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Defining Dyslexia Within and Across Disciplines:

A Systematic Review of the Literature

Ann Marie Trumbo

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Science

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ABSTRACT

Defining Dyslexia Within and Across Disciplines:
A Systematic Review of the Literature

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Purpose: In the present study, we conducted a systematic review to investigate the core features of the definition of dyslexia across different disciplines according to their associated professional organizations and published research in order to evaluate the presence and type of inconsistencies within and across disciplines in how dyslexia is defined.

Method: Definition statements of dyslexia from professional organizations in medicine, education, speech-language pathology, psychology, and the International Dyslexia Association were collected via scope of practice guidelines or via the organization's official website. Using a database with a wide disciplinary reach, we collected 764 of the most cited articles from 2000-2020 with subjects that were children formally identified with dyslexia. We created a coding scheme to examine specific core features of each article and professional organization's definition of dyslexia. We completed data analysis regarding the core features of definitions per organization and journal article discipline.

Results: We report descriptive results for dyslexia definition statements from professional organizations and the collected articles. Chi-square tests of independence were conducted between each of the identified core features and professional discipline. We find statistically significant consistencies and inconsistencies in how the definition of dyslexia is reported across disciplines journals. Core features of dyslexia that are reported differently across disciplines include: neurobiological, genetic, normal intelligence, reading disorder, unrelated to environmental influences, word reading deficits, and visual processing deficits. Core features of dyslexia that are equally included as a characteristic of dyslexia are phonological deficits and that dyslexia is a learning disability. Core features that are equally not included as a characteristic of dyslexia included a spelling deficit, need for an IQ discrepancy, that dyslexia is a language-based disorder, or motor processing deficit.

Conclusion: Although this study confirms the presence of some inconsistencies in the core features of how dyslexia is defined across different disciplines, other encouraging consistencies were found. Namely, across all disciplines researchers appear to acknowledge that dyslexia is a phonological deficit that doesn't require the presence of an IQ discrepancy. Future work should further analyze the specific diagnostic criteria used to classify children with dyslexia and whether such criteria vary across disciplines.

Keywords: dyslexia, children, dyslexic, definition, diagnostic criteria

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DESCRIPTION OF THESIS STRUCTURE AND CONTENT

This thesis, *Defining Dyslexia Within and Across Disciplines: A Systematic Review of the Literature,* is written in a hybrid format. The hybrid format includes components of a traditional thesis and its requirements along with journal publication formats. This thesis will be submitted to the *Journal of Learning Disabilities* upon completion.

The preliminary pages of the thesis reflect requirements for submission to the university. The thesis report is presented as a journal article and conforms to length and style requirements for submitting research reports to education journals.

The review of the literature is included in Appendix A. The definitions of dyslexia collected from professional organizations in medicine, psychology, speech-language pathology, education, and the International Dyslexia Association with the appropriate references are included in Appendix B. The coding scheme utilized by research assistants to collect data is included in Appendix C. Each journal included in the study was coded into a category of either medicine, psychology, speech-language pathology, education, dyslexia specific, interdisciplinary, or other. The categorization of each journal is included in Appendix D. Appendix E includes examples of what was included in coding core features of each definition of dyslexia from journal articles.

This thesis format contains three reference lists. The first reference list contains references included in the journal-ready article. The second list includes all citations used in the Appendix entitled “Annotated Bibliography”. The third list includes all citations used in the Appendix entitled “Definitions of Dyslexia from Professional Disciplines”.

Introduction

The Progression of the Definition of Dyslexia Over Time

Literacy, the ability to read and write, was not widely available until the introduction of education to the general public in the 19th century (Center on Education Policy, 2020). It has since become an essential skill required for educational, social, and occupational success; those with the inability to learn literacy skills at the same rate or level of their peers have been labeled as deficient (Kirby, 2020). Hoover and Gough (1990) described reading as consisting of two distinct and separate components: *decoding* and *linguistic comprehension.* In this simple view of reading, *decoding* is defined as effective word reading where an individual has an ability to access appropriate word meaning based on graphemic representation at the word level (e.g., the letters 'c', 'a', and 't' correspond with the phonemes /kæt/). *Linguistic comprehension* is defined as one's ability to interpret orthographic representations at a semantic lexical level to understand and comprehend language (e.g., understanding the letters 'cat' refer to a domesticated animal with whiskers and a long tail). With this simple view, one can conclude that a child needs adequacy in *both* skills to achieve successful reading comprehension and if he or she lacks adequate skills in one or both components of reading, intervention is necessary to ensure the child achieves reading success. An inefficiency in decoding is typically labeled as dyslexia, but there is not consensus as to whether dyslexia includes other deficits (Wagner et al., 2020). Therefore, in this thesis, we investigate the language used by different disciplines to define and describe dyslexia in children in educational and research settings.

Since its first description in the late 19th century, the evolution of the definition of dyslexia has shifted across numerous research studies and various professional disciplines, including medicine, psychology, speech-language pathology, and special education. Each have

asserted ownership of best practice for assessment, diagnosis, and intervention for dyslexia. Dyslexia was first described in 1877 by a German scholar of medicine, Adolph Kussmaul, who hypothesized that his patient's poor acquisition of literacy skills was due to ocular deficits and labeled this difficulty "word-blindness" (Kirby, 2020, p. 476; Kussmaul, 1877). Many years after research identified its characteristics, professionals labeled the deficit Dyslexia, which came from the root words 'dys-' meaning bad and 'lexia' meaning reading (Kirby, 2020; Merriam-Webster, n.d.).

The inconsistency of diagnostic criteria utilized to assess and diagnose dyslexia has been a topic of interest and heated debate (Elliott, 2020; Elliott & Grigorenko, 2014; Hogan, 2018; Kirby, 2020; Miciak & Fletcher, 2020). This may be due to differing professional opinions and definitions employed by each discipline (Miciak & Fletcher, 2020). Researchers are encouraging their colleagues to "reach a common understanding" to ensure equitable intervention for all those with reading difficulties (Elliott, 2020, p. 561). Despite dyslexia research across disciplines providing an increased understanding of the development of reading and reading difficulty, a lack of understanding and knowledge of intervention best practices for struggling readers continues to exist among clinicians (Elliott, 2020).

Gibbs and Elliot (2020) identified several "terms that are often used interchangeably with dyslexia [including] reading difficulties, reading disorder, specific reading difficulties, specific learning difficulties, learning disability, word-level reading disability, specific reading retardation, unexpected reading difficulty, reading disability, and specific reading disability" (p. 488). Semantic differences in labels lead to disparity in definitions and subsequent diagnostic criteria. The label 'dyslexia' refers to poor word reading and decoding specifically, so other labels connotate different meanings (Hoover & Gough, 1990; Kirby, 2020; Merriam-Webster,

n.d.). Even a slight change in the definition can create ambiguity in the diagnostic criteria. For example, if someone described dyslexia as a 'reading difficulty' or 'reading problems,' that could mean many things: poor text comprehension, poor phonological awareness, decreased reading fluency, etc. If someone described dyslexia as 'a specific learning disability,' then one would assume that the child has a disability in the cognitive/psychological process of learning how to read despite adequate intelligence (American Psychiatric Association, 2013). In sum, the label we use to describe a disorder is integral to the definition and subsequent diagnostic criteria.

Diagnostic Criteria of Dyslexia Among Disciplines

Today, there is no widely accepted criteria used to diagnose dyslexia due to differing opinions across disciplines and lack of implementation of the current literature into clinical settings. Many practitioners and researchers utilize an extensive battery of psychological and language tests in addition to word reading measures. In research, investigators have the time, funding, and resources to evaluate characteristics and attributes of dyslexia with extensive psychological testing. In addition to evaluating word reading, this may include but is not limited to assessing aspects of working memory, short-term memory, phonological awareness, rapid automatized naming (RAN), grammatical competence, non-verbal IQ, auditory discrimination, attention, executive function, etc. (Elliott, 2020; Gibbs & Elliot, 2020; Horowitz & Brenzitz, 2013; Ziegler et al., 2009). In schools, professionals may have considerably less time, funding, and resources and are expected to be efficient with their case load. Considering this, it may be unrealistic to expect comparable diagnostic procedures between research and educational settings. However, schools are primarily where children with dyslexia receive academic instruction. Thus, it is critical that school professionals have adequate understanding of

diagnostic criteria for children with dyslexia so that children can receive appropriate intervention.

Current United States Federal Dyslexia Legislation

In order for a child with dyslexia to receive services in schools according to the free appropriate public education (FAPE) mandate for all by the United States federal government, he or she must be considered to have a specific learning disability under Section 1401 of the Individuals with Disabilities Education Act (IDEA, 2004). A child is considered to have a specific learning disability if "one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which disorder may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations," (IDEA, 2004, Section 1401) which includes dyslexia. For a child to qualify for eligibility for intervention services under IDEA, there are several steps that must occur: referral, parental consent for evaluation, multi-disciplinary evaluation, eligibility determination, development of a proposed Individualized Education Plan (IEP), and IEP confirmation (Zirkel, 2012). Attempting to implement this legislation, professionals involved in determining eligibility have typically avoided using the term 'dyslexia' leaving parents and teachers uninformed to the nature of the disorder and which has often prevented the provision of adequate treatment to address the child's core deficit (Phillips & Odegard, 2017). The U.S. Office of Special Education and Rehabilitative Services (OSERS) has recently clarified that dyslexia is one form of specific learning disability and the term could be used on a student's IEP (Phillips & Odegard, 2017).

Regardless of the OSERS announcement, many struggling readers still do not qualify for services under IDEA due to invalid and inconsistent definitions of dyslexia, diagnostic criteria, and diagnostic assessments employed (Elliott, 2020; Snowling et al., 2020; Wagner et al., 2020).

It is estimated that up to 20% of the population of elementary school children have dyslexia, but approximately less than 5% of that population are accurately diagnosed and treated in the public school system (Phillips & Odegard, 2017; Wagner et al., 2020). With accurate dyslexia screeners in kindergarten and grade 1 and appropriate diagnostic criteria employed in the education system, remediation could be provided earlier to close the gap between typically developing and poor readers.

Current United States State Dyslexia Legislation

While there is no clear-cut single definition of dyslexia widely agreed upon or used across the country, many states have recognized that dyslexia hinders word reading development and this is the language that has been used in most, if not all, of the state laws regarding the subject (Phillips & Odegard, 2017). The majority of states have also adopted the International Dyslexia Association's definition, which coins dyslexia as a specific learning disability, and established laws outlining characteristics of dyslexia typically evaluated for identification in the schools (Phillips & Odegard, 2017). For example, the Department of Education in the state of Texas created a Dyslexia Handbook that describes in detail the screening and evaluation processes including: (a) what characteristics to identify, specifically reading isolated words, decoding nonwords, fluency, and spelling, (b) which educational professionals are equipped to perform an evaluation, and (c) the steps to remediation for a child with dyslexia (Texas Education Agency, 2018). One of the positive effects of this widely adopted defining feature of dyslexia among state legislation in Texas is that effective word reading intervention and instruction has been implemented to combat reading difficulties in this population (Phillips & Odegard, 2017).

Although it is encouraging that Texas has successfully integrated statewide diagnostic criteria and intervention recommendation for dyslexia, this is not the case for many other states. Unfortunately, public policy does not evolve as quickly as research, but as Wagner et al. (2020) stated, "science should inform public policy and practice rather than using public policy and practice to inform science" (p. 362). The legislative side does not always consider how the educational side will enact and implement the new law. Phillips and Odegard (2017) brought attention to the fact that legislation and new policy typically lacks "clear guidance, training, or funding" and plans for implementation which leaves it unclear as to how education professionals should implement new policy to help their struggling readers (p. 366).

Professionals Equipped to Diagnose and Treat Dyslexia

Because of its birth in medicine, medical organizations and neuroscientists have studied and continue to research dyslexia extensively. Lopes et al. (2020) found that approximately 95% of the most cited research in dyslexia from the years 2000-2019 were published in medically based journals whereas approximately 5% of the literature was published in educational journals. This statistic demonstrates that research regarding dyslexia, which is typically diagnosed and treated in the educational setting, is likely not reaching educational professionals. Referring to dyslexia, Elliott (2020) stated "reading disability is essentially an educational problem requiring an educational solution" especially since a main goal of elementary school is to promote literacy (p. 567).

Various educational professionals are equipped to screen, diagnose, and treat dyslexia, such as speech-language pathologists and school psychologists. Lindstrom (2019) stated that because a child with dyslexia can only be eligible for an Individualized Education Program (IEP) by qualifying under the diagnosis specific learning disability, school psychologists or speech-

language pathologists may assess these areas to determine if a weakness in reading exists as each scope of practice includes determining typical cognitive processing

According to the American Speech-Language-Hearing Association (2001), a speech-language pathologist's (SLP) scope of practice and expertise resides in language, written or spoken, and includes assessment, diagnostics, and treatment for word recognition disorders or dyslexia (Hogan, 2018). A portion of an SLP's expertise resides in cognitive deficits and how to habilitate or rehabilitate to improve functioning (American Speech-Language Hearing Association, 2001). Though SLP training and expertise adequately prepares them to diagnose and treat written language comprehension, only 50% of SLPs feel prepared to help struggling readers (Hogan, 2018; Katz et al., 2010). Many children with dyslexia will often have co-morbid communication or executive function difficulties (Adlof & Hogan, 2018, as cited in Hogan, 2018), so SLPs may need to provide intervention for reading and concomitant speech, language and/or cognitive deficits.

According to the American Psychological Association (APA), educational psychologists have expertise in cognitive processes involved in learning academic skills and considering that dyslexia is recognized institutionally as a learning disability, it indirectly falls within their scope of practice to assess and diagnose dyslexia (2014). In the *Guidelines for Psychological Assessment and Evaluation* outlined by the APA, it is stated that an educational or school psychologist is licensed and authorized to identify children at risk for or those that require special education services through the appropriate selection of and administration of assessments and interpretation and determination of cognitive ability and academic achievement, but dyslexia is not specifically mentioned (2020).

Current Prevalence of Children With Dyslexia in the U.S.

Predictions of prevalence are useful to understand how common or uncommon a disorder is as well as determining the occurrence of under- or overidentification of a condition (Wagner et al., 2020). Current literature on dyslexia demonstrates inconsistent predictions of prevalence ranging from approximately 5% to 20% of the population (Wagner et al., 2020). Wagner et al. (2020) recently published a study investigating the difficulty of predicting dyslexia prevalence. They stated that three major problems exist: (a) determining a cut point for diagnostic assessments for identification, (b) inconsistency in definitions of dyslexia across professional disciplines, states, and legislation, and (c) inconsistency in diagnostic criteria and assessments (Wagner et al., 2020). For example, prevalence estimates will be higher with a higher cut point, such as the 25th percentile or 1 standard deviation (SD) below the mean and will be lower with a lower cut point, such as the 10th percentile or 1.5 to 2 SD below the mean. In this thesis, we aim to address the second problem identified by Wagner et al. (2020): to examine how dyslexia is defined within and across disciplines, as delineated in organizational statements and in the research published in various disciplinary journals.

Organizational Definitions of Dyslexia

Each organization that presents research and subsequent clinical practice advice for assessment, diagnosis, and intervention for dyslexia provides definitions of the disorder on their respective organizations' websites and/or guidelines for how dyslexia fits within their scope of practice.

The way individuals with dyslexia are identified for inclusion in scientific studies has significant ramifications. Research with substantial evidence to support its findings in diagnostics and intervention is a crucial component which guides professionals to provide

evidence-based practice. Also, professional organizations' definitions and understanding of disorders, diseases, and disabilities is dependent upon the scientific literature's support. We hypothesize the presence of inconsistencies in how dyslexia is defined in the scientific literature, which may call into question whether the findings in studies with children and adolescents with dyslexia can be universally applied.

This systematic review is part of a larger project which focuses on evaluating definitions of dyslexia, the labels used interchangeably for dyslexia across the literature, and the diagnostic criteria used for dyslexia including word reading, IQ, language, spelling, and non-word reading diagnostic assessments. The present study will investigate the current state of the literature according to the second noted inconsistency identified by Wagner et al. (2020) that may contribute to difficulty determining a true prevalence of dyslexia: inconsistencies in definitions of dyslexia across disciplines. No other known investigation has conducted a systematic review across multiple disciplines to determine the level of variability of these factors within and across disciplines. We will review the most cited scientific literature involving children with dyslexia from the years 2000-2020. We will investigate whether the core features of an organization's definition are consistent with definitions of dyslexia used in the research of that organization's premier academic journals.

Research Questions

This study will address the following research questions:

1. What are the core features of dyslexia according to organization definitions in each professional discipline (i.e., medicine, psychology, speech-language pathology, education, International Dyslexia Association)?

2. What is the frequency of core features of dyslexia according to each professional discipline's subsequent research articles?
3. Are there specific core features of dyslexia that are more or less likely to be reported in a discipline?

Method

Data Sample

Organizational Definitions

We collected definition statements from professional organizations from each organization's website or most current document/scope of practice guideline regarding dyslexia. We collected definitions from organizations in medicine, psychology, speech-language pathology, education, and the International Dyslexia Association (IDA) as they all have had an impact on the research and clinical practice regarding dyslexia. Because the field of medicine covers such a wide variety of subdisciplines, we included three definitions so as to provide a representative sample of definitions from associations in clinical practice (Mayo Clinic), neurological disorders and neuroscience (National Institute of Neurological Disorders and Stroke), and research in pediatrics (American Academy of Pediatrics) and ophthalmology (American Academy of Ophthalmology & American Academy for Pediatric Ophthalmology and Strabismus).

