

## Curriculum Vitae

### Zachary Hawes

Assistant Professor

Department of Applied Psychology & Human Development  
Ontario Institute for Studies in Education/University of Toronto

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Lab Website: <https://www.mathematicalthinkinglab.com/>

ResearchGate: [https://www.researchgate.net/profile/Zachary\\_Hawes](https://www.researchgate.net/profile/Zachary_Hawes)

Google Scholar: <https://scholar.google.com/citations?user=ZRlyUH8AAAAJ&hl=en>

Open Science Framework (OSF): <https://osf.io/5fuf5/>

### Address

45 Walmer Road

Dr. Eric Jackman Institute of Child Study

Department of Applied Psychology & Human Development

Ontario Institute for Studies in Education/University of Toronto

Toronto, ON, Canada, M5R 2X2

### Education

2015 - 2019      PhD Cognitive, Developmental, and Brain Sciences  
University of Western Ontario  
Advisor: Daniel Ansari

2009 - 2011      MA Child Studies and Education  
Applied Psychology & Human Development  
Ontario Institute for Studies in Education (OISE)  
University of Toronto

2008              Post-degree studies in Psychology  
Wilfrid Laurier University

2002 - 2006      BKin Honours Kinesiology  
Faculty of Sciences  
Wilfrid Laurier University

### Academic Positions

2019 - present      Assistant Professor  
Department of Applied Psychology & Human Development  
Ontario Institute for Studies in Education/University of Toronto

2011 - 2015                      Research Officer  
 The Robertson Program for Inquiry-Based Teaching in Mathematics and  
 Science  
 Dr. Eric Jackman Institute of Child Study  
 Department of Applied Psychology & Human Development  
 Ontario Institute for Studies in Education/University of Toronto

## Refereed Journal Publications

Whitehead, H.L., & **Hawes, Z.** (2023). Cognitive foundations of early mathematics: Investigating the unique contributions of numerical, executive function, and spatial skills. *Journal of Intelligence*, 11(12), 1-18. <https://doi.org/10.3390/jintelligence11120221>

Scerif, G., Blakey, E., Gattas, S., **Hawes, Z.**, Howard, S., Merkley, R., O'Connor, R., & Simms, V. (2023). Making the executive 'function' for the foundations of mathematics: The need for explicit theories of change for early interventions. *Educational Psychology Review*, 35(110), 1-27. <https://doi.org/10.1007/s10648-023-09824-3>

Gilligan-Lee, K., **Hawes, Z.**, Williams, A.Y., Farran, E.K., & Mix, K.S. (2023). Hands-on: Investigating the role of physical manipulatives in spatial training. *Child Development*, 94(5), 1205-1221. <https://doi.org/10.1111/cdev.13963>

Bruce, C.D., Flynn, T., Yearley, S., **Hawes, Z.** (2023). Leveraging number lines and unit fractions to build student understanding: Insights from a mixed methods study. *Canadian Journal of Science, Mathematics, and Technology Education*, 1-18, <https://doi.org/10.1007/s42330-023-00278-x>

Sokolowski, H. M., **Hawes, Z.**, & Ansari, D. (2023). The neural correlates of retrieval and procedural strategies in mental arithmetic: A functional neuroimaging meta-analysis. *Human Brain Mapping*, 44(1), 229-244, <https://doi.org/10.1002/hbm.26082>

Sokolowski, H. M., **Hawes, Z.**, Leibovich-Raveh, T., & Ansari, D. (2022). Number symbols are processed more automatically than nonsymbolic numerical magnitudes: Findings from a Symbolic-Nonsymbolic Stroop task. *Acta Psychologica*, 228, <https://doi.org/10.1016/j.actpsy.2022.103644>

Gilligan-Lee, K.A., **Hawes, Z.C.K.**, & Mix, K.S. (2022). Spatial cognition as the missing piece of mathematics curricula. *npj Science of Learning*, 7(10), 1-4, <https://doi.org/10.1038/s41539-022-00128-9>

