

Introduction

The study of sentence processing in aphasia is important for the development of effective treatments for sentence processing deficits in aphasia. Recent research has shown that syntax and semantics can interact during sentence processing in a variety of ways. However, the way the interaction between syntax and semantics plays out in aphasia has not been satisfactorily explained. One unexplored area in this body of research is the effect of plausibility on syntactic priming of the dative alternation in persons with aphasia. To date, persons with aphasia have been shown to be sensitive to plausibility during sentence processing in general (Caramazza & Zurif, 1976) and the dative alternation has been shown to be primed in persons with aphasia (Hartsuiker & Kolk, 1998). Plausibility has been shown to affect syntactic priming in neurologically healthy adults, such that implausible active or passive sentences prime the opposite structure in production (Christiansen et al., 2010). Recently, the dative alternation has been shown to be particularly sensitive to semantic influences in neurologically healthy adults (Gibson & Bergen, 2011, manuscript in preparation). Therefore, exploring the effect of plausibility on priming the dative alternation in persons with aphasia is a novel and especially interesting way in which to examine the interaction of syntax and semantics that will inform aphasia treatment research.

Methods

Participants

Nine persons with aphasia (PWA) (mean age = 55.8; 6 male, 3 female), seven neurologically healthy older adults (NHOA) (mean age = 70.8; 2 male, 5 female), and 11 neurologically healthy younger adults (NHYA) (mean = 27.3; 6 male, 6 female) participated in the experiment. All participants were native English speakers and had at least a high school education.

Stimuli

Each participant received one of four versions of the task, counterbalanced across participants, which contained 20 experimental sentences and 20 filler sentences. The 20 experimental sentences consisted of five of each type: plausible double-object (DO) (e.g., *the mother gave the girl the candle*), implausible DO (e.g., *the mother gave the candle the girl*), plausible prepositional-object (PO) (e.g., *the mother gave the candle to the girl*), and implausible PO (e.g., *the mother gave the girl to the candle*). Filler sentences consisted of active and passive constructions which also varied in local plausibility (e.g., *the boy kicked the ball* and *the ball kicked the boy*). Sentences with the same nouns and verbs across sentence types (as shown above) were separated into different versions.

Task

Each participant was instructed to listen carefully to a sentence (prime) provided by the experimenter and show comprehension of the prime by acting out the events in the sentence using paper dolls which represented each noun in the sentence. As soon as the participant finished acting out the sentence, s/he was shown a picture and instructed to describe the event occurring in the picture with one sentence (primed response). Drawings depicting ditransitive events (e.g., *a woman giving a boy a gift*) were shown after DO and PO primes and those depicting simple transitive events (e.g., *a woman holding a baby*) were shown after active and passive primes (fillers). Prior to beginning the task, the experimenter gave examples (using

sentences not included in the actual task) of how to act out the events of each type of sentence. Each participant completed all conditions regardless of accuracy.

Results

Production data was analyzed using a 3 x 2 log-linear analysis. The three factors were: canonicity of the prime, plausibility of the prime, and primed response type. The two levels of canonicity of the prime were canonical (i.e., PO sentences) and noncanonical (i.e., DO sentences). The two levels of plausibility of the prime were plausible and implausible. The two levels of primed response type were same (e.g., PO response to a PO prime) and opposite (e.g., PO response to a DO prime).

PWA and NHOA exhibited a 3-way interaction among primed response, plausibility, and canonicity, ($p < .001$ for both groups). With the effect of canonicity removed, plausibility was no longer a significant factor ($p = .73$ and $p = .17$, respectively). However, with the effect of plausibility removed, canonicity was still a significant factor, ($p < .001$ for both groups). Like NHOA and PWA, the 2-way interaction between canonicity and primed response, with the effect of plausibility removed, was significant for NHYA ($p = .02$) (see Figure 1).

Comprehension of the prime was also analyzed to further understand the priming results. The three factors were canonicity of the prime, plausibility of the prime, and comprehension of the prime. The levels of canonicity and plausibility of the prime were the same as above. The two levels of comprehension of the prime were 'follows syntax' and 'doesn't follow syntax'.

Data from all three groups resulted in 3-way interactions among comprehension, plausibility, and canonicity ($p < .001$). With the effect of canonicity removed, the effect of plausibility still affected comprehension (PWA: $p < .001$; NHOA: $p < .05$; NHYA: $p < .001$). Act-out of plausible primes followed the syntax of the prime more often than that of implausible primes. For NHOA and NHYA, this effect was restricted to DO primes. With the effect of plausibility removed, canonicity still affected comprehension ($p < .001$ for all three groups). Act-out of PO primes followed the syntax of the prime more often than that of DO primes. For NHYA, this effect was restricted to implausible primes (see Figure 2).

