Does Rule Learning Influence Cognitive Control on the DCCS Task?

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Summary

Three experiments tested whether cognitive control in kindergarten children varies as a function of rule learning or rule-given conditions. The experiments manipulated attentional and learning demands in order to detect any effect due to rule condition. The results showed that learning a rule, as opposed to being given a rule, appears to have no bearing on cognitive control or flexibility. Instead, increasing the trials to criterion, regardless of whether this involves being given the rule or learning the rule, appears to be responsible for improved cognitive flexibility.

Introduction

The ability to switch responding between dimensions in a DCCS task, called cognitive control, increases dramatically during the preschool years as children become able to use and reflect upon hierarchical rule structures. An essential element of this task is that the rules are given to the child in order to determine how they are used.

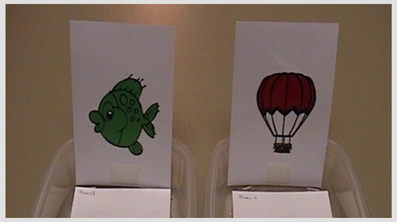
In contrast to rule-use tasks such as the DCCS, a substantial body of evidence supports the crucial role of learning a rule. It has been argued that learning a rule engages hypothesis-testing processes necessary for using the rule. Therefore, it is plausible that differences in cognitive flexibility may arise as a function of rule condition because learning rules and using rules are mediated by distinct areas of the prefrontal cortex. One possibility is that the learning process would increase the depth of processing of a rule making it unlikely to be easily abandoned. Or, the learning process of sampling and testing rules could increase cognitive flexibility.

Three experiments were conducted to test whether cognitive control in kindergarten children varies as a function of rule learning or rule-given conditions. The experiments varied attentional and learning demands in order to detect any effect due to rule condition.

Experiment 1

Thirty-two kindergarten children solved a two-dimensional DCCS task (color/shape). Half the children were told the dimension to use to sort the cards (rule-given), while the other half had to infer the rule for sorting (rule-learning). Children had up to 30 trials to attain five correct consecutive trials. In the post-shift, children received five trials in which they were told to shift responding to the opposite dimension.

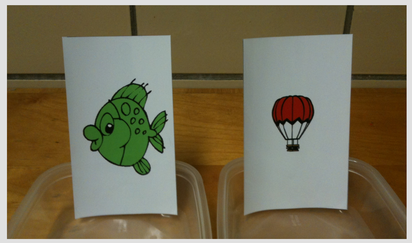
Not surprisingly, children who had to learn the sorting rule required more trials to criterion. There was no effect, however, of the rule condition on the number of errors in the post-shift, suggesting that rule learning had no effect upon cognitive control. However, because of the apparent ease to learn a two dimensional task, increasing the number of dimensions could reveal an effect of rule learning.



Experiment 2

Sixty kindergarten children participated in a three dimensional DCCS task (color/shape/size). As in Experiment 1, children were either given the rule or learned the rule, and then received five post-shift trials in which they were told to respond to the opposite dimension.

As in the first experiment, children in the rule learning condition took significantly longer to meet the pre-shift criterion than those given the rule. Unlike Experiment 1, children in the rule-learning condition made significantly fewer errors in the post-shift phase, hinting that rule learning may increase flexibility. One problem, however, is the confound between rule learning and the higher number of trials to reach criterion. Is the difference in flexibility because of rule learning or because of exposure to more trials?



	Rule condition	Pre-shift Phase (trials to criterion)	Post-shift Phase (errors)
Experiment 1 *(2 dimensional task)*	Rule-given	5.00*	.375
	Rule-learning	5.81*	.125
Experiment 2 *(3 dimensional task)*	Rule-given	5.53*	.876*
	Rule-learning	10.53*	.200*
Experiment 3 *(3 dimensional task with 10 trials to criterion for rule given condition only)*	Rule-given	10.13	.267
	Rule-learning	8.38	.133

*significantly different at the .05 level or less.

Experiment 3

This experiment included 60 kindergarten children and was identical to the second experiment with the exception that the learning criterion in the rule-given condition was doubled to 10 trials. This manipulation was designed to equate the number of trials to criterion thereby exposing any effect of the rule condition.

Under these conditions, there was no difference in the number of trials to criterion in the pre-shift phase as a function of rule condition; further, there were no differences in the post-shift errors due to the effect of rule condition.

Conclusions

Learning a rule, as opposed to being given a rule, appears to have no bearing on cognitive control or flexibility. Instead, increasing the trials to criterion, regardless of whether this involves being given the rule or learning the rule, appears to be responsible for improved cognitive flexibility. The beneficial effect of repeated exposure to stimulus dimensions for cognitive control may be interpreted within the iterative repossessing model. As children are exposed to more trials, regardless of their rule learning activity, their depth of processing to the higher-order dimensional rule increases thereby facilitating their cognitive control or flexibility.

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