Lau, N., **Hawes, Z.**, Tremblay, P., & Ansari, D. (2022). Disentangling the individual and contextual effects of math anxiety: A global perspective. *Proceedings of the National Academy of Sciences*, 119(7), <https://doi.org/10.1073/pnas.2115855119>

**Hawes, Z.C.K.**, Gilligan-Lee, K.A., & Mix, K.S. (2022). Effects of spatial training on mathematics performance: A meta-analysis. *Developmental Psychology*, 58(1), 112-137 <http://doi.org/10.1037/dev0001281>

Sokolowski, H. M., **Hawes, Z.**, Peters, L., & Ansari, D. (2021). Symbols are special: An fMRI adaptation study of symbolic, nonsymbolic and non-numerical magnitude processing in the human brain. *Cerebral Cortex Communications*, 2(3), tgab048  
<https://doi.org/10.1093/texcom/tgab048>

**Hawes, Z.**, Merkley, R., Stager, C. L., & Ansari, D. (2021). Integrating numerical cognition research and mathematics education to strengthen the teaching and learning of early number. *British Journal of Educational Psychology*, 91(4), 1073-1109  
<https://doi.org/10.1111/bjep.12421>

Muñoz-Rubke, F., Will, R., **Hawes, Z.**, & James, K. (2021). Enhancing spatial skills through mechanical problem solving. *Learning and Instruction*, 75, 1-12.  
<https://doi.org/10.1016/j.learninstruc.2021.101496>

McDonald, J., Merkley, R., Mickle, J., Collimore, L., **Hawes, Z.**, & Ansari, D. (2021). Exploring the implementation of early math assessments in kindergarten classrooms: A research-practice collaboration. *Mind, Brain, and Education*, 15(4), 311-321. <https://doi.org/10.1111/mbe.12293>

Wilcox, G., Morett, L.M., **Hawes, Z.**, & Domett, E. (2021). Why educational neuroscience needs educational and school psychology to effectively translate neuroscience to educational practice. *Frontiers in Psychology*, 11:618449. <https://doi.org/10.3389/fpsyg.2020.618449>

Woolcott, G., Chamberlain, D., **Hawes, Z.**, Drefs, M., Bruce, C. D., Davis, B., ... & Mulligan, J. (2020). The central position of education in knowledge mobilization: Insights from network analyses of spatial reasoning research across disciplines. *Scientometrics*, 125(3), 2323-2347.  
<https://doi.org/10.1007/s11192-020-03692-2>

**Hawes, Z.**, Moss, J., Caswell, B., Seo, J., Thomson, M., Thomson, N., Bailey, C. (2020). Effects of a teacher-designed and teacher-led number board game intervention: A randomized controlled trial with 4- to 6- year-olds. *Mind, Brain, and Education*, 14(1), 71-80.  
<https://doi.org/10.1111/mbe.12215>

**Hawes, Z.**, & Ansari, D. (2020). What explains the relationship between spatial and mathematical skills? A review of evidence from brain and behavior. *Psychonomic Bulletin & Review*, 27, 465-482. <https://doi.org/10.3758/s13423-019-01694-7>

**Hawes, Z.**, Sokolowski, H. M., Ononye, C. B., & Ansari, D. (2019). Neural underpinnings of spatial and numerical cognition: An fMRI meta-analysis of brain regions associated with symbolic number, arithmetic, and mental rotation. *Neuroscience & Biobehavioral Reviews*, 103, 316-336. <https://doi.org/10.1016/j.neubiorev.2019.05.007>

**Hawes, Z.**, Moss, J., Caswell, B., Seo, J., & Ansari, D. (2019). Relations between numerical, spatial, and executive function skills and mathematics achievement: A latent-variable approach. *Cognitive Psychology*, 109, 68-80. <https://doi.org/10.1016/j.cogpsych.2018.12.002>

Sokolowski, H. M., **Hawes, Z.**, & Lyons, I. M. (2019). What explains sex differences in math anxiety? A closer look at the role of spatial processing. *Cognition*, 182, 193-212.  
<https://doi.org/10.1016/j.cognition.2018.10.005>

**Hawes, Z.**, Nosworthy, N., Archibald, L., & Ansari, D. (2019). Kindergarten children's symbolic number comparison skills predict 1st grade mathematics achievement: Evidence from a two-minute paper-and-pencil test. *Learning and Instruction*, 59, 21-33.

