ARE SPATIAL INDEXES USED TO IDENTIFY THEMATIC ROLES FOR LANGUAGE?

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Introduction

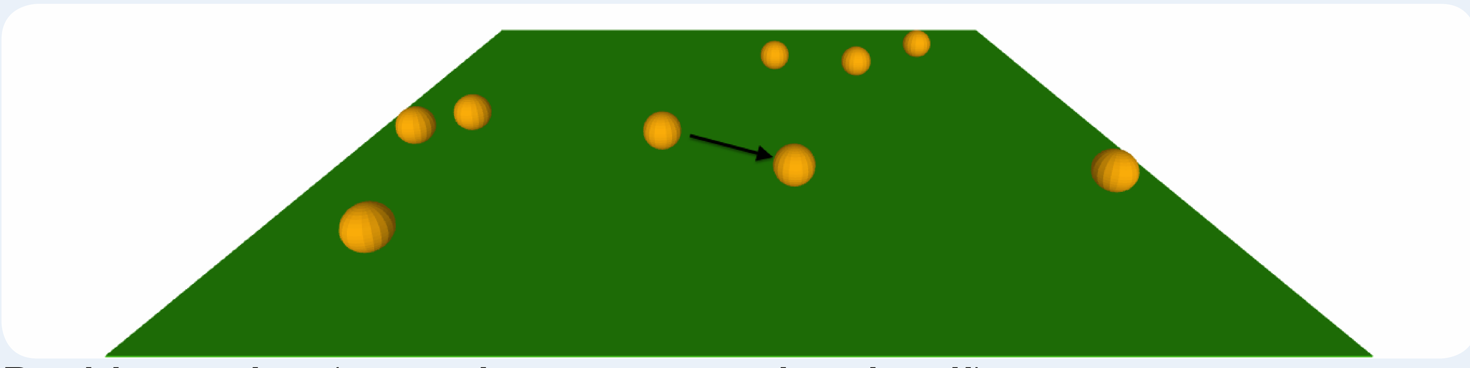
Language is used to convey who did what to whom and thematic roles label the participants in the event. For example in the sentence "the girl pushed the boy", the girl is the agent (the doer of action) and the boy is the patient (the entity affected by the action). Linguistic accounts of thematic roles assume that highly abstract thematic features must be computed to assign these roles (e.g., sentience, Dowty, 1991). However, multiple object tracking studies have shown that these roles can be computed from simple scenes involving randomly moving circles without abstract thematic features (Gao, Newman & Scholl, 2009). Here, we examine the link between these visual/spatial abilities and thematic role use in sentence production.

The Present Study

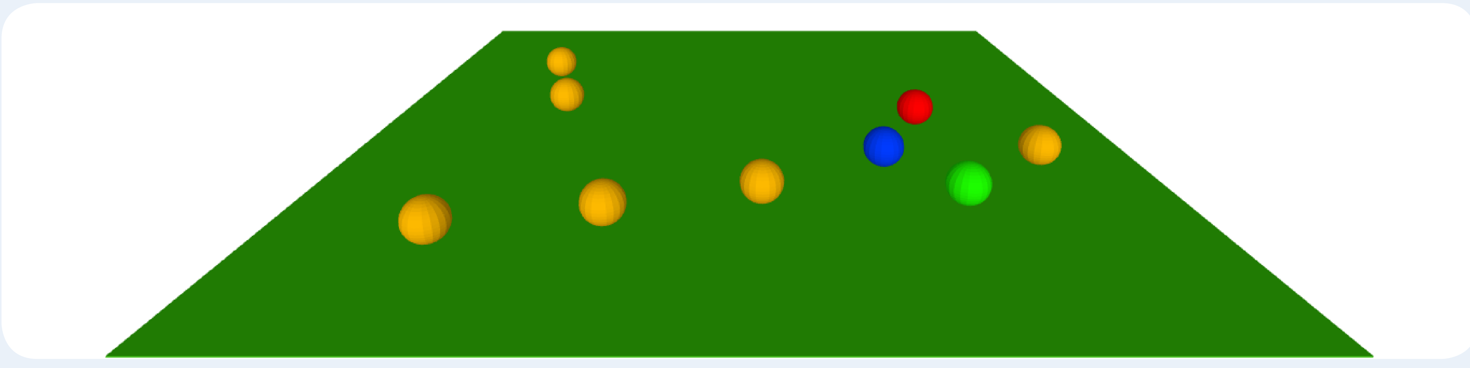
Multiple object tracking studies have shown that people can track multiple randomly moving identical circles using spatial indices, but this ability has a limited capacity of between 4 or 5 individual objects (Pylyshyn & Storm, 1988). Thus, the present study examined whether word ordering choices in sentence production are sensitive to such visual-spatial codes and how spatial resources support the number of roles that can be identified. It was predicted that participants' assignment accuracy would depend on the availability of tracking resources, with accuracy being high when tracking only two objects (one agent, one patient) and at chance for six objects (three agents, three patients).

