

UC Merced

Proceedings of the Annual Meeting of the Cognitive Science Society

Title

Arithmetic Principle Acquisition via Implicit Learning

Permalink

<https://escholarship.org/uc/item/8w268560>

Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 29(29)

ISSN

1069-7977

Author

Prather, Richard

Publication Date

2007

Peer reviewed

Arithmetic Principle Acquisition via Implicit Learning

Richard Prather (rwprather@wisc.edu)
Department of Psychology, 1202 W. Johnson Street
Madison, WI 53706 USA

Keywords: Implicit Learning; Arithmetic

Introduction

Principles can be defined as regularities or general rules within a domain. Learners have been shown to use principles in a variety of domains, including language acquisition (Aslin, Saffran, & Newport, 1998) proportional reasoning (e.g., Dixon & Moore, 1996), and artificial grammars (Altmann, Dienes, & Goode, 1995). The focus of the current proposal is the acquisition of arithmetic principles.

Arithmetic principle knowledge is generally a well researched area from the perspective of cognitive development. However, relatively little is known of the mechanisms of arithmetic principle acquisition (Dixon, 2005). The current study uses methods similar to implicit learning of artificial grammars to investigate learning of arithmetic principles.

We examined adults' knowledge of *Relationship to Operands* in division. For a simple equation, $A \div B = C$, C must be less than A . Previous work has shown that adults have relatively weak knowledge of this principle (Dixon, Deets, & Bangert, 2001).

Method

Adult participants ($N = 13$) viewed equations presented serially on a computer screen for 1300 ms each. Instructions were that the equations had been produced by two students, John and Dan. The participants were to view all of the equations and consider if either student seemed to understand arithmetic better than the other. The equations were all in the $A \div B = C$ format. In each, the answer (C) was color coded, green for correct or red for incorrect. This enabled the participant to quickly determine if the equation was correct without having to verify it themselves.

All participants saw 56 equations total. The number of correct equations (16) and incorrect equations (40), was the same for all participants. Participants in the control condition saw incorrect equations that did not violate the principle. Participants in the learning condition saw both non-violations and violations.

Principle knowledge evaluation was via an equation rating task based on prior work (Dixon et al., 2001). Participants rated sets of equations with instructions that the equations had been produced by students learning arithmetic. Participants rated how well the students seem to understand arithmetic on a 1 (bad) to 7 (pretty good) scale. Equation sets were created so that all equations were incorrect. Half of the equation sets included violations of the *Relationships to Operand* principle, while half did not. The

average deviation from the correct answer was the same for violation and non-violation sets. Participants who had knowledge of the principle should rate violation sets lower than non-violation sets.

Results and Discussion

Data were analyzed with an ANOVA, with the within subject factor of equation type (violation or non-violation), and the across subject factor of condition (learning or control). Participants showed a main effect of equation type, $F(1, 63) = 19.10, p = .001$. Participants also showed a significant interaction between equation type and condition, $F(1, 63) = 9.74, p = .003$.

Planned contrasts revealed significant differences between the ratings of violation and non-violation equations for participants in the learning condition, while no such difference is found for control condition participants (see figure 1). This indicates that only learning condition participants show knowledge of the *Relationship to Operands* principle at posttest.

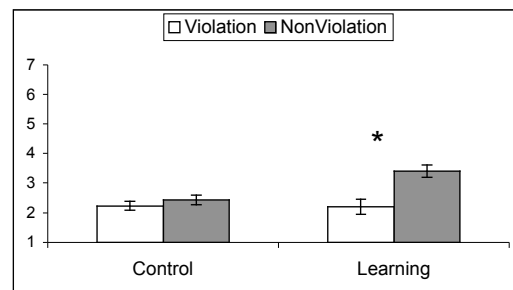


Figure 1: Average ratings of equation sets.

References

- Altmann, G., Dienes, Z., Goode, A. (1995) Modality Independence Implicitly learned grammatical knowledge. *Journal of Experimental Psychology: Learning, Memory, and cognition*, 21(4), 899-912.
- Aslin, R., Saffran, J., & Newport, E. (1998). Computation of conditional probability statistics by 8 month old infants. *Psychological Science*, 9(4), 321-324.
- Dixon, J., & Bangert, A. (2005). From regularities to concepts. *Cognitive Development*, 20, 65-86.
- Dixon, J., Deets, J., & Bangert, A. (2001). The representations of the arithmetic operations include functional relationships. *Memory & Cognition*, 29(3), 462-477.
- Dixon, J., & Moore, C. (1996). The developmental role of intuitive principles in choosing mathematical strategies. *Developmental Psychology*, 32, 241-253.