<u>Worth a thousand words: On comprehenders' visuospatial representation of transitive sentences</u>
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Psycholinguistics has yielded key insights into how we form utterances based on *visuospatial input*; e.g., eye-tracking speakers as they describe visually-depicted events reveals how we map event structures onto grammatical structures during linguistic encoding (e.g. Gleitman et al. 2007, Do & Kaiser 2019). But less is known about the other direction: When a person reads or hears a sentence describing an event, what kind of visuospatial representation do they construct? (see e.g. Glenberg et al. 1987) Not all events can be visually depicted, but many can. **The present work** investigates how the syntactic, semantic and discourse properties of the subjects and objects of transitive sentences influence how they are depicted in visuospatial event representations, with the ultimate aim of helping us understand how linguistic properties influence how prominently referents are represented in comprehenders' minds.

We take as a starting point the **<u>S</u>patial <u>A</u>gency <u>B</u>ias.** According to SAB, we conceptualize events with a L-to-R trajectory, with the **left side** associated with agency (at least in languages written L-to-R), e.g. Chatterjee et al. 1995, 2011, Maass & Russo 2003, Suitner & Maass 2016, Suitner et al. 2021. When asked to draw *Tom kicks Bob* or *The circle pushes the square*, people often draw the agent on the left. But researchers disagree on the source, nature and robustness of this effect. We suggest a key obstacle to understanding the SAB, and how linguistic cues drive visuospatial representations, is lack of systematic testing of the notion of *agency* and its relation to other concepts. We ran 2 studies manipulating **verb type**, **voice** and **topicality**.

Exp.1 (n=62 native US-English speakers, 24 targets, 24 fillers): People saw sentences one by one, and drew a quick sketch showing the meaning of each sentence (over the internet, using a touchpad/mouse). Targets were transitive sentences; the subject and object were shapes (square, circle, triangle, star, etc) to facilitate subsequent coding of their locations. We manipulated verb type (agent-patient/stimulus-experiencer) and voice (active/passive), see ex.1.

Expanding from agent-patient verbs (e.g. *chase, kick, tickle*) to stimulus-experiencer verbs (e.g. *amaze, impress, irritate*) will reveal whether agentivity is what triggers privileged left-side placement, or whether the relevant factor is syntactic subjecthood. Testing both actives and passives will reveal how demotion of the agent to a by-phrase influences spatial biases. This will indicate whether (non)subject status matters and if this interacts with verb type.

Exp.1 results (Fig.1, proportion of trials where subject is on the left) reveal a clear interaction between verb-type and voice: With stimulus-experiencer verbs (without agents), whichever argument is the subject tends to be on the left (above chance, p<.01). But with agent-patient verbs, the agent is more likely to be on the left when it is the subject (actives) than when it is in the *by*-phrase and competing with a patient promoted to subject position (passives): Both subjecthood and agentivity boost the likelihood of privileged left-side placement.

Exp.2 (n=80 native US-English speakers) used the same targets and fillers as Exp.1, but the subject or object was topical/pronominalized, thanks to a preamble phase (ex.2). This allows us to test for discourse-level effects: does being topical/pronominal boosts a referent's likelihood of being on the left? If this obtains even with object pronouns, this would show subjecthood and agentivity are not required and topicality alone increases the likelihood of privileged left-side placement. **Exp.2 results** (Fig.2) reveal topicality effects, modulated by agentivity: Pronominal / topical subjects tend to be on the left (1st 2 bars, last bar, above chance p<.05), but non-subject demoted *agents* compete with them (penultimate bar). Non-pronominal/nontopic subjects are rarely on the left (4th-6th bars, below chance p<.05), unless they are *agents* (3rd bar).

In sum, these studies provide the first systematic investigation of the Spatial Agency Bias that manipulates the syntactic, semantic and discourse properties of the arguments. The results suggest we have a **Spatial Prominence Bias**, not an *Agency* bias: Factors that render entities more prominent/salient make them more likely to occur on the left. More generally, these results show that the visual representations we construct are highly sensitive to linguistic cues.

