Investigating Rational Adaptation in reliance on world vs. linguistic knowledge in L1 and L2 English speakers

Cole Caudle[1,2], Tessa Warren[1,2,3], & Michael Walsh Dickey[3,1,4]

[1]Department of Psychology, University of Pittsburgh [2]Learning Research and Development Center, University of Pittsburgh, [3] Communications Science and Disorders, University of Pittsburgh, [4] VA Pittsburgh Healthcare System—Geriatric Research Education and Clinical Center

Email:coc82@pitt.edu

Abstract

We investigated rational adaptation in reliance on world vs. linguistic knowledge in L1 and L2 English speakers. We predicted that compared to English L1 (L1E) speakers, L2 English (L2E) speakers would rely more heavily on world knowledge and less heavily on verb knowledge when completing English sentence fragments, because for less proficient speakers, world knowledge would be a more reliable cue than verb knowledge. Reliance on verb knowledge was operationalized as a higher rate of providing a locative phrase after a verb that requires one than after a verb that doesn't. Participants provided more locatives after verbs that required them, but there was no effect of speaker group and no interaction between speaker group and verb condition. The same effects held using LexTale score as a continuous measure of English proficiency. We plan to investigate reliance on world knowledge by measuring the semantic relatedness of a participant's response to the fragment they are completing. We will interpret higher semantic relatedness as being indicative of greater reliance on world knowledge. We are currently gathering these cosine values.

Sensitivity to verb cues and reliance on linguistic knowledge was similar across our sample. This could reflect its high English proficiency.

Background

- People rely on both their knowledge of language (word meaning, usage, patterns) and their knowledge of the world (objects, events, periodic occurrences) to understand language (e.g., McRae & Matsuki, 2009).
- Reliance on knowledge of language vs. the world changes depending on the context. According to the theory of rational adaptation, when the bottom-up linguistic input is noisy, people rely more on top-down expectations about what is likely to be said/written (e.g., Gibson et al., 2013; Dresang et al., 2021).
- For people whose linguistic knowledge is either limited or difficult to access, like less proficient speakers or people with aphasia, bottom-up linguistic input is noisier and less reliable than it is for neurotypical/high proficiency speakers. Consistent with this, evidence suggests that people with aphasia may rely less on verb cues and more on plausibility/world knowledge during comprehension and production than neurotypical adults (Dresang et al., 2021; Hayes et al. 2016). We are looking at the same kinds of effects for speakers of low vs. high proficiency.

- Distributional semantics (e.g., Lenci, 2018) is a way of quantifying how similar words' meanings are by measuring the similarity of their distributions across language. Our knowledge of objects, events, and patterns in the world affects the way words are distributed across contexts. For example, a bread-making event would involve a baker, dough, kneading, and an oven. The words that we use to describe such events are more likely to occur near each other or in similar contexts than they are to words that would describe a different event like planting seeds.
- Following this logic, we will interpret completions that are more semantically similar to their fragments as reflecting more reliance on world knowledge.

Materials and Methods

Participants
49 university students from the University of Pittsburgh. 25 L1E and 24 L2E.

Stimuli
40 items adopted from Hayes et al. (2016)
- *The medal is valuable, so the detective is tucking it …* [Location Argument]
- *The medal is valuable, so the detective is looking at it …* [No location argument]

Four counterbalanced item lists were generated via Latin Square. The study was completed online via Qualtrics.

Measures

<u>Reliance on Linguistic Knowledge:</u>
Location score (DV1): Did participant provide a locative argument? – Binary coding, 1 = location 0 = no location
- *The medal is valuable, so the detective is tucking it <u>in the safe</u>* (1)
- *The medal is valuable, so the detective is looking at it <u>hurriedly</u>* (0

<u>Reliance on World Knowledge:</u>
Semantic Relatedness (DV2): Operationalized as the cosine value of the participant's completion and the average of the words in the sentence fragment they were completing using both word2vec and BERT. We used the matrix comparison tool on the University of Colorado LSA word embeddings website. Higher Cosine values (nearer to 1) indicate a closer semantic relationship between the participant's completion and the sentence fragment (i.e., more reliance on world knowledge when providing a completion) and lower values indicate a more-distant relationship (i.e., less reliance on world knowledge to provide completions).

Procedure
Participants were given partial sentences and asked to "complete the sentence naturally". Participants first completed a brief demographic survey, then completed the 96-item experimental task. Participants then completed a language history battery which consisted of the Language Experience And Proficiency Questionnaire (LEAP-Q: (Marian et al., 2007) and the Lexical test for Advanced Learners of English (LexTALE: Lemhöfer & Broersma, 2012)

Completed Analyses
DV1: 1. Conducted 2-way ANOVA to test for main effects and interaction of verb type and speaker group on location score.

   2. Ran a linear model to test for main effects and interaction of verb type and LexTale score on location score.

Planned Analyses
DV2: 1. Conduct a 1-way ANOVA to test for main effect of speaker group on cosine value.

   2. Run a linear model to test for main effect of English proficiency on cosine value.

   3. We will do both (1) and (2) for the cosine values calculated by both BERT and word2vec.

Results
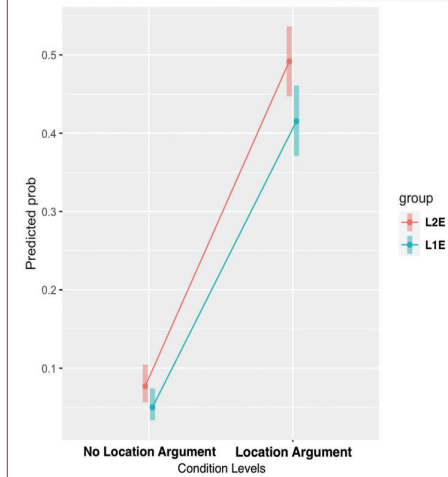
- Neither Speaker group (categorical IV) nor LexTale scores (continuous IV) was a significant predictor of producing locative arguments.
- Verb type was a significant predictor of locative arguments.
- No interaction between verb type and speaker group.

Discussion

- Lack of group/proficiency effects could be due to the high overall proficiency of our participants
- There was a trend for L2E speakers to provide more locative arguments than L1E speakers. This may have been related to the fact that unexpectedly, L1E speakers used many locative particles rather than argument locations. E.g. *The medal is valuable, so the detective is tucking it <u>away.</u>*

Future Directions

1. A second item set in this experiment addressed the same questions, but operationalized language knowledge as knowledge of the pragmatic ramifications of "surprisingly" and "obviously". We are gathering word2vec and BERT cosine values for those data now.
2. We are about to run an experiment in which we manipulate syntactic complexity and semantic reversibility to determine reliance on linguistic vs. world knowledge in comprehension. The degree of syntactic complexity varies across items such that many items will be difficult even for L1E speakers.

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