<https://doi.org/10.1016/j.learninstruc.2018.09.004>

**Hawes, Z.**, Moss, J., Caswell, B., Naqvi, S., & MacKinnon, S. (2017). Enhancing children's spatial and numerical skills through a dynamic spatial approach to early geometry instruction: Effects of a 32-week intervention. *Cognition and Instruction*, 35(3), 236-264.

<https://doi.org/10.1080/07370008.2017.1323902>

Bruce, C.D., Davis, B., Sinclair, N., McGarvey, L., Hallowell, D., Drefs, M., Francis, K., **Hawes, Z.**, Moss, J., Mulligan, J. & Okamoto, Y. (2017). Understanding gaps in research networks: Using “spatial reasoning” as a window into the importance of networked educational research. *Educational Studies in Mathematics*, 95(2), 143-161.

<https://www.jstor.org/stable/45184558>

Francis, K., Bruce, C., Davis, B., Drefs, M., Hallowell, D., **Hawes, Z.**, McGarvey, L., Moss, J., Mulligan, J., Okamoto, Y. & Sinclair, N. (2017). Multidisciplinary perspectives on a video case of children designing and coding for robotics. *Canadian Journal of Science, Mathematics and Technology Education*, 17(3), 165-178. <https://doi.org/10.1080/14926156.2017.1297510>

**Hawes, Z.**, Moss, J., Caswell, B., & Poliszczuk, D. (2015). Effects of mental rotation training on children's spatial and mathematics performance: A randomized controlled study. *Trends in Neuroscience and Education*, 4(3), 60-68. <https://doi.org/10.1016/j.tine.2015.05.001>

**Hawes, Z.**, LeFevre, J., Xu, C., & Bruce, C. (2015). Mental rotation with tangible three-dimensional objects: A new measure sensitive to developmental differences in 4- to 8-year-old children. *Mind, Brain, and Education*, 9(1), 10-18. <https://doi.org/10.1111/mbe.12051>

Moss, J., **Hawes, Z.**, Naqvi, S., & Caswell, B. (2015). Adapting Japanese Lesson Study to enhance the teaching and learning of geometry and spatial reasoning in early years classrooms: A case study. *ZDM – The International Journal on Mathematics Education*, 47(3), 377-390.

<https://doi.org/10.1007/s11858-015-0679-2>

Bruce, C. D., & **Hawes, Z.** (2015). The role of 2D and 3D mental rotation in mathematics for young children: What is it? Why does it matter? And what can we do about it? *ZDM – The International Journal on Mathematics Education*, 47(3), 331-343.

<https://doi.org/10.1007/s11858-014-0637-4>

**Hawes, Z.**, Moss, J., Finch, H., & Katz, J. (2013). Choreographing patterns and functions.

*Teaching Children Mathematics*, 19(5), 302-309. <https://doi.org/10.5951/teacchilmath.19.5.0302>

## Book Chapters

**Hawes, Z.**, Gilligan-Lee, K.A., & Mix, K.S. (2023). Infusing spatial thinking into elementary and middle school mathematics: What, why, and how? In K.M. Robinson, D. Kostopoulos, and A. Dubé (Eds.), *Mathematical cognition and understanding: Perspectives on mathematical minds in the elementary and middle school years* (pp. 13-33). Springer Nature Publishing

Flynn, T., **Hawes, Z.**, & Bruce, C. (in press). Paying attention to spatial reasoning in early years mathematics: Empowering children's learning through a playful, spatial approach. In S. Youmans and L. Colgan (Eds.) *Beyond 1, 2, 3: Early mathematics education in Canada*. CSP Books Inc.