Systematic Search Strategy for Research Articles on Dyslexia in Children

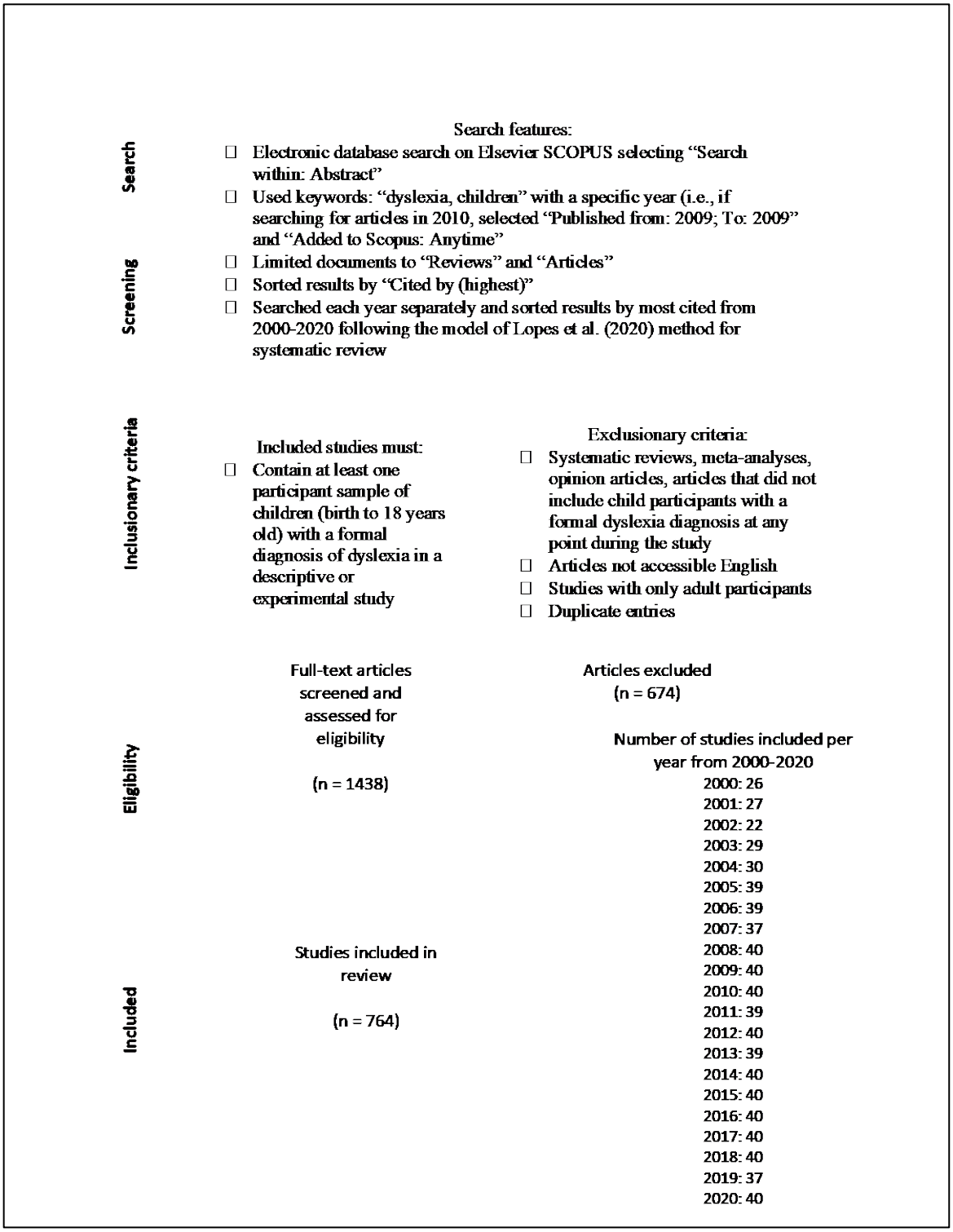
The search strategy followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2020) and aligned with a previously published systematic review identifying research articles on dyslexia (Lopes et al., 2020). The flow diagram depicting the study selection process is presented in Figure 1. Three undergraduate and two graduate

research assistants comprised the team for collecting articles. Each team member independently searched for articles using the Elsevier Scopus database using the search terms “dyslexia, children” published between the years 2000-2020. Articles were collected from June to August 2021. The Elsevier SCOPUS database includes over 25,000 peer-reviewed journals containing research from social, physical, health, and life sciences (Elsevier Scopus, n.d.). Due to a preliminary article search, we narrowed the search criteria to “Search within: Abstract” to avoid filtering through articles that may have mentioned dyslexia in the key terms but did not mention the disorder in any form throughout the article. We further limited the articles to document types of “Reviews” and “Articles” and sorted them by “Cited by (highest).” We filtered the articles by most cited as we aimed to include articles that have the largest impact and influence on research and among professional practice, consistent with Lopes et al. (2020). We collected and included up to 40 per year of the most cited articles from 2000-2020 that included at least one participant sample of children (birth to 18 years old) with a formal diagnosis of dyslexia in a descriptive or experimental study. We excluded systematic reviews, meta-analyses, opinion articles, articles that did not include child participants with a formal dyslexia diagnosis at any point during the study (i.e., family-risk for dyslexia but not formally diagnosed), articles that were not accessible in English, and studies with only adult participants. Please refer to Figure 1 for a diagram outlining the search and inclusion/exclusion criteria used to collect studies for this review.

With inclusionary and exclusionary criteria in place, we collected as many articles as were identified by the initial database search that met all of our research criteria for the years 2000-2020. Some years included fewer than 40 articles due to the exclusionary criteria. Please refer to Figure 1 for the number of articles from each year that we collected, analyzed, and included in the study based on inclusionary and exclusionary criteria.

Figure 1

Flowchart Diagram for the Search and Inclusion/Exclusion Criteria for Studies Included in Review



Coding

We created a coding scheme and trained nine undergraduate and two graduate research assistants using a coding protocol. The coding scheme employed by trained research assistants aimed to code and examine the title of each article, the article publication year, the journal and field of study in which the article was published, the definition of dyslexia given in the article, and core features used in the definition of dyslexia (Refer to Table 2). Research assistants were required to undergo training in which they coded five sample articles and matched the graduate research assistants' coding from the same five articles with at least 90% accuracy. The research assistants were provided specific feedback and completed coding of two more articles if their coding did not match 90% in the first round of training. All research assistants passed the training. The research assistants independently coded each article. Twenty percent of all articles are currently being double coded by trained research assistants. Inter-rater reliability will be calculated with a point-by-point agreement ratio and will be reported in later dissemination.

We created a second coding scheme to analyze features of dyslexia (See Table 3) as defined by each professional discipline: (a) medicine, (b) psychology, (c) speech-language pathology, (d) education, (e) dyslexia specific, (f) interdisciplinary, and (g) other (Refer to Table 1) in the collected articles. We also utilized this coding scheme to analyze features of dyslexia as defined by prominent organizations in each professional discipline with exception of "interdisciplinary" and "other". One graduate research assistant and a professor coded and examined the inclusion or exclusion of 13 coded categories (refer to Table 2) in each professional discipline's definition of dyslexia and in each journal article collected. In the appendix, we provided further details of terminology that was included in each category. The

two coders met to discuss coding and any discrepancies were discussed until consensus was reached.

Table 1

Professional Disciplines Included in Study

Professional Disciplines
Medicine/Medical
Psychology
Speech-Language Pathology
Education
Dyslexia Specific
Interdisciplinary
Other

Table 2

Core Features Coded From the Definition of Dyslexia

Core Features
Genetic/Familial/Inherited/Heritable
IQ-discrepancy
Learning or Specific Learning Disability
Literacy/Reading Deficit/Disorder
Motor Processing/Coordination Deficits
Neurobiological
Oral/Written Language/Language-Based Deficits
Phonological Deficits (Phonological Awareness/Processing)
Poor Spelling Skills
Unexpected Reading Difficulty of Normal/Adequate/Typical Intelligence
Unrelated to Environmental Influences
Word Recognition/Reading, Poor Decoding, Non-word/Pseudoword Reading Deficits
Visual Processing Deficit/Difficulty

Data Analysis

We analyzed the core features of the definition of dyslexia per professional organization and compared how each professional discipline reported core features of dyslexia in research literature from the years 2000-2020. Our analyses included a categorical analysis for each professional discipline and a descriptive and quantitative analysis of definitions of dyslexia used

in research articles. Therefore, for our quantitative analysis, the independent variables are the different professional disciplines and the dependent variables are the core features used to define dyslexia.

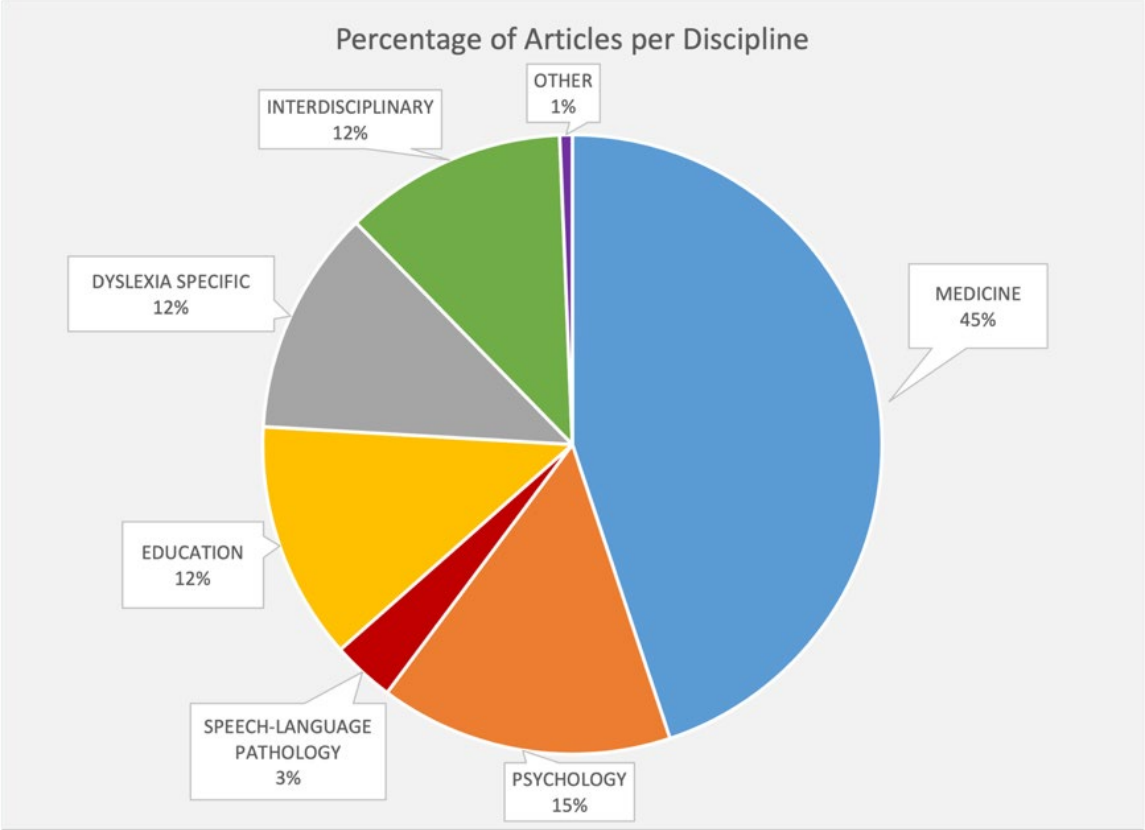
Results

Percentage of Journals Publishing Studies About Dyslexia

Similar to Lopes et al. (2020), we calculated the percentage of articles per professional discipline that were included in the study. Each article out of the total number of articles collected (N = 764) was categorized as either coming from the fields of Medicine (n = 343), Psychology (n = 117), Speech-Language Pathology (n = 25), Education (n = 95), Dyslexia Specific (n = 90), Interdisciplinary (n = 89), or Other (n = 5). Articles included in the Interdisciplinary category included "Medicine + Psychology," "Medicine + Psychology + Education" or "Medicine + Speech-Language Pathology." Findings revealed that studies of dyslexia in children are most commonly found in medical journals (45%), followed by psychology journals (15%), educational journals (12%), dyslexia specific journals (12%), interdisciplinary journals (12%), speech-language pathology journals (3%), and other journals (1%). Due to the small number of papers that qualified under the "Other" discipline classification, these five papers were not included in any further analysis of core features. Similar to Lopes et al. (2020), we found that the majority of articles came from medical journals. However, we noted a slight increase in percentage of educational journals between the current study (12%) and that reported by Lopes et al. (2020) (5%). Please see Figure 2 for a visual representation of where research about dyslexia is being published.

Figure 2

Percentage of Articles Included in Study From Each Discipline



Descriptive Data in Professional Disciplinary Definitions

Organizational Definitions

We evaluated the frequency of core features reported in definitions across professional disciplines (N=759). Please see Figure 3 for a visual representation of the reported core features from each organizational definition.

Medicine

To examine how dyslexia is described and defined in medical disciplines, we examined definitions from two prominent medical associations including the Mayo Clinic and the National Institute of Neurological Disorders and Strokes and examined a joint definition statement from the American Academy of Pediatrics, the American Academy of Ophthalmology, and the

American Association for Pediatric Ophthalmology and Strabismus. The specific professional organizations listed in this study were organizations that provided a definition of dyslexia that could be identified. The definition of dyslexia from the National Institute of Neurological Disorders and Strokes (NINDS) described dyslexia as being neurobiological and genetic in origin, including a spelling and phonological deficit, unexpected in relation to normal intelligence, and considered a learning disability (NINDS, n.d.). The definition statement from the American Academy of Pediatrics (AAP), American Academy of Ophthalmology (AAO), and American Association for Pediatric Ophthalmology and strabismus (AAPOS) similarly stated that dyslexia was neurobiological and genetic in origin, that it occurred unrelated to environmental influences and despite normal intelligence, included spelling and word reading difficulties, and was considered a reading disorder (AAP, AAO, AAPOS, 2009). The Mayo Clinic, a medical clinic many researchers and clinicians look to for professional opinions, defined dyslexia as a learning disability and reading disorder that is language-based and neurobiological in origin. This definition also included that a child with dyslexia typically demonstrates phonological and word reading deficits despite normal intelligence (Mayo Clinic, 2017).

Psychology

The American Psychological Association (APA) definition statement of dyslexia included that dyslexia was a reading disorder and learning disability that was neurobiological in origin and occurred despite normal intelligence and adequate opportunity for education and instruction. The definition described children with dyslexia as demonstrating spelling, phonological, visual processing, and word reading deficits (APA, n.d.).

Speech-Language Pathology

The American Speech-Language-Hearing Association (ASHA) defined dyslexia as a language-based reading disorder that included phonological, spelling, and word reading deficits (ASHA, n.d.).

Education

The National Association of Special Education Teachers (NASET) defined dyslexia as a language-based reading disorder and learning disability (NASET, n.d.).

International Dyslexia Association

The International Dyslexia Association (IDA) is one of the largest organizations that advocates for children with dyslexia across the world. The IDA defined dyslexia as a language-based reading and learning disorder that was neurobiological in origin. This definition states that dyslexia occurs unrelated to environmental influences and despite normal intelligence and typical characteristics include phonological, spelling, and word reading deficits (IDA, 2002).

Summary of Descriptive Data

No core feature was represented in all definitions across all disciplines. Across all organizational definitions of dyslexia, most reported that dyslexia is a reading disorder that occurs despite normal intelligence and is characterized by language-based, word reading, and phonological deficits. Across all organizational definitions of dyslexia, none reported that characteristics of dyslexia include motor processing deficits or IQ-discrepancy. Only medical organizations defined dyslexia as genetic in origin. The APA was the only organization to include visual processing deficit as a characteristic of dyslexia.

Figure 3

Visual Representation of Core Features Reported in Definitions From Medical, Psychological, Speech-Language Pathologist, Educational, and Dyslexia Specific Professional Organizations

Core Features	Professional Organizations: Medicine			Psychology	SLP	Education	Dyslexia Specific
	NINDS	AAP, AAO, AAPOS	Mayo Clinic	APA	ASHA	NASET	IDA
Neurobiological	✓	✓	✓	✓			✓
Genetic	✓	✓					
Phonological Deficit	✓		✓	✓	✓		✓
Normal IQ	✓	✓	✓	✓			✓
Reading Disorder		✓	✓	✓	✓	✓	✓
Unrelated to Environment		✓		✓			✓
Spelling Deficit	✓	✓		✓	✓		✓
IQ Discrepancy							
Learning Disability	✓		✓	✓		✓	✓
Word Reading Deficit		✓	✓	✓	✓		✓
Language-Based Deficit		✓	✓		✓	✓	✓
Visual Processing Deficit				✓			
Motor Processing Deficit							

Note: National Institute of Neurological Disorders and Stroke (NINDS), American Academy of Pediatrics (AAP), American Academy of Ophthalmology (AAO), American Association for Pediatric Ophthalmology and Strabismus (AAPOS), American Psychological Association (APA), American Speech-Language-Hearing Association (ASHA), National Association of Special Education Teachers (NASET), and International Dyslexia Association (IDA); a checkmark signifies that it was reported in the professional organization's definition

Descriptive Data From Collected Articles

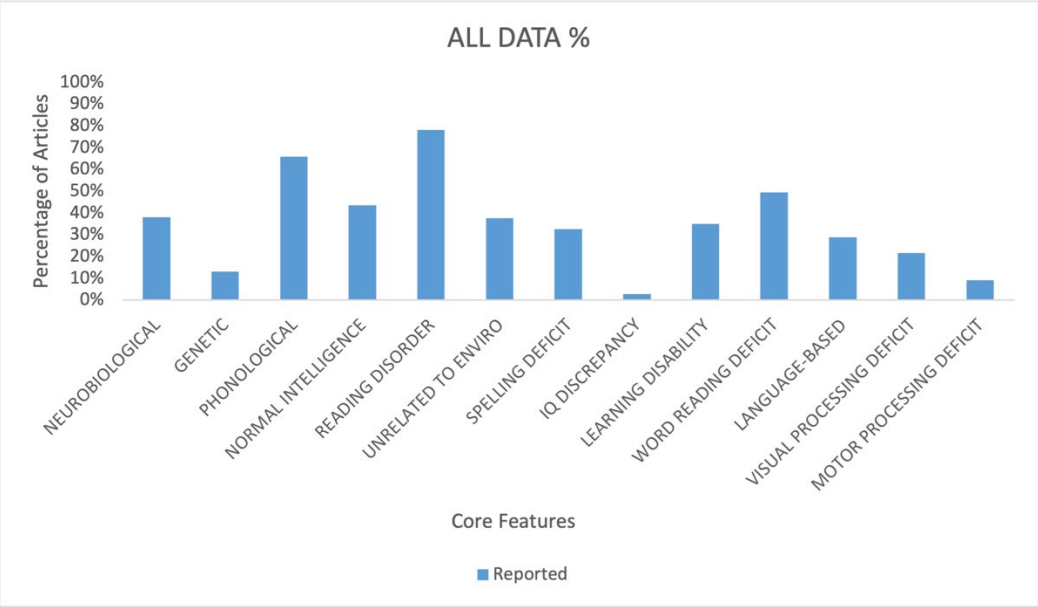
All Data

We evaluated the frequency of core features reported in definitions of dyslexia across all articles from all disciplines (N=759). The four most commonly reported core features included

reference to the following: reading disorder, phonological skills, word reading, and normal intelligence. Core features that were not commonly reported included motor processing deficits, a genetic basis, and a need to demonstrate an IQ discrepancy. Please see Figure 4 for a visual representation of the descriptive data.

