

## Individual differences in ERP profiles to agreement attraction anomalies

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We used ERPs to investigate the neural mechanisms involved in processing long distance grammatical dependencies, as part of a large scale investigation of individual differences in sentence comprehension. 196 participants read 30 sentences of each type 1-4:

1. *The key to the cabinet **was** rusty.*
2. *\*The key to the cabinet **were** rusty.*
3. *The key to the cabinets **was** rusty.*
4. *\*The key to the cabinets **were** rusty.*

Such sentences have been used in many studies of grammatical agreement during language production (Eberhard et al., 2005, *Psych. Rev.*) but in only a few studies of comprehension (e.g., Tanner et al., 2014, *JML*; Wagers et al., 2009, *JML*). In each sentence, an embedded noun (*cabinet[s]*) intervened between the subject noun (*key*) and the verb (*was/were*). The embedded noun potentially interferes in two ways with subject-verb agreement. First, in (4), the embedded noun shares the verb's number and might contribute to failure to detect the violation of subject-verb agreement (fail-to-detect). Second, in (3), the embedded noun differs in number from the verb, which might contribute to the incorrect detection of ungrammaticality (false alarm).

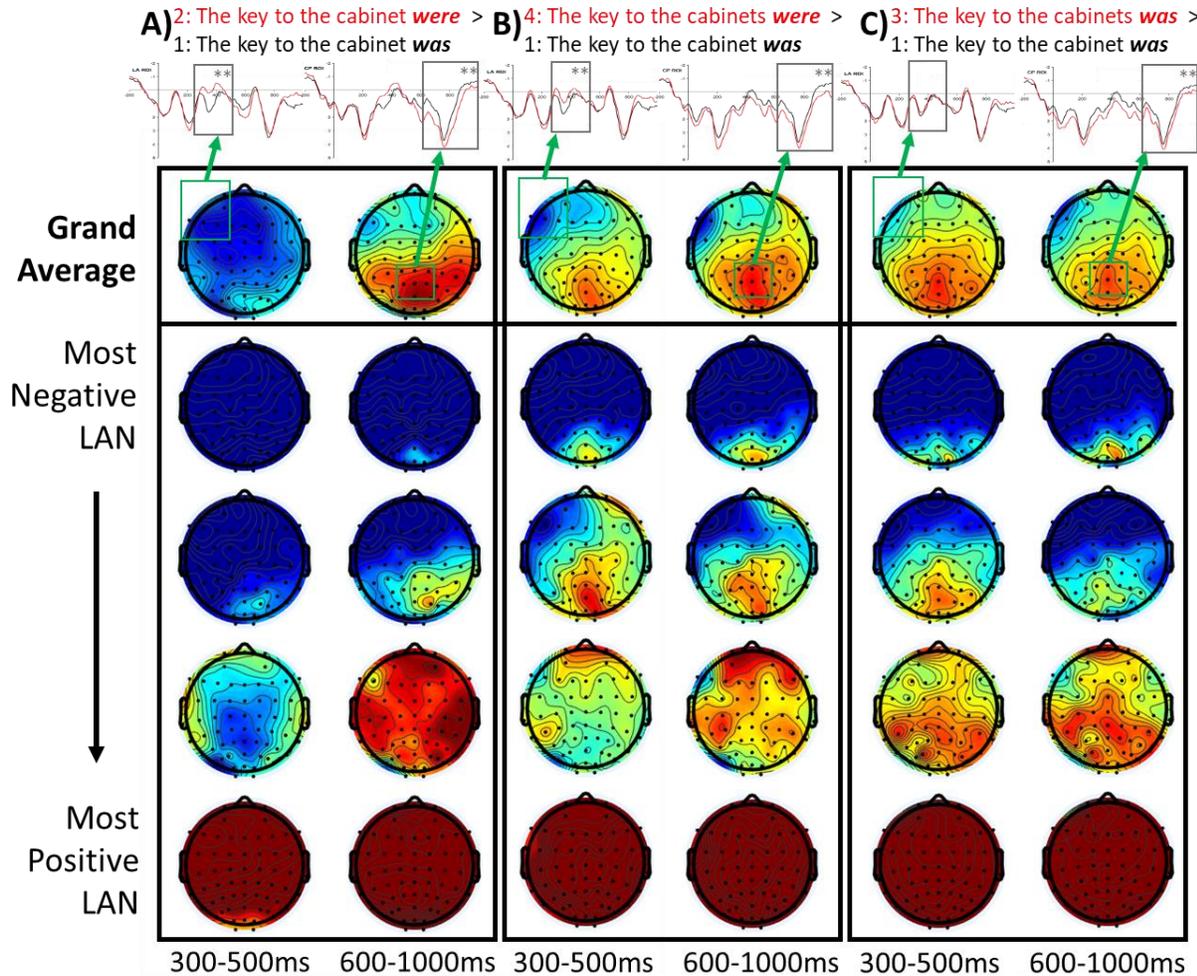
**Group Averaged Patterns.** In data averaged across all participants, the embedded noun created interference of both the false alarm (3) and fail-to-detect (4) varieties. The simple anomaly (2) elicited a left anterior negativity (LAN) and a P600 ERP effect at the critical verb, relative to (1) (Fig 1A, top row). (4) elicited a similar but smaller effect, consistent with interference of the fail-to-detect variety. (3) elicited an extended positivity relative to (1), but no significant LAN-like difference (top row; Fig 1c). This effect is consistent with interference of the false alarm variety.