Sinclair, N., Moss, J., **Hawes, Z.**, & Stephenson, C. (2019). Learning through and from drawing in early years geometry. In K. Mix and M. Battista (Eds.), *Visualizing mathematics: The role of spatial reasoning in mathematical thought* (pp. 229-252). New York, NY: Springer Nature Publishing.

McGarvey, L., Luo, L., **Hawes, Z.**, & Spatial Reasoning Study Group. (2018). Spatial skills framework for young engineers. In L. English and T. Moore (Eds.), *Early engineering learning* (pp. 53-81). Singapore: Springer Nature Publishing

**Hawes, Z.**, Tepylo, D., & Moss, J. (2015). Developing spatial thinking: Implications for early mathematics education. In B. Davis and Spatial Reasoning Study Group (Eds.), *Spatial reasoning in the early years: Principles, assertions and speculations* (pp. 29-44). New York, NY: Routledge.

Bruce, C., Sinclair, N., Moss, J., **Hawes, Z.**, & Caswell, B. (2015). Spatializing the mathematics curricula. In B. Davis and Spatial Reasoning Study Group. (Eds.), *Spatial reasoning in the early years: Principles, assertions and speculations* (pp. 85-106). New York, NY: Routledge

## Books

Moss, J., Bruce, C.D., Caswell, B., Flynn, T. & **Hawes, Z.** (2016). *Taking shape: Activities to develop geometric and spatial thinking*. Toronto, ON: Pearson

Davis, B., & Spatial Reasoning Study Group (2015). *Spatial reasoning in the early years: principles, assertions and speculations*. New York, NY: Routledge

## Educational Policy and Government Publications

**Hawes, Z.**, Flynn, T., (co-lead authors) (2014). *Paying attention to spatial thinking: K-12; Support document for paying attention to mathematical education*. Toronto, ON: Queen's Printer for Ontario. **Note:** Over 10, 000 copies in print; every school in Ontario received a copy

**Hawes, Z.** (2013). *Capacity Building Series: Inquiry-based learning*. Toronto, ON: Queen's Printer for Ontario. **Note:** Over 5, 000 copies in print; every school in Ontario received a copy

**Hawes, Z.**, Gibson, A., Mir, S., & Pelletier, J. (2012). Children's experiences in full-day programs for 4-and 5-year-olds: Play and self-regulation. In Corter, C., Janmohamed, Z., & Pelletier, J. (Eds.), *Toronto First Duty Phase 3 Report* (pp. 31-55). Toronto, ON: Atkinson Centre for Society and Child Development, OISE/University of Toronto.

## Editorials

Wilcox, G., Morett, L.M., **Hawes, Z.**, & Domett, E. (2022). The role of educational psychology as a bridge between neuroscience and education. *Frontiers in Education*.  
<https://doi.org/10.3389/feduc.2022.962930>

## Papers Under Review or in Preparation

**Hawes, Z.**, Whitehead, H.L, & Cai, Y. (revise and resubmit). How language shapes thought: The case of multiplication of fractions. Submitted as a registered report to *Journal of Cognition and Development*

Atit, K., Petersen, E.G., Gilligan-Lee, K., & **Hawes, Z.** (under review). Examining the relations between spatial skills and science achievement: A meta-analysis.

Avendano, K., Zamorano, V., **Hawes, Z.**, Soto, J., Castillo, J.S., & Munoz-Rubke, F. (under review). Relations between spatial skills and mechanical problem solving.

Scerif, G., Sučević, J., Blakey, E., Gattas, S., Godfrey, A., **Hawes, Z.**, Howard, S., Merkle, R., O'Connor, R., & Simms, V. (under review). Orchestrating early numeracy and the executive: Probing intervention mechanisms via efficacy metrics, disadvantage, and network analyses.

