Temple University

Cognition & Learning Lab

Newsletter

Fall 2021

We hope everyone has had a safe and rejuvenating summer! Over the past year, in response to the ongoing pandemic, we conducted our first fully online, Zoom-based research studies. We are grateful to be able to continue our research in this new format, and to be able to work with families from all over the U.S. and even abroad. This coming year, we are hoping to be able to safely return to in-person research with our local school partners. We are also planning new online, Zoom-based studies. We look forward to seeing you, whether in a classroom, in the lab, or on our screens!

In this issue of our newsletter, we've included information on who we are and highlights from the research we've completed in the past year. The Research Profiles in this newsletter look at some exciting results related to the development of children's spatial skills, number line estimation, and calculation skills. We have also been asking questions about parent-child interactions, children's responses to praise, preschoolers' understanding of sizes and numbers, and more – stay tuned for results in a future newsletter!

As always, we are very grateful to our school partners and the students and parents who generously give their time to these studies. Without you, we could not answer these exciting research questions. We hope you find the information in this newsletter both interesting and useful! Our contact information is at the end of this newsletter if you have questions or want to know how to get involved in our research. We wish you the best this year and hope to see you soon!

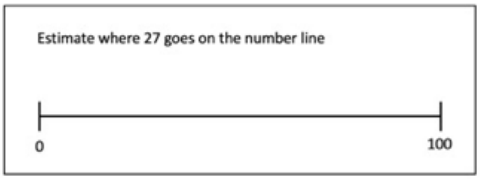
Liz Gunderson, Ph.D.

Associate Professor of Psychology,
Temple University

Research Profiles

Spatial Skills, but Not Spatial Anxiety, Mediate the Gender Difference in Number Line Estimation (Part 1)

Jing Tian, Ph.D.



The ability to accurately represent numbers on a number line is important for general math achievement. Recent research shows that, on average, boys are better than girls at number line estimation. What factors might contribute to this gender difference?

In this study, we examined whether spatial skills and spatial anxiety contribute to the gender difference in number line estimation. Similar to number line estimation, prior studies often found that, on average, boys to be better at spatial tasks than girls whereas girls to express higher levels of anxiety when completing spatial tasks. Estimating where a number goes on a spatial line likely taxes spatial skill. Therefore, we hypothesized spatial skills and spatial anxiety contribute to the gender difference in number line estimation.

To test these expectations, we assessed number line estimation, spatial skills, and spatial anxiety among 490 children from kindergarten through 4th grade. Four spatial skills were assessed.

- Proportional reasoning, the skill to reason with proportions. Measured by a task on which children need to translate proportions represented by rectangles onto lines. *(see figure a)*

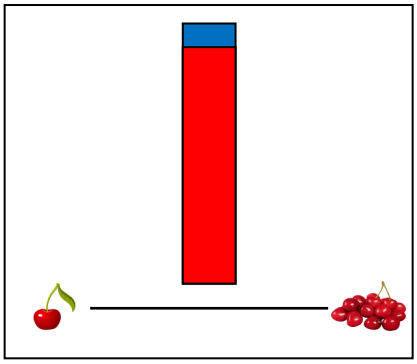


Figure a. "The vertical rectangle represents a cup cherry drink. The blue part is water, and the red part is cherry juice. The left end of the horizontal line at the bottom represents "tastes not at all like cherries", and the right end represents "tastes a lot like cherries".

- Mental rotation, the skill to distinguish between mirror-reversed rotated images. *(see figure b)*

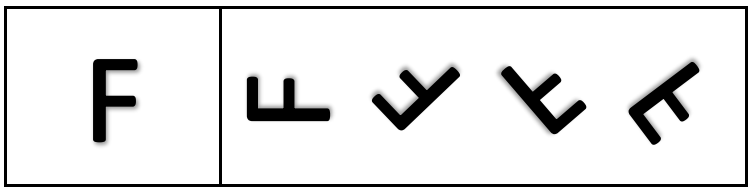


Figure b. "Which two of the four letters on the right match the target letter on the left?"

Research Profiles

Spatial Skills, but Not Spatial Anxiety, Mediate the Gender Difference in Number Line Estimation (Part 2)

Jing Tian, Ph.D.

