Spatial Language and Reference Tracking

When a referent is salient in the discourse, a subsequent repeated full reference (i.e. a name or definite description) is read more slowly than a pronominal reference. This cognitive processing delay has been named the "repeated name penalty" (Gordon et al., 1993). Recent fMRI research suggests that the repeated name penalty activates the same parietal regions involved in perceptual feature binding and spatial processing (Almor et al. 2007). A possible interpretation of these findings is that our brain relies on the same neural circuits to track multiple spatial representations and to keep track of linguistic referents in discourse. In this view, pronouns act as "spatial indices" by utilizing spatial representations to reduce representational burden and interference between activated referents.

At present, there is no direct evidence in support of this interpretation. The aim of the current study is therefore to test the hypothesis that linguistic reference tracking involves spatial cognitive processes. Moreover, we ask whether these processes are engaged differently by pronouns and repeated definite descriptions, and whether pronouns use spatial neural circuits more efficiently. One way to address this question is to contrast the processing of different referential forms in spatial and non-spatial language contexts. In the present study, we therefore examine whether the repeated name penalty varies between spatial and non-spatial language.

The current study utilized an image verification task in which 120 undergraduate students read discourses that described either previously (E1, E2) or subsequently (E3) seen images. They then indicated whether the sentences accurately described the images. The reading portion included either three-sentence (E1) or four-sentence discourses (E2, E3). Items were presented in eight-discourse blocks, half of which were spatial and the other half non-spatial. Figure 1 shows a schematic of this task and a sample item.

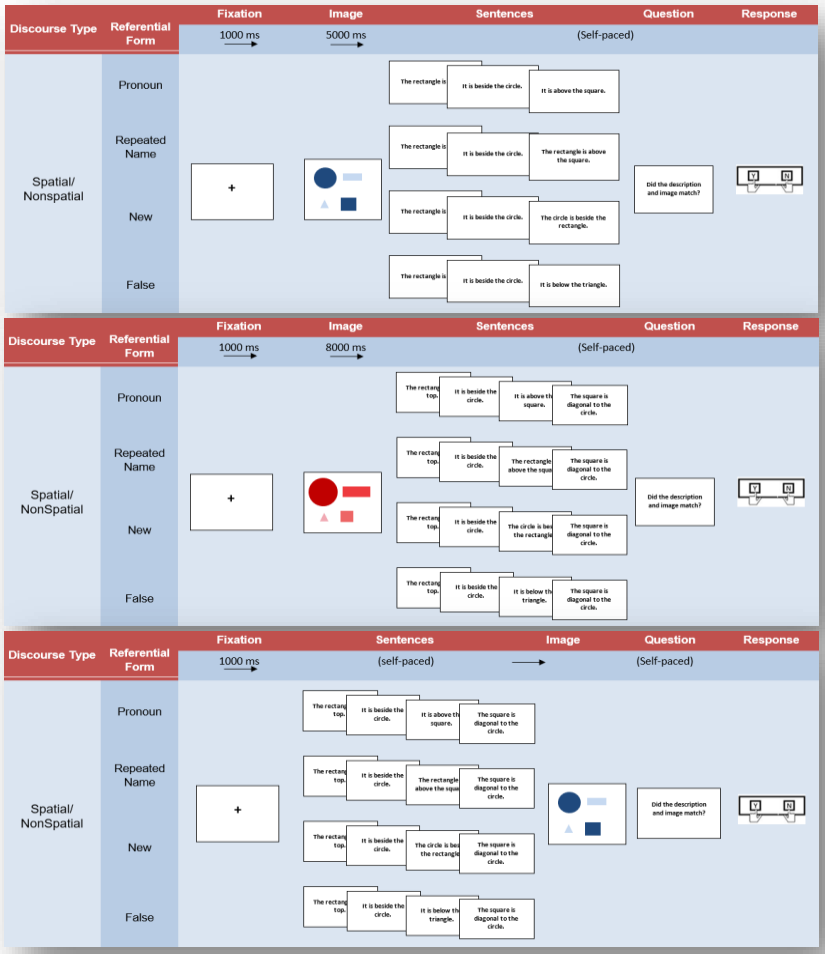
The first sentence in each item introduced a target shape with a definite noun (e.g., "the square") as the grammatical subject to establish it as the most salient entity. The second sentence referenced the target with the pronoun "it" in the subject position to further enhance its salience. The critical third sentence included the repeated name penalty manipulation. It either referenced the target shape with a pronoun or referred to it with a repeated definite noun.

