

Final report for Internal LRDC Project
“Tell me about math: A longitudinal training study on the effects of parent-child interactions and parental cognition on children's math abilities”

Melissa Libertus & Klaus Libertus

The goal of the project is to examine the relations between the basic number skills and math abilities in parents and their preschool-aged children and how parents’ basic number skills and math abilities influence their informal STEM learning activities with their children – a known predictor of future math abilities. To achieve this goal, we are conducting a 6-month longitudinal training study, in which parents (and children) are randomly assigned to five different training conditions: 1) parent-child number game training, 2) parent-child color game training, 3) parent basic number skills training, 4) parent general world knowledge training, or 5) no training. We are assessing the relation between parents’ basic number skills and math ability, number-related parent-child interactions (number talk, home learning activities), and children’s own basic number skills and math ability using a series of behavioral tasks and standardized assessments administered in the lab. Semi-structured parent-child interactions in the lab are supplemented by naturalistic in-home observations via video chat before, immediately after, and two months after the completion of the respective training conditions.

Pilot data generated from this internal award were used for a successful grant application to the National Science Foundation (DUE-1534830; PI: Melissa Libertus; Co-PIs: Klaus Libertus, Aidan Wright) and has supported six additional, unsuccessful applications for extramural funding (two applications for NSF CAREER awards, one NIH R01 application, one NIH R21 application, one NSF application, and one application submitted to the Jacobs Foundation). Three additional grant applications are currently pending or in preparation (one NSF CAREER award and two NSF applications due in September 2017) and resubmissions to NIH are planned for the future.

Even though data collection for the NSF-funded continuation of the project is still ongoing, the project has already resulted in one peer-reviewed journal publication, another one currently under review, and one conference presentation, each described in more detail below. In addition, two further conference submissions (one for the Biennial Meeting of the Cognitive Development Society (CDS), and one for the Annual Meeting of the American Education Research Association (AERA)) are currently pending. All of these publications and posters are first-authored by graduate students, except for the CDS submission, which is first-authored by an undergraduate honors student in the lab.

In collaboration with two graduate students (Leanne Elliott, Developmental Psychology PhD program, and Emily Braham, Cognitive Psychology PhD program), we recently published a paper in *Journal of Experimental Child Psychology*, in which we report a significant link between parents' math talk and a broad measure of children's math abilities, expanding previous reports of links between parents' math talk and children's counting skills. Importantly, we show that parents' approximate number system acuity correlates with their math talk, i.e., parents with greater precision in their approximate

number representations tend to talk more about numbers when playing with their children. This is the first study to illustrate potential origins of individual differences in parents' math talk.

In a follow-up study led by Emily Braham, we provided half of the parents with specific prompts to play with their child in a way that incorporated greater levels of math talk while the other half of parents received specific prompts to talk about another topic. After these parent-guided play interactions, children in the math talk condition showed a significantly higher level of spontaneous focus on number than children in the control condition. Importantly, other studies have shown that spontaneous focus on number is predictive of children's math ability suggesting that our findings highlight an important avenue to improve children's math abilities through a low-cost parent-guided intervention. These findings are currently under review for publication in a top-ranking journal in developmental psychology.

Finally, we recently presented some of our results at a symposium of the Biennial Meeting of the Society for Research in Child Development (Elliott & Libertus, 2017). There has been an on-going debate in the field regarding the existence of the approximate number system (Leibovich et al., 2017; Gebuis, Cohen Kadosh & Gevers, 2016). Several recent papers claimed that tasks tapping into the approximate number system were merely reflecting inhibitory control skills and that the link between the approximate number system and math abilities could be explained by the shared reliance on inhibitory control (Gilmore et al., 2013; Fuhs & McNeil, 2013). Our data from this project supported our previous conclusions (Keller & Libertus, 2015) that inhibitory control and approximate number system acuity are independent predictors of children's math abilities.

In sum, the LRDC internal award has been extremely helpful in getting this new line of research off the ground and has already generated several important results. Since we were able to secure additional extramural funding quickly – a sign that this type of work is of general interest to many people in the field, we were able to return part of the original internal funds to LRDC. As we continue our work, we expect further publications and funding for follow-up projects expanding the current work to different populations (e.g., low SES, ethnically and racially diverse families, younger children, and/or children at heightened risk for math learning disabilities).