Visual-Spatial Processing Differences Among Those with Dyslexia and Those Without Dyslexia

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Introduction

Children are expected to meet certain expectations in school, home, and life from a young age. Culturally there are a general set of expectorations for what a "good child" should do. A good child should behave kindly and nicely, follow directions, do well in school, and be at the top of their class. Dyslexia makes being a "good child" difficult due to the academic challenges individuals with dyslexia face. Dyslexia, in its most basic form, causes difficulties in reading and spelling words (Fletcher, 2009; Odegard, 2019).

According to the International Dyslexia Association, "Dyslexia is a specific learning disability that is neurological in origin. It is characterized by difficulties with accurate and/ or fluent word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge" (IDA, 2002).

Dyslexia affects between 3 – 15 % of the population and represents approximately 35% of those classified with a learning disability, according to reports from 2016 (Fletcher et al., 2019). The prevalence of dyslexia and its implications for success in school and life has led to a groundswell of state legislation intended to address the needs of individuals with dyslexia (Odegard et al., in press). The goal is to identify the risk of dyslexia before children are developmentally expected to read and spell words to provide early intervention to prevent the emergence of word reading and spelling deficits or to lessen the severity of these deficits if they do emerge.

While intended to provide a gateway to support, some advocates for individuals with dyslexia also view a label characterized solely by deficits as detrimental to a child. They argue that children labeled as having dyslexia may feel that the issue is intrinsic, leaving them hopeless (Knight, 2021). A neurodiversity perspective provides a counterpoint to a deficit perspective of dyslexia and similar learning differences. The neurodiversity perspective views learning differences, such as dyslexia, as natural variations in how the brain is structured and functions rather than a disorder or disability. Opposed to viewing these learning differences as an inherent deficiency, this perspective celebrates diversity in thinking and learning styles by recognizing that individuals, such as those with dyslexia, bring unique strengths and gifts to society (Majeed, N. M., Hartanto, A., & Tan, J. J. X., 2021).

Central to the tenets of a neurodiversity perspective is that in addition to being marked by deficits in word reading and spelling, individuals with dyslexia also have inherent strengths. Among the strengths commonly attributed to individuals with dyslexia is creativity. However, two recent meta-analyses of research exploring potential strengths in creativity found no evidence that individuals with dyslexia are inherently more creative than their neurotypical peers. As such, to date, there is no empirical support to suggest that a gift of creativity marks individuals with dyslexia, but creativity is just one of the gifts commonly attributed to dyslexia. Another such gift is visual-spatial processing. In support of this strength, individuals have cited evidence documenting an overrepresentation of individuals with dyslexia in fields of study dependent on visual-spatial processing, such as astrophysics (Schneps et al., 2011). These compensatory mechanisms are thought to privilege these individuals with relative strengths in how well they can process visual-spatial information. However, the findings of studies exploring a potential strength in visual-spatial processing for individuals with dyslexia have been mixed.

These mixed results motivate the need for a systematic, quantitative review of research investigating the visual-spatial processing of individuals with dyslexia to help clarify the pattern of results in this area of study.

Background

With previous research experience, I was very excited to engage in college research. I began discussing the opportunity to participate in research at the dyslexia center in the Spring of 2022. I then began to be involved in lab meetings and projects in the Fall of 2022, specifically reviewing literature addressing the definition of dyslexia. I have continued on these projects into the Spring of 2023. Additionally, I took Research Methods in the Spring of 2022 with Dr. Rogers and the lab, where we engaged in research projects design and execution as part of this class.

The proposed project has also been approved by the Honors Thesis Committee to serve as my honors thesis with a proposed defense date in the Fall of 2023. I have begun extensive research on this topic up to this point to ensure the viability of the proposed project.

Purpose

To address this gap in the extant research literature, the proposed study would explore the claim that individuals with dyslexia have inherent strengths in visual-spatial reasoning by undertaking a meta-analysis of the literature published testing this hypothesis.

Methods

A systematic search will be undertaken to review all existing literature that explores differences in visual-spatial processing between individuals with dyslexia and their neurotypically developing peers. This will be accomplished through a search of relevant literature in five databases: ERIC, PsycINFO, PubMed, Scopus, and Web of Science using the search terms “dyslexia” AND “visual-spatial processing” OR “3-D rotation” OR “visual-spatial reasoning." The searches will be undertaken to see how many articles are yielded. The search will be constrained to articles published between January 1, 2000, and December 31, 2022. Studies published outside of this range will not be included in the analysis.

After duplicates and irrelevant articles (based on titles and abstracts) are removed, the remaining articles will be identified for additional review to determine if they meet the criteria for the meta-analysis. Criteria included a sample with dyslexia and a neurotypically developing sample with no reading disabilities that compared these samples on their performance on a visual-spatial processing task. Exclusion criteria will include studies that utilized an outcome measure other than performance on a visual-spatial processing task, including fMRI, eye tracking, and ERP. Studies that employ a single-subject design will also be excluded because this study design does not generate the data needed to compare outcomes to studies adopting experimental or quasi-experimental designs. Studies needing more data to calculate effect size also will be excluded.

After the initial searches, a backward search will be performed using the included studies' reference lists to find additional studies for inclusion in the meta-analysis. Then, the corresponding authors of the included studies identified for inclusion in the meta-analysis will be contacted via email in search of unpublished studies on the topic. This basic algorithm conforms to procedures outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher et al., 2009).

Proposed Analytic Approach

After coding the included studies to identify effect sizes, a meta-analysis will be completed to analyze the relative size of the differences in performance observed between individuals with dyslexia and their neurotypical peers on visual-spatial processing tasks. A random effects model will be used because it is likely that the studies identified for inclusion in the meta-analysis will vary in observed effect size and sample type. Additionally, Hedges *g* will be used to estimate effect size to correct for possible bias due to what will likely be a small number of studies included in the analysis (Borenstein et al., 2021).

The descriptive statistics (i.e., means, standard deviations, sample size) for individuals with dyslexia and neurotypical individuals will be used to calculate Hedge's *g.* The Q-test and I^2 will be calculated to determine the extent of heterogeneity and variance. If I^2 is greater than 20%, this will give reason to move forward with moderator analyses to find the potential reasons for the variance (Clinton, 2019).

Timeline

05/22-05/30	Conduct Literature Search
05/25	Meet with Dr. Odegard (discuss findings in Literature Search)
06/05-06/07	Identify any possible factors to be coded
06/08	Meet with Dr. Odegard (Discuss factors to be coded)
06/12-07/03	Code Studies and Identify Effect Sizes
06/12-07/03	Meet with Dr. Odegard (Check in on Coding each week)
07/07-07/28	Conduct a Meta-Analysis using Effect Sizes pulled from articles included in the study
07/07-07/28	Meet with Dr. Odegard (Review Meta-Analysis process each week)

Collaboration with Faculty Mentor

Dr. Tim Odegard, the faculty mentor, will play a prominent role in guiding, advising, and providing feedback throughout the collection of literature, data, running of the meta-analysis, and editing drafts. Throughout the research, there will be weekly meetings to get feedback on work and address questions that come up during the week. Dr. Tim Odegard's expertise in Dyslexia will provide support and encouragement throughout this process.

References

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Budge Justification – Madalyn Dye URECA Proposal Summer 2023

Item	Quantity	Total Price	Link to Product	Reason
Covidence Software	Single	$240	https://www.covidence.org/pricing/	Software to be used for Meta-Analysis