Our group-level pattern is at odds with two previous studies that have reported interference in (4) but not (3). These studies have argued that in (4) the subject noun's failure to match the verb in number leaves an opening for the partially matching embedded noun to attract agreement (Wagers et al., 2009, *JML*). Meanwhile, interference in (3) is proposed to be impossible, because when the subject noun matches the verb in number, subject-verb agreement is always successful, precluding interference from the embedded noun. Our data are more compatible with an account in which an embedded noun interferes with agreement regardless of whether the subject noun matches the verb's features, by influencing the complex noun phrase's number representation, as proposed by theories of agreement in language production (Eberhard et al., 2005). Because our data are obtained in a large sample of participants ( $N = 196$ ), they provide more power to detect interference in (3) than the previous studies.

**Individual Differences.** We observed substantial individual differences in ERPs by sorting participants based on the magnitude of their LAN effect for sentence type (2), which yielded a bimodal distribution of individuals with LAN-dominated or P600-dominated effects (Figure 2A). The LAN+P600 pattern in the group average data, which has been reported in a number of other studies, appears to be the result of summing brain activity across different categories of people, rather than a two-part brain response that is expressed within each individual. Moreover, individual differences in ERPs were stable within individuals as they encountered different sentence types. An individual's response to sentence type (2), whether LAN-dominated or P600-dominated, predicted how the same individual would respond to the fail-to-detect (4) and false alarm (3) sentences (rows 2-5; Fig 1A-C). These correlations strengthen the conclusion that sentences (2)-(4) elicit similar brain responses (Fig 2A-B).

Our next step in this work will be to identify the cognitive sources of individual differences in ERP profiles. Each participant has completed an extensive battery of cognitive abilities, including executive function and language skill/knowledge tasks. We will test the hypothesis that

susceptibility to interference in the computation of long distance agreement dependencies varies across individuals and whether that susceptibility is related to specific cognitive abilities.



**Figure 1:** Row One - Grand average ERP responses to sentence types 2 (A), 4 (B), and 3 (C) over and above activity to the control condition 1. Waveforms above the scalp distributions show the anomalous condition (red) vs the control condition (black) over selected ROI channels. In the grand average, all contrasts except 3v1 LAN were significant. All effects are scaled between -1 and 1 microvolt, with more negative-going differences in blue and positive-going differences in red. Rows 2-5 represent averages of 40 participants aggregated by their place in the LAN effect distribution.