

Role of Topology in Children's Representations

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Background

Working memory is a limited capacity processing system that is often required for goal-directed behaviors. Performance in working memory tasks is influenced by attentional deployment during the encoding period and the contents of representations maintained. Previous research has shown that working memory performance for surface features (like colors) increases into late adolescence. Research on infants and children shows that attentional pre-cues can influence working memory performance (Ross-Sheehy, Oakes, & Luck, 2011, Shimi et al., 2014). Research on infants and adults suggests that working memory performance can be limited by the content of representations (Kibbe and Leslie, 2016, Wei et al., 2019). However, there is a significant gap in our understanding of whether and how toddlers represent structural properties of objects (topology) in working memory compared to surface features (colors) and whether toddlers working memory performance can be influenced by attention cues by interacting with different contents of representations (topology and color). In this study, I planned to test these two research questions while modifying the task used by Kibbe and Applin (2022).

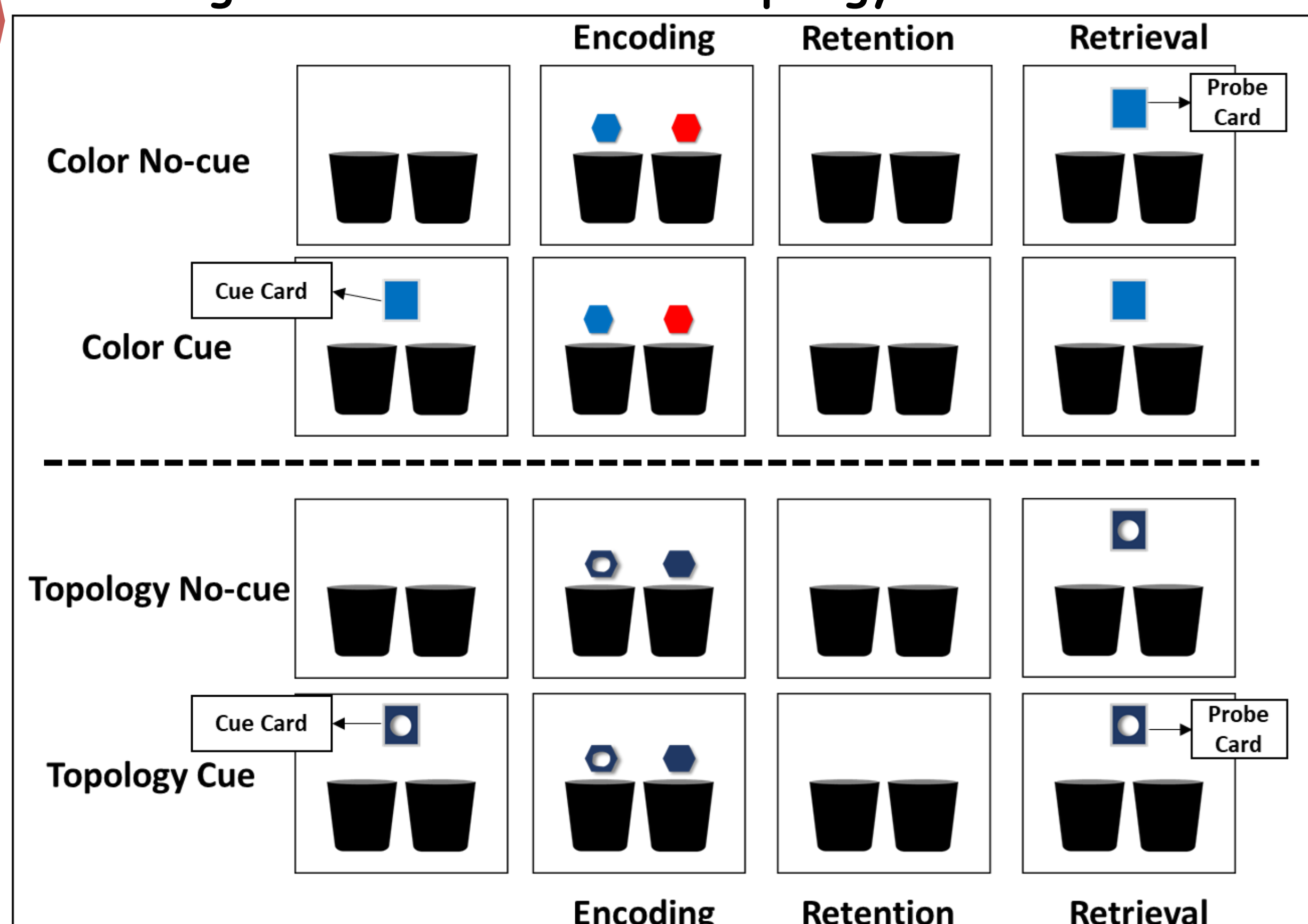
Research Questions

- Whether toddlers represent topologically-distinct objects similar to surface features (colors)?
- Does selective attention influence representation of topological properties differently from surface features (color)?

