grammatical), and the dispreferred conditions in blue (e.g., predicted ungrammatical).

Selected References. [1] Tanner, D. (2019). Robust neurocognitive individual differences in morphosyntactic processing: A latent variable approach. *Cortex* 111, 210-237. [2] Tanner, D., & Van Hell, J.G. (2014). ERPs reveal individual differences in morphosyntactic processing. *Neuropsychologia* 56, 289-301. [3] Tanner, D. (2018). "General files for "Robust neurocognitive individual differences in grammatical agreement processing: A latent variable approach"", https://doi.org/10.7910/DVN/DKEKBH, Harvard Dataverse, V1. [4] Martin, R. (2001). Null Case and the Distribution of PRO. *Linguistic Inquiry* 32(1), 141-166. [5] Dröge, A., Fleischer, J., Schlesewsky, M., & Bornkessel-Schlesewsky, I. (2016). Neural mechanisms of sentence comprehension based on predictive processes and decision certainty: Electrophysiological evidence from non-canonical linearizations in a flexible word order language. *Brain Research* 1633, 149-166. [6] Luck, S. J. (2014). *An introduction to the event-related potential technique*. Cambridge, Mass.: MIT Press. [7] Tanner, D. (2018). "Analysis Scripts and Outputs for "Robust neurocognitive individual differences in grammatical agreement processing"", https://doi.org/10.7910/DVN/031YTY, Harvard Dataverse, V2.