- Mental transformation, the skill of mentally transforming images by rotating, translating, and feature matching. *(see figure c)*

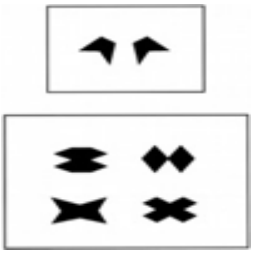


Figure c. "The two pieces on the top make one of the four pictures. Which picture do

- Visuospatial working memory, the capacity to maintain visuospatial information in the mind for a brief period. *(see figure d)*

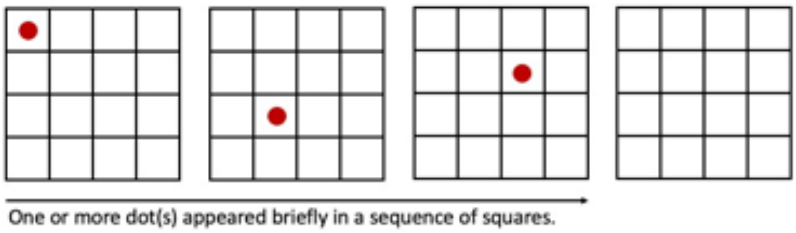


Figure d. "After the sequence is completed,"Point to the squares in the sequence that the dt(s) appeared in them."

Our results showed that a composite measure of all the four spatial skills contributed to the gender difference in number line. When examining the four individual spatial skills, proportional reasoning and mental rotation skills contributed to the gender difference in number line estimation. These results suggest that one reason for boys to be more accurate than girls at estimating numbers on the number line was that boys had better spatial skills, proportional reasoning and mental rotation in particular, than girls. However, spatial anxiety did not contribute to the gender difference in number line estimation.

Additionally, we assessed children's number line estimation five months later to examine whether spatial skills or spatial anxiety contribute to the development of the gender difference in number line estimation. Similarly, we found spatial skills (proportional reasoning and mental rotation in particular), but not spatial anxiety, to contribute to the development of the gender difference in number line estimation. These findings suggest that improving girls' spatial skills might reduce the gender gap in number line estimation.

Research Profiles

Relations Between Spatial Skills, Calculation, and Number Line Estimation (Part 1)

By Elizabeth Gunderson, Ph.D.

We recently published the results of a two-year longitudinal study of spatial and numerical skills in a diverse group of 612 pre-k through 4th graders (Gunderson & Hildebrand, 2021). Spatial skills involve being able to hold in mind and mentally manipulate visual information including shapes, locations, and lengths. For example, visualizing how a puzzle piece would look if turned 90 degrees involves spatial skills. Because both spatial and numerical skills have many specific components, we were interested in whether specific spatial skills would relate to specific numerical skills. We also asked whether children with higher spatial skills at the start of the study would improve more rapidly in numerical skills over time. At the start of the study, we assessed the same spatial skills mentioned in the prior Research Profile: proportional reasoning, mental rotation, mental transformation, and visuospatial working memory. We also assessed a fifth skill, the ability to quickly estimate which is more between two sets of dots (see figure a).

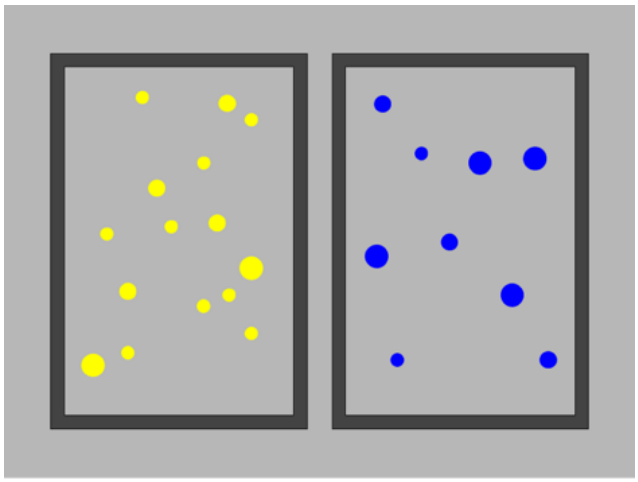


Figure A. Dot comparison task example.

We then assessed children's exact calculation (figure b), approximate calculation (figure c), and number line estimation skills (figure d) twice per year for two school years.

$6 + 1 = \square$	$2 + 4 = \square$	$\begin{array}{r} 5 \\ -2 \\ \hline \end{array}$

Figure B. Exact calculation task example.

Research Profiles

Relations Between Spatial Skills, Calculation, and Number Line Estimation (Part 2)

By Elizabeth Gunderson, Ph.D.