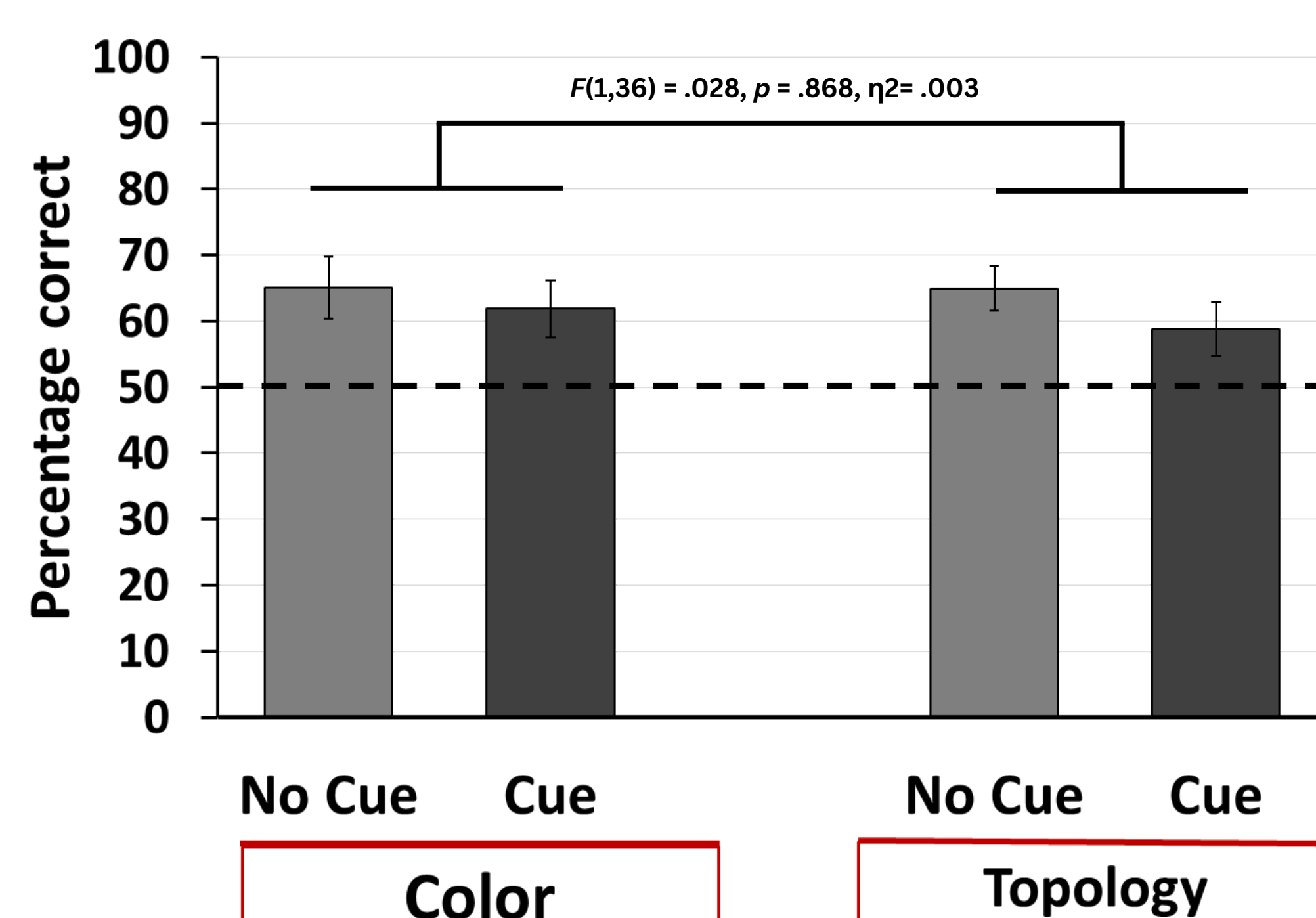
Method

- **Participants:** 41 24-40-month-old children (Females = 24).
 - Color Condition: $n = 21$ (Mean age = 31.1 months).
 - Topology Condition: $n = 20$ (Mean age = 31.25 months).
- **Design:** 2 (color, topology) \times 2 (cue, no cue) mixed design.
 - Participants were randomly assigned to topology or color condition.
 - Cue and no cue blocks were presented within each condition and these blocks were counterbalanced between participants.
- **Procedure:**

