Children's Understanding of Time of Day Through Time-place Learning

Christina M. Thorpe, Darcy Hallett, Joy Crocker, and Erin Carter

Memorial University of Newfoundland

Introduction

- Psychologists have previously studied children's ability to discern or describe the current time of day
- Previous research relied heavily on children's knowledge of time words, which confounded children's understanding of time of day with their level of vocabulary development (Ames, 1946; Bradley, 1947; Oakden & Sturt, 1922)
- Time-Place-Learning (TPL) research investigates the ability of non-human animals to learn the location of a resource when its location varies according to time
- There are three types of TPL (Carr & Wilkie, 1997):
  - Circadian: location of the reward varies depending on time of day
  - Interval: spatial location of a reward varies depending on the time since some external event
  - Ordinal: do not learn timing of occurrences but rather the order in which they occur within a particular time frame
- Can children incorporate time-of-day information in a non-verbal TPL task?

Method

A total of 38 pre-school children from 6 different daycares in St. John's, NL, Canada participated (20 boys and 18 girls). Nine children were eliminated because they completed less than 38 morning and afternoon trials. One more child was eliminated because they were not interviewed. Of the 10 children who were eliminated, 7 were girls.

- Children were randomly assigned to one of two test groups:

Explicit Group	Implicit Group
Was told:	Was told:
"there is a toy in one of the boxes and it will be in one box in the morning and the other box in the afternoon"	"there is a toy in one of the boxes and it is sometimes in one box and sometimes in the other"

- Used two boxes, one contained a toy and the other remained empty
- The toy was in one location in the morning and the other location in the afternoon
- For the first week, the researcher shook each box and then asked the child to chose which box the toy was in
- For the test trials, the child was asked to go to whatever location they thought the toy was in during each testing session

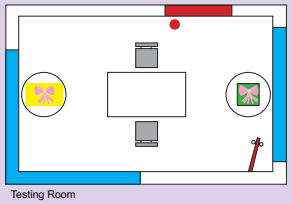

Figure 1. Regression of conceptual knowledge and procedural knowledge. The solid line is the regression line predicting procedural knowledge from conceptual knowledge while the dotted line is the regression line predicting conceptual knowledge from procedural knowledge. Being above the solid line would mean that a person has a positive procedural residual score, while being to the right of the dotted line would mean that a person has a positive conceptual residual score.

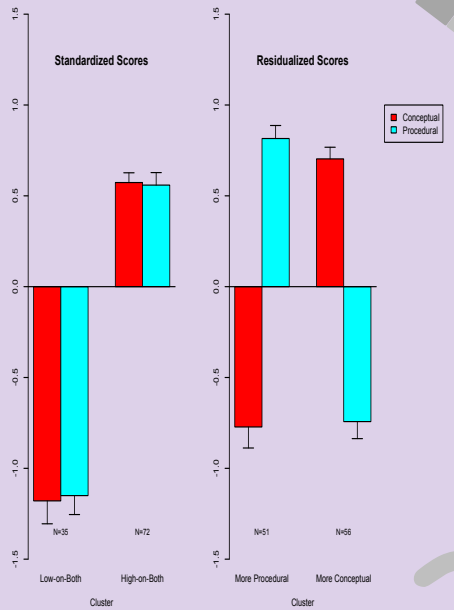

Figure 2. Standardized (absolute) and Residualized (relative) cluster solutions

Table 1 Cross-tabulation of Residualized vs. Standardized Cluster Solutions

	Standardized Scores	
Residualized Scores	Low-on-Both	High-on-Both
More Procedural	16	35
More Conceptual	19	37

Results

Results indicate that both the absolute scores and the relative scores exhibit a 2-cluster solution (see Figure 2). For the absolute scores, one group of children performed poorly on both conceptual and procedural knowledge while the other group performed well on both measures. For the relative scores, one group of children had procedural scores that were much stronger than their conceptual scores, while the second group exhibited the opposite pattern. Interestingly, however, these two classifications of the same students were independent of each other ($\chi^2(1) = 0.079$, $p = .778$, see Table 1).

The absolute clusters also demonstrated significant mean differences across all the other variables (General Fractions Measure, Working Memory, Math Facts RT). The residualized clusters did not demonstrate a significant on General Fractions or Math Facts RT, but did demonstrate a significant difference on Working Memory. The More Procedural children had a slightly higher working memory capacity than the More Conceptual children (Ms = 5.08 vs. 4.32, respectively, $F[1,101] = 4.932$, $p = .029$).

Conclusion

These results suggest that not only are there different profiles of conceptual and procedural knowledge in Grade 8 students, but also that profiles of relative scores and absolute scores may give us different information about how children learn about fractions. Further research is needed to explore other differences between these clusters and how they may learn differently.

References

Byrnes, J. P. & Wasik, B. A. (1991). Role of Conceptual Knowledge in Mathematical Procedural Learning. *Developmental Psychology, 27*(5), 777 - 786. doi:10.1037/0012-1649.27.5.777

Canobi, K. H. (2009). Concept-procedure interactions in children's addition and subtraction. *Journal of Experimental Child Psychology, 102*(2), 131-149. doi:10.1016/j.jecp.2008.07.008

Canobi, K. H., Reeve, R. A., & Pattison, P. E. (2003). Patterns of knowledge in children's addition. *Development Psychology, 39*(3), 521-534.

Gilmore, C. K., & Bryant, P. (2006). Individual differences in children's understanding of inversion and arithmetical skill. *British Journal of Educational Psychology, 76*(2), 309-331. doi:10.1348/000709905X39125

Hallett, D., Nuñes, T., & Bryant, P. (2010). Individual differences in conceptual and procedural knowledge when learning fractions. *Journal of Educational Psychology, 102*(2), 395-406. doi:10.1037/a0017486

Kerslake, D. (1986). *Fractions: Children's strategies and errors. A report of the strategies and errors in Secondary Mathematics Project.* Windsor, UK: NFER-Nelson Publishing.

Mabbot, D. J., & Bisanz, J. (2003). Developmental change and individual differences in children's multiplication. *Child Development, 74*(4), 1091-1107, doi:10.1111/1467-8624.00594

Rittle-Johnson. B., Siegler, R. S. & Alibali, M. W. (2001). Developing conceptual understanding and procedural skill in mathematics: An iterative process. *Journal of Educational Psychology, 93*(2), 346 - 362. doi:10.1037/0022-0663.93.2.346

Smith, P., Hallett, D., Canning, A., & Snow, C. (2009, April). *Differing profiles in the conceptual and procedural understanding of fractions.* Poster presented at the biennial meeting of the Society for Research in Child Development, Denver, Colorado.

Please address correspondence to:
Darcy Hallett
Department of Psychology, Memorial University of Newfoundland
St. John's, NL, A1B 3X9, CANADA

e-mail: darcy@mun.ca
Website: http://dogsbody.psych.mun.ca/rcdmc