

Postdoctoral Position in Educational Neuroscience & Cognitive Development of Mathematics

We seek a Postdoctoral Research Associate to work on a longitudinal behavioral and fMRI study of fractions processing (project summary below) at the University of Wisconsin-Madison (PI Edward Hubbard; Co-PI Percival Matthews). This is a 2-year appointment that will begin October 2016, with the possibility of extension for a third.

The ideal candidate will have a background in neuroimaging of numerical cognition, and especially working with imaging in developmental populations. Experience with neuroimaging analysis programs (e.g., AFNI, FSL, SPM, or other relevant programs), stimulus presentation programs (e.g., E-prime, Presentation, Cogent/Psychtoolbox [MATLAB]), and statistical analysis (e.g., MATLAB, R, SPSS) is required. Excellent scientific writing skills and strong publication records are highly desired. Applicants should be able to work independently and with minimal supervision, but should also demonstrate interpersonal skills and an interest in working collaboratively.

Please send a letter of interest describing graduate training and research interests, a CV, two publications and the names and contact information for three potential references, by electronic mail to emhubbard@wisc.edu with POSTDOC INQUIRY in the subject line.

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Project Summary

Mathematical competence is an important determinant of life chances in modern society, and knowledge of fractions is a foundational skill for establishing mathematical competence. Despite the importance of fraction knowledge, children and adults often encounter considerable difficulties understanding fractions. To explain these widespread difficulties, many researchers have argued for an innate constraints account. They propose that fractions are difficult because they do not correspond to any preexisting categories in our brain, unlike whole numbers, which correspond to sets of countable things. Thus, they argue fraction concepts are challenging because they do not benefit from existing cognitive abilities and instead must be learned through adapting children's whole number understanding.

The study team proposes a competing hypothesis, the cognitive primitives account, which integrates previously unrelated findings from neuroscience, developmental psychology and education. We argue that a primitive ability that we dub the ratio processing system (RPS) is tuned to the processing of non-symbolic fractions—such as the relative length of two lines or the relative area of two figures—and is present even before formal instruction. On this view, children are equipped with cognitive

mechanisms that support fraction concepts in the same way that the ability to process countable sets equips them to learn about whole numbers.

To test the predictions of these competing hypotheses, this project will follow two cohorts of children (2nd graders until 5th grade and 5th graders until 8th grade) using behavioral and brain imaging methods to (a) trace the development of non-symbolic fraction processing abilities, (b) determine how symbolic fraction knowledge builds on these abilities and (c) investigate whether individual differences in the RPS predict later math achievement. To test whether the acuity or recruitment of these non-symbolic architectures plays a role in fraction difficulties as well as general math learning difficulties, the study team will compare the behavioral performance and neural activity on a battery of cognitive tasks.

This research has important implications for our understanding of number processing and for designing educational practices that are optimal for fraction learning. Improving fractions understanding would help children to clear a critical hurdle in the acquisition of higher-order mathematical competencies that impact educational, employment, and even health outcomes. If cognitive primitives for non-symbolic fractions can provide a foundation for the acquisition of symbolic fraction ability, then instruction should attempt to recruit these primitives. If deficits in these primitives contribute to math learning difficulties, then screening should include measures of non-symbolic abilities and interventions should be designed to address these abilities.