(1) Exp1 sample item (2x2 Latin Square design: verb type x voice)
(a) The triangle {tickled$_{AGENT-PATIENT}$/amazed$_{STIM-EXP}$} the circle.
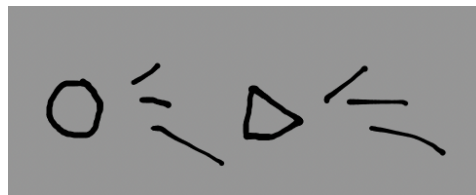(b) The triangle was {tickled$_{AGENT-PATIENT}$/amazed$_{STIM-EXP}$} by the circle.

(2) Exp 2 sample item

| Preamble	Active	Passive
Tell me about the hexagon.	It {tickled/amazed} the circle [subject = topical/pronoun]	It was {tickled/amazed} by the hexagon. [subject = topical/pronoun]
Tell me about the circle.	The hexagon {tickled/amazed} it. [object = topical/pronoun]	The circle was {tickled/amazed} by it. [object = topical/pronoun]

(3) Sample drawings for "The triangle chased the circle" (The grey background is due to file download format; participants saw a white background)
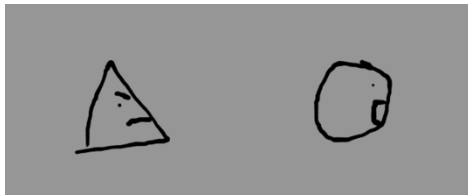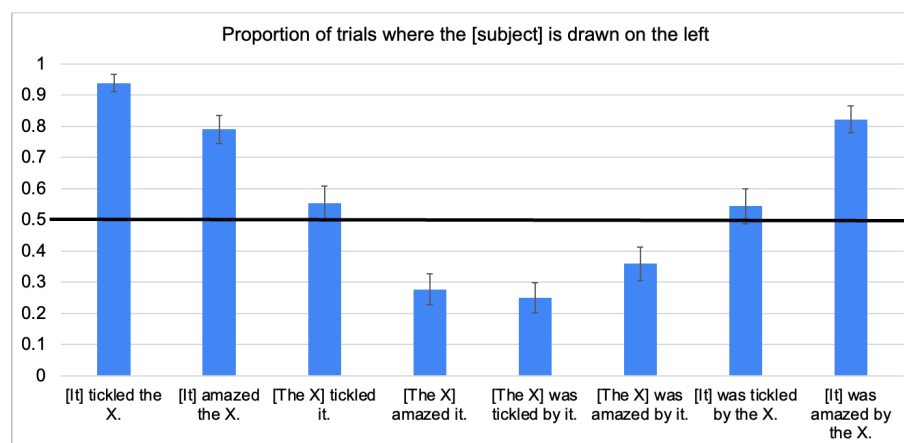

(coded as subject on left)   (coded as subject on right)
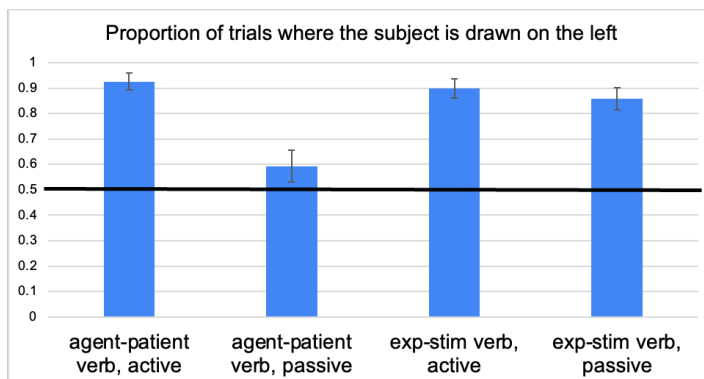
Fig.1 Exp.1: **Proportion of trials where the subject is drawn on the left.** (Only horizontally-oriented trials included; we excluded trials (2.2%) where shapes are vertically-oriented). Error bars: +/- 1 SE

Fig.2 Exp.2: Proportion of trials where the subject is drawn on the left. The conditions are represented with sample 'sentence frames' for ease of comprehension. X = one of the shapes. (Only horizontally-oriented trials included; we excluded trials (4.2%) where shapes are vertical) Error bars: +/- 1 SE