Figure 4

Frequency of Core Features Reported in Definitions Across all Professional Disciplines



Medicine

We evaluated the frequency of core features reported within the discipline of medicine. The most commonly reported core features within the discipline of medicine included reading disorder, phonological deficits, neurobiological origin, and normal intelligence. The least commonly reported core features included motor processing deficits, IQ discrepancy, and a genetic basis.

Psychology

We evaluated the frequency of core features reported within the discipline of psychology. The most commonly reported core features within the discipline of psychology included reading

disorder, phonological deficits, and word reading difficulties. The least commonly reported core features included motor and visual processing deficits, IQ discrepancy, and genetic origin.

Speech-Language Pathology

We evaluated the frequency of core features reported within the discipline of speech-language pathology. The most commonly reported core features within the discipline of speech-language pathology included reading disorder, learning disability, and phonological and word reading deficits. The least commonly reported core features included motor processing deficits, IQ discrepancy, and genetic and neurobiological origin.

Education

We evaluated the frequency of core features reported within the discipline of education. The most commonly reported core features within this discipline included reading disorder, phonological deficits, and word reading difficulties. The least commonly reported core features included motor and visual processing deficits, IQ discrepancy, and genetic and neurobiological origin

Dyslexia Specific

We evaluated the frequency of core features reported within journals specifically focused on dyslexia. The most commonly reported core features within this area of focus included reading disorder, phonological deficits, and word reading difficulties. The least commonly reported core features included motor and visual processing deficits, IQ discrepancy, and genetic origin.

Interdisciplinary

We evaluated the frequency of core features reported within journals that were interdisciplinary in nature (i.e., both medicine and psychology, or medicine, psychology, and

education, etc.). The most commonly reported core features within interdisciplinary journals included reading disorder, phonological deficits, normal intelligence, unrelated to environmental influences (i.e., not due to lack of adequate instruction or socioeconomic status), and word reading difficulties. The least commonly reported core features included motor processing deficits, IQ discrepancy, and genetic origin.

Summary of Descriptive Data

Across the collected articles, the core features that each discipline most commonly reported included dyslexia as a reading disorder characterized by phonological deficits. The majority of collected articles across disciplines also commonly reported that dyslexia is also characterized by word reading deficits. Across all collected articles, each discipline was less likely to report dyslexia as genetic in origin, the need for IQ discrepancy, and that motor processing deficits are characteristic of dyslexia.

Statistical Analysis of Core Features From Collected Articles

We conducted several chi-square tests of independence between each core feature and each discipline to statistically determine whether disciplines report core features differently. We will first discuss those core features that statistically differed across disciplines. We will then discuss those core features that did not statistically differ across disciplines.

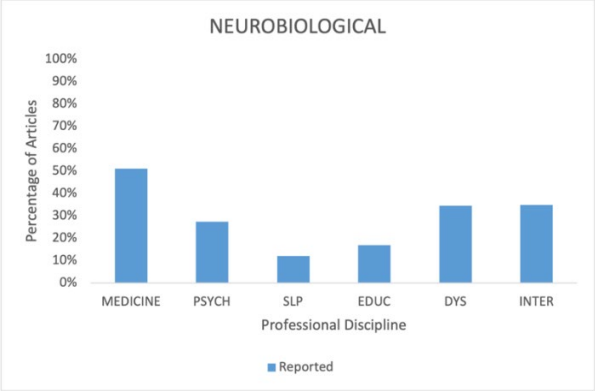
Core Features That Were Reported Differently Across Disciplines

Neurobiological. A chi-square test of independence was conducted between the neurobiological core feature and professional discipline. All expected cell frequencies were greater than five, which is required to meet the assumption for a chi-square analysis. There was a statistically significant association between the neurobiological core feature and professional discipline, $\chi 2(9) = 56.430$, $p < .001$. The association was moderately strong (Cohen, 1988),

Cramer's V = .273. There was an association between the two variables such that research studies from journals in a medical discipline were more likely than other disciplines to report that dyslexia is neurobiological in origin. In contrast, research studies from journals in psychology, speech-language pathology, and education were less likely than other disciplines to report that dyslexia is neurobiological in origin. See Figure 5 for a descriptive understanding of this statistical data.

Figure 5

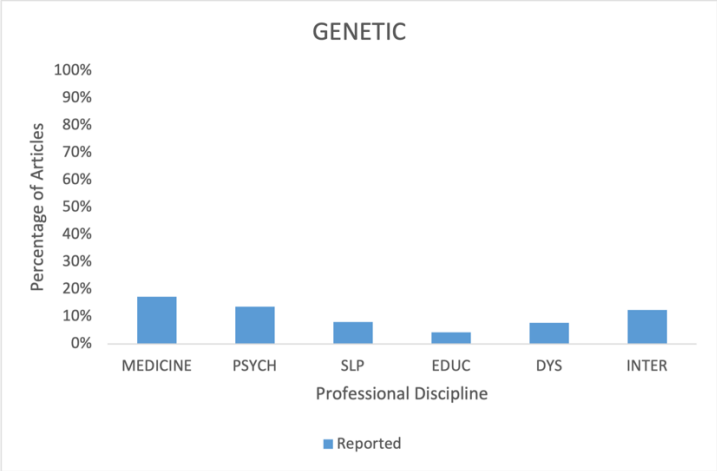
Frequency of Neurobiological Reported in Definitions Across all Disciplines



Genetic. A chi-square test of independence was conducted between the genetic core feature and professional discipline. All expected cell frequencies were greater than five. There was a statistically significant association between the genetic core feature and professional discipline, $\chi 2(9) = 14.601$, $p = .012$. The association was small (Cohen, 1988), Cramer's V = .139. There was an association between the two variables such that research studies from journals in medicine were more likely than other disciplines to report that dyslexia is genetic in origin. In contrast, research studies from education journals were less likely than other disciplines to report that dyslexia is genetic in origin. See Figure 6 for a descriptive representation of this association.

Figure 6

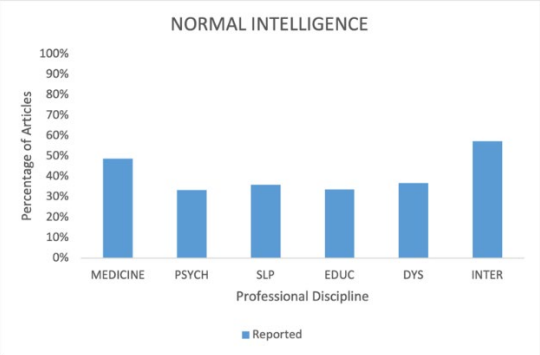
Frequency of Genetic Reported in Definitions Across all Disciplines



Normal Intelligence. A chi-square test of independence was conducted between the normal intelligence core feature and professional discipline. All expected cell frequencies were greater than five. There was a statistically significant association between the normal intelligence core feature and professional discipline, $\chi 2(9) = 21.566$, $p < .001$. The association was small (Cohen, 1988), Cramer's V = .169. There was an association between the two variables such that research studies in interdisciplinary and medical journals were more likely than other disciplines to report that dyslexia occurs despite normal intelligence. In contrast, research studies in psychology, speech-language pathology, education, and dyslexia-specific journals were slightly less likely than medical and interdisciplinary journals to report that dyslexia occurs despite normal intelligence. See Figure 7 for a descriptive representation of this association.

Figure 7

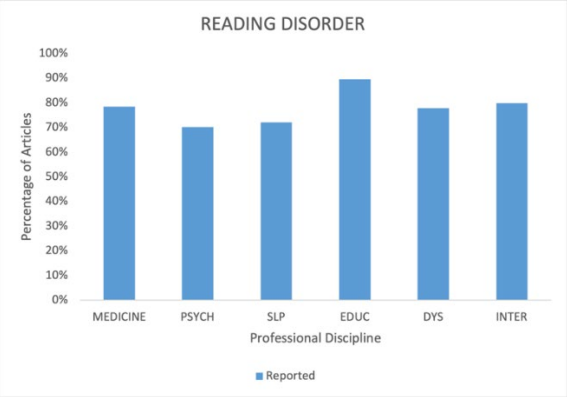
Frequency of Normal Intelligence Reported in Definitions Across all Disciplines



Reading Disorder. A chi-square test of independence was conducted between the reading disorder core feature and professional discipline. All expected cell frequencies were greater than five. There was a statistically significant association between the reading disorder core feature and professional discipline, $\chi 2(9) = 12.377$, $p = .03$. The association was small (Cohen, 1988), Cramer's V = .128. Research studies in education journals were slightly more likely than others to include reading disorder as a core feature of dyslexia as a compared to studies from journals of other disciplines. See Figure 8 for a descriptive representation of this association.

Figure 8

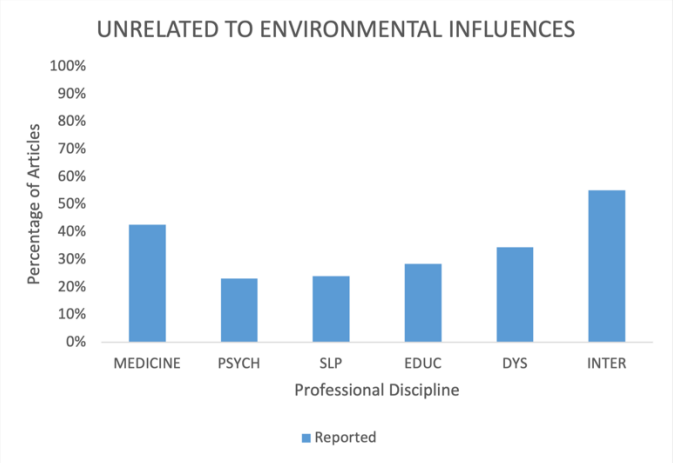
Frequency of Reading Disorder Reported in Definitions Across all Disciplines



Unrelated to Environmental Influences. A chi-square test of independence was conducted between the unrelated to environmental influences core feature and professional discipline. All expected cell frequencies were greater than five. There was a statistically significant association between the unrelated to environmental influences core feature and professional discipline, $\chi 2(9) = 31.417$, $p < .001$. The association was moderately strong (Cohen, 1988), Cramer's V = .203. There was an association between the two variables such that research studies from medical and interdisciplinary journals were more likely than other disciplines to report that the cause of dyslexia is unrelated to environmental influences. Research studies from the journals in psychology and education were less likely than other disciplines to report that the cause of dyslexia is unrelated to environmental factors. See Figure 9 for a descriptive representation of this association.

Figure 9

Frequency of Unrelated to Environmental Influences Reported in Definitions Across all Disciplines

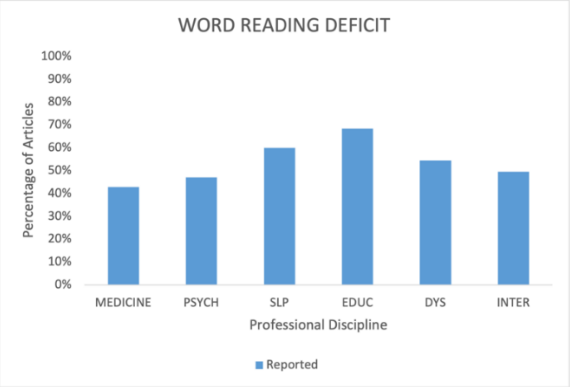


Word Reading Deficits. A chi-square test of independence was conducted between the word reading deficit core feature and professional discipline. All expected cell frequencies were greater than five. There was a statistically significant association between the word reading

deficit core feature and professional discipline, $\chi^2(9) = 21.932$, $p < .001$. The association was moderately small (Cohen, 1988), Cramer's V = .170. There was an association between the two variables such that research studies in journals from education were more likely than other disciplines to report that children with dyslexia demonstrate word reading deficits, whereas research studies from medical journals were less likely than other disciplines to report word reading deficits as a characteristic of dyslexia. See Figure 10 for a descriptive representation of this association.

Figure 10

Frequency of Word Reading Deficits Reported in Definitions Across all Disciplines

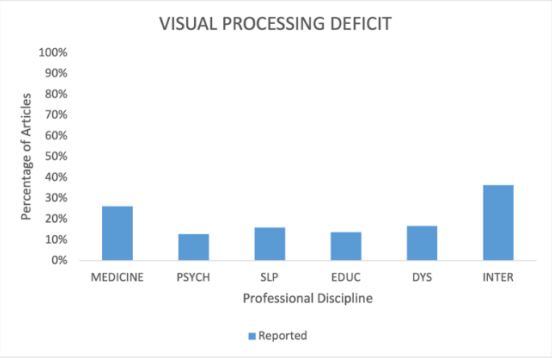


Visual Processing Deficits. A chi-square test of independence was conducted between the visual processing deficit core feature and professional discipline. All expected cell frequencies were greater than five. There was a statistically significant association between the visual processing deficit core features and professional discipline, $\chi^2(9) = 18.071$, $p = .003$. The association was moderately small (Cohen, 1988), Cramer's V = .154. There was an association between the two variables such that journals from a medical discipline were more likely than other disciplines to report that dyslexia includes visual processing deficits, whereas research studies from education and psychology journals were less likely than other disciplines to report

that visual processing deficit is a characteristic of dyslexia. See Figure 11 for a descriptive representation of this association.

Figure 11

Frequency of Visual Processing Deficits Reported in Definitions Across all Disciplines



Core Features That Were Equally Reported Across Disciplines

Phonological Deficits. A chi-square test of independence was conducted between the phonological deficit core feature and professional discipline. All expected cell frequencies were greater than five. There was not a statistically significant association between the phonological deficit core feature and professional discipline, $\chi^2(9) = 9.714$, $p = .084$. The association was small (Cohen, 1988), Cramer's V = .113. That is, research studies from journals in each discipline were equally likely to report phonological skills as a core feature of dyslexia in their definition.

Learning Disability. A chi-square test of independence was conducted between the learning disability core feature and professional discipline. All expected cell frequencies were greater than five. There was not a statistically significant association between the learning disability core feature and professional discipline, $\chi^2(9) = 8.666$, $p = .123$. The association was small (Cohen, 1988), Cramer's V = .107. That is, research studies in journals from each

discipline were equally likely to report learning disability as a core feature of dyslexia in their definition.

Spelling Deficits. A chi-square test of independence was conducted between the spelling deficit core feature and professional discipline. All expected cell frequencies were greater than five. There was not a statistically significant association between the spelling deficit core feature and professional discipline, $\chi 2(9) = 7.587$, $p = .181$. The association was small (Cohen, 1988), Cramer's V = .100. That is, research studies in journals from each discipline were equally likely to not report spelling as a core feature of dyslexia in their definition. We suspect that if spelling deficits are included as core features, it is mostly reported in studies conducted in non-English orthographies, such as Dutch or German, where spelling scores are typically used as criteria for dyslexia.

IQ Discrepancy. A chi-square test of independence was conducted between the IQ discrepancy core feature and professional discipline. All expected cell frequencies were greater than five. There was not a statistically significant association between the IQ discrepancy core feature and professional discipline, $\chi 2(9) = 7.200$, $p = .206$. The association was small (Cohen, 1988), Cramer's V = .097. That is, research studies in journals from each discipline were equally likely to not report IQ discrepancy as a core feature of dyslexia in their definition.

Language-Based Disorder. A chi-square test of independence was conducted between the language-based disorder core feature and professional discipline. All expected cell frequencies were greater than five. There was not a statistically significant association between the language-based disorder core feature and professional discipline, $\chi 2(9) = 4.796$, $p = .441$. The association was small (Cohen, 1988), Cramer's V = .079. That is, research studies in journals

from each discipline were equally likely to not report language-based deficits as a core feature of dyslexia in their definition.

Motor Processing Deficits. A chi-square test of independence was conducted between the motor processing deficit core feature and professional discipline. All expected cell frequencies were greater than five. There was not a statistically significant association between the motor processing deficit core feature and professional discipline, $\chi 2(9) = 7.554$, $p = .183$. The association was small (Cohen, 1988), Cramer's V = .100. That is, research studies in journals from each discipline were equally likely to not include motor processing deficits as a core feature of dyslexia in their definition.

