The non-quantum nature of parsing the late-closure ambiguity

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Readers do not always arrive at correct interpretations after reading garden-path sentences such as (1) (Christianson et al., 2001; Ferreira et al., 2001). Rather, they tend to misinterpret (1) as meaning that *Anna dressed the baby and the baby spit up on the bed*. The earlier version of the "good-enough (GE)" sentence processing account proposed that if the misinterpretation is chosen, the correct parse cannot be fully created (Christianson et al., 2001, 2006) and so the mis-parse and the correct parse do not co-exist, whereas the later version of GE stated that if the wrong parse is chosen, the correct parse is still created, leading to the co-existence of both propositions (Ferreira, 2003; Slattery et al., 2013).

(1) *While Anna dressed the baby who was cute and cuddly spit up on the bed.*

Our study approached this issue with an analogy to quantum physics. If light is passed through two slits, it creates a series of bright and dark bands (the interference pattern). Surprisingly, when photons are sent through the slits one at a time, they still produce the interference pattern, indicating that each photon passed through both slits. We refer to this as the "both-ness" feature of quantum theory. The both-ness-generated interference pattern was reduced when a detector was placed to see which slit each photon went through, demonstrating another feature of quantum theory, that measurement changes things. In the present study, we examine both-ness and measurement-context sensitivity in sentence processing. Does the parsing of sentences like (1) go through one slit (either the mis-parse or the correct parse) or two slits (both mis-parse and correct-parse)? Does asking a question about one parse affect answering a question about the other parse?

Participants (N=55) read sentences with late-closure ambiguity such as (1) and answered two comprehension questions after each sentence. The sentence and each of the two questions were presented on separate screens. Twelve reflexive verbs such as "dress" were each used three times to create 36 items, with each item in 6 conditions. The 6 conditions differed in which questions were asked and the order of these questions: Corr-then-Mis, Mis-Corr, Corr-Main, Main-Corr, Mis-Main, and Main-Mis (see 2 below). The questions for the Corr-Mis condition, for example, are *Did Anna dress herself?* and then *Did Anna dress the baby?* Participants pressed "yes" and "no" buttons to indicate their answers. There were 108 fillers.

(2) Correct parse question (Corr): *Did Anna dress herself?*
    Misparse question (Mis): *Did Anna dress the baby?*
    Main clause question (Main): *Did the baby spit up on the bed?*

We first examined the both-ness issue. Are the incompatible parses both present? There were 620 events in which the Corr and Mis questions were given opposite answers and only 18 events in which they were both answered "yes". The mean Phi-coefficients for answers to these questions revealed a very powerful negative relation, such that "yes" on the correct parse questions implied "no" on the mis-parse questions (t=-36, p<.0001, mean Phi=-.86). Participants either correctly or incorrectly parsed the sentences (going through one slit), only rarely asserting that *Anna dressed the baby* and that *Anna dressed herself*. Furthermore, there was little evidence that question order has an effect on the answers given (no quantum-like context effects). The accuracy rates for main clause questions were comparable when asked first (96%), asked after the misparse questions (96%), and asked after the correct parse questions (97%). There was no difference in the accuracy to mis-parse questions when asked first (45%), asked after the correct parse questions (44%), and asked after the main clause questions (43%). The only small context effect was that first asking about the main clause increased accuracy on the correct parse question (62% yes) compared to asking the same question after answering the misparse question (54% yes, p<.05). Taken together, these results showed that 1) the mis-parse was often present for this type of sentences (45%), 2) context effects resulting from prior question answering were small or non-existent, suggesting that beliefs about the propositions expressed were not easily pushed around, and 3) participants either believe the mis-parse or the correct parse, but not both, which is compatible with the earlier version but not the later version of the good-enough sentence processing account.