Dyslexia and Dyscalculia: Current Status and Research

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Setting the stage

- Brief overview of dyslexia and dyscalculia and particularly their intersection
  - Contextualize differences in the science base
  - Brief background on science base for dyscalculia
  - Viewpoint from the intersection
- Moving forward

Working definition and prevalence - Dyslexia

- Dyslexia
  - A brain-based type of learning disability that specifically impairs a person's ability to read. Individuals with dyslexia typically read at levels significantly lower than expected despite having normal intelligence. Although the disorder varies from person to person, common characteristics among people with dyslexia are difficulty with phonological processing (the manipulation of sounds), spelling, and/or rapid visual-verbal responding.
  - http://www.nichd.nih.gov/health/topics/reading/conditioninfo/pages/disorders.aspx

- Prevalence
  - Prevalence estimates generally range from about 5% to 17.5% of the general population of learners.
  - Differences in estimates are expected because of factors such as diagnostic measures used, inclusion criteria and sample characteristics and definitions used

Working definition - Dyscalculia

- Mathematical learning disorder (MD) also known as dyscalculia is a term used for a wide range of disorders caused by abnormalities in one or more of the basic psychological processes involved in understanding or use of math. Several manifestations of the disorder may occur throughout the life of the individual.

- http://emedicine.medscape.com/article/915176-overview

Dyscalculia – terminology and prevalence

- Terms used inconsistently in field
  - The field uses varying terms to refer to this concept (e.g., dyscalculia, math learning disability) and definitions can be more or less inclusive of individuals with significant difficulties learning mathematics

- Prevalence estimates are generally 7% or less of the general population (e.g., Shalev, 2007) and identification tends to occur later vis-à-vis reading

Dyscalculia - Background

- Longer term consequences
  - Most students identified with dyscalculia (MLD) struggle with math learning into high school and adulthood (e.g., Butterworth et al., 2011; Shalev et al. 2005)
  - Poor math achievement correlates with economic, psychological, and health-related well being (e.g., Apter et al., 2009; Dewalt et al., 2004; Reyna et al., 2009
  - Good numeracy skills are associated with higher wages and greater use of preventive health care and health behavior (e.g., Ashenfelter & Krueger, 1994; Butterworth et al., 2011)

Examples of difficulties - Elementary and beyond

There are early indicators of dyscalculia

- Difficulties with counting and magnitude (e.g., Butterworth et al. 2011; see Powell et al. 2013 for discussion)
- Difficulty with math facts (i.e., basic and multi-digit addition, subtraction, multiplication, division) (e.g., Geary et al. 2012)
- Difficulty telling time (e.g., Burny et al. 2012 and 2014)
- Math problem solving difficulties
  - Genesis can vary
  - This can be due to basic difficulties with math facts, limited math vocabulary and/or exacerbated by reading or language based problems, algebra, etc. (see Powell et al 2013 for discussion)

Recent lens on scale of math achievement problem PIAAC (2013)

- International assessment of adult competencies in literacy, math, and problem solving in adult context
  - U.S. was 1 of 23 countries involved in the first round of assessment
  - Nationally representative
  - Sample of adults 16-65 years of age

- U.S. ranked 21/23 countries participating in numeracy
  - ~38% of adult respondents in U.S. scored at Level 1 or below
  - Level 1 constitutes "basic mathematical processes in common, concrete contexts"

Research Differences in Dyslexia versus Dyscalculia

Dyslexia

- Learned symbolic skill utilizing language, visual, and memory systems
- Core cognitive deficit – moderately well defined
- Responsive to intervention – challenges remain
- Moderately-well defined neurologic underpinnings
- Influenced by G & E

Dyscalculia

- Non-symbolic capacity plus learned symbolic skill
- Core cognitive deficit – competing hyp.
- Responsive to intervention – less well understood
- Moderately-well defined neurologic underpinnings
- Influenced by G & E

FOCUSING ON THE INTERSECTION

The Intersection

- Most of the research base looks at one learning disability in isolation and far less work looks at the 'intersection' of topics
  - E.g., individuals with dyslexia and dyscalculia

- Reasons for historic focus on one condition
  - Difficulties in the conduct of science
  - Differences in clarity of constructs
    - I.e., what constitutes reading or math learning disability
  - Disparate grounding in genetic and neurobiological foundations

- Co-occuring or comorbid dyslexia and dyscalculia is not uncommon (Prevalence estimates)
  - About 17%-66% of individuals with dyscalculia are estimated to also have dyslexia

Why attend to intersection now?

- **Critically, we need better outcomes for these learners!!**
  - Individuals with both dyslexia and dyscalculia tend to have poorer outcomes than individuals with dyslexia OR dyscalculia

- Need for improved outcomes for all learners
  - High prevalence of comorbidity or co-occurring learning disabilities
  - Inadequate evidence base for interventions in children with co-occurring learning disabilities
  - Lower rate of response to intervention in comorbid learning disability
  - Poorer short- and long-term outcomes for children with co-occurring learning disabilities
  - Need data to inform services for ALL of learners

Why attend to the intersection now?

- Build off our relative strengths; cross-fertilize fields
  - Longer, richer research base in dyslexia is more mature than in dyscalculia and could inform dyscalculia research
  - Modeling strategies across both learning disabilities may enable development of strong "blended" comorbid models

- Opportunity to co-collect/co-localize data and provide research-based info on comorbid condition

Why this focus on the intersection is not enough?

