

THE ROLE OF VARIABILITY IN LEARNING GENERALIZATION: A COMPUTATIONAL  
MODELING APPROACH

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## THE ROLE OF VARIABILITY IN LEARNING GENERALIZATION: A COMPUTATIONAL MODELING APPROACH

Researchers and educators have long been interested in how the variability of training examples experienced during learning influences subsequent generalization. However, previous studies have reported both beneficial and detrimental effects, leaving the nature of this relationship unclear. Furthermore, a formal computational modeling approach to account for the effects of training variability has been largely lacking within the domain of visuomotor skill learning. The current work presents two projects which shed light on this issue, each consisting of several experiments which compare varied training (i.e., multiple training items) in comparison to constant training (training with a single item). The empirical results, much like those of the broader literature, provide evidence both for and against a benefit of variable training in visuomotor skill learning, highlighting the complex interplay between training conditions and generalization performance. To provide a theoretical account of these findings, this dissertation employs both instance-based and connectionist computational modeling approaches. The instance-based modeling approach introduced in project 1 provides a theoretically justifiable method of quantifying/controlling for similarity between training and testing conditions, while also demonstrating that varied training may induce broader generalization in the similarity function relating training and test items. In project 2, the Extrapolation- Association Model (EXAM) provided the best account of the testing data across all experiments, capturing the constant groups' ability to extrapolate linearly to novel regions despite limited training experience, while also revealing potential detriments of varied training for simple extrapolation tasks. By integrating empirical findings with computational modeling approaches, this dissertation sheds light on the complex relationship between training variability and generalization performance.

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## Introduction

### Varied Training and Generalization

Varied training has been shown to influence learning in a wide array of different tasks and domains, including categorization (Hahn et al., 2005; Maddox & Filoteo, 2011; Morgenstern et al., 2019; Nosofsky et al., 2019; Plebanek & James, 2021; Posner & Keele, 1968), language learning (Brekelmans et al., 2022; Jones & Brandt, 2020; Perry et al., 2010; Twomey et al., 2018; Wonnacott et al., 2012), anagram completion (Goode et al., 2008), perceptual learning (Lovibond et al., 2020; Manenti et al., 2023; Robson et al., 2022; Zaman et al., 2021), trajectory extrapolation (Fulvio et al., 2014), cognitive control tasks (Moshon-Cohen et al., 2024; Sabah et al., 2019), associative learning (Fan et al., 2022; Lee et al., 2019; Livesey & McLaren, 2019; Prada & Garcia-Marques, 2020; Reichmann et al., 2023), visual search (George & Egner, 2021; Gonzalez & Madhavan, 2011; Kelley & Yantis, 2009), voice identity learning (Lavan et al., 2019), face recognition (Burton et al., 2016; Honig et al., 2022; Menon et al., 2015), the perception of social group heterogeneity (Gershman & Cikara, 2023; Konovalova & Le Mens, 2020; Linville & Fischer, 1993; Park & Hastie, 1987), simple motor learning (Braun et al., 2009; Kerr & Booth, 1978; Roller et al., 2001; Willey & Liu, 2018), sports training (Breslin et al., 2012; Green et al., 1995; North et al., 2019), and complex skill learning (Hacques et al., 2022; Huet et al., 2011; Seow et al., 2019). See Czyż (2021) or Raviv et al. (2022) for more detailed reviews.

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## Curriculum Vitae

### Education

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**Indiana University - Bloomington**

PhD in Psychology and Cognitive Science

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Thesis: *Short-term mindfulness intervention reduces the negative attentional effects associated with heavy media multitasking*

### Journal Articles and Conference Proceedings

- **Gorman**, T. E., & Goldstone, R. L. (2022). An instance-based model account of the benefits of varied practice in visuomotor skill. *Cognitive Psychology*, 137, 101491.
- Kattner, F., Cochrane, A., Cox, C. R., **Gorman**, T. E., & Green, C. S. (2017). Perceptual learning generalization from sequential perceptual training as a change in learning rate. *Current Biology*, 27(6), 840-846.
- **Gorman**, T.E., & Green, C.S. (2016). Short-term mindfulness intervention reduces the negative attentional effects associated with heavy media multitasking. *Scientific Reports*, 6.

### Reviews and Book Chapters

- **Gorman**, T.E., Gentile, D.A., & Green, C.S. Problem gaming: a short primer (2018). *American Journal of Play*, 10 (3), 309-327
- **Gorman**, T.E., & Green, C.S. (2017). Young minds on video games. In *Cognitive development in digital contexts*. 121-143. Academic Press.
- Green, C. S., **Gorman**, T., & Bavelier, D. (2016). Action Video-Game Training and Its Effects on Perception and Attentional Control. In *Cognitive Training* (pp. 107-116). Springer International Publishing.

## **Presentations**

- Half Day Tutorial on Measuring Mindfulness Behaviorally: Onsite/Online Data Collection with jsPsych - Cognitive Science Conference – 2018
- Does interleaving go the distance? Exploring the effect of dissimilarity on interleaved category learning - Math Psych/ICCM 2018
- Short term mindfulness intervention reduces cognitive deficits in heavy media multi-taskers - Undergraduate Research Symposium – UW-Madison – April 16th, 2015

## **Awards**

IU-Bloomington – Development Training Grant – Fall 2019

IU-Bloomington - Steinmetz Summer Research Award - 2018

UW-Madison - Undergraduate Research Scholar Award – 2015

UW-Madison - Hildale Undergraduate/Faculty Research Fellowship – 2014

## **Ad-hoc Reviewer**

Cognitive Science

Journal of Experimental Psychology: General

Journal of Experimental Psychology: Human Perception and Performance

## **Conferences**

Cognitive Science Conference - 2021

Cognitive Science Conference - 2018

Mathematical Psychology & ICCM 2018

Boston Meeting on Methods in Cognitive Training (NSF Sponsored) – May 2017