Single trial for color and topology cue and no cue



Results

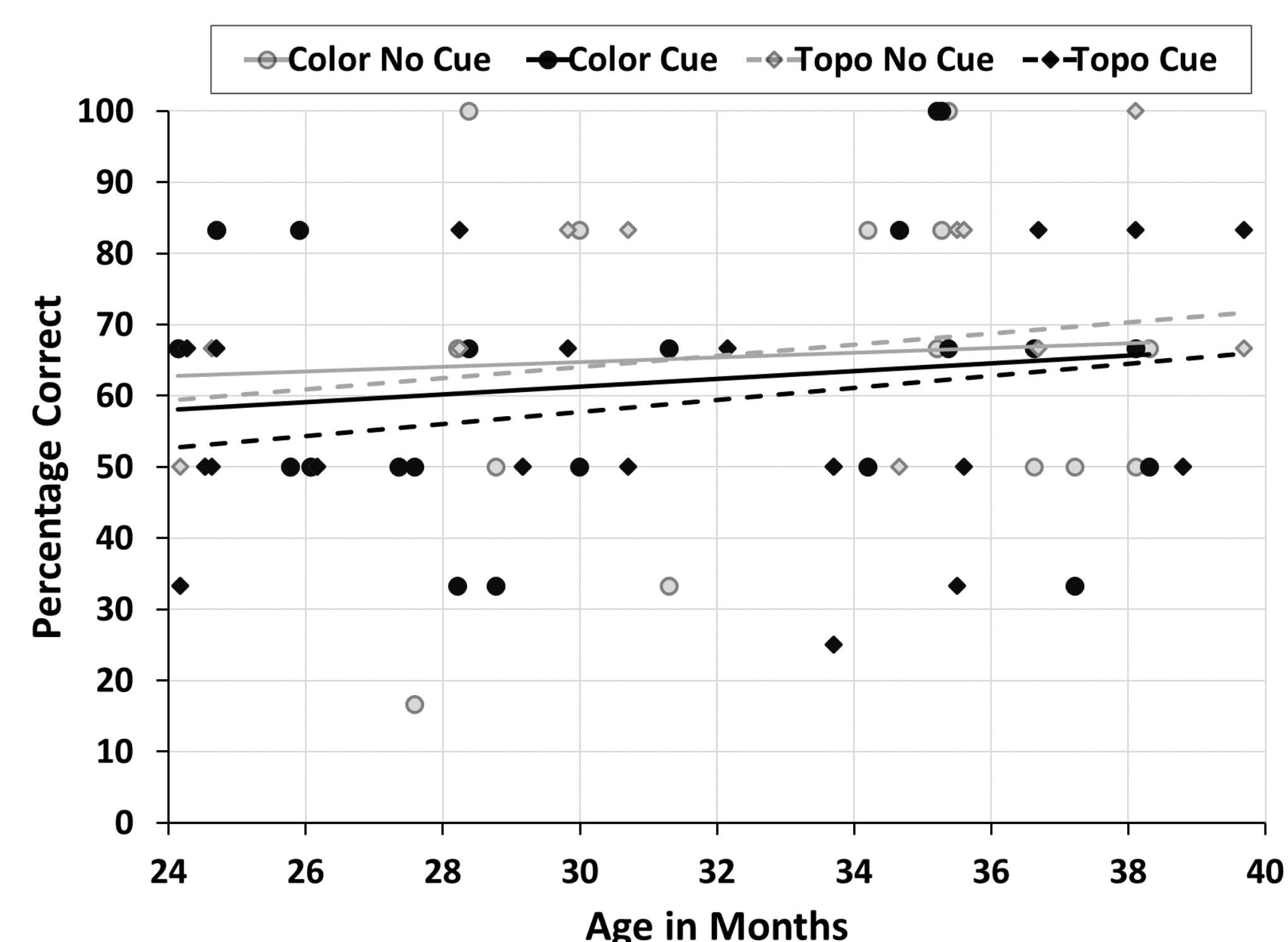


- Toddlers performed significantly above chance in both color and topology condition blocks.

- **Color condition:**
 - No cue: $t(20) = 2.75, p = .012$, Cohen's $d = .60$.
 - Cue: $t(20) = 3.19, p = .005$, Cohen's $d = .7$.

- **Topology condition:**
 - No cue: $t(19) = 2.146, p = .045$, Cohen's $d = .48$.
 - Cue: $t(19) = 4.42, p < .001$, Cohen's $d = .99$.

- Main effects of condition ($F(1,36) = .028, p = .868, \eta^2 = .003$) and attention cue ($F(1,36) = .41, p = .53, \eta^2 = .011$) were not significant.



- Working memory performance did not improve with age in our sample ($b = .132, t(39), p = .85$).

- Age in months variable explained 0.6% of variance in working memory performance while holding condition constant ($R^2 = .006, F(2,38) = .121, p = .886$).

Conclusions

1. Whether toddlers represent topologically-distinct objects similar to surface features (colors)?
 - Toddlers (24-40-month old's) showed no significant difference in performance between topology and color conditions.
2. Does selective attention influence representation of topological properties differently from surface features (color)?
 - Attention cues did not influence memory performance in both color and topology condition.
3. Whether there are age differences in working memory performance?
 - We did not find improvement of performance with increase in age (24-40-months).

Future Directions

- Conduct studies to explore whether and when in development children prioritize either topological properties over surface features and vice-versa.
- Should test whether spatial pre-cues enhance toddlers working memory performance for different content of representations.

References

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