- Limits of knowledge of single condition constrain ability to move forward looking at complex etiologies
  - Much work remains with dyscalculia (or math learning disabilities) AND dyslexia

- Historically less research attention paid to dyscalculia vis-à-vis reading

- Need for enhanced understanding of how to identify, classify and remediate individuals with dyscalculia

Moving forward

- Reasons to be optimistic
  - Increased attention to the issue of math learning and math disabilities at the federal level
    - Both research and practice
  - Increased connectivity between the reading and math learning disabilities community
    - Necessary step for cross-talk and more rapid advancement
- **Symposia like this!**
  - Build awareness, understanding, and attention to high need area

Thank you!!

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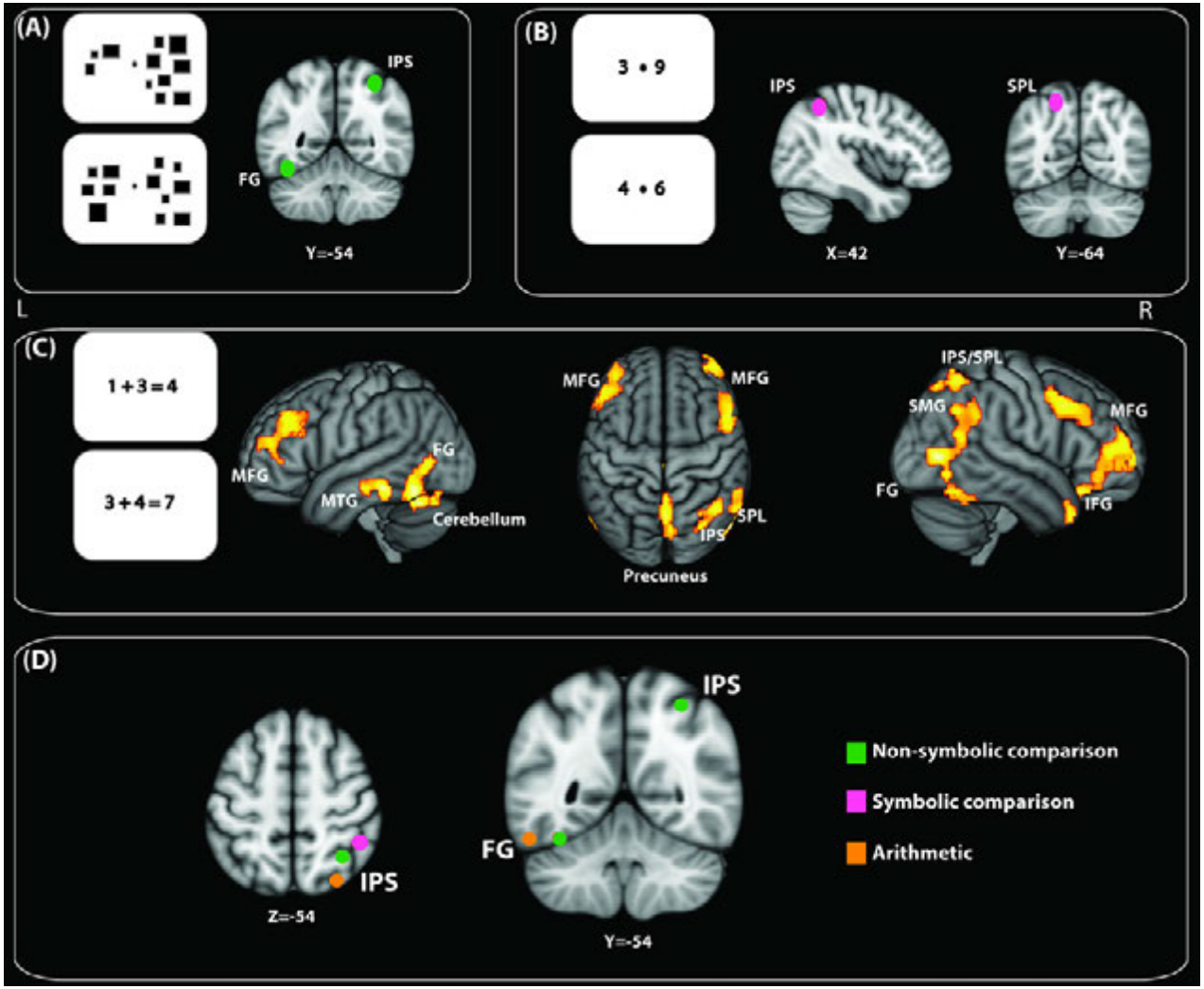
APPENDIX

Nature of underlying challenges in dyscalculia

Competing accounts of the nature of the underlying difficulties

- Defective number module hypothesis
  - Difficulty is in the innate capacity to understand and represent numeric magnitudes (e.g., Butterworth)
- Access Deficit hypothesis
  - Locus of difficulty is in accessing numeric meaning from symbols
- Domain-general hypothesis
  - Difficulties involve working memory and attention rather than being specific to number processing (e.g., Rotzer et al., 2009; Ashkenazi & Henik, 2010)

Neurobiological foundations



Used with permission - from Ashkenazi et al., 2013