Discussion

Purpose of the Study

The present study investigated the current state of the literature according to noted inconsistencies identified by Wagner et al. (2020) that may contribute to difficulty determining a true prevalence of dyslexia. Specifically, we aimed to investigate inconsistencies in definitions of dyslexia across disciplines. A systematic review was conducted across multiple disciplines to determine the level of variability of how core features of dyslexia are discussed within and across disciplines. We reviewed the most cited scientific literature involving children as participants with dyslexia from the years 2000-2020. We investigated whether the core features of an organization's definition were consistent with the definition of dyslexia in the research of that organization's premier academic journals. We also evaluated the frequency of the core features in the definition of dyslexia per professional discipline.

Key Inconsistencies in Definitions Across Disciplines

In answer to Wagner et al.'s (2020) noted inconsistencies about the definitions of dyslexia, we noted the following inconsistencies in the definition of dyslexia across disciplines. First, the results demonstrated that medical journals were more likely than other disciplines to include a neurobiological and genetic origin to dyslexia and to exclude word reading deficit as a core feature in the definition of dyslexia. In contrast, journals in education were more likely to include word reading deficit and less likely to include neurobiological and genetic as features of dyslexia. We hypothesize that this inconsistency may be due to medicine's general focus on internal structure and function of the brain and education's general focus on behavioral characteristics. For example, a medical researcher may argue that magnetic resonance imaging (MRI) or functional magnetic resonance imaging (fMRI) may be an important way to determine the presence of dyslexia. On the other hand, an educational researcher may argue that considering an MRI or fMRI for diagnosis of dyslexia is unrealistic due to time and funding limitations. Therefore, a researcher from education is more likely to argue that a word reading assessment may be more appropriate to use than neurological imaging to determine the presence of dyslexia.

Though it may be beneficial to understand the neurology or genetics that may be a factor of origin for dyslexia, the majority of dyslexia assessment and intervention is conducted in educational settings (Elliott, 2020). Determining that dyslexia is neurobiological or genetic in origin is not likely to have a direct impact on diagnostic assessments and criteria utilized in educational settings. On the other hand, regardless of etiology, word reading instruction is beneficial and is required to improve word reading for children with dyslexia (Stuebing et al., 2009). That said, knowing that dyslexia is of genetic origin could be useful for educational

professionals in order for them to identify children at-risk for dyslexia who may demonstrate symptoms of this difficulty later in their academic career (Snowling et al., 2007).

According to a study conducted by Lopes et al. (2020), over half of the studies regarding dyslexia from 2000-2019 were published in medical journals and about five percent of studies were published in educational journals. We found a similar trend in our systematic review. The lack of papers in education may be problematic if the research providing evidence to support intervention and instructional practices is given "lower consideration and status" than the research being published in medical journals (Lopes et al., 2020, p. 597). If dyslexia is considered neurobiological, then it is consequently thought of like a disease or disorder, but there is no pill that cures dyslexia. It is now widely understood, however, that dyslexia is remediated by instruction and intervention in education (Elliott, 2020; Lopes et al., 2020). The majority of dyslexia research, however, is conducted in decontextualized settings outside of a classroom setting, which calls into question whether the findings are ecologically valid. In order for research results regarding dyslexia to hold ecological validity, researchers across all disciplines should aim to investigate dyslexia in educational/classroom settings. Researchers may also need to consider the training that may be required for educators to provide instruction or intervention. Is the method of instruction accessible to educators? What is the ecological validity in a classroom setting? Future research should seek to investigate these important factors to better serve children with dyslexia.

Key Consistencies in Definitions Across Disciplines

In contrast to Wagner et al.'s (2020) noted inconsistencies about the definitions of dyslexia, the current study found the following consistencies in the definition of dyslexia across disciplines. Articles from each discipline consistently did not report that dyslexia includes a

discrepancy between reading ability and intelligence, is a language-based deficit, or that children with dyslexia may demonstrate motor processing deficits.

Although current evidence supports that dyslexia can be found across an intellectual spectrum, a majority of professionals in clinical/education settings continue to employ cognitive-achievement measures, specifically an achievement gap between reading performance and IQ, to diagnose dyslexia (Elliott, 2020; Miciak & Fletcher, 2020). To date, there is little evidence to support that the notion that the assessment of cognitive aptitude (i.e., IQ) "has value for dyslexia identification or for guiding intervention" (Gibbs & Elliott, 2020, p. 489; Miciak & Fletcher, 2020). In 2004, the reauthorization of IDEA determined that IQ discrepancy (a difference between IQ scores and reading achievement scores) was no longer necessary for dyslexia diagnosis for qualification of special education services in the public school system, yet many professionals continue to use it as a means of diagnosis (Adlof, 2020). Cognitive-achievement testing is not necessary to include in dyslexia diagnostic criteria for multiple reasons: (a) because the psychometric properties of IQ-achievement tests are questionable and lack substantial validity for the classification (Miciak & Fletcher, 2020), (b) IQ-measures are typically dependent on some form of language and communication disorders are a typical co-morbidity in children with dyslexia which may invalidate the results (Bishop & Snowling, 2004; Lopes et al., 2020), and (c) dyslexia occurs across a spectrum of intellect, therefore cognitive ability does not need to be considered (Adlof, 2020; Miciak & Fletcher, 2020). Snowling et al. (2020) stated that children with other difficulties, such as ADD/ADHD or communication disorders, are more likely to have a lower IQ because of test bias, and because professionals are still employing the IQ-discrepancy method, many children are not diagnosed with dyslexia and do not receive the help and assistance that they need to achieve academic success.

It is concerning, especially for speech-language pathologists who are equipped to assess and diagnose written language disorders such as dyslexia, that the majority of studies within and across all disciplines included in the current study do not mention that dyslexia is a language-based deficit. Strong evidence has been found to support the continuity between oral and written language difficulties (Bishop & Snowling, 2004; Hulme & Snowling, 2016). Children with dyslexia demonstrate significant deficits in the phonological component of language namely phonological processing, phonological awareness, phonological memory, and/or nonword repetition (Catts et al., 2005). Several studies have provided evidence to support that oral language difficulties are present in children at-risk for dyslexia in the pre-school age (Catts et al., 2005; Hulme & Snowling, 2016). Catts et al. (2005) found evidence to support their claim that dyslexia highly co-occurs with developmental language disorder (DLD). A vast majority of the previous research with children with dyslexia has been conducted without accounting for comorbid language disorders in which children may have difficulty in other components of language besides phonology (Catts et al., 2005). It is estimated that up to 50% of children with dyslexia have co-occurring DLD (Catts et al., 2005). Therefore, future research should include language measures in their studies in order to correctly subtype the children with only dyslexia, with dyslexia and DLD, and those with only DLD in order for results to generalize to the school-age population.

Motor processing deficits as a core feature of dyslexia is an area that has had a recent surge of interest (Bellocchi & Ducrot, 2021; Bellocchi et al., 2021; Bellocchi et al., 2018), but our current study found that the professional disciplines included here are not readily incorporating these deficits into how dyslexia is defined. As research in this area continues, it

will be interesting to note whether motor processing deficits are included as a core feature of dyslexia in the future.

Universal Agreement – Dyslexia as a Phonological Deficit

An encouraging result from this study was the presence and consistency of phonological deficit as a core feature of the definition of dyslexia within and across all disciplines. The majority of all disciplines reported that dyslexia was due to a phonological deficit that was the underlying cause behind word reading difficulties found across children with dyslexia. This encouraging consistency found within and across disciplines creates a common ground with which all disciplines can build upon for further assessment development and implementation of intervention strategies.

Limitations

There are a number of limitations that should be borne in mind. First, each journal was coded into a discipline category based on judgements from the researchers from the field of Communications Sciences and Disorders (CSD). Therefore, there is a possibility that the coding scheme needs to be refined for disciplines. In follow up studies, it would be important to determine the consistency of the coded journals and evaluate whether they'd be classified the same way in other studies.

Second, inter-rater reliability has yet to be coded. The definitions of dyslexia have been coded by the first author prior to dissemination and a second rater is needed to code each definition to ensure an appropriate level of inter-rater reliability. Furthermore, 20% of the articles are currently undergoing recoding so that, in the future, we can report inter-rater reliability of the coding scheme.

Third, there is a possibility that our method for selecting articles may not have captured a full representation of how dyslexia is discussed or defined in each discipline. We aimed to investigate the articles that were most widely disseminated and those that had a large impact and thus focused our review using the Elsevier Scopus database which has a representative sampling of journals from a wide variety of disciplines. This database also enabled us to sort articles by those that were most cited, a replication from a previous study which evaluated different characteristics of dyslexia diagnosis (Lopes et al., 2020). Future work should include additional databases to determine whether these findings remain consistent across multiple databases.

Future Directions

The current study evaluated how different disciplines characterized dyslexia according to the definitions provided by professional associations and research articles associated with each discipline. We have yet to determine whether these definitions align with how investigators utilize specific assessment tools and cut-off criteria to diagnose dyslexia in children within each scientific study. Future studies should explore whether the diagnostic criteria employed within and across disciplines is consistent with the definition of dyslexia from professional discipline's premier organizations. This finding would provide concrete data to either support or reject the hypothesis that diagnostic criteria is consistent within professional disciplines in professional organizations and research (Wagner et al., 2020). Future studies should also explore the presence and consistency of word reading, non-word reading, spelling, language, IQ assessment, and any other included assessment criteria (i.e., cut-off scores) within and across disciplines. This finding would provide concrete evidence to support or reject Wagner et al.'s (2020) statement that there are inconsistencies across diagnostic criteria for dyslexia within and across disciplines. A specific finding that would be noteworthy would be to determine the presence of IQ discrepancy

in diagnostic criteria employed among all disciplines. Considering that in this study we found that the majority of research articles and professional organizations do *not* include IQ discrepancy as a core feature in their definitions it would be curious to investigate whether IQ discrepancy is still utilized as diagnostic criteria within research articles.

Conclusion

This study systematically reviewed consistencies and inconsistencies in core features included in the given definition of dyslexia across research articles (N = 759). We investigated the frequency of core features included in each definition of dyslexia within and across disciplines. We then determined statistical significance through chi-square tests of independence within and across the disciplines of medicine, psychology, speech-language pathology, education, and interdisciplinary. We found statistically significant consistencies and inconsistencies in how the definition of dyslexia is reported across disciplinary journals. An encouraging result from the study was that across all disciplines researchers acknowledge that dyslexia is a phonological deficit that doesn't require the presence of an IQ discrepancy.

References

Adlof, S. M. (2020). Promoting reading achievement in children with developmental language disorders: What can we learn from research on specific language impairment and dyslexia? *Journal of Speech, Language, and Hearing Research: JSLHR*, *63*(10), 3277–3292. https://doi.org/10.1044/2020_JSLHR-20-00118

American Academy of Pediatrics, American Academy of Ophthalmology, and American Association for Pediatric Ophthalmology and Strabismus. (2009). Learning disabilities, dyslexia, and vision. *Pediatrics, 124*(2), 837-844. https://doi.org/10.1542/peds.2009-1445

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

American Psychological Association. (2014). *Educational psychology promotes teaching and learning.* Available from https://www.apa.org/education-career/guide/subfields/teaching-learning.

American Psychological Association (2020). *APA guidelines for psychological assessment and evaluation*. APA Council of Representatives. https://www.apa.org/about/policy/guidelines-psychological-assessment-evaluation.pdf

American Psychological Association. (n.d.). *APA dictionary of psychology.* American Psychological Association. https://dictionary.apa.org/dyslexia

American Speech-Language-Hearing Association. (2001). *Roles and responsibilities of speech-language pathologists with respect to reading and writing in children and adolescents* [Position Statement]. Available from www.asha.org/policy.

American Speech-Language-Hearing Association. (n.d.). *Written language disorders.* ASHA Practice Portal. https://www.asha.org/practice-portal/clinical-topics/written-language-disorders/

Bellocchi, S., & Ducrot, S. (2021). "Same, same but different": The optimal viewing position effect in developmental dyslexia, developmental coordination disorder and comorbid disorders. *Dyslexia*, *27*(3), 294-311. https://doi.org/10.1002/dys.1688

Bellocchi, S., Ducrot, S., Tallet, J., Jucla, M., & Jover, M. (2021). Effect of comorbid developmental dyslexia on oculomotor behavior in children with developmental coordination disorder: A study with the Developmental Eye Movement test. *Human Movement Science*, *76*, 102764. https://doi.org/10.1016/j.humov.2021.102764

Bellocchi, S., Maziero, S., Bailleux, C., Biotteau, M., Tallet, J., Livet, M. O., Alabaret, J. M., Jover, M., Ducrot, S., Chaix, Y., & Jucla, M. (2018, April 12-14). *Dyslexia, with or without developmental coordination disorder: Different reading mechanisms?* 11th British Dyslexia Association's International Conference (IC) and EXPO, Telford, UK. https://doi.org/10.13140/rg.2.2.24842.16324

Bishop, D. V., & Snowling, M. J. (2004). Developmental dyslexia and specific language impairment: Same or different? *Psychological Bulletin*, *130*(6), 858–886. https://doi.org/10.1037/0033-2909.130.6.858

Catts, H. W., Adlof, S. M., Hogan, T. P., & Weismer, S. E. (2005). Are specific language impairment and dyslexia distinct disorders? *Journal of Speech, Language, and Hearing Research, 48*(6), 1378-1396. https://doi.org/10.1044/1092-4388(2005/096)

Center on Education Policy. (2020). *History and evolution of public education in the US.* (ED606970). ERIC. https://files.eric.ed.gov/fulltext/ED606970.pdf

Cohen, J. (1988). *Statistical power of analysis for the behavioral sciences* (2nd ed.). New York: Psychology Press.

Elliott, J. G. (2020). It's time to be scientific about dyslexia. *Reading Research Quarterly*, *55*(S1), S61– S75. https://doi-org.erl.lib.byu.edu/10.1002/rrq.333

Elliott, J. G., & Grigorenko, E. L. (2014). *The dyslexia debate.* Cambridge University Press. https://doi.org/10.1017/CBO9781139017824

Elsevier Scopus. (n.d.). *Content*. Elsevier. https://www.elsevier.com/solutions/scopus/how-scopus-works/content

Gibbs, S. J., & Elliott, J. G. (2020). The dyslexia debate: Life without the label. *Oxford Review of Education*, *46*(4), 487-500. https://doi.org/10.1080/03054985.2020.1747419

Hogan, T. P. (2018). Five ways speech-language pathologists can positively impact children with dyslexia. *Language, Speech, and Hearing Services in Schools*, *49*(4), 902–905. https://doi-org.erl.lib.byu.edu/10.1044/2018_LSHSS-DYSLC-18-0102

Hoover, W. A., & Gough, P. B. (1990). The simple view of reading. *Reading and Writing: An Interdisciplinary Journal, 2*(2), 127–160. https://doi.org/10.1007/BF00401799

Horowitz-Kraus, T., & Breznitz, Z. (2013). Compensated dyslexics have a more efficient error detection system than noncompensated dyslexics. *Journal of Child Neurology*, *28*(10), 1266–1276. https://doi.org/10.1177/0883073812460917

Hulme, C., & Snowling, M. J. (2016). Reading disorders and dyslexia. *Current opinion in pediatrics*, *28*(6), 731–735. https://doi.org/10.1097/MOP.0000000000000411

Individuals with Disabilities Education Act, 20 U.S.C. § 1401 (2004).

International Dyslexia Association. (2002, November 12). *Definition of Dyslexia.* International Dyslexia Association. https://dyslexiaida.org/definition-of-dyslexia/

Katz, L. A., Maag, A., Fallon, K. A., Blenkarn, K., & Smith, M. K. (2010). What makes a caseload (un)manageable? School-based speech-language pathologists speak. *Language, Speech, and Hearing Services in Schools*, *41*(2), 139–151. https://doi.org/10.1044/0161-1461(2009/08-0090)

Kirby, P. (2020). Dyslexia debated, then and now: A historical perspective on the dyslexia debate. *Oxford Review of Education*, *46*(4), 472-486. https://doi.org/10.1080/03054985.2020.1747418

Kussmaul, A. (1877). Chapter XXVII. In H. von Ziemssen (Ed.), *Cyclopaedia of the practice of medicine: Vol. XIV: Diseases of the nervous system and disturbances of speech* (pp. 770–778). William Wood.