Method

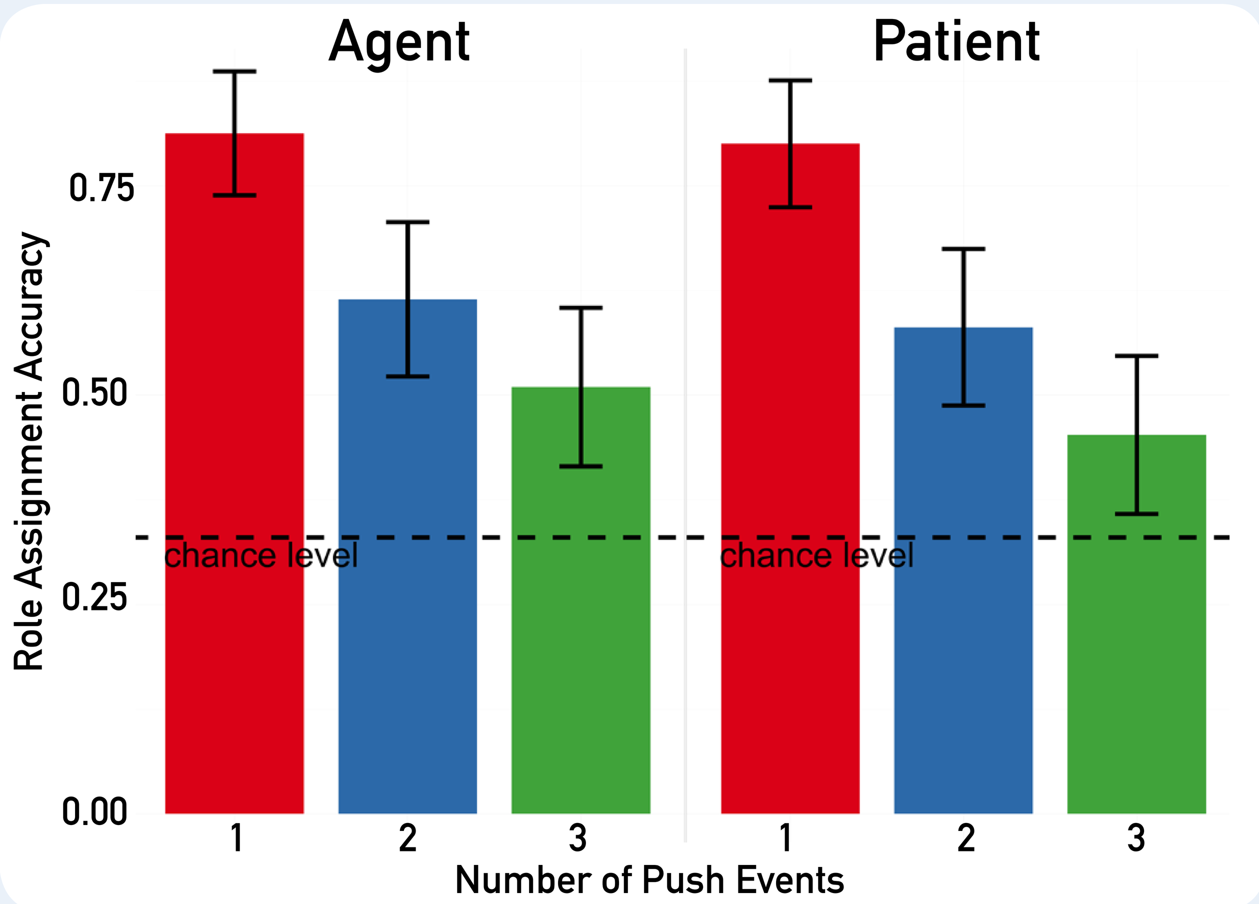
Thirty participants described pushing actions between two spheres (an agent and patient) amongst a display of nine identical spheres that moved randomly before and after the push events. Scenes could have one, two, or three pushing actions between different pairs of objects and each push was separated by periods of random motion. At test, three objects were coloured, two from a previous push action and a third unrelated foil. Participants were asked to describe the pushing action with those objects by producing a sentence like "blue pushed red", where blue was the agent in a previous pushing action and red was the patient. We separately recorded how often participants correctly mentioned the agent and patient, and chance was 0.33.



Pushing action (arrow is not present in stimuli)



Test scene: Participant describes which spheres were involved in previous pushing action (e.g.,"blue pushed red")



Production of agents and patients with different numbers of pushing events

Assignment Errors

	Agent	Patient
Role Swap	138	142
Uninvolved Foil	64	63
Agent Foil	25	17
Patient Foil	17	20

Results

Two separate mixed effects models were applied to the agent and patient assignment accuracy, with the number of push events (1 vs. 2 vs. 3) as the fixed factor in both. The maximal model that converged for agent accuracy contained subject as a random intercept. This revealed a significant decline in assignment accuracy as the number of push events increased ($B = 0.81$, $SE = 0.03$, $X2(2) = 51.28$, $p < 0.01$). The maximal model that converged for patient accuracy similarly contained subject as a random intercept. This model also showed a significant decline in assignment accuracy as the number of push events increased ($B = 0.80$, $SE = 0.04$, $X2(2) = 68.62$, $p < 0.01$). However, despite the linear decrease in accuracy as the number of push events increased, accuracy in three push trials remained significantly above chance for both agent ($t(209) = 5.09$, $p < .001$) and patient assignment ($t(209) = 3.46$, $p < .001$).

Furthermore, a Pearson's correlation revealed a strong positive relationship between agent and patient assignment accuracy ($r = .8073$, $t(26) = 6.98$, $p < .001$). This was also consistent with an analysis of participants' assignment errors, which revealed that participants were significantly more likely to swap the labels than produce any other type of error ($X2(3) = 317.80$, $p < .001$).

Conclusion

This study demonstrates that speakers can track multiple agent-patient pairs (up to three pairs), but accuracy decreases as the number of pairs increase. As errors tended to be within agent-patient pairs, it appears that participants track thematically related objects rather than individual circles. Speakers fluently mapped spatial information into language, suggesting that the visual representations in multiple object tracking could support sentence production.