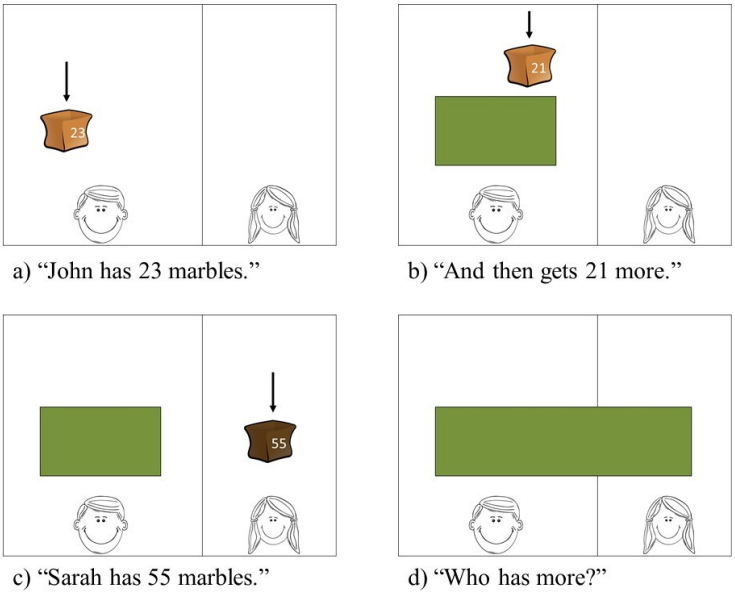
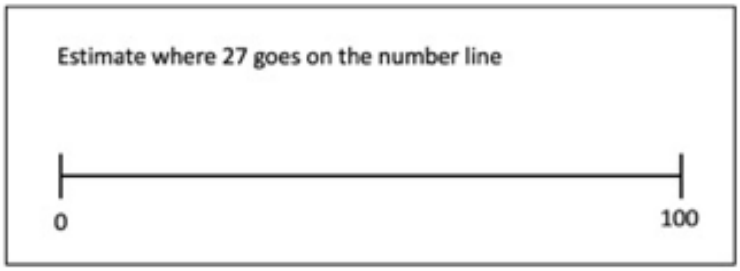


Figure C. Approximate calculation task example. In this task, students see animated images of buckets disappearing behind a green screen, and must estimate to determine which side has a larger number of marbles.

Figure D. Number line estimation task



The results of this study showed that there were specific relations between certain types of spatial and numerical skills at the start of the study. In particular, children with higher mental rotation, proportional reasoning, and dot comparison skills had higher exact calculation skills. Further, children with higher proportional reasoning skills tended to do better at number line estimation. Finally, children's better dot comparison skills were related to better approximate calculation skills. However, we did *not* find any evidence that children with stronger spatial skills at the start of the study improved more quickly in numerical skills over time, suggesting that the relations between these skills were already present at a young age. Rather than thinking of "spatial skill" as a single competency, our study indicates that researchers and educators should consider specific aspects of spatial skills (mental rotation, proportional reasoning, and dot comparison skills) and specific aspects of numerical thinking (exact calculation, approximate calculation, and number line estimation) to better understand why and how these skills are intertwined.

Meet the Lab

Dr. Elizabeth Gunderson

Elizabeth Gunderson, Ph.D., is an Associate Professor in the Department of Psychology at Temple University and director of the Temple University Cognition & Learning Lab. She received her Ph.D. in Developmental Psychology from the University of Chicago in 2012 and her B.A. in Computer Science & Psychology from Yale University in 2005. Dr. Gunderson's research focuses on the cognitive and socio-emotional factors that affect young children's academic achievement, especially in the domain of mathematics.

Dr. Jing Tian

Jing is a post-doctoral researcher in the Department of Psychology at Temple University. Jing completed her Ph.D. in Psychology at Carnegie Mellon University in 2018 and received her B.S. in Chemistry and Psychology from Peking University in 2013. Jing is interested in children's learning, especially in the area of mathematics. Her research focuses on understanding difficulties children experience during learning and aims to provide insights for more effective instruction.

Meet the Lab

Xinhe Zhang

Xinhe is a doctoral student in Developmental Psychology at Temple University. She received her M.Sc. in Psychology at University of Birmingham in 2017. After graduation, she worked in educational companies to research and develop competence assessments for middle school students and then focus on gamified cognitive ability tests and training for Primary School students. In the Temple Cognition and Learning Lab, she is interested in the development of spatial and numerical processing.

