Developmental Differences in Encoding and Completing Patterns

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What comes next in this pattern? To answer this question, one must encode, or mentally represent, features of the pattern, and apply a strategy to determine the next item. Klahr (1970) has shown that children use systematic strategies to solve such problems.

The present study investigated whether children and adults use different strategies to solve such problems, and whether they encode different features of the patterns. As Siegler (1976; 1989) has argued, understanding problem encoding may be one key to understanding the process of strategy change.

Method

Fifteen adults and eight five-year-olds participated in two experimental tasks. In the *completion* task, participants viewed a pattern and were asked "What comes next?" and "Why?" In the *reconstruction* task, participants viewed a pattern for six seconds, and then reconstructed the pattern using felt shapes.

For each task, participants completed six trials for each of three pattern types. Each pattern consisted of six items, which were either circles (C) or squares (S), and were either big (B) or little (L). In *Same-Same* patterns, shape and size repeated in the same period and same pattern (e.g., BS-BS-LC-BS-BS-LC). In *Same-Different* patterns, shape and size repeated in the same period but different patterns (e.g., BC-BS-LS-BC-BS-LS). In *Different- Different* patterns, shape and size repeated in different periods and different patterns (e.g., BC-LC-BS-LC-BC-LS).

To assess strategy use, we transcribed participants' explanations in the completion task, and categorized them in terms of strategies. To assess encoding, we compared participants' reconstructions to the original patterns. Four types of errors were identified: (a) Shape-only errors (e.g., BC for BS), (b) Size-only errors (e.g., BC for LC), (c) Both-shape-and-size errors (e.g., BC for LS), and (d) Omissions.

Results and Discussion

Adults and children showed little overlap in the specific strategies used. Among children, the most common strategies were Decipher Shape (identify the pattern for shape only) and Last Match (find a previous instance of the final item, and copy the following item). Among adults, the most common strategy by far was Decipher Together (identify the pattern treating size and shape as integrated). Adults also used Decipher Separate (identify the patterns for size and shape separately) and Invert (invert part of the pattern).

We assessed each participant's most frequent strategy for each pattern type. Most adults (87%) used the same primary strategy for Same-Same (SS) and Same-Different (SD) patterns, but used a different strategy for Different-Different (DD) patterns. In contrast, most children (88%) used the same primary strategy across all pattern types. Consequently, children used fewer strategies overall than adults. Thus, adults adapted their strategy use to the specifics of the patterns, but children did not.

Children's reconstructions were less accurate than adults', $F(1,21)=56.13$, $p<.01$, and children and adults had different patterns of reconstruction performance across pattern types, $F(2,42)=4.54$, $p<.02$. Adults encoded SS and SD patterns nearly perfectly, and DD patterns slightly less well. Children encoded SS patterns best, and SD and DD patterns equally poorly.

The distribution of encoding error types also differed for children and adults, $F(3,63)=13.89$, $p<.01$. Since children's problem-solving strategies often focused exclusively on shape (e.g., Decipher Shape), but adults' strategies typically focused on both shape and size (e.g., Decipher Together), we hypothesized that children would make fewer shape-only errors than adults. As predicted, among single-dimension errors, children made proportionately fewer shape-only errors than adults (42 vs. 80%, $t(19)=3.04$, $p<.01$).

These results suggest that problem encoding and strategy use are closely linked. However, differences in encoding did not inevitably lead to differences in strategy use—children's encoding performance differed across problem types, but their problem solving strategies did not. These findings suggest that, for the pattern completion task, improvements in encoding may *precede* changes in strategy use. Indeed, new encodings may be one source of new problem-solving strategies.

References

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