Lindstrom, J. H. (2019). Dyslexia in the schools: Assessment and identification. *Teaching Exceptional Children*, *51*(3), 189–200. https://doi.org/10.1177/0040059918763712

Lopes, J. A., Gomes, C., Oliveira, C. R., & Elliot, J. G. (2020). Research studies on dyslexia: Participant inclusions and exclusion criteria. *European Journal of Special Needs Education*, *35*(5), 587-602. https://doi.org/10.1080/08856257.2020.1732108

Mayo Clinic. (2017). *Dyslexia.* Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/dyslexia/symptoms-causes/syc-20353552

Merriam-Webster. (n.d.). Dys-. *Merriam-Webster Online Dictionary.* https://www.merriam-webster.com/dictionary/dys-

Merriam-Webster. (n.d.). Lexia. *Merriam-Webster Online Dictionary.* https://www.merriam-webster.com/dictionary/lexia

Miciak, J., & Fletcher, J. M. (2020). The critical role of instructional response for identifying dyslexia and other learning disabilities. *Journal of Learning Disabilities*, *53*(5), 343–353. https://doi.org/10.1177/0022219420906801

National Association of Special Education Teachers. (n.d.). *Introduction to learning disabilities*. National Association of Special Education Teachers. https://www.naset.org/publications/ld-report/introduction-to-learning-disabilities

National Institute of Neurological Disorders and Stroke. (n.d.). *Dyslexia.* National Institute of Neurological Disorders and Stroke. https://www.ninds.nih.gov/Disorders/All-Disorders/Dyslexia-Information-Page

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J.M., Hrobjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuiness, L. A., Stewart, L. A., Thomas, J., Tricco, A. C., Welch, V. A., Whiting, P., Moher, D. (2020). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *Systematic Reviews, 10*, Article 89. https://doi.org/10.1186/s13643-021-01626-4

Phillips, B. A. B. & Odegard, T. N. (2017) Evaluating the impact of dyslexia laws on the identification of specific learning disability and dyslexia. *Annals of Dyslexia, 67***,** 356–368. https://doi.org/10.1007/s11881-017-0148-4

Snowling, M. J., Hulme, C., & Nation , K. (2020) Defining and understanding dyslexia: Past, present, and future. *Oxford Review of Education, 46*(4), 501-513. https://doi.org/10.1080/03054985.2020.1765756

Snowling, M. J., Muter, V., & Carroll, J. (2007). Children at family risk of dyslexia: A follow-up in early adolescence. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *48*(6), 609–618. https://doi.org/10.1111/j.1469-7610.2006.01725.x

Stuebing, K. K., Barth, A. E., Molfese, P. J., Weiss, B., & Fletcher, J. M. (2009). IQ is not strongly related to response to reading instruction: A meta-analytic interpretation. *Exceptional Children*, *76*(1), 31–51. https://doi.org/10.1177/001440290907600102

Texas Education Agency. (2018). *The dyslexia handbook – 2018 update: Procedures concerning dyslexia and related disorders.* Texas Education Agency. https://tea.texas.gov/sites/default/files/2018-Dyslexia-Handbook_Approved_Accomodated_12_11_2018.pdf

Wagner, R. K., Zirps, F. A., Edwards, A. A., Wood, S. G., Joyner, R. E., Becker, B. J., Liu, G., & Beal, B. (2020). The prevalence of dyslexia: A new approach to its estimation. *Journal of Learning Disabilities*, *53*(5), 354–365. https://doi.org/10.1177/0022219420920377

Ziegler, J. C., Pech-Georgel, C., George, F., & Lorenzi, C. (2009). Speech-perception-in-noise deficits in dyslexia. *Developmental Science*, *12*(5), 732–745. https://doi.org/10.1111/j.1467-7687.2009.00817.x

Zirkel, P. A. (2012). The legal issues of identification and intervention for K-12 students with dyslexia. *Perspectives on Language and Literacy, 38*(3), 13-16. Retrieved from http://www.parentcenterhub.org/wp-content/uploads/repo_items/journals/ZirkelDyslexiaArticle.pdf

APPENDIX A

Annotated Bibliography

Adlof, S. M. (2020). Promoting reading achievement in children with developmental language disorders: What can we learn from research on specific language impairment and dyslexia? *Journal of Speech, Language, and Hearing Research: JSLHR*, *63*(10), 3277–3292. https://doi.org/10.1044/2020_JSLHR-20-00118

Objectives: This article focuses on comparing and contrasting specific language impairment (SLI) and dyslexia, which frequently co-occur. The author discusses exclusionary and inclusionary criteria for both disorders and reviews studies that have directly compared the two. Another purpose of the article is to identify what procedures are used in schools for identification of oral language impairment or word reading and the implications therein.

Methods: Section one reviews and discusses the definitions and criteria for inclusion and exclusion for SLI and dyslexia. Section two is a review of the research with evidence to support that SLI and dyslexia are distinct disorders but co-occur often. The authors discuss how schools identify children with SLI and dyslexia and the potential benefits for implementing response to intervention (RTI) assessment and intervention frameworks.

Results/Conclusions: Using RTI helps identify and treat children with SLI and dyslexia and provide support to improve reading comprehension in all students. Many children are going misdiagnosed due to many factors, so RTI helps prevent professionals from disregarding children that don't present with a need for speech and language services.

Relevance to the current study: This article provided insight to how SLI and dyslexia have been defined and diagnosed. This article is a compilation of studies that discuss identification for the two disorders and the current issues associated with the current diagnostic criteria in schools.

Bishop, D. V., & Snowling, M. J. (2004). Developmental dyslexia and specific language impairment: Same or different? *Psychological Bulletin*, *130*(6), 858–886. https://doi.org/10.1037/0033-2909.130.6.858

Objectives: The authors explored the relationship between specific language impairment (SLI) and dyslexia to determine whether these two disorders originated from the same etiology and neurobiology (underlying problem) or whether the two disorders are distinct, the same, or if a new way of thinking about these disorders should be adopted. They also highlight diagnostic issues between the two disorders. Research about SLI has generally been completed by speech-language pathologists and dyslexia has been explored by educators and psychologists. The author's main objective was to explore the relationship between the two disorders to evaluate whether professionals should continue to distinguish the two as separate disorders or whether differentiation needs to continue.

Methods: While this article is less of a study and more of a discussion of the current evidence-based literature, the authors focus a significant portion of their efforts on the issues related to the diagnostic criteria and definitions for SLI and dyslexia. The *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* diagnostic guidelines from the American Psychiatric Association express that dyslexia occurs in the absence of poor cognitive ability. In order to meet diagnostic criteria according to the *DSM-IV,* a person must perform poorly on a test of language or literacy (with no regards to

comprehension or accuracy) and have a normal or average IQ. Nonverbal IQ is used more than verbal IQ and if the reading score of a person falls at or below 1 SD below the nonverbal IQ score, this is enough for diagnosis of dyslexia. The researchers suggest that because the two disorders have been characterized so similarly for decades, that diagnosis of either dyslexia or SLI depends on the professional discipline of the person doing the diagnosis, the severity of the deficit, and the age of the child.

Results/Conclusions: The researchers claim that professionals may adopt diagnosis of dyslexia and SLI of poor literacy skills from phonological processing, oral language, semantic, syntactic, and discourse deficits in a quadrant fashion. Diagnostic criteria using nonverbal IQ and poor reading accuracy does not accurately reflect the context of a child's normal performance and therefore would likely identify children with poor comprehension, classic SLI and classic dyslexia. Diagnostic criteria using verbal IQ and poor reading accuracy would likely provide a higher proportion of children with dyslexia with pure phonological deficits.

Relevance to the current study: This study provided insight to how SLI and dyslexia have been diagnosed and the current issues associated with the current diagnostic criteria among professionals across disciplines.

Catts, H. W., Adlof, S. M., Hogan, T. P., & Weismer, S. E. (2005). Are specific language impairment and dyslexia distinct disorders? *Journal of Speech, Language, and Hearing Research, 48*(6), 1378-1396. https://doi.org/10.1044/1092-4388(2005/096)

Objectives: The objective of this study was to evaluate the relationship (if any) between Specific Language Impairment (SLI) and Dyslexia to evaluate whether these two

disorders overlap or are distinct in nature. Three possible models for the two disorders were presented and two studies were presented to evaluate any overlap between them.

Methods: Study 1 evaluated the overlap between SLI and dyslexia in a longitudinal study of language and reading development. The sample included 527 school-aged children followed from kindergarten to eighth grade. The criteria used to identify intelligence in SLI and dyslexia were estimates of nonverbal and Full-Scale IQ. The diagnostic batteries administered in kindergarten were the Block Design and Picture Completion subtests of the Wechsler Preschool and Primary Scale of Intelligence-Revised combined with the nonverbal IQ. In second grade, the children were assessed with the full Performance scale of the Wechsler Intelligence Scale for Children-III. In eighth grade, the children were assessed with the Block Design and Picture Completion subtests from the Wechsler Intelligence Scale for Children-III. At second, fourth, and eighth grades, the children were administered the Peabody Picture Vocabulary Test-Revised (PPVT-R). Criteria to evaluate language included the TOLD-2:P and a narrative story task. For word recognition, the children were administered The Word Identification and Word Attack subtests of the Woodcock reading Mastery Tests-Revised in the second, fourth, and eight grades.

Criteria for SLI: Children identified with language impairment scored at least two of five language composite *z* scores below -1.25 SD. Children with language impairment were considered to have "specific" language impairment if they demonstrated normal or above-normal nonverbal IQ and normal sensory and socioemotional development.

Criteria for Dyslexia: Children were considered to have dyslexia if they scored below -1 SD in word reading and scored above -1 SD in intelligence.

Results: Almost 1/3 of the children diagnosed with dyslexia in eighth grade were diagnosed with SLI in kindergarten, showing significant overlap. These results should be evaluated with caution as they do not reflect many other studies that have controlled for more variables. Only a small percentage of children with SLI in kindergarten met the criteria for dyslexia, while a small percentage of the children with dyslexia met criteria for SLI in kindergarten.

Study 2 evaluated whether phonological processing was a primary characteristic of dyslexia alone, dyslexia and SLI combined, SLI only, or neither of the two disorders. The participants in this study were identified with SLI and/or dyslexia from sample of children in Study 1. The different groups were comprised of four subgroups: children diagnosed with SLI in kindergarten with normal reading achievement in fourth grade (scored above the 40^{th} percentile on word recognition), children with SLI and dyslexia (those who met criteria based on Full Scale IQ and low achievement scores), children with dyslexia only (same criteria as the second group) with normal language in kindergarten (no SLI present), and children with normal language in kindergarten with normal reading achievement scores in the fourth grade. The researchers also administered phonological memory (non-word repetition tasks) and phonological awareness (deleting phonemes from words or non-words) measures to participants in this study.

Results: The researchers found evidence to support their hypothesis that phonological processing deficits were more closely associated with dyslexia than

SLI. Both children with dyslexia and children with both dyslexia and SLI performed more poorly on measures of phonological memory and awareness across all grades (2nd, 4th, and 8th). Children with SLI only demonstrated difficulty with phonological processing tasks, but the results were not statistically significant and suggest that children with SLI only have mild deficits in this area. The researchers suggest that children with comorbidities of dyslexia and SLI have been included in studies where other researchers are trying to evaluate whether non-word repetition is a deficit for children with SLI. They essentially state that these other studies didn't account for the prevalence of dyslexia as well as SLI and that may have account for the results of poor phonological processing among children with SLI. The authors also suggest that children with dyslexia have deficits in phonological processing but may not demonstrate difficulty with semantics and syntax, but children with SLI have the opposite to be true.

Results/Conclusions: Catts et al. claims that dyslexia and SLI are two distinct and different disorders: dyslexia is characterized by poor phonological processing and decoding deficits, while SLI involves deficits in semantics, syntax, reading comprehension and discourse. The researchers found evidence to support that phonological processing may be a mild deficit in children with SLI only but is mainly characteristic of dyslexia. They claim that SLI and dyslexia are different and distinct disorders but may co-occur in children with a large amount of overlap. Another group was introduced as "poor comprehenders" or children that have poor oral language skills not enough to be considered SLI or those with a history of SLI but intact phonological processing.

Relevance to the current study: The methods section of each study provides an overview of how Speech-Language Pathologists diagnose and characterize dyslexia and specific language impairment. The discussion of this article claims that dyslexia and SLI are separate and distinct disorders, which will be considered as we discuss how different fields of study (i.e., neuroscience, psychology, speech-language pathology) diagnose and characterize dyslexia and/or SLI.

Elliott, J. G. (2020). It's time to be scientific about dyslexia. *Reading Research Quarterly*, *55*(S1), S61– S75. https://doi-org.erl.lib.byu.edu/10.1002/rrq.333

Objectives: In this article, the author argues that labeling children as dyslexic to distinguish them from other poor or struggling readers is inconsistent among research, clinical, and education practice and that this problem results in social inequity and reduced life changes for millions of students. This author intended to break the binary positions plaguing the progress of teaching of reading and to push professionals in each field forward "to reach a common understanding, consistent operationalization, and equitable practice for all struggling readers."

Methods: Elliott provides four definitions that are currently accepted by different groups of people (i.e., researchers, clinicians, practitioners, educational professionals, dyslexia advocacy groups, politicians, etc.), which include defining dyslexia as a) dyslexia 1, a word-level reading difficulty synonymous for reading disability, b) dyslexia 2, a subgroup from a large group of poor decoders, c) dyslexia 3, those poor readers who do not respond to evidence-based, high-quality intervention, and d) dyslexia 4, a neurodiverse disorder in which people experience other difficulties aside from reading. Dyslexia 1 is identified based on individual characteristics and does not require extensive

psychological testing for diagnosis. Assessment would simply involve tests that involved decoding or fluent reading and children who do poorly are identified as dyslexic. This definition requires no clear boundary between those considered to be normal readers and those considered to have a reading disability. Instead of establishing arbitrary cutoffs, the author argues to operate this definition with loose thresholds to take measurement error into account. The dyslexia 2 definition is difficult to distinguish because there is currently no scientifically valid way to distinguish or identify a subgroup of poor decoders of dyslexia within the large group of those who struggle with decoding. Dyslexia 3 defines the disability as those children that are resistant to the evidence-based practices for reading intervention. This definition has many problems because it is unclear when the point "of failure to improve" a child's reading abilities for diagnosis could be made. There is no evidence to support a period of how long it is appropriate to wait in this instance. Dyslexia 4 is defined as a neurodiverse disorder in which the difficulties the person faces may or may not directly include reading difficulties. This one confuses me. The whole definition of dyslexia is based on reading difficulties and this definition presents ethical, operational, and conceptual challenges.

Results/Conclusions: Science from research studies investigating reading difficulty has compiled, but little of that evidence has translated to legislation, clinical, or educational practice. Elliott suggests the discontinuance of the term dyslexia and use of the term reading disability to combat the challenges faced by each definition of dyslexia previously presented. Elliott acknowledges that due to social constructs, anecdotal experiences, and political popularity the term dyslexia will likely never be pushed out and replaced with reading disability. However, Elliott urges researchers, clinicians, and

educational professionals to focus on scientific evidence in support for providing intervention for all struggling readers and not just those classified as dyslexic.

Relevance to the current study: Elliott discussed the widely accepted differentiation in definition for dyslexia across disciplines and settings (i.e., research and clinical practice). He provided evidence that will likely be used for the introduction of my thesis.

Gibbs, S. J., & Elliott, J. G. (2020). The dyslexia debate: Life without the label. *Oxford Review of Education*, *46*(4), 487-500. https://doi.org/10.1080/03054985.2020.1747419

Objectives: This article was published in an education journal. This article introduced the issue with the polarized of beliefs between advocates and deniers of dyslexia across disciplines. The authors discuss a need for an assessment and intervention that avoids using the term dyslexia and promote serving the struggling readers with 'Response to Intervention.' Though many argue about whether dyslexia exists, researchers and clinicians should be aware that dyslexia only describes a "subset" of children with reading difficulties and currently, there is no clear diagnosis to distinguish those with dyslexia to other struggling readers. They state that terms often used "interchangeable with dyslexia include reading difficulties, reading disorder, specific reading difficulties, specific learning difficulties, learning disability, word-level reading disability, specific reading retardation, unexpected reading difficulty, reading disability and specific reading disability."

Methods: Definitions and diagnostic criteria of dyslexia vary widely. One researcher hypothesized that dyslexia is on the lower end of a reading continuum and that all children face reading difficulties, but those with dyslexia have more deficits with

specific components of reading. This hypothesis (and definition) would be acceptable if there were an appropriate and consistent cut-off point of determination, but this does not exist. Discrepancies and disagreements regarding cut-off points among professionals across disciplines prevents assurance of any application or practice of using an arbitrary cut-off point for diagnosis. Professionals diagnosing dyslexia often identify the presence of one or more deficits from the processes of "phonological awareness, rapid naming, working/short-term memory, attention and concentration, motor impairments, personal organization, visual perception/sequencing, and arithmetical difficulties." The authors discuss the issue with defining dyslexia as neurobiological in origin, including deficits in phonological awareness, and something that is unexpected because of cognitive ability.

Results/Conclusions: The authors argued that labeling children as dyslexic prevents other children that are poor readers from receiving necessary and needed services. They call professionals to action to put aside the traditional diagnostic model of waiting to diagnose until the child is failing and instead intervene and provide services as soon as the difficulties are noticed.

Relevance to the current study: This study was a further argument that the diagnostic criteria for dyslexia is inconsistent across and within disciplines. There are issues that need to be addressed in regard to dyslexia diagnosis that can no longer be ignored.

Hogan, T. P. (2018). Five ways speech-language pathologists can positively impact children with dyslexia. *Language, Speech, and Hearing Services in Schools*, *49*(4), 902–905. https://doi.org/10.1044/2018_LSHSS-DYSLC-18-0102

Objectives: Hogan offered five ways that speech-language pathologists can contribute to the positive intervention related to children with dyslexia. Hogan hoped to educate speech-language pathologists on the role they can play in providing intervention for children with dyslexia.

Methods: In the first section of this paper, Hogan ensured the reader that if he or she is a speech-language pathologist, he or she has adequate knowledge to assess, identify, and treat dyslexia due to their unique knowledge of language, especially phonology, written language, and literacy. In the second section of Hogan's paper, she encourages SLPs to seek out facts about dyslexia through the International Dyslexia Association (IDA) and share those facts with others. The third section of this article encourages SLPs to seek how information about dyslexia and frequent co-occurring communication disorders. The fourth section discusses using the correct label of dyslexia. The last way Hogan encourages SLPs to be aware of evidence-based interventions and popular interventions that may not be effective.

Results/Conclusions: Hogan's hope was that this article would encourage SLPs to take an active role in dyslexia assessment, identification, and intervention because of their expertise and knowledge of language.

Relevance to the current study: This article helped clarify the SLP's role in dyslexia assessment, identification, and intervention in education settings.

