Teaching and Learning in Communication Sciