Using quantitative labels to promote children's patterning skills

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Introduction

This study investigated how the labels used to describe patterns affect children's understanding of pattern structure.

Background

Early patterning skills have been shown to relate to formal math and reading achievement (see Burgoyne et al, 2017 for review).

Research is needed to identify factors of the environment that improve patterning skills.

Previous research suggests a critical role of language. Providing abstract letter labels (e.g. calling square-square-circle 'A-A-B') increased children's performance on pattern tasks relative to using concrete labels (e.g., red-red-blue; Fyfe et al, 2015).

Here, we investigate several different abstract labels.

Pattern Abstraction

Children are shown model patterns made with one set of materials (here, black shapes printed on strips of paper) and asked to recreate the structure of each pattern using a different set of materials (here, colored wooden tiles).

Method

Participants: 90 children (*M* age = 5.4 years; 52% female) participated in a one-on-one session.

Design: Using a between-subjects design, children were taught pattern abstraction in one of four conditions that differed in how the experimenter labeled the model patterns.

Procedure: Children were shown three examples and asked to solve ten pattern abstraction problems (one baseline, seven training, and two posttest) and asked "how is your pattern like my pattern?"

Results

Performance by Condition
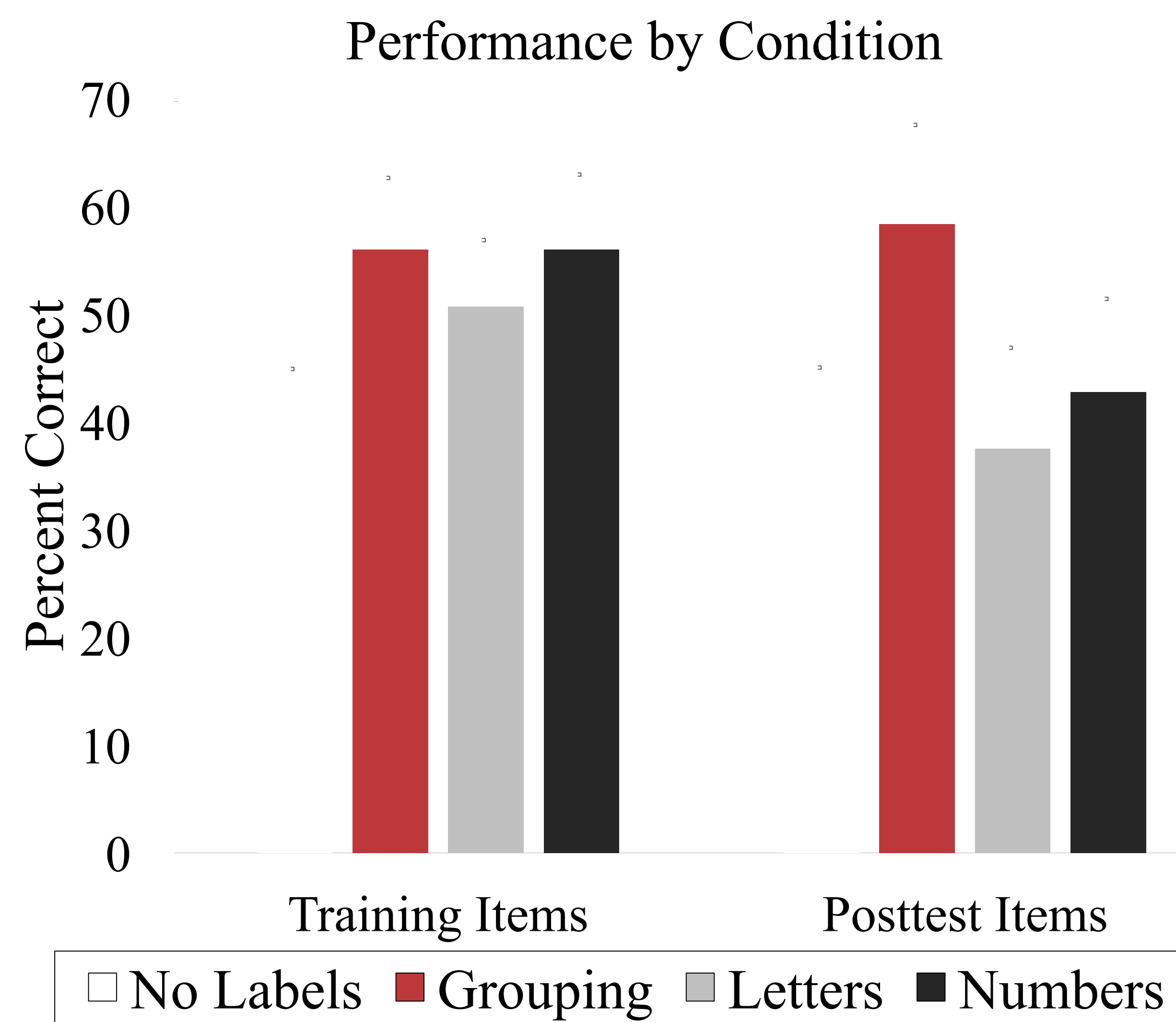
Training: Significant effect of Labels vs. No Labels ($\beta = 0.18$, $p = .04$)
Posttest: Significant effect of Grouping vs. Two Arbitrary Labels ($\beta = 0.19$, $p = .04$)

Training performance favored all label conditions.

Posttest performance favored grouping condition.

Children's use of grouping labels and grouping gestures positively correlated with performance on the training items (rs = .31 and .32, ps < .005).
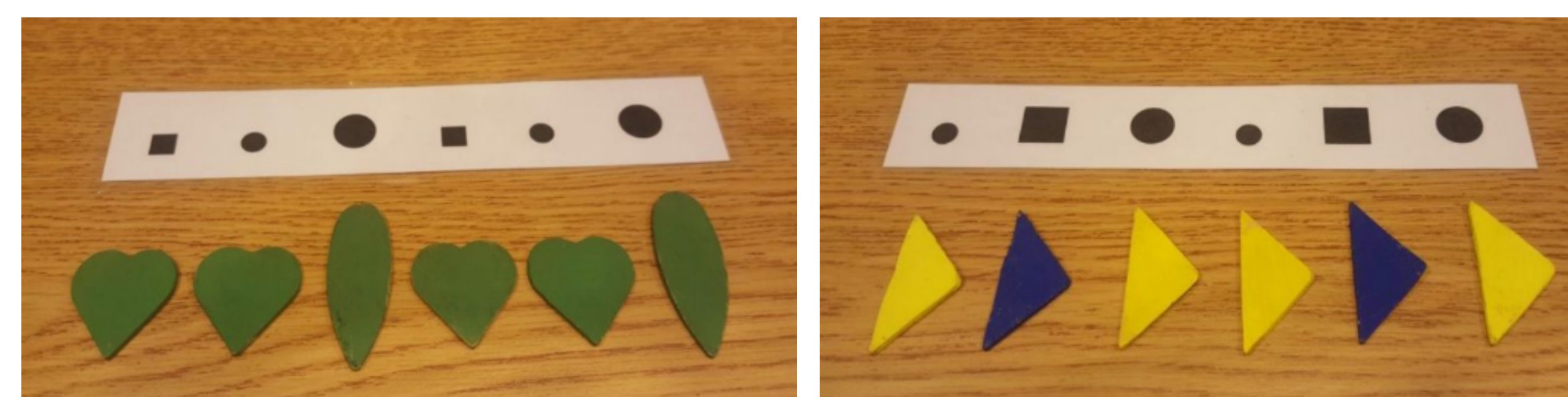
Types of Labels

The part that repeats in my pattern is…

| this part | two-one | A-A-B | 1-1-2 |
| (No Labels) | (Grouping) | (Letters) | (Numbers) |

…because it has two that are the same and then one other that is different.

examples of correct pattern abstraction:

Frequency of Label Use by Condition

	No Labels	Grouping	Letters	Numbers
Letters Correct	0%	0%	**28%**	0%
Numbers Correct	0%	3%	1%	**17%**
Grouping Correct	11%	**40%**	3%	14%
Concrete Correct	14%	13%	22%	21%
Names Feature	**28%**	7%	5%	14%
Other	47%	37%	41%	34%
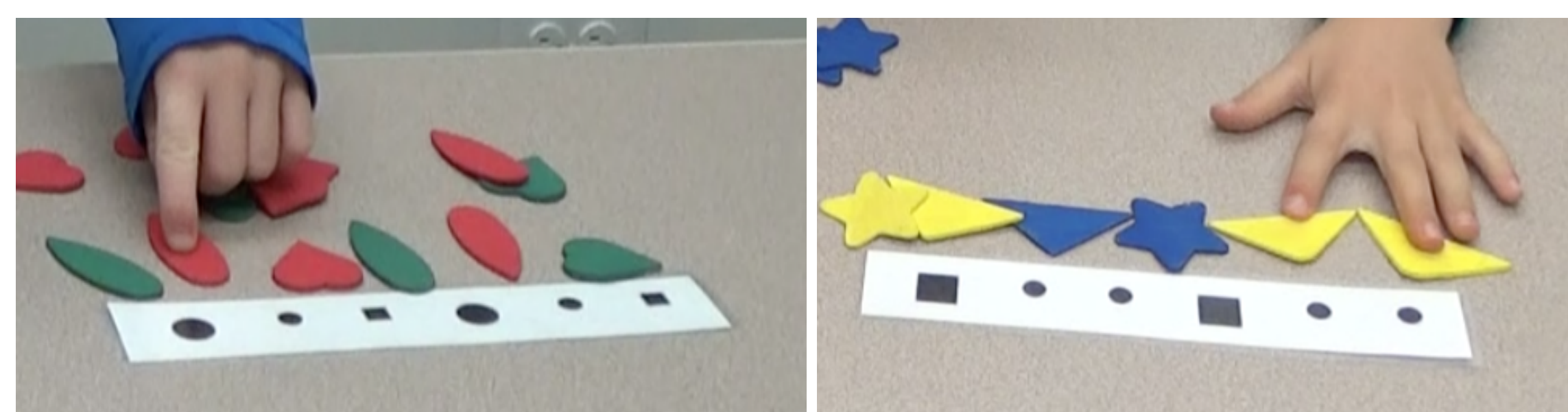
Frequency of Gesture Use by Condition

	No Labels	Grouping	Letters	Numbers
Pointing	30%	32%	54%	46%
Grouping	31%	**35%**	10%	19%
Other	39%	33%	36%	35%

Conclusions

Abstract labels aided performance on training problems and grouping labels aided performance on posttest problems on which no labels were provided. Across conditions, evidence from children's speech and gestures suggests that mentally "grouping" similar elements together (e.g., thinking of a small circle and a big circle as the same) was positively related to pattering performance.

This could be because grouping labels draw children's attention to quantitative information and reduce cognitive load. Children have also previously been observed to use grouping labels spontaneously (unlike letters and numbers labels), indicating that grouping labels may align better with their intuitive representations of patterns.

The benefits of grouping labels may have practical implications for early mathematics education and interventions.

References

Burgoyne, K., Witteveen, K., Tolan, A., Malone, S., & Hulme, C. (2017). Pattern understanding: Relationships with arithmetic and reading development. *Child Development Perspectives, 11*, 239-244.

Fyfe, E. R., McNeil, N. M., & Rittle-Johnson, B. (2015). Easy as ABCABC: Abstract language facilitates performance on a concrete patterning task. *Child Development*, 86, 927-935.