Horowitz-Kraus, T., & Breznitz, Z. (2013). Compensated dyslexics have a more efficient error detection system than noncompensated dyslexics. *Journal of Child Neurology*, *28*(10), 1266–1276. https://doi.org/10.1177/0883073812460917

Objectives: This article was published from researchers in the field of neurology (in Israel – Hebrew speaking participants used). A few important definitions to note: 1. Compensated dyslexic readers exhibit less difficulty decoding (with fewer decoding errors) but demonstrate a slow reading rate that affects comprehension. 2. Noncompensated dyslexic readers (with normal IQ) exhibited more difficulty decoding and a slower reading rate than their compensated dyslexic peers. 3. Error monitoring is a function to prevent repetition of errors and bring a reader's awareness to reading errors. It is hypothesized that this occurs within the anterior cingulate cortex, closely connected to the prefrontal cortex. It is identified by two measures: error-related negatives (evoked after an errored response due to mismatch between desired and actual responses) and correct-related negatives (evoked after a correct response due to uncertainty in performance or incomplete stimulus processing). Based on these definitions and previous findings, the researchers attempted to examine the error monitoring mechanism with error-related negativity and correct-related negativity in adolescents considered compensated dyslexic readers, noncompensated dyslexic readers, and nonimpaired readers.

Methods: A sample was collected from 94 participants: 34 noncompensated dyslexic readers, 28 compensated dyslexic readers, and 32 typical readers. The average ages (with +/-) spanned from approximately 12-15 years old. The diagnostic criteria for inclusion in the study included the following: nonverbal IQ score of 90 or above measured by the Raven Standard Progressive Matrices, normal or corrected vision, normal hearing, and no history of neurological or emotional disorders or attention deficits according to the Conners Rating Scale for teenagers. Both groups of readers with

dyslexia scored -1.5 SD or below the mean on standardized tasks, such as oral accuracy and fluency in word and nonword reading. These standardized tasks from the Aleph-Taph diagnostic assessment measured reading considering decoding (1-minute words/nonwords test for children), oral reading, and parsing. They also measured general ability using the Wechsler Abbreviated Scale of Intelligence-III for short-term memory and capacity with the Digit Span subtest, coding, and symbol search. General ability for naming letters and rapid automatized naming after a model were also used.

Results/Conclusions: The adolescents characterized as noncompensated dyslexic readers demonstrated poorer reading skills, slower processing speed, and a smaller error-related negative amplitude value. All participants characterized as dyslexic demonstrated poorer reading skills, slower processing speed, lower memory scores, and smaller error- and correct-related negative amplitude differences than their nonimpaired peers.

Relevance to the current study: Though the findings of this study are fascinating and contribute to the literature of neurology, the main purpose of collecting information from this study was to evaluate the criteria used by neuroscientists and neuropsychologists to diagnose dyslexia. Different fields of study define and diagnose dyslexia differently, so this study contributed to help us how neurology diagnoses dyslexia based on inclusionary criteria and the assessments used.

Kirby, P. (2020). Dyslexia debated, then and now: A historical perspective on the dyslexia debate. *Oxford Review of Education*, *46*(4), 472-486. https://doi.org/10.1080/03054985.2020.1747418

Objectives: The author provides a history about the origins of dyslexia and the ongoing debate of its existence. He provides the history of the dyslexia debate to present a broader

view of efforts to address the causes of reading difficulties. Dyslexia has a deep history of "conceptual and political baggage", to quote Elliott and Grigorenko. This article discusses the social and scientific aspects of its history.

Methods: The first characteristic symptoms of dyslexia were identified and labeled as 'word-blindness' in the 1870s, which stemmed from a belief that this reading deficit was due to ocular deficits. Research over approximately the next 80 years eventually led professionals to label it dyslexia in the 1960s. Professionals have been disagreeing about the label of dyslexia and its accompanying difficulties since the late 1800s. The two major case studies evaluated in the early development of reading disabilities emerged due to fathers who brought their sons to professionals for assessment due to literacy becoming an education and career success. Children began attending school in the late 19th century and those with the inability to learn at the same rate or level of their peers were labeled as having a deficit. Samuel Orton, an American neuropathologist, though wrong in his hypothesis about the disability involving visual components, led others to shift their concern "towards dyslexia as a developmental disorder." The field of psychology took over examining this disability in the 20th century when psychologists realized it wasn't a physical defect of the brain and more of a cognitive processing issue. In 1962, professionals across disciplines attended a conference and decided that more research needed to attend to dyslexia. Approximately 14 years later in 1972, organizations to advocate for dyslexia legislation and education were created and this is where the critiques of dyslexia and the debate of its existence emerged. Debates over dyslexia's definition typically stem because this is a hidden, cognitive disability that is not visible to the eye. Parental concern also played a large role

in the debate as many professionals bluntly hypothesized that dyslexia was due to a parent "exonerating [themselves] from responsibility and opening…funding support." Even though professionals see that dyslexia can occur across the intellectual spectrum, many diagnostic criteria indicated discrepancy methods to diagnose dyslexia.

Results/Conclusions: The debate around dyslexia has been a theme throughout its history for approximately 140 years due to literacy as a necessary aspect for educational and career success. The authors indicates that the scientific debate around dyslexia has yet to diverge from the social contexts where dyslexia has existed for the last 50 years, such as dyslexia: "1) has no clear definition, and cannot be differentiated from other reading difficulties; 2) is a product of over-anxious parents, seeking to explain and justify their children's learning difficulties, 3) is a 'middle-class myth, more common in pupils from wealthier backgrounds for social rather than scientific reasons; 4) is over-diagnosed…and 5) is frequently associated with high intelligence, despite there being no scientific basis for this claim." Despite dyslexia's long debated history, many efforts have been made to help children with reading difficulties achieve success in education and careers. Scientists need to evaluate the critiques from science and social histories that stem from dyslexia in order for dissenters of the disability to take new work seriously.

Relevance to the current study: This article provided a rich history of the development of the label of dyslexia across a 140-year span in the United Kingdom. The author outlined several key concepts that will help the current researchers keep dyslexia in perspective (i.e., social, political, cultural, scientific factors that have defined dyslexia in the past).

Lindstrom, J. H. (2019). Dyslexia in the schools: Assessment and identification. *Teaching Exceptional Children*, *51*(3), 189–200. https://doi.org/10.1177/0040059918763712

Objectives: This article brought attention to the fact that dyslexia is a reading difficulty that has inconsistent terminology and identification procedures across professions (i.e., medical, school, research, etc.). The author's purpose was to explain the criteria for specific learning disability (SLD) eligibility services under IDEA (2006) and its connection to dyslexia, which can be helpful to school personnel in identifying dyslexia and referring for remediation services.

Methods: There are several deficits that are specific to dyslexia. Table 1 provides a list of deficits that are related to reading and identifies several formal assessments used to identify these deficits. These deficits include letter-sound knowledge, fluency, word decoding, spelling, and reading comprehension. To be included for services, reading-related deficits may not be related to visual, hearing, or motor impairments, intellectual disability, emotional disturbance, cultural factors, economic/environmental disadvantage, lack of instruction, or limited English proficiency. Speech-language pathologists and school psychologists will generally assess cognitive processing to identify any weaknesses in phonological processing, orthographic awareness, rapid naming, processing speed and working memory. Table 2 provides assessments that SLPs and psychologists may use to qualify students for reading intervention services.

Results/Conclusions: Although children with dyslexia may not be eligible for services under IDEA as a disability category, children can be eligible for services under the SLD category. Teachers and other school professionals need to be aware of the

process for how to refer students with reading difficulties so these students can receive appropriate services.

Relevance to the current study: This article provided lists of assessments that are generally used in school settings by professionals to diagnose dyslexia.

Lopes, J. A., Gomes, C., Oliveira, C. R., & Elliot, J. G. (2020). Research studies on dyslexia: Participant inclusions and exclusion criteria. *European Journal of Special Needs Education*, *35*(5), 587-602. https://doi.org/10.1080/08856257.2020.1732108

Objectives: The authors had five goals of this study. 1) They wanted to identify inclusion/selection criteria from studies about dyslexia to assess the homogeneity of the criteria used for sample selection. 2) They wanted to compare the inclusion criteria for samples of struggling readers against selection criteria for dyslexics. 3) They wanted to identify the contexts where the samples of those identified as dyslexia were collected. 4) They wanted to identify professional characteristics of those involved diagnosing participants included in studies on dyslexia. 5) They wanted to review the characteristics of journals publishing studies on dyslexia.

Methods: The authors analyzed 800 journal articles about dyslexia. Out of the 800 samples, only 7 compared dyslexic readers with other poor readers. The rest of the research articles compared dyslexic groups to normal control groups or other subjects with a different impairment (speech and language impairment). They employed an analytic grid to assess the title of the article, publication year, journal of the publication, number of dyslexia participants in the sample, contexts of sample collection, criteria for sample selection and inclusion, test batteries indicated for inclusion, and professional categories who were involved in diagnosing participants in the studies with dyslexia.

Their articles were from databases and the search was limited to "Articles" using the keywords "dyslexia or dyslexics" from 2000-2019. Systematic reviews and meta-analyses were excluded from the study.

Results/Conclusions: Table 1 displays the results of the analysis of the criteria for the selection of samples among dyslexic, normal readers, and struggling readers in journal articles across disciplines. The most commonly used cognitive measures were the WPPSI-R, WISC-R, WAIS, and the Raven scales. Less frequently used cognitive measures were the Stanford-Binet, Woodcock-Johnson Test of Cognitive Abilities, The Primary Test of Cognitive Skills, or the KBIT. Reading tests ranged significantly more and there were standardized, and non-standardized measures typically used. Exclusionary criteria were also indicated, and the most common criteria was sensory deficits and comorbidities. The contexts most widely employed for research was clinical and in the community. In regard to professional characteristics to identifying dyslexia, the majority of professional groups were researchers, unspecified professional context, psychologists, or labeled as other. Studies about dyslexia are most commonly found in neuroscience, psychology, medical, interdisciplinary, and education journals. It was found that only 6% of the studies published were from education journals and 94% were from medically based journals. The results indicate that dyslexia is treated more as a medical diagnosis than by instructional methods. It was also found that typical sample sizes of these studies were small, with 50% of the studies only using between 1-50 participants.

Relevance to the current study: This study indicated that the majority of publications related to dyslexia are not involved in education, but medicine. The appallingly low percentage of studies that discuss dyslexia in education journals is a

testament to why dyslexia laws, evidence-based assessment, and intervention practices are inconsistent in practice throughout education professionals. The majority of journals compare those identified with dyslexia to normal readers, but do not account for the poor readers in between. Many poor readers are unidentified due to arbitrary cut-off points or decent response-to-intervention and it has a negative effect on their literacy proficiency in the future.

Miciak, J., & Fletcher, J. M. (2020). The critical role of instructional response for identifying dyslexia and other learning disabilities. *Journal of Learning Disabilities*, *53*(5), 343–353. https://doi.org/10.1177/0022219420906801

Objectives: This article reviews the variation in literature among professionals about definitions of dyslexia related to diagnostic criteria and assessment types, the etiology of the disorder, and the difficulties that occur. The authors identify the discrepancies and variations in definitions among national organizations, legislative acts, and professionals. The overall objective of the study is to introduce multitier systems of support (MTSS) to prevent, screen, identify, and treat children with dyslexia.

Methods: The etiology of dyslexia has been argued among professionals for decades and these authors strongly argue that to base the definition of dyslexia on its proposed etiology of neurobiology forces one to suppose that dyslexia is a condition predetermined and that it cannot just develop. They argue that perhaps the combination of a poor literacy environment at home, which may be the exacerbate the heritability of the disorder, and environmental factors influence the etiology of dyslexia. Miciak and Fletcher also discuss current identification methods for dyslexia and specific learning disabilities and the issue with using cognitive achievement for diagnostic criteria. They

argue that IQ is not a strong prognostic indicator for response to reading intervention and should not be included as diagnostic criteria. They instead offer a different solution to approach specific learning disability that classifies children based on their response to instruction and intervention, but specifically say that response to intervention (RTI) treatments don't overcome these challenges.

Results/Conclusions: Miciak and Fletcher claim that, based on the current research, dyslexia should be defined by academic deficits and key attributes of the disorder. They also propose a hybrid approach to identify dyslexia that improves reliability. The criteria would include "low reading achievement in accurate and fluent word reading and spelling, "inadequate instructional response to generally effective instruction," and "a consideration of exclusionary factors and their potential impact on student learning." They conclude that this method of diagnosis is best implemented through MTSS because it is "dynamic, treatment oriented, preventative, and less likely to result in diagnostic problems because of its recursive and sequential nature."

Relevance to the current study: This article was published in 2020 and provides relevant and current definitions and diagnostic criteria use to diagnose dyslexia. This article discusses relevant difficulties that professionals face as they diagnose dyslexia and the reality of the issue that is dyslexia definition and diagnosis. This study addresses what should be changed in the schools to provide more reliable and valid diagnosis.

Melby-Lervåg, M., & Lervåg, A. (2012). Oral language skills moderate nonword repetition skills in children with dyslexia: A meta-analysis of the role of nonword repetition skills in dyslexia. *Scientific Studies of Reading, 16*(1), 1-34. https://doi.org/10.1080/10888438.2010.537715

Objectives: Melby-Lervag and Lervag conducted a meta-analysis to review studies comparing nonword repetition skills in children with dyslexia and typically developing peers without reading difficulties. At the time, the current data showed great variability among researchers and Melby-Lervag and Lervag (2012) examined the cause for the inconsistent findings among the literature for nonword repetition skills in children with dyslexia.

Methods: In this study, researchers used electronic databases (ERIC, Medline, PsychAPA, ProQuest dissertations, etc.) to search for studies using the terms, dyslexia, reading, word recognition, and decoding coupled with phon * awareness, phon * sensitivity, metalinguistic awareness, short-term memory, working memory, phonological memory, nonword repetition, pseudo* repetition, and other terms related to memory and phonological awareness to search for articles to include in their study. Other methods used to find relevant literature was found by scanning reference lists and searching citations, systematic reviews and previous meta-analyses, and google scholar. The researchers examined several types of literature, including non-peer-reviewed studies, chapters from books, dissertations, and peer-reviewed studies. The 1,375 studies collected based on the search criteria were screened for inclusion criteria. Those included met the inclusion criteria in which a child was either asked to repeat a nonword or nonword lists, a mean sample age below 18, samples with no comorbidity of ADHD or MR, and those that reported standard deviation and mean correlations for children with dyslexia and control subjects. Out of the 1,375 studies initially screened, the researchers included a total of 44 full-text articles in the meta-analysis. Exclusion criteria included

studies without measures of nonword repetition, insufficient data for effect size calculation, and sample subjects chosen due to other variables than reading skills.

Results/Conclusions: Melby-Lervag and Lervag found that children and youth with dyslexia typically perform worse on nonword repetition tasks than chronologically aged and reading level control groups. The variability among the studies included was due to the inconsistent effect sizes where there was great variability between oral language skills among the samples of those with dyslexia.

Relevance to the current study: The methods section of this article provided insight and instruction for ways to thoroughly search through the current literature for relevant studies, appropriately screen studies based on inclusion criteria, and determine eligibility for inclusion.

Phillips, B. A. B. & Odegard, T. N. (2017) Evaluating the impact of dyslexia laws on the identification of specific learning disability and dyslexia. *Annals of Dyslexia, 67*, 356–368. https://doi.org/10.1007/s11881-017-0148-4

Objectives: Phillips and Odegard attempted to determine whether changed laws pertaining to dyslexia identification changed the rate of identification for specific learning disability (SLD). They also attempted to characterize the rate of how Texas and Arkansas identify students with dyslexia in the public school system of those states. The last objective was to characterize the rate of identification across first to twelfth grade.

Methods: These researchers collected and analyzed observational data to accomplish their study objectives. The data was collected from the US Department of Education Part B State Performance Plus and Annual Performance Reports in all 50 states for students ages 6-21 years old for consecutive school years beginning in Fall 2011 and ending in Spring

2016. To complete the first objective, the researchers compared the rates of identification for SLD in states that did and did not include dyslexia legislation. They also analyzed the states that had implemented dyslexia laws in the previous 4 years to evaluate if the rate of identification of SLD had changed once the laws were enacted. Table 1 provide the SLP identification rate for all 50 states. The complete the second objective, the researchers collected data from Texas and Arkansas public schools to determine whether the predicted prevalence (5%) of the population with dyslexia matched the actual prevalence identified. Data from Texas was collected from the Texas Public Education Information Management System (PEIMS) and Arkansas from the Arkansas Department of Education. Both of the states included do not have to qualify students under IDEA for SLD in order for the child to receive services for dyslexia intervention. To complete the third objective, the researchers analyzed data collected from the public schools in Arkansas to determine the identification rate across grades one through twelve.

Results/Conclusions: The researchers found appalling information among the data collected, such as there was not 100% compliance with a mandate to identify and report all students with dyslexia in the public school system. From the analysis about SLD identification rates among states with and without dyslexia laws, the researchers found that there was no variation of the prevalence of SLD between states between those with and without laws in place for dyslexia. Table 2 shows numerical data for this analysis. Analysis from data within the states that had implemented dyslexia laws showed that there was no significant difference in identification rates in those states after the dyslexia laws had been enacted. The researchers also found that the rate of identification in Texas and Arkansas did not meet or exceed the predicted among of dyslexia prevalence of 5%.

Essentially what the researchers found is that the efforts to improve dyslexia diagnosis has failed to achieve their goal. The overall finding is that students with dyslexia are under identified in the public school system and that this is a major problem.

Relevance to the current study: This study is relevant to the current study because it further emphasizes that dyslexia identification is a major issue that needs to be rectified in the public-school systems in America. The legislative acts issued by each state to fix this issue have failed or have not received the support necessary for successful implementation. It's important to note that this is observational data that has been collected so we can see what has been reported and how there needs to be a solution to the problem of under identification not just in theory but in practice.

