Grammatical Metaphor Increases AI-Animacy Perception in Online Sentence Processing

Introduction. Linguists argue that the subject position of transitive clauses carries proto-agentive entailments, such as causativity and animacy.[1] Psycholinguistic research has shown that this grammatical agency influences the situation models that readers construct (e.g., assigning higher financial liability to grammatical agents).[2] Notably, English allows this agentive subject position to be occupied by non-animates in a phenomenon known as grammatical metaphor,[3] which is known to increase the responsibility (agency) assigned to non-animates in rating tasks.[4,5,6] However, it is not known 1) how grammatical metaphor affects online sentence processing or 2) whether grammatical metaphor increases perception of animacy. We investigated both these questions by testing whether grammatical metaphors about AI make readers more likely to accept AIs as subjects of animate verbs using both a rating task (Ex. 1) and an eye-tracking paradigm (Ex. 2). We hypothesize that reading grammatical metaphors will increase participants' acceptance of AIs as subjects of animate verbs in both an outcome measure (ratings) and in late eye-tracking measures which reflect semantic integration (dwell time),[7] but not early measures which reflect lexical access (first fixation duration). We further hypothesize based on theories of anthropomorphism[8] that participants with lower AI knowledge will be more affected by the grammatical metaphors to perceive AIs as animate.

Stimuli. We produced 36 short stories about AIs and other technologies with two versions each—an *Agentive* Framing (i.e., grammatical metaphor) in which the technology was the subject of each sentence ("Scan AI™ saved many lives") and an *Instrumental* Framing in which the technology was a causal adjunct ("Doctors saved many lives by using Scan AI™"). The two framings were otherwise identical. Each story was followed by a causal explanation in the form "It all happened because [the technology] had [VP]", with either an *Animate* or *Inanimate* verb (e.g., understand vs compute). Verbs were normed for animacy by Prolific participants (n=100).

Experiment 1 (Ratings). Experiment 1 followed a 2[Framing: *Agentive*, *Instrumental*] x 2[Explanation: *Animate*, *Inanimate*] x 2[Outcome: *Positive*, *Negative*] design. Prolific participants (n = 73) were each assigned to either the *Agentive* or *Instrumental* framing condition and then read all 36 stories in that condition. Each story was followed randomly by either an *Animate* or *Inanimate* explanation sentence. Participants rated their agreement with each explanation and then completed an AI knowledge quiz. All data were analyzed in R 4.4.2 using mixed effects models.[9] Participants were significantly more likely to agree with both types of explanations in the *Agentive* Framing condition than in the *Instrumental* Framing Condition ($p < .05$), but there was no interaction between Framing and Explanation. This suggests that while the *Agentive* Framing caused participants to see the technology as an agent (as both explanation types were technology-*agentive*), it did not affect their perception of its *animacy*.

Experiment 2 (Eye-tracking). Experiment 2 followed the same design in an eye-tracking-while-reading paradigm using an Eyelink 1000.[10] Preliminary results (n = 39) show a three-way interaction between Framing, Explanation, and Outcome on log dwell time (i.e. total reading time) for the critical verbs ($p < .05$) such that participants read the critical verbs faster when they were congruent with the Framing condition (e.g. *Animate* verb with *Agentive* Framing) than when they were incongruent, in all combinations of conditions except the *Instrumental* Framing-*Negative* Outcome Condition.

Conclusions. We find that grammatical metaphor affects online sentence processing (not just offline judgments). The fact that there was an effect of congruency on dwell time but not on first fixation duration provides evidence that this was a result of situation model construction, not just lexical priming. Additionally, we find that grammatical metaphor increased perception of AI-animacy in online sentence processing, but not in offline judgments. This finding is consistent with theories of anthropomorphism which claim that anthropomorphism is a tool for thinking about the unknown; however, the fact that this effect was found only in online processing suggests that this automatic anthropomorphism can be regulated by controlled processing.

References

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Appendix

Figure 1. shows participants' agreement with technology-agentive explanation sentences in Experiment 1.

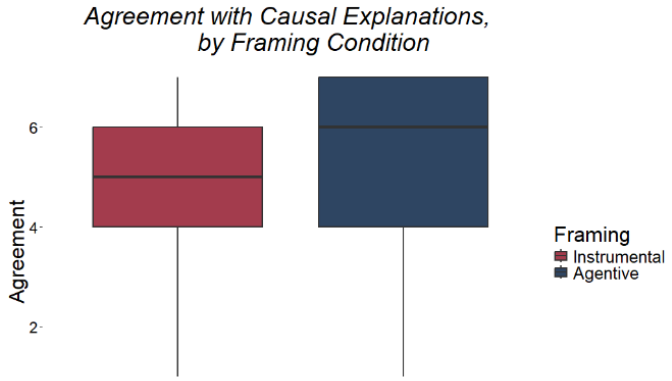
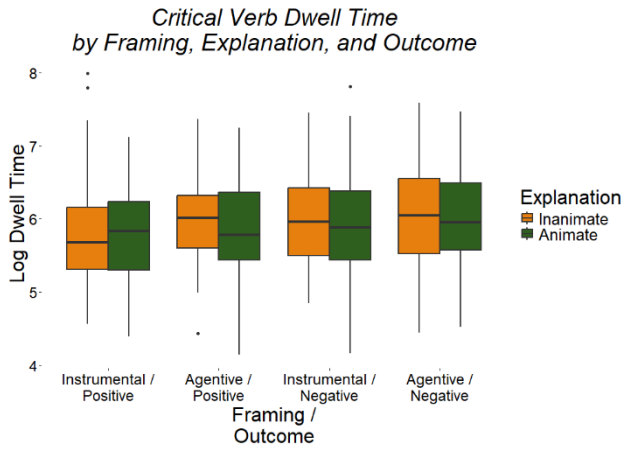


Figure 2. shows log mean dwell times on critical verbs by Framing, Explanation, and Outcome condition in Experiment 2.



Term	Estimate	Std. Error	df	*t* value	*p*
Framing	-1.404	0.079	2835	-3.016	0.002*
Explanation	0.080	0.077	2835	1.045	0.296

Table 1. Selected coefficients from the optimal model of agreement in Experiment 1. The interaction of Framing and Explanation did not improve model fit.

Term	Estimate	Std. Error	df	*t* value	*p*
Verb Frequency	-0.17	0.05	15.43	-3.152	0.0064*
Verb Concreteness	-0.12	0.06	15.41	-2.030	0.0599
Framing * Explanation * Outcome	-2.57	1.05	362.34	-2.440	0.0152*

Table 2. Selected coefficients from the optimal model of critical verb dwell time (i.e. total reading time) in Experiment 2