Conclusion

The results of this study suggest that the dative alternation is susceptible to semantic influences, such as plausibility, as well as grammatical influences, such as canonicity. All groups preferred the canonical form in production for both experimental (DO/PO alternation) and filler (active/passive) items. The exception being that NHYA produced roughly equal numbers of PO and DO sentences in response to DO primes, regardless of plausibility. That being said, there was a definite trend of implausible sentences priming the opposite structure more than plausible sentences and plausible sentences priming the same structure more than implausible sentences. A larger data set is needed to confirm this effect.

During comprehension, PWA show a clear interaction of plausibility and canonicity where the DO version of a sentence is more affected by plausibility than the PO version, which concurs with work by Ferreira (2003). Additionally, although both NHOA and NHYA tend not to be affected by plausibility as much as by canonicity during sentence comprehension, this effect still surfaces to varying degrees, possibly due to cognitive aging. Importantly, these results are in line with the noisy channel hypothesis of sentence comprehension proposed by Levy (2008, 2009) which suggests that comprehenders of a language use multiple resources in

processing sentences. In cases where meanings can be uncertain, the comprehender uses prior knowledge and the knowledge that speakers make errors, in addition to sensory input and grammatical knowledge in order to gain meaning from the sentence (Levy, 2008; Levy, et al., 2009). In the current study, sentence meaning is uncertain due to implausibility and insertions or deletions are common speaker errors that can change an implausible DO to a plausible PO (e.g., *the mother gave the candle the girl* → *the mother gave the candle to the girl*). This notion will be further explored in a subsequent experiment testing more sentence types with a larger group of participants.

References

- Caramazza, A., & Zurif, E. B. (1976). Dissociation of algorithmic and heuristic processes in language comprehension: evidence from aphasia. *Brain and Language*, 3(4), 572-582.
- Christianson, K., Luke, S. G., & Ferreira, F. (2010). Effects of plausibility on structural priming. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 36(2), 538-544.
- Hartsuiker, R. J., & Kolk, H. H. J. (1998). Syntactic Facilitation in Agrammatic Sentence Production. *Brain and Language*, 62(2), 221-254.
- Ferreira, F. (2003). The misinterpretation of noncanonical sentences. *Cognitive Psychology*, 47(2), 164-203.
- Levy, R. (2008). A noisy-channel model of rational human sentence comprehension under uncertain input. Paper presented at the *Conference on Empirical Methods in Natural Language Processing* Honolulu, Hawaii.
- Levy, R., Bicknell, K., Slattery, T., & Rayner, K. (2009). Eye movement evidence that readers maintain and act on uncertainty about past linguistic input. *Proceedings of the National Academy of Sciences U S A*, 106(50), 21086-21090.

