Reducing similarity based interference in sentence processing for individuals with agrammatic Broca's aphasia: a semantic approach

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Individuals with agrammatic Broca's aphasia (IWBA) typically exhibit difficulty comprehending sentences that do not conform to canonical (S-V-O for English) word order, and thus contain a syntactic dependency. In this study, we investigate the real-time processing of canonically ordered sentences that contain unaccusative verbs, resulting in a filler-gap syntactic dependency. As shown in the subject-extracted sentence [1] below, a link between the 'filler', *the girl*, and the post verb (*disappeared*) 'gap' must be made for successful comprehension of the sentence to occur.

[1] The girl that observed the boy disappeared <the girl> into the trees.

Although, [1] is in canonical word order, it contains an unaccusative verb (*disappeared*) whose fronted single argument is the direct object [1]. This creates a filler-gap dependency and poses difficulty in processing for IWBA [2,3]. To account for such difficulties, the Intervener Hypothesis (IH) posits that the presence of an intervening noun phrase (*the boy*) that is structurally similar (Det N) to one of the elements (*the girl*) in a syntactic chain causes similarity-based interference[4,5]. The IH has typically been investigated in terms of structural similarity with different sentence structures (e.g., Wh-questions, overt anaphora, respectively) [7,8]. However, in the present study, we investigate sentence constructions such as [1] above and manipulate the semantic properties of the intervening noun phrase (NP) in attempts to reduce similarity-based interference.

The <u>purpose</u> of this study is twofold: 1) to determine the impact of a structurally similar intervener on real-time auditory sentence processing in sentences containing unaccusative verbs in IWBA, and 2) to determine if manipulating the animacy of an intervening NP can reduce similarity-based interference and improve final comprehension for IWBA.

Methods: Eye tracking while listening with a visual world paradigm was used to test for activation and reactivation of a displaced NP (direct object noun) during the ongoing auditory presentation of sentences containing unaccusative verbs.

Subjects: Two groups of monolingual English speaking subjects participated in this study: ten age-matched control participants (mean age: 62 years old; range: 57-66 years old) and eight individuals diagnosed with agrammatic Broca's aphasia (IWBA) (mean age: 64 years old; range: 56-77 years old). IWBA were diagnosed based on standardized assessments (e.g., BDAE-3 [9]) as well as performing at or below chance on complex sentence comprehension (i.e. object relative constructions, OR) from the S.O.A.P. Test of Auditory Comprehension [10]. All participants were neurologically and physically stable (i.e., at least 6 months post onset), with no reported history of active or significant alcohol and/or drug abuse, active psychiatric illness or intellectual disability, and/or other significant brain disorder or dysfunction (e.g., Alzheimer's/dementia, Parkinson's, Huntington's, Korsakoff's).

Results: While aurally processing sentences that contain unaccusative verbs and an intervener of similar animacy, IWBA show a similarity-based interference effect, unlike age-matched control participants (Figure 1). This effect is reduced when the animacy of the intervening NP is dissimilar to the displaced NP. IWBA show 'normal' reactivation patterns when the similarity-based

interference is reduced which supports the Intervener Hypothesis (Figure 2). These effects are confirmed with growth curve analyses which found significant reactivation in the inanimate condition by IWBA (linear term=.26, *SE*=.10, *p*<.05) and not in the animate condition. These results will be compared with competing hypothesis regarding syntactic processing deficits in IWBA.

[Last night at the Halloween party], [the pirate] [that observed] [**the wizard**] [suddenly] [emerged] [before the costume contest].
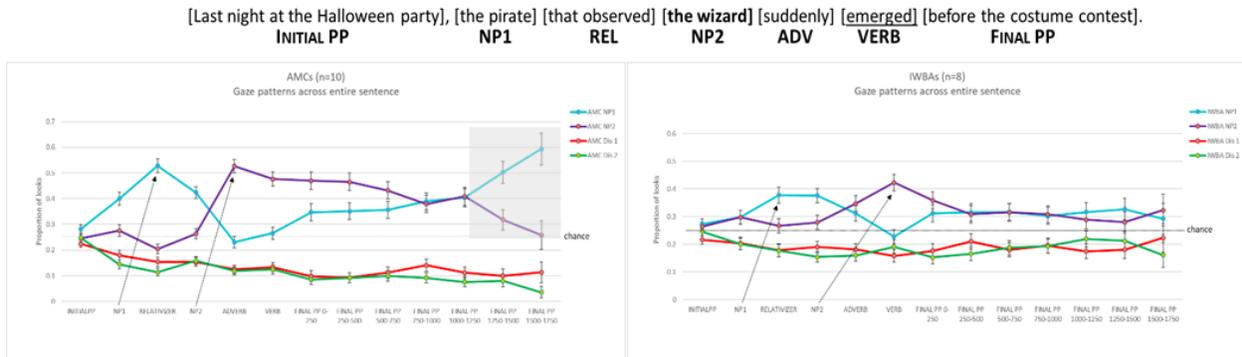INITIAL PP   NP1   REL   NP2   ADV   VERB   FINAL PP

Figure 1. Animate condition. Time course of gaze patterns for all four Areas of Interest across the whole sentence for AMCs (n=10, left panel) and IWBA (n=8, right panel). Both groups show little gaze interest in the distractors (red, green) lines. Arrows point to peak looks to NP1 and NP2 after hearing the NP in the sentence. The shaded area represents re-activation of the direct object.
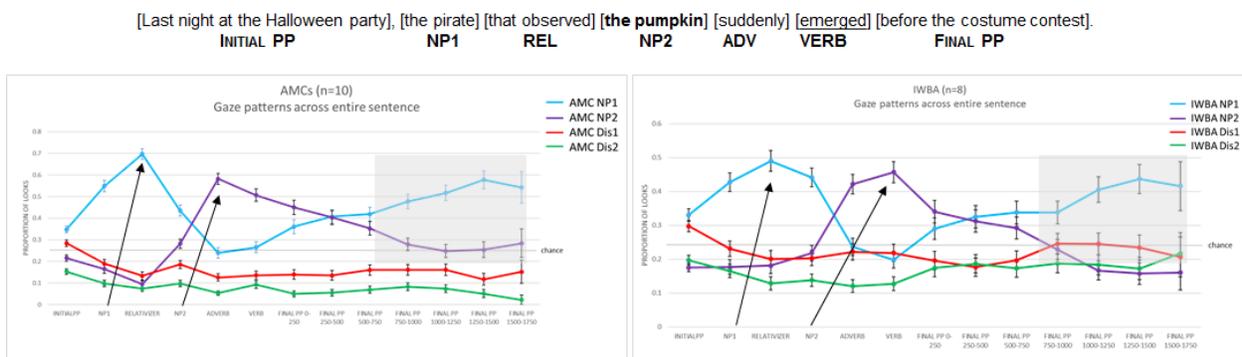
[Last night at the Halloween party], [the pirate] [that observed] [**the pumpkin**] [suddenly] [emerged] [before the costume contest].
INITIAL PP   NP1   REL   NP2   ADV   VERB   FINAL PP

Figure 2. Inanimate condition. Time course of gaze patterns for all four Areas of Interest across the whole sentence for AMCs (n=10, left panel) and IWBA (n=8, right panel). Both groups show little gaze interest in the distractors (red, green) lines. Arrows point to peak looks to NP1 and NP2 after hearing the NP in the sentence. The shaded area represents re-activation of the direct object

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