Schneider, W. J., & Kaufman, A. S. (2017). Let's not do away with comprehensive cognitive assessments just yet. *Archives of Clinical Neuropsychology*, *32*(1), 8-20. https://doi.org/10.1093/arclin/acw104

Objectives: Schneider and Kaufman reference Fletcher and Miciak's dislike for cognitive assessment identification for learning disabilities and though they do not agree on throwing cognitive assessment out altogether, they do agree that it does needs to be reformed for diagnostic purposes. They clarify that their definition of cognitive assessment refers to IQ tests and any assessment designed to identify deficits in cognitive processing influencing academic success. They admit that most of the research and gumption behind the argument to continue to use cognitive assessments for learning disability diagnosis is based on anecdotal opinions not supported by data and essentially groundless. Their acknowledgement of the lack of empirical data for cognitive

assessment for diagnosis of learning disability turns into a plea to wait until more data has been collected and fine-tuned before casting it into the fire to burn.

Methods: Schneider and Kaufman present ways that Fletcher, Miciak, and colleagues have misrepresented the former's data and opinions in their publications and arguments for not using cognitive assessment for diagnostic criteria. They then list what they agree and disagree with, such as "the IQ-Achievement Discrepancy definition of learning disability was not helpful" and that RTI "is a pragmatic and moral step forward" to evaluation. Schneider and Kaufman discuss how cognitive assessments help professionals provide intervention and provide evidence as to why these assessment lead to better outcomes.

Results/Conclusions: Schneider and Kaufman conclude that cognitive assessment is still a valid form of evaluation that needs to be fine-tuned instead of thrown out completely.

Relevance to the current study: This article contradicts the article by Fletcher and Miciak (2020) and argues for the use of cognitive assessment in dyslexia diagnosis. This article also supports the notion that professionals, even within their own fields, disagree with the diagnosis of dyslexia, what assessments and criteria should be used, definitions of the disorder, and what intervention should be provided. This article provides further insight as to why professionals in all domains need to come to a conclusion about dyslexia definition and diagnosis to create a cohesive and consistent plan for assessment and intervention based on the evaluation.

Snowling, M. J., Hulme, C., & Nation , K. (2020) Defining and understanding dyslexia: Past, present and future. *Oxford Review of Education*, *46*(4), 501-513. https://doi.org/10.1080/03054985.2020.1765756

Objectives: The authors argue that expanding the criteria for dyslexia diagnosis to include looser definitions means that more individuals than necessary are receiving the label.

Methods: "Dyslexia is the outcome of multiple risks which accumulate towards a threshold for what is usually termed diagnosis." The authors discuss the comorbidities of dyslexia and present that nearly 40% of children diagnosed with a reading disorder also have another disorder. Developmental Language Disorder may occur alongside dyslexia and is actually considered a major risk factor for the learning disorder. These authors argue that children are being over-diagnosed with dyslexia. The authors liken dyslexia to other conditions, such as obesity, hypertension, or depression where there are no clear "cut-offs" for diagnosis, but clinical decisions based on professional judgement have to be made to decide when treatment is necessary. Many have advocated that the label of dyslexia is inappropriate in an RTI setting because there's poor reliability around diagnostic criteria for the disorder.

Results/Conclusions: The authors propose conclusions to this article. First, the authors propose to drop the label dyslexia for a shorthand description of a "reading disorder" in order to increase specificity on what the disorder actually entails: poor decoding and spelling fluency. Second, the authors propose that dyslexia definition be defined as low academic functioning compare to peers in literacy-based curriculum. Third, children with comorbidities may have cooccurring features of dyslexia. Fourth,

diagnosis for dyslexia should be labeled from mild to severe and that those labeled severe would have a comorbidity.

Relevance to the current study: This study provides another professional opinion contradicting an earlier article by Adolf that children with dyslexia are under diagnosed. These authors have an interesting perspective on how dyslexia should be handled diagnostically. It's interesting to note that the authors propose that there be no specific diagnostic criteria, but that labels from mild to severe should be utilized.

Snowling, M. J., & Melby-Lervåg, M. (2016). Oral language deficits in familial dyslexia: A meta-analysis and review. *Psychological Bulletin, 142*(5), 498-545. http://dx.doi.org/10.1037/bul0000037

Objectives: This article completed a meta-analysis to examine language deficits in children with familial history (i.e., first degree-affected relative) of dyslexia. The authors examined the relationship between dyslexia and language impairment and the collected evidence to support preventative and/or improve dyslexia in children at high risk for the disorder. The authors formed various hypotheses to predict outcomes from the prevalence of dyslexia in children at family risk, home and literacy environments of these children, endophenotypes of dyslexia, predictive correlations between cognitive and reading skills, and interventions for dyslexia.

Methods: The authors designed and reported the meta-analysis using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. To find publications to include in the present study, the authors used the keywords "at-risk, famil* risk paired with dyslexia, reading disorders, decoding, and decoding problems" in abstracts on electronic databases (ERIC, Medline, PsychInfo, and all Citation Databases),

citation searchers based on author names, e-mails to authors and the list server for Scientific Studies of Reading, searching journals by hand (Dyslexia, Annuals of Dyslexia, and Scientific Studies of Reading), and scanning reference lists. From this search, the researchers found 300 article abstracts with study designs of group comparisons, longitudinal prediction, and experimental intervention, which were then screened for inclusion criteria. Out of the studies eligible to be reviewed from the screening, full-text articles were evaluated, and 95 publications were included in the review. Different developmental groups (0-3 years, below 5.5 years and before formal reading instruction begins, early primary school up to 4th grade, and late primary school/secondary school from 5th grade an above) were used to code so as to keep data from longitudinal studies and group comparisons independent. The study was coded by two independent raters and the correlation for main outcomes (means, SD, sample size, and age) was r = .98 with an agreement rate of 93%.

Results/Conclusions: The researchers found that children with a first-degree relative with dyslexia have a heightened risk for dyslexia and four times as likely to demonstrate reading difficulty than peers from families without histories of the disorder.

Relevance to the current study: This study is relevant to the current study by providing an example for how to search for literature, screen abstracts, determine inclusion criteria, review full-text articles, and choose publications to include in the analysis. Information from the methods section gleaned light on the process of, the correlation coefficient, and coder agreement rate.

Tilanus, E. A., Segers, E., & Verhoeven, L. (2020). Responsiveness to intervention after second versus third grade diagnosis of dyslexia. *Reading & Writing Quarterly*, *36*(6), 521-541. https://doi.org/10.1080/10573569.2019.1667929

Objectives: This study was published in a special education reading and writing journal. The purpose of this study was to determine a difference in a child's level of responsiveness to intervention depending on the age and grade of diagnosis (second vs. third grade).

Methods: Participants in the study were those diagnosed with dyslexia by meeting formal criteria according to the Dutch Protocol Dyslexia Diagnostics and Treatment in a clinic in the Netherlands. Participants of 122 second graders (75 boys, 47 girls) ranging from ages ranging from 7- to 8-years-old and 158 third graders (91 boys, 67 girls) ranging from ages 7- to 11-years-old were diagnosed with dyslexia at the time of the study. The children with dyslexia in both grades and the typically reading control groups attended different schools. The diagnostic criteria used from the Wechsler Intelligence Scale for Children III, Dutch edition for eligibility for dyslexia diagnosis and intervention with a score of 85 or above in the 95% confidence interval for total intelligence. The typically reading group was assessed with the Raven's colored progressive matrices and no difference in intelligence to the group with dyslexia were found. The researchers also used a reading and spelling test. Evaluations that the authors used to measure different aspects of reading abilities were not included in the diagnostic testing but are listed as follows: word decoding (One-Minute-Test), pseudoword decoding (Klepel), spelling word dictation test), letter knowledge (letter naming task), rapid automatized naming

(digit naming task of *Continu Benoemen & Woorden Lezen*), phoneme manipulation (*DST)*, phoneme deletion (*DST*), verbal working memory (WISC-III).

Results/Conclusions: The data collected from the intervention demonstrated that early intervention for dyslexia shows favorable results and that children respond to intervention equally at both grade levels.

Relevance to the current study: This study was included because it was published in a special education journal. It will be used to represent, along with other studies from this field, how research professionals in special education diagnosed and define dyslexia regarding diagnostic criteria and assessment.

Wagner, R. K., Zirps, F. A., Edwards, A. A., Wood, S. G., Joyner, R. E., Becker, B. J., Liu, G., & Beal, B. (2020). The prevalence of dyslexia: A new approach to its estimation. *Journal of Learning Disabilities*, *53*(5), 354–365. https://doi.org/10.1177/0022219420920377

Objectives: This article is from the *Journal of Learning Disabilities* and uses the International Dyslexia Association's (IDA) definition for defining dyslexia. This study used a model-based meta-analysis and simulation to estimate the prevalence of dyslexia in a population of a sample of poor readers. The authors hope to determine a way for dyslexia prevalence to be estimated accurately so school districts, states, or organizations with known prevalence rates can determine whether children are being under or overidentified. This study replicated the Wagner et al. (2009) study to evaluate whether the same results were found.

Methods: In the introduction of this study, the authors use the IDA definition of dyslexia and present that it is a specific learning disability most commonly in phonological processing and is unexpected in relation to IQ-achievement discrepancy,

response to intervention (RTI), and patterns of strengths and weaknesses (PAWS). They acknowledge that dyslexia definitions have been debated in the past but state that, from a survey of 30 dyslexia researchers and practitioners, the current IDA definition is still supported. The authors continue to introduce the difficulty with determining prevalence for this disability because of inconsistent cut points used for identification, what kind of performance is required (i.e., poor, relative, or both), and reliability and validity measures in identification assessment. Prevalence estimates are higher when cut-off points are less strict. For example, if the cut off is the 25th percentile vs. the 5th percentile, the prevalence will likely be must higher. Prevalence estimates are difficult to determine due to an inconsistent consensus on whether performance is relative to an individual's performance on other subjects in school (i.e., math or science vs. reading) or compared to a grade-level or state standard. In their study, the authors presented a hybrid model for identifying the prevalence of dyslexia, which included impaired phonological processing, genetic risk, and environmental influences including quality and quantity of educational instruction and intervention. The nine assessments included in the study were: the Kaufman Test of Educational Achievement, Woodcock Johnson-IV, the Iowa Test of Basic Skills, the Wechsler Individual Achievement Test-III, the Woodcock Reading Mastery Test-III, the Early Reading Diagnostic Test and Written Language Scales-II, the Brigance Comprehensive Inventory of Basic Skills-II, and the Stanford Achievement Test-10.

Results/Conclusions: These authors found two similar findings to the study they replicated: 1) samples of poor readers will contain more expected poor readers than unexpected poor readers and 2) individuals who perform lower in reading than oral language occur in a spectrum of severity across reading difficulty. The authors suggest

that in order to improve the reliability of diagnosis, the expansion of the operational definition of dyslexia to include multiple indicators is necessary. In order for many students to qualify for services as a poor reader, they are limited to the current policies that limit identification to individuals who are behind their peers or state standards. "We argue that science should inform public policy and practice rather than using public policy and practice to inform science."

Relevance to the current study: This study discusses the prevalence rates of dyslexia and the methods currently employed to estimate the prevalence. The authors raise important concerns about the inconsistencies in definition and how they inform prevalence rates throughout the country and among researchers. This article holds information critical to push the argument forward and validate the current hypothesis and concerns.

Youman, M., & Mather, N. (2018). Dyslexia laws in the USA: A 2018 update. *Perspectives on Language and Literacy, 44*(2), 37-41. http://erl.lib.byu.edu/login/?url=https://www-proquest-com.erl.lib.byu.edu/scholarly-journals/dyslexia-laws-usa-2018-update/docview/2082576564/se-2?accountid=4488

Objectives: Youman and Mather explored and discussed the current dyslexia laws regarding early screening, identification, accommodations, interventions, teacher training, service eligibility in the public school system in the United States of America.

Methods: To identify students with dyslexia, many states required early screenings in kindergarten through second grade, including phonological awareness skills, decoding, and fluency with reading skills. If children seemed to struggle with any of these areas, they were referred for a comprehensive evaluation. IDEA 2004 supported

cognitive achievement testing as a form of assessment along with a lack of response to intervention (RTI) services.

Results/Conclusions: Many children are not qualifying for eligibility for services for dyslexia under SLD in IDEA 2004. Many of these children do receive accommodations from Section 504 of the Rehabilitation Act of 1973, but do not receive the intervention they need under this law. Though progress has been made in paving the way for students with dyslexia to receive services, much still needs to be done for these individuals across the U.S.

Relevance to the current study: Table 1 provides a list of states in the U.S. that had implemented dyslexia laws for screening, assessment, definition, and treatment programs for public schools in 2012. To date in this study, 22 states had created and implemented dyslexia laws.

Youman, M., & Mather, N. (2013). Dyslexia laws in the USA. *Annals of Dyslexia, 63*(2), 133-53. https://doi.org/10.1007/s11881-012-0076-2

Objectives: This article is a follow up to Youman and Mather's previous article in 2013 discussing dyslexia laws across the United States. They discuss the current dyslexia laws in each state and how the laws are influencing educational practice.

Methods: These authors reported that 42 states had created, passed, and began to implement laws regarding dyslexia for defining the disorder, diagnosing or identifying, and providing intervention. They report that professionals in schools have begun to comfortably use the label dyslexia in Individualized Education Plan (IEP) meetings. In 2018, they reported that there were 18 states that had attempted to implement screening procedures as opposed to 2 states in 2013. Though these screening procedures have been

implemented, many states are having difficulty providing effective intervention for these students.

Results/Conclusions: Since the original article in 2013, we have seen a significant amount of dyslexia laws passed, but many professionals and parents are unsure or unaware of how to put these laws into practice.

Relevance to the current study: This article helps us understand better the current state of dyslexia laws in the U.S.

Ziegler, J. C., Pech-Georgel, C., George, F., & Lorenzi, C. (2009). Speech-perception-in-noise deficits in dyslexia. *Developmental Science*, *12*(5), 732–745. https://doi.org/10.1111/j.1467-7687.2009.00817.x

Objectives: This study was published by cognitive and developmental psychologists in a journal of psychology. The authors referred to a disorder defined as written language acquisition difficulties with normal intelligence and in the absence of neurological or sensory deficits as *developmental dyslexia* with the acronym DD. Individuals with DD demonstrate slow and error-prone reading, poor nonword decoding and spelling skills. The researchers in this study discussed the speech perception abilities of children with dyslexia found in previous studies and claimed that each of the previous studies were investigated in quiet or optimal conditions. These researchers looked to examine speech perception deficits in in dyslexia using a psychophysical approach in the presence of noise.

Methods: Participants of this study included 19 children with dyslexia from France between the ages of 8;6 and 12;1 years. Each participant had received extensive medical, psychological, neuropsychological, and cognitive assessment performed by a

team of inter-disciplinary professionals including psychologists, neurologists, and speech-language pathologists. Children with dyslexia were included in the study if their reading age was considered 18 months or below the norm for their age on a standardized reading test and if they scored above 80 for IQ on the Wechsler III intelligence scale. Children with dyslexia were excluded from the study if their oral language scores were within range for a formal diagnosis of specific language impairment (SLI) on the L2MA, NEEL, and the ECOSEE assessments. All children included in the study showed pure-tone audiogram thresholds between 0.25 and 6 kHz or less than 20 dB HL.

Results/Conclusions: The data collected and analyzed displayed that children with DD demonstrate speech-perception-in-noise deficits and is not an effect of poor reading ability. They also found that place of articulation perception was the main difficulty that children with DD faced.

Relevance to the current study: We are not as focused on the findings of this study, but rather how the psychologists defined dyslexia in terms of name and diagnostic criteria. This study provided information about how what assessments and diagnostic criteria psychologists use to define dyslexia.

APPENDIX B

Definitions of Dyslexia From Professional Disciplines

Medicine

National Institute of Neurological Disorders and Strokes (n.d.):

> "Dyslexia is a brain-based type of learning disability that specifically impairs a person's ability to read. These individuals 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. In individuals with adult onset of dyslexia, it usually occurs as a result of brain injury or in the context of dementia; this contrasts with individuals with dyslexia who simply were never identified as children or adolescents. Dyslexia can be inherited in some families, and recent studies have identified a number of genes that may predispose an individual to developing dyslexia."

American Academy of Pediatrics, American Academy of Ophthalmology, and American Association for Pediatric Ophthalmology and Strabismus (2009):

> "The terms "reading disability" and "dyslexia" are often used interchangeably in the literature. Dyslexia is a primary reading disorder and results from a written word processing abnormality in the brain. It is characterized by difficulties with accurate and/or fluent sight word recognition and by poor spelling and decoding abilities. These difficulties are unexpected in relation to the child's other cognitive skills. Dyslexia has been identified as having a strong genetic basis. Recent genetic-linkage studies have identified many loci at which dyslexia-related genes are encoded. Approximately 40% of siblings, children, or parents of an affected individual will have dyslexia. Although dyslexia is often inherited, it may exist in the absence of a family history. Dyslexia can be mild or severe, occurs throughout the world, seems to affects boys more than girls, involves children with all levels of intelligence, and can persist for a lifetime. Dyslexia is identified in some people early in their lives but in others is not diagnosed until much later, when more complex reading and writing skills are required. People with dyslexia can be very bright and may be gifted in math, science, the arts, or even in unexpected areas such as writing. Dyslexia should be separated from other secondary forms of reading difficulties caused by visual or hearing disorders, mental retardation, and experiential or instructional deficits. Early reading difficulties may be caused by experiential and instructional deficits."

Mayo Clinic (2017):

> "Dyslexia is a learning disorder that involves difficulty reading due to problems identifying speech sounds and learning how they relate to letters and words (decoding).