E1 found that the interaction between discourse type (spatial vs. non-spatial) and reference form (pronoun vs. repeated name) had a significant effect on Sentence 3 reading times, such that the repeated name penalty was reduced in the spatial contexts in comparison to non-spatial ones. Specifically, we found that sentences with repeated definite references benefit more than pronouns from spatial contexts (see Figure 2 for results and statistics). E2 addressed concerns about possible wrap-up effects by adding a fourth sentence after the critical third sentence, and concerns about possible difficulty differences between the spatial and non-spatial conditions by making the latter ones easier. The results from this experiment closely replicated those of E1 in showing a similar significant interaction, with repeated definite references again benefiting in spatial contexts (Figure 3). E3 asked if the reduction in the repeated name penalty in spatial contexts would hold even if participants read the descriptive sentences before seeing the visual display. The results showed no interaction between discourse type and reference form (Figure 4), indicating that a visuo-spatial load is required for modulating the repeated name penalty.

In summary, these results show that, under conditions of visuo-spatial memory load, spatial discourses are subject to a reduced repeated name penalty such that the processing of repeated definite descriptions becomes easier. This shows that definite descriptions but not pronouns benefit from explicit spatial associations. We speculate that pronouns inherently function as spatial indices and therefore don't stand to benefit more from making the discourse spatial. In contrast, repeated definite descriptions do not initially take advantage of spatial resources unless the discourse context is inherently spatial.

Figures:

Figure 1. E1, E2, E3 task schematics



Non-Spatial passage examples:

S1: The rectangle is medium.
S2: It is smaller than the circle
S3:
Pronoun: It is larger than the triangle.
Repeated N.: The rectangle is larger than the triangle.
New: The triangle is smaller than the rectangle.
S4: The square is smaller than the circle.

Spatial passage examples:

S1: The rectangle is on the bottom.
S2: It beside the circle
S3:
Pronoun: It is above the square.
Repeated N.: The rectangle is above the square.
New: The square is below the circle.
S4: The square is diagonal to the circle.

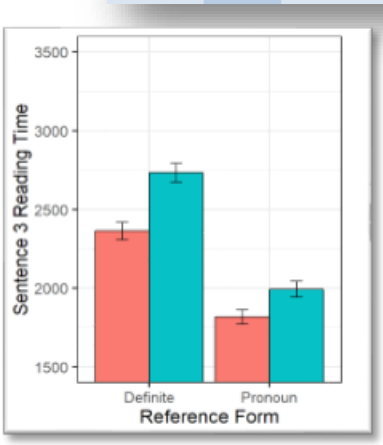


Figure 2. E1 (N = 55)
Sentence 3 reading times.

Spatial F(1, 54) = 14.65, p < .001,
Ref type F(1, 54) = 128.39, p < .001,
Interaction F(1, 54) = 4.76, p < .05

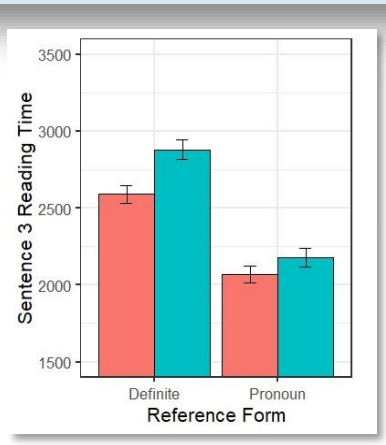


Figure 3. E2 (N = 61) Sentence 3 reading times.

Spatial F(1, 60) = 8.54, p < .005
Ref type F(1, 60) = 74.85, p < .001
Interaction F(1, 60) = 4.45, p < .05

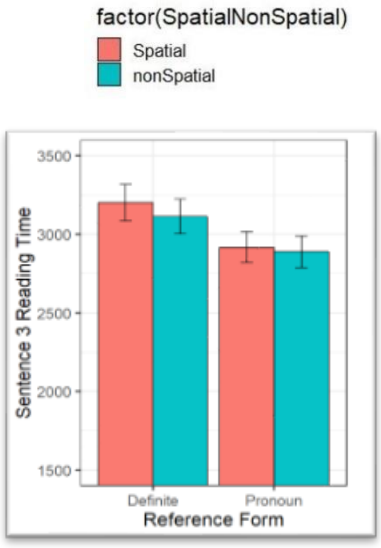


Figure 4. E3 (N=30)
Sentence 3 reading times.

Ref type F(1, 29) = 4.51, p < .05

References

- Almor, A., Smith, D. V., Bonilha, L., Fridriksson, J., Rorden, C. (2007). What's in a name? Spatial brain circuits are used for tracking personal reference during discourse. ***Neuroreport***, ***18 (12)***, 1215-1219.
- Gordon, P. C., B. J. Grosz, and L. A. Gilliom. (1993). Pronouns, names, and the centering of attention in discourse. **Cognitive Science** 17.311–47.