Rosenbaum, L., D'Silva, I., Whitehead, H., Crawford, M., Turco, J., Birrell, M., & **Hawes, Z.** (in preparation). Factors that shape teachers' relationship with mathematics.

**Hawes, Z.**, Anderson, E., Buhot, L., Dhir, S., Gottesman, S., Habib, A., Kim, D., Kingstone-Faria, B., Kupferschmidt, R., Mallette, J., Marchione, K., Selvin, S., Vlahos, & Yasmeen, S. (in preparation). Why should we care about spatial thinking? An evidence-based argument for the 'spatialization' of education

**Hawes, Z.**, & Shafir, T. (in preparation). The role of spatial thinking in mathematics learning difficulties.

**Hawes, Z.**, Moss, J., Caswell, B., Seo, J., Thomson, M., Thomson, N., Bailey, C. & Sinclair, N. (in preparation). Learning to see geometrical relationships: Effects of a teacher-led drawing intervention for 4- to 6- year-olds.

## Funding

- 2024 – 2026      Jacobs Foundation Research Fellowship  
*Maximizing human potential through spatial learning*  
 CAD: **\$255,000**  
 Role: Primary Investigator (PI)
- 2023 – 2025      Connaught New Researcher Award  
*How Language Influences Thought: The Case of Multiplying Fractions*  
 CAD: **\$19,978**  
 Role: Primary Investigator (PI)
- 2023 – 2025      Social Sciences and Humanities Research Council (SSHRC) Partnership  
 Engage Grant (PEG)  
*Leveraging Children's Interest in Basketball to Improve Access,  
 Understanding, and Attitudes Towards Mathematics*  
 CAD: **\$24,948**  
 Role: Primary Investigator (PI)
- 2023 – 2025      Education Endowment Foundation (EEF) and Stronger Practice Hubs  
*Embedding Executive Challenge into Early Maths: A Randomized  
 Controlled Trial* (abbreviated title: The ONE Project)  
 CAD: **\$1,667,644.48**  
 Role: Co-Investigator (PI: Gaia Scerif)
- 2023              Social Sciences and Humanities Research Council (SSHRC) Connection  
 Grant (SIG)  
 CAD: **\$24,966**  
*Connecting Advance Assessment and Intervention in Math Education: The  
 AIM Summit*  
 Role: Co-Applicant (PI: Rebecca Merkle)
- 2023              Social Sciences and Humanities Research Council (SSHRC) Institutional  
 Grant (SIG)  
 CAD: **\$6,864**  
*What's Your Relationship with Math? Uncovering the Factors that  
 Influence Elementary Teachers' Mathematical Identities*  
 Role: Primary Investigator (PI)
- 2023 – 2025      Education Research Funding Program (ERFP); Ministry of  
 Education, Singapore  
 CAD: **\$290,699.07**  
*A Study on Early Mathematics Professional Development (PD)*  
 Role: Co-Principal Investigator (PI: Pierina Cheung)
- 2022 – 2024      Social Sciences and Humanities Research Council (SSHRC)  
 Partnership Development Grant