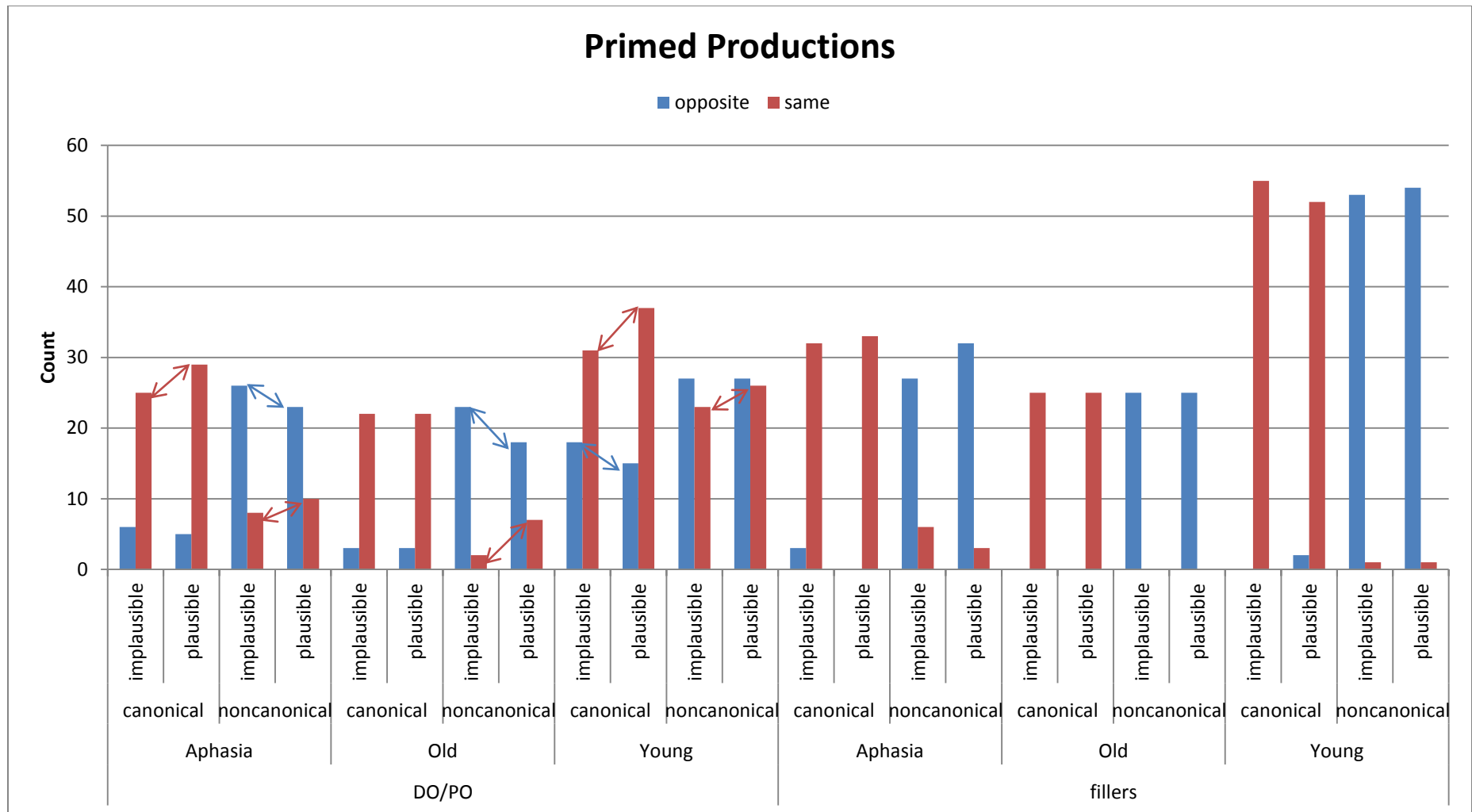


Figure 1. Count of primed productions for all three groups organized by canonicity and plausibility. Note that for the experimental items (DO/PO alternation), implausible sentences tend to prime the opposite structure more than plausible sentences (indicated by blue arrows) and plausible sentences tend to prime the same structure more than implausible sentences (indicated by red arrows). This is in the face of a preference for producing the PO (canonical) form. For the fillers, actives (canonical form) are overwhelmingly produced for all three groups in response to both canonical (active) and noncanonical (passive) primes.

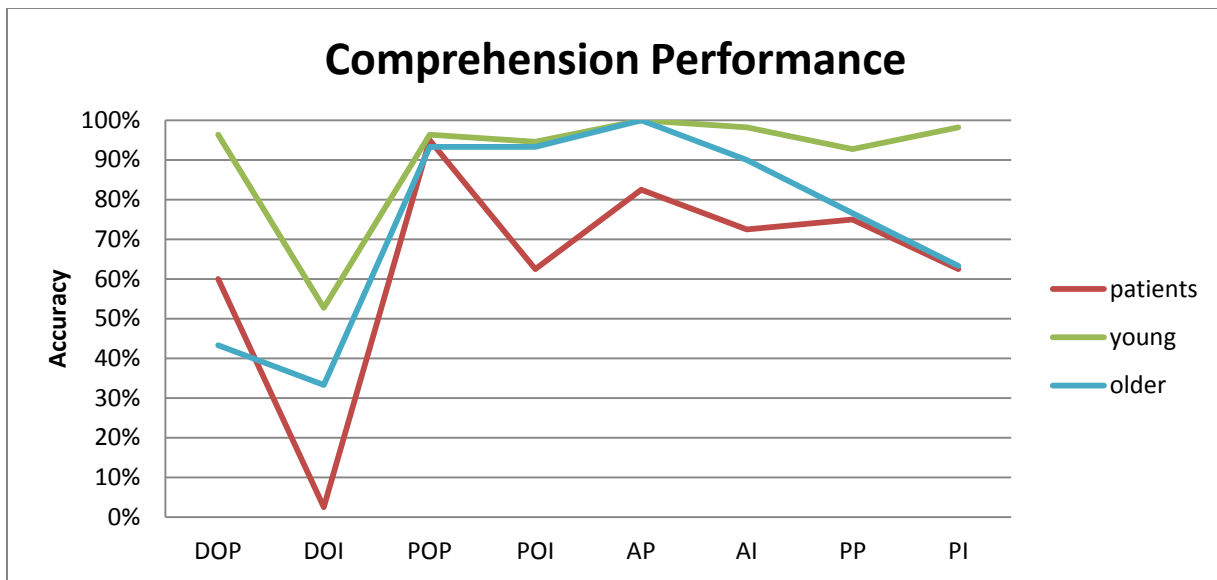


Figure 2. Sentence comprehension performance for all participants. Note that there is a considerable drop in performance for the DO implausible sentences for all three groups. Persons with aphasia also show a similar, but less pronounced drop in comprehension for other implausible sentence types. DO = double-object, PO = prepositional-object, A = active, P = passive, P (affix) = plausible, I (affix) = implausible.