Grace Bennett-Pierre

Grace is pursuing her doctoral degree in Developmental Psychology at Temple University, after completing her B.A. in Psychology at Wellesley College in 2016. She has previously studied the development of young children's understanding of difficulty and its use in decision-making as a lab manager for Dr. Hyowon Gweon. In the Temple Cognition & Learning Lab, she is excited to explore how children form domain-specific concepts of difficulty and how these conceptions influence their achievement motivation.

Nadia Tavassolie

Nadia is a doctoral student in Developmental Psychology at Temple University. She received her B.A. at George Washington University double majoring in Anthropology and Human Services & Social Justice. She is interested in how children develop math knowledge, with a focus on social factors that influence academic motivation and achievement in math. She hopes to apply this research towards identifying the most important skills for later math achievement, and to develop tools that can be used at home or in school to cultivate those skills.

Meet the Lab

Emily D'Antonio

Emily is a full-time lab manager in the Temple University Cognition & Learning Lab. They received their B.A. in Psychology from Catholic University of America in 2021. As a research assistant for Dr. Nancy Adleman, they studied social and attention abilities as well as the impacts of implicit memory on mood recall. They hope to study parent-child interactions with LGBTQ+ populations to understand children's social and cognitive development and school performance.

Lexi Sylverne

Lexi is a full-time lab manager in the Temple University Cognition & Learning Lab. Lexi received their B.A in Psychology with a minor in Gender, Sexuality and Women's Studies from Temple University in 2021. Lexi was previously an undergraduate research assistant for Dr. Gunderson, where they assisted on projects investigating predictors of early math achievement, and how parent-child interactions can influence the development of children's spatial skills. They are interested in researching how to best support mental health and educational performance in children with developmental disabilities, such as Autism Spectrum Disorder and ADHD.

Meet the Lab

Khushi Sibal

Undergraduate Intern

B.A. expected Spring 2022

Major: Psychology

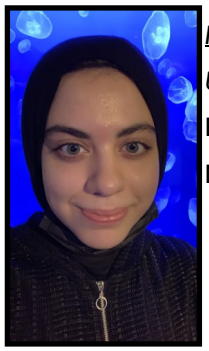
Minor: Cognitive Neuroscience

Sevila Temirova

Undergraduate Intern

B.A expected Spring 2023

Major: Psychology



Rawan Altamimi

Undergraduate Intern

B.A. expected Spring 2022

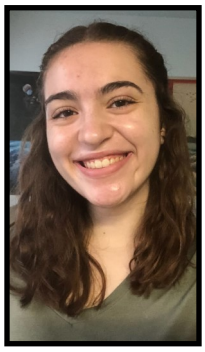
Major: Psychology

Asravi Chilakamarri

Undergraduate Intern

B.A. expected Fall 2023

Major: Psychology



Ashley Bontempo

Undergraduate Intern

B.A. expected Spring 2024

Major: Psychology

Minor: Criminal Justice

Certificate: American Sign Language

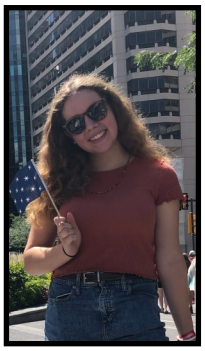
Taylor Chernuta

Undergraduate Intern

B.A. expected Spring 2023

Major: Psychology

Minor: Adult & Organizational Development



Joei Camarote

Undergraduate Intern

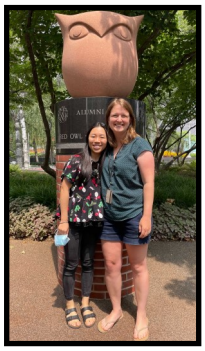
B.A. expected Spring 2023

Major: Psychology

Minor: Cognitive Neuroscience

Meet the Lab

Congratulations Class of 2021! This summer we said goodbye to another group of graduating undergraduate research assistants. We wish them all the best and will miss them here in the TUCL Lab!



Congratulations to Dr. Cathy (Kexin) Ren for completing her Ph.D. program this year! We are excited to see her start her journey doing user research at Google!

TUCL Lab (*from left to right*): Dr. Elizabeth Gunderson, Lexi Sylverne, Kimberly Bohl, Nadia Tavassolie (graduate student), Dr. Jing Tian, Grace Bennett-Pierre (graduate student) & Dr. Cathy (Kexin) Ren.

Contact Information

If you would like more information about our research, or are interested in participating, please contact us via e-mail or phone.

Email: tucl@temple.edu
Phone: +1 (215) 204 - 9175

Check us out on the web!
https://sites.temple.edu/cognitionlearning/

Interested in participating in research?

https://redcap.link/TUCLResearch

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