Also called reading disability, dyslexia affects areas of the brain that process language. People with dyslexia have normal intelligence and usually have normal vision."

Psychology

American Psychological Association (n.d.):

"A neurologically based learning disability manifested as severe difficulties in reading, spelling, and writing words and sometimes in arithmetic. Dyslexia is characterized by impairment in the ability to process sounds, that is, to make connections between written letters and their sounds; written work is often characterized by reversal errors. It can be either acquired (in which case it is often referred to as alexia) or developmental (see developmental dyslexia), is independent of intellectual ability, and is unrelated to disorders of speech and vision that may also be present. It is not the result of lack of motivation, sensory impairment, inadequate instructional or environmental opportunities, emotional disturbances, or other such factors. Since the 1960s, information-processing and other psychological accounts of acquired dyslexia have prompted investigators to subdivide it into two general classes: (a) visual word-form dyslexia, which is characterized by difficulty in the visual analysis of written words; and (b) central dyslexia, which is characterized by difficulty in later stages of the reading process (i.e., pronunciation and comprehension). Various types and subtypes of dyslexia, both acquired and developmental, have also been proposed, but there is no universally accepted system of classification."

Speech-Language Pathology

American Speech-Language-Hearing Association (n.d.):

"A disorder of written language involves a significant impairment in fluent word recognition (i.e., reading decoding and sight word recognition), reading comprehension, written spelling, or written expression (i.e., written composition; Ehri, 2000; Gough & Tunmer, 1986; Kamhi & Catts, 2012; Tunmer & Chapman, 2007, 2012). A word recognition disorder is also known as dyslexia. Written language disorders, as with spoken language disorders, can involve any of the five language domains (i.e., phonology, morphology, syntax, semantics, and pragmatics). Problems can occur in the awareness, comprehension, and production of language at the sound, syllable, word, sentence, and discourse levels"

Education

National Association of Special Education Teachers (n.d.):

"Dyslexia is a type of learning disability. It is not another term for learning disability. It is a specific language-based disorder affecting a person's ability to read, write, and verbally express him or herself."

International Dyslexia Association

> "Dyslexia is a specific learning disability that is neurobiological 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." (2002)

References

American Academy of Pediatrics, American Academy of Ophthalmology, and American Association for Pediatric Ophthalmology and Strabismus. (2009). Learning disabilities, dyslexia, and vision. *Pediatrics, 124*(2), 837-844. https://doi.org/10.1542/peds.2009-1445

American Psychological Association. (n.d.). *APA dictionary of psychology.* American Psychological Association. https://dictionary.apa.org/dyslexia

American Speech-Language-Hearing Association. (n.d.). *Written language disorders.* ASHA Practice Portal. https://www.asha.org/practice-portal/clinical-topics/written-language-disorders/

International Dyslexia Association. (2002, November 12). *Definition of Dyslexia.* International Dyslexia Association. https://dyslexiaida.org/definition-of-dyslexia/

Mayo Clinic. (2017). *Dyslexia.* Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/dyslexia/symptoms-causes/syc-20353552

National Association of Special Education Teachers. (n.d.). *Introduction to learning disabilities*. National Association of Special Education Teachers. https://www.naset.org/publications/ld-report/introduction-to-learning-disabilities

National Institute of Neurological Disorders and Stroke. (n.d.). *Dyslexia.* National Institute of Neurological Disorders and Stroke. https://www.ninds.nih.gov/Disorders/All-Disorders/Dyslexia-Information-Page

APPENDIX C

Systematic Review Coding Scheme

Instructions given to Research Assistants:
Some articles may not include all information requested. If the article doesn't have the requested information, type "NR" into the cell. (NR stands for "not reported").

Coding Scheme:

A	BLANK	BLANK
B	RA_ID	The Research Assistant's (RA) ID number The first ID number indicated the RA that compiled the articles The second ID number indicated the RA that coded the article
C	Search engine	Search engine or databased used to find articles It was Elsevier SCOPUS for each year
D	Search terms	Search term(s) used to find the article on the database Keywords: "dyslexia, children"
E	Full APA reference	Listed the full APA reference
F	Overall goal of study	This was used to find what the researchers, in general, were attempting to study.
G	Authors	Last names of all authors
H	Title of article	The full title of the paper
I	Publication year	Year the article was published
J	Journal	Name of the journal in which the article was published
K	Number of participants	List how many children participated in the study Split out by groups, if needed (*Number how many girls and boys were in each group)*
L	Mean age (in years)	What was the reported average age of the participants? If they reported mean ages of both males and females or another group of participants had a mean age different than another, list each mean age. For example: Males – 4.7 years old; Females – 9 years old
M	Grade (in school) if specified	What grade were the participants in?
N	Language spoken	Language(s) the participants in the study spoke
O	Professional discipline of journal	The professional discipline (or field of practice) the journal is from
P	Professional discipline of journal (coded)	Coding for the professional discipline the journal is from
Q	Definition of dyslexia given	How the researchers defined dyslexia – copy and paste definition

APPENDIX D

Journals Coded in Each Category

Medicine	**Journals Included in "Medicine" Category**	
Fields that fall under Medicine: Associated with American Medical Association, Neuroscience, Neuropsychology, Ophthalmology, Neurology, Genetics, Psychiatry Specifically	*Acta Ophthalmologica*	*Acta oto-rhino-laryngologica belgica*
	Acta Paediatrica	*Advances in Medical Sciences*
	American Journal of Medical Genetics Part B: Neuropsychiatric Genetics	*American Journal of Neuroradiology*
	Annals of Human Genetics	*Applied Neuropsychology: Child*
	Applied Psychophysiology and Biofeedback	*Archives of Disease in Childhood*
	Arquivos de Neuro-psiquiatria	*Behavioral and Brain Functions*
	Behavioral Genetics	*Behavioral Neurology*
	Biological Psychiatry	*Brain*
	Brain and Behavior	*Brain and Development*
	Brain and Language	*Brian Research*
	Brain Sciences	*Brain Stimulation*
	Brain Structure and Function	*Brazilian Journal of Medicine and Biological Research*
	Cerebral Cortex	*Child Neuropsychology*
	Chinese Medical Journal	*Clinical and Experimental Optometry*
	Clinical Chiropractic	*Clinical Neurophysiology*
	Clinical Neuropsychology	*Cognitive and Behavioral Neurology*
	Cognitive Brain Research	*Cognitive Neuropsychology*
	Complementary Therapies in Clinical Practice	*Computer Methods and Programs in Biomedicine*
	Cortex	*Current Biology*
	Developmental Cognitive Neuroscience	*Developmental Medicine & Child Neurology*
	Developmental Neuropsychology	*Experimental Brain Research*
	Experimental Ophthalmology	*European Child & Adolescent Psychiatry*
	European Journal of Human Genetics	*European Journal of Neurology*
	European Journal of Pediatric Neurology	*Frontiers in Human Neuroscience*
	Frontiers in Pediatrics	*Frontiers in Psychiatry*
	Genes, Brain, and Behavior	*Graefe's Archive for Clinical and Experimental Ophthalmology*
	Human Brain Mapping	*Human Movement Science*
	Human Physiology	*IEEE Engineering in Medicine and Biology Magazine*
	Indian Journal of Medical Sciences	*Indian Journal of Pediatrics*
	International Journal of Neuroscience	*International Journal of Pediatric Otorhinolaryngology*
	International Journal of Psychophysiology	*JAMA Ophthalmology*

	Journal of Basic and Clinical Physiology and Pharmacology	*Journal of Child and Adolescent Psychopharmacology*
	Journal of Child Neurology	*Journal of Clinical and Experimental Neuropsychology*
	Journal of Cognitive Neuroscience	*Journal of Human Genetics*
	Journal of the International Neuropsychological Society	*Journal of the Medical Association of Thailand*
	Journal of Medicinal Food	*Journal of Molecular Neuroscience*
	Journal of Neural Transmission	*Journal of Neurolinguistics*
	Journal of Neurology, Neurosurgery, & Psychiatry	*Journal of the Neuropsychological Society*
	Journal of Neuroscience	*Journal of Ophthalmic & Vision Research*
	Journal of Pediatric Neurology	*Journal of Physiology-Paris*
	Journal of Psychophysiology	*Journal of Vision*
	Medicine	*Nature Neuroscience*
	Neurocase	*NeuroImage*
	NeuroImage Clinical	*Neuroimaging*
	Neurology	*Neuron*
	Neuropsychiatric Disease and Treatment	*Neuropsychiatry, neuropsychology, and behavioral neurology*
	Neuropsychologia	*Neuropsychological Rehabilitation*
	Neuropsychology	*NeuroRegulation*
	Neuroreport	*Neuroscience Letters*
	Neurosciences Journal	*NMR in Biomedicine*
	Nordic Journal of Psychiatry	*Ophthalmic and Physiological Optics*
	Perceptual and Motor Skills	*Progress in Neuro-Psychopharmacology and Biological Psychiatry*
	Prostaglandins, Leukotrienes and Essential Fatty Acids (PLEFA)	*Psychiatry*
	Psychiatry and Clinical Neurosciences	*Psychophysiology*
	Radiology	*Restorative Neurology and Neuroscience*
	Sleep	*Strabismus*
	The Clinical Neuropsychologist	*The Journal of Pediatrics*
	Translational Psychiatry	*Vision Research*

Psychology	**Journals Included in "Psychology" Category**	
Fields that fall under Psychology: Psycholinguistics, Linguistics, Developmental Psychology, Educational Psychology,	*Applied Linguistics*	*Applied Psycholinguistics*
	Australian Psychologist	*Biological Psychology*
	Bilingualism: Language and Cognition	*British Journal of Developmental Psychology*
	Canadian Journal of Experimental Psychology	*Child and Adolescent Psychiatry and Mental Health*
	Child Development	*Clinical Linguistics and Phonetics*
	Cognition	*Cognitive Psychology*
	Counseling Psychology Quarterly	*Developmental Psychology*

Anything related to Cognitive Processing, Psychiatry + Child Psychology	*Educational and Child Psychology*	*Educational Psychology*
	Electronic Journal of Research in Educational Psychology	*Experimental Psychology: Learning, Memory, and Cognition*
	Frontiers in Psychology	*Interaction Studies*
	International Journal of Psychology	*Journal of Abnormal Child Psychology*
	Journal of Abnormal Psychology	*Journal of Applied Clinical and Experimental Psychology*
	Journal of Child Language	*Journal of Child Psychology and Psychiatry*
	Journal of Developmental Psychology	*Journal of Educational Psychology*
	Journal of Experimental Child Psychology	*Journal of Experimental Psychology: Human Perception and Performance*
	Journal of Memory and Language	*Journal of Psycholinguistic Research*
	Journal of School Psychology	*Language*
	Language and Cognitive Processes	*Laterality: Asymmetries of Body, Brain and Cognition*
	Memory and Cognition	*Music Perception*
	Psychological Medicine	*Psychological Reports*
	Psychological Science	*Psychology International*
	Psychonomic Bulletin & Review	*Quarterly Journal of Experimental Psychology*
	School Psychology International	*The Journal of Child Psychology and Psychiatry and Allied Disciplines*
	The Psychoanalytic Study of the Child	

Speech-Language Pathology	**Journals Included in "Speech-Language Pathology" Category**	
	American Journal of Speech-Language Pathology	*Canadian Journal of SLP*
	Communication Disorders Quarterly	*Ear and Hearing*
	International Journal of Language and Communication Disorders	*International journal of speech-language-pathology*
	Journal of Speech, Language, and Hearing Research	*Language Speech Language Hearing Services in Schools*
	Pró-Fono Revista de Atualização Científica	*Speech Communication*
	Topics in Language Disorders	

Education and Literacy	**Journals Included in "Education" Category**	
Fields that fall under Education: The goal of education is literacy, so included journals	*American Annals of the Deaf*	*British Journal of Special Education*
	Computers & Education	*Educational Studies*
	European Journal of Special Needs Education	*Exceptional Children*
	Gifted Child Quarterly	*International Journal of Disability, Development and Education*

that are focused on reading and writing.	*International Journal of Inclusive Education*	*Journal of Learning Disabilities*
	Journal of Research in Reading	*Journal of Research in Special Education Needs*
	Learning and Individual Differences	*Learning and Instruction*
	Learning Disability Quarterly	*Reading and Writing*
	Reading and Writing Quarterly	*Reading Research Quarterly*
	Scandinavian Journal of Disability Research	*Scientific Studies of Reading*
	Teaching Exceptional Children	

Dyslexia Specific	**Journals Included in "Dyslexia Specific" Category**	
	Annals of Dyslexia	*Dyslexia*

Interdisciplinary	**Journals Included in "Interdisciplinary" Category**	
	Medicine + Psychology	
	Brain and Cognition	*Developmental Science*
	Journal of Autism and Developmental Disorders	*Journal of Neurodevelopmental Disorders*
	PLoS One	*Proceedings of the National Academy of Sciences*
	Scientific Reports	*The Cerebellum*
	The Journal of the Acoustical Society of America	
	Medicine + Psychology + Education	
	Journal of Developmental and Behavioral Pediatrics	*Research in Developmental Disabilities*
	Medicine + Speech-Language Pathology	
	The Cleft-Palate-Craniofacial Journal	

Other	**Journals Included in "Other" Category**
	Computers & Graphics
	Environment International
	International Journal of Environmental Research and Public Health
	Pattern Recognition
	Symmetry

APPENDIX E

Examples of Coded Core Features From Articles

Neurobiological

Structural and functional deficits in brain regions involved in reading	Neurodevelopmental disorder
Neurobiologically-based	Underlying disruption in neural system
Neurobiological dysfunction	Dysfunction of cerebellar circuits
Atypical neural organization	Underlying neural substrates
Universal biological origin	Neurocognitive disorder
Abnormal patterns of neural activity	Neurobiological in origin

Genetic/Familial/Heritable/Inherited

Hereditary	Family risk
Familial risk	Genetic base
Genes for dyslexia	Gene influenced
Connected to the existence of family heritage	Genetic component may be involved

Phonological awareness/Phonological processing

Working memory/verbal working memory deficit	Rapid Automatized Naming
Specific impairment of the phonological representation	Phonological deficit hypothesis
Problems affecting short-term memory, sound segmentation, and sound blending	Deficit in phonological processing especially in identifying and manipulating the sound structure of a word
Poorly specific phonological representations	Impaired phonological skills
Phonological processing deficit	Phonological Awareness
Difficulty with nonword repetition tasks	Auditory perceptual deficit
Temporal perceptual deficit	Speech perceptual deficit

Unexpected reading difficulty/Normal or average or adequate intelligence

Unexpected in relation to other cognitive abilities	Cannot be accounted for by a deficit in general intelligence
Normal intelligence	Average intelligence
Unexpected difficulties	Apparently normal cognitive profile
Cannot be explained as the results of poor intelligence	Normal cognitive development
Typical Intelligence	

Literacy/Reading disorder

Reading disorder	Reading disability
Pronounced difficulties in acquiring the alphabetic code	Failure to acquire efficient reading and writing skills

Specific reading disability	Reading comprehension difficulties
Fail to develop age-adequate reading skills	Serious reading problems
Poor readers	Specific deficit in reading
Literacy difficulties	Difficulty with reading and/or literacy acquisition
Significant Reading Difficulty	Reading failure

Unrelated to environmental influences (e.g., lack of reading instruction, low SES, etc.)

Cannot be explained by lack of education	Cannot be explained by inadequate schooling
In the context of typical educational opportunities	Cannot be explained by deficits in learning opportunity
Despite adequate education	In children who are otherwise healthy, well-nurtured, earnest
Despite conventional instruction and sociocultural opportunity	Adequate educational and socioeconomic opportunities

Poor spelling skills

Problems with spelling	Poor spelling
Affects the acquisition of spelling	Spelling difficulties
Very poor and bizarre spelling	Misspelling of known and unknown words
Severe and persistent difficulties in spelling	

IQ-discrepancy (Gap between intelligence and reading skill)

Significant difference between non-verbal intelligence and spelling and/or reading skills
IQ-Achievement discrepancy
Discrepancy between the acquisition of reading skills and other intellectual abilities

Learning or specific learning disability

Learning disability	Specific learning disability
Learning disorder	Learning difficulties
Failure to learn	Difficulty learning

Word recognition/reading, Poor decoding, Non-word/Pseudoword reading

Grapheme to phoneme correspondence	Impair the ability to learn consistencies in the mapping between letters and sounds
Deficiency in reading pseudowords and irregular words	Impaired orthographic skills
Visual-orthographic skills	Orthographic processing deficit
Difficulty in accurate and/or fluent word recognition and decoding abilities	Failure to build solid letter-speech sound associations
Persistent difficulties in word reading	Failure to acquire word recognition skills
Slower reading	Impaired reading fluency
Poor word reading abilities	

Oral language/language deficits, Written language deficits

Difficulties in morphological awareness	Linguistic disorder
Language-based disorder	Difficulties with figurative language competence and pragmatic comprehension
Language weaknesses	Language deficits in dyslexia
Acquisition of written language	Language problems
Associated linguistic deficits in spoken language	Difficulties with oral language perception and/or production
Deviant semantic incongruence processing	Developmental Language Impairments
Disordered acquisition of written language	

Visual processing deficits/Visual-spatial attention

Magnocellular deficit hypothesis	Visual sensory deficit
Lack of coordination between peripheral and foveal vision	Deficits include functions specific to the magnocellular visual pathways
Visuospatial attention impairment	Visual abnormalities
Visual deficits	Deficits in the visual processes

Motor processing deficits/dysfunction

Motor skill difficulties	Significant difficulties in the developmental of motor skills
Motor sequencing difficulties	Motor deficits
Motor and oral motor deficits	Deficient balancing
Deficient postural control	Impair motor skill performance