Domain-specific vs. general processes in linguistic conflict resolution

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Recent evidence suggests that the cognitive control mechanisms recruited in sentence processing may overlap with those employed in attention and non-linguistic perception (Ye & Zhou, 2009; January et al., 2008; Novick et al., 2005). This notion clashes with the traditional view that sentence comprehension is a highly specialized cognitive task, which engages dedicated domain-specific modules (Kuperberg, 2007).

Engaging domain-specific as opposed to domain-general cognitive systems during linguistic conflict resolution should be reflected in the differential activation of specific brain areas. The left temporal cortex is a prime candidate for an encapsulated linguistic system (Hagoort, 2005). By contrast, if linguistic conflict is resolved outside the linguistic system, then conflict resolution should rely on large-scale neuronal networks, typically engaging the prefrontal cortex (PFC). To study domain-general vs. domain-specific network contributions in sentence processing, we focused on three test cases involving conflicting information: EEG-experiments 1 and 2 examined anaphoric and cataphoric conflict resolution using a gender mismatch manipulation ([A], [B]) and contrasting lexical-(king) with stereotypical gender nouns (minister). EEG-experiment 3 compared spoken sentences containing reduced-relative clauses [C] (garden-path effect at “by”) to an unambiguous control condition [D]. We investigated oscillatory brain activity in the alpha (8-12Hz), theta (4-7Hz), and beta (16-26Hz) band in relation to each type of conflict, since amplitude changes in specific frequency bands are thought to reflect the dynamic recruitment of the relevant neuronal networks engaged in cognitive processing.

For anaphora sentences (Experiment 1), we hypothesized that a gender-mismatch would engage general cognitive systems because anaphora are less constrained in terms of linguistic predictions (syntactic gender becomes available late). For cataphora (Experiment 2), we expected that linguistic predictions (syntactic gender being available early) lead to activation of domain-specific posterior or temporal areas. In line with our hypotheses, we found distinct activation patterns between the two experiments: For anaphora, the gender-mismatch in both the lexical and stereotypical gender conditions elicited a significant increase in theta activity in the right frontal lobe (specifically, the right IFG (BA 46) in the lexical conditions, and the ACC (BA 32) in the stereotypical conditions). By contrast, cataphora processing engaged domain-specific posterior brain areas: a decrease of alpha activity for the lexical conditions, localizing in the left middle temporal gyrus (BA 21)), and a left-lateralized parietal increase in theta activity for the stereotypical conditions (BA 40).

For Experiment 3 we hypothesized that if linguistic conflict triggers domain-general conflict mechanisms, this should result in increased activity in domain-general network such as PFC for the garden-path condition compared to the unambiguous control. Nonparametric permutation tests revealed a significant cluster of theta-band power increase at frontal-midline electrodes (4-7Hz, 200ms-580ms post-“by”; p<0.05, right superior frontal gyrus) which was preceded by an early and short-lived decrease of beta-activity at frontal-midline electrodes (16-26Hz, 50ms-180ms post-“by”; p<0.05, ACC) for [C] as opposed to [D].
Taken together, when linguistic context is sufficiently constraining (cataphoric pronoun resolution), domain-specific networks seem to play a dominant role. By contrast, anaphoric pronoun resolution and, interestingly, conflicts induced by ‘unforeseeable’ reduced-relative clauses engage domain-general conflict resolution processes.

**Examples:**

**Experiment 1 (Anaphora, 20 participants, visual presentation):**

[A] Yesterday the *king / minister* left London after reminding *himself / herself* about the letter.

**Experiment 2 (Cataphora, 20 participants, visual presentation):**

[B] After reminding *himself / herself* about the letter, the *king / minister* immediately went to the meeting.

**Experiment 3 (syntactic garden path sentences, 32 participants, auditory presentation):**

[C] The nurse examined by the doctor was not on duty.

[D] The nurse that was examined by the doctor was not on duty.

**References**


