Determinants of Perseveration in the Dimensional Change Card Sort

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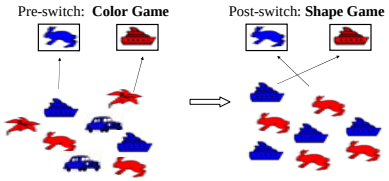
Introduction

In the Dimensional Change Card Sort (DCCS), children sort test cards to target cards by one rule (e.g., color) in the pre-switch phase, and sort the same cards by a conflicting rule (e.g., shape) in the post-switch phase. Most 3-year-olds perseverate and continue to sort by the pre-switch rule in the post-switch phase (Zelazo, Frye, & Rapus, 1996). One proposal for the difficulty is the ***negative priming*** explanation, which forms a part of the Cognitive Complexity and Control Theory-Revised (CCC-R; Müller, Dick, Gela, Overton, & Zelazo, 2005; Zelazo, Müller, Frye, & Marcovitch, 2003).

Prior Research

- Negative priming describes the disruption of the response to a stimulus that has previously been ignored. On the DCCS, children may have problems engaging attention to the values of the formerly *irrelevant* dimension when these values become relevant in the post-switch phase of the task.
  - Prior research: Recently presented conflicting test cards appear to yield more negative priming than randomly distributed conflicting test cards (Dick, Müller, & Overton, 2003; Müller et al., 2005).
    - Children perform better if the conflicting test cards were randomly distributed with non-conflicting cards (e.g., red and blue flowers and cars; Fig. 1a).
    - Children perform poorly if conflicting test cards (e.g., red and blue rabbits and boats) were presented en bloc as the last four pre-switch cards (Fig. 1b).

a. Negative Priming-Random (**47% 3-4-year-olds pass**).



b. Negative Priming-Recency (**0% of 3-4-year-olds pass**).

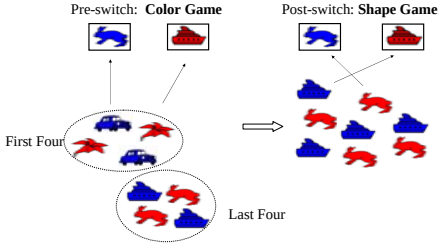


Figure 1. The Negative Priming-Random and Negative Priming-Recency versions of the DCCS.[1]

[1] To allow for direct comparison, the stimuli shown are for the "color-rule-first". In the actual experiment, the rule presentation (color-first or shape-first) was counterbalanced, and different stimuli were used accordingly.

The Present Study

- The prior research left open the question of how the frequency of conflicting stimuli and their placement relative to the rule switch might affect task performance.
  - Frequency and recency of conflicting stimuli were manipulated in the present study.

- A second goal of the present study was to assess the persistence of the negative priming effect.
  - To test this, we imposed a ten minute delay between the first post-switch phase and a second post-switch phase.

Participants

Sixty-four children between 36 and 57 months were recruited. Sixteen children were assigned to each of 4 conditions (Frequent and Last Trial mean age = 45.06, *SD* = 6.58; Frequent and Not Last Trial *M* = 45.69, *SD* = 6.24; Infrequent and Last Trial *M* = 45.38, *SD* = 7.14; Infrequent and Not Last Trial *M* = 45.50, *SD* = 5.97).

Design

There were four conditions:

- Children sorted test cards to target cards according to a pre-switch rule (e.g., color rule) and then a post-switch rule (e.g., shape rule).
- Target and post-switch test cards were the same for all conditions
- The conditions differed by the pre-switch test cards and their order of presentation.

❖ The Frequency of Mismatching (M) test cards was manipulated by presenting either 2 or 8 pre-switch test trials.
❖ The Recency of M test cards was manipulated by positioning a M test card as either the last or the second to last test card of the pre-switch phase. The conditions with the order of test cards were thus:

- Frequent-Last Trial (FLT): M, N, N, M, M, N, N, M
- Frequent Not-Last Trial (FNLT): M, N, N, M, M, N, M, N
- Infrequent-Last Trial (ILT): Two pre-switch cards, with the constraint that the second to last card was a N card, and the last card was a M card (i.e., N, M).
- Infrequent Not-Last Trial (INLT): Two pre-switch cards, with the constraint that the second to last card was a M card, and the last card was a N card (i.e., M, N).

In each condition, children received the pre-switch trials, then 8 post-switch trials. After 10 minutes, 8 additional post-switch trials were administered (Fig. 2). Finally, children received 4 knowledge questions.

Figure 2. Each condition consisted of a pre-switch phase, a first post-switch phase (A), a ten-minute delay, and a second post-switch phase (B).

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Results

There were no significant differences among conditions in either post-switch phase (*p*'s > .79). Conditions with frequent mismatching test-target card pairings (FLT, FNLT) did not differ from conditions with infrequent mismatching test-target card pairings (ILT, INLT) for either the first or the second post-switch, *p*'s > .60. Neither was there any significant effect of recency (FLT and ILT vs. FNLT and INLT), *p*'s > .31.

Twenty-four children who failed Post-switch A also failed Post-switch B, though there was a significant difference between phases, McNemar (N = 64) $p < .001$. Age was significantly correlated with performance on the first post-switch, $r(64) = .30$, $p < .05$, and the second post-switch, $r(64) = .35$, $p < .01$.

Table 1
Number of Children Passing and Failing Each Condition and Each Post-switch Phase

	Pass	Fail
Post-Switch A		
FLT	6 (37)	10 (63)
FNLT	8 (50)	8 (50)
ILT	6 (37)	10 (63)
INLT	8 (50)	8 (50)
Post-switch B		
FLT	10 (63)	6 (37)
FNLT	11 (69)	5 (31)
ILT	9 (56)	7 (44)
INLT	10 (63)	6 (37)

Note. Percentages in parentheses. FLT = Frequent and Last Trial; FNLT = Frequent and Not Last Trial; ILT = Infrequent and Last Trial; INLT = Infrequent and Not Last Trial.

Discussion

There were 3 major findings.

1. Performance did not differ depending on whether the mismatching test-target pairing was presented in the second-to-last or last pre-switch trial.
   - This suggests that the recency effect observed in past research was due to frequency of mismatching test-target card pairings over several pre-switch trials, and not just the last pre-switch trial.
2. There was no difference between Negative Priming versions with 2 and 8 pre-switch trials.
   - Fifty percent (INLT) and 63% (ILT) of the children perseverated in conditions with two pre-switch trials, even though they received only one mismatching test-target card pairing.
   - Even single exposure to a mismatching test-target card pairing is effective in triggering negative priming.
3. The third finding was that exposure to mismatching test-target card pairings survives a 10-minute interval, suggesting that, in the DCCS, negative priming effects last across a delay.

References:
Dick, A.S., Müller, U., & Overton, W.F. (October, 2003). *Further support for negative priming in the Dimensional Change Card Sort*. Poster presented at the meeting of the Cognitive Development Society, Park City, UT.
Müller, U., Dick, A.S., Gela, K., Overton, W. F., & Zelazo, P. D. (2005). *The role of negative priming in preschoolers' flexible rule use on the Dimensional Change Card Sort Task*. Manuscript submitted for publication.
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