- CAD: **\$198,980**  
*Assessment and Intervention for Mathematics (AIM)*  
 Role: Co-Applicant (PI: Jo-Anne LeFevre)  
 Ranked #1 out of 52 applications
- 2021 – 2023      National Institute of Education (NIE) Singapore  
 CAD: **\$111,810.40**  
*Early Foundations of Place Value*  
 Role: Co-Principal Investigator (PI: Pierina Cheung)
- 2021 – 2023      Nuffield Foundation  
 CAD: **\$299,772.40**  
*Fostering Resilience by Injecting Executive Challenge into Early Maths*  
 Role: Co-Investigator (PI: Gaia Scerif)  
 Link: <https://www.nuffieldfoundation.org/project/fostering-resilience-executive-challenge-early-maths>
- 2021 – 2023      The British Academy Leverhulme Small Research Grants  
 (SRG20\201210)  
 CAD: **\$17,161**  
*Hands-On: Investigating the Role of Physical Manipulatives in Spatial Training.*  
 Role: Co-Applicant (PI: Katie Gilligan-Lee)
- 2019 - 2021      Chilean Commission for Scientific and Technological Research  
 (CONICYT). Fund for Promotion of Scientific and Technological  
 Development (FONDEF IDeA I+D)  
 CAD: **\$367,678.66.**  
*Relations between Spatial Skills and Mathematics Performance in  
 Elementary School Children.*  
 Role: Co-Investigator/International Collaborator (PI: Felipe Munoz-Rubke)
- 2019 - 2021      Chilean Commission for Scientific and Technological Research  
 (CONICYT). Scientific and Technological Development Fund for Early  
 Career Researchers (FONDECYT de Iniciación)  
 CAD: **\$105,100.96**  
*An Investigation of Causal Relations between Mechanical Reasoning and  
 Spatial Skills.*  
 Role: Co-Investigator/International Collaborator (PI: Felipe Munoz-Rubke)
- 2014 - 2015      TVOntario (TVO) technology grant  
 CAD: **\$9,004.80**  
*Examining the Effects of Computerized Spatial Training*  
 Role: Co-Principal Investigator with Joan Moss
- 2011 - 2012      TVOntario (TVO) technology grant  
 CAD: **\$31, 280**  
*Computerized Learning*  
 Role: Co-Principal Investigator with Janette Pelletier



## Scholarships and Awards

2024 – 2026	Jacobs Fellow, Jacobs Foundation Research Fellowship Program (\$255,000)
2023	Award for Excellence in Initial Teacher Education, Ontario Institute for Studies in Education, University of Toronto
2016 - 2019	University of Western Ontario Doctoral Excellence Research Award (\$5000/year)
2015 - 2019	Western Graduate Research Scholarship (\$ ~ 5,900/year)
2015 - 2019	Social Sciences and Humanities Research Council of Canada (SSHRC) Doctoral Fellowship (\$80,000 over 48 months)
2018	Latin American School for Education, Cognition, and Neural Sciences Fellowship. Aconcagua Valley, Chile. June 17 <sup>th</sup> – 23 <sup>rd</sup> .
2016	Latin American School for Education, Cognition, and Neural Sciences Fellowship. Buenos Aires, Argentina. March 7 <sup>th</sup> – 18 <sup>th</sup> .
2015 - 2016	Ontario Graduate Scholarship (declined)
2011	Dr. Eric Jackman Graduate Studies Researcher Award, University of Toronto (\$500)

## Consulting

2013 - present	Independent educational consulting for the Ontario Ministry of Education, TVOntario (TVO), Branksome Hall, My Oral Village
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## Editorial Service

2023 – present	Associate Editor, <i>Mind, Brain, and Education</i>
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## Ad Hoc Journal Reviews

Developmental Science / Psychonomic Bulletin & Review / Psychological Bulletin / Educational Studies in Mathematics / ZDM – International Journal for Mathematics Education / Child Development / Journal of Educational Psychology / Journal of Experimental Child Psychology / Frontiers in Psychology / Intelligence / Cognitive Research: Principles and Implications / Scientific Reports / Learning and Individual Differences / Learning and Instruction / Cognition and Instruction / Developmental Psychology / Mind, Brain, and Education / Mathematical Thinking and Learning / Journal of the Learning Sciences / Journal of Cognition and

Development / Mathematics Education Research Journal / Journal of Mathematical Behavior / Digital Experiences in Mathematics Education / British Journal of Educational Psychology / Nature Reviews Psychology / Journal of Research in Mathematics Education / Journal of Numerical Cognition / Mathematics Teacher: Learning and Teaching PK-12 / Journal of Intelligence / Journal of Experimental Psychology: General / International Journal of STEM Education / British Journal of Developmental Psychology / Canadian Journal of Experimental Psychology / Child Development Perspectives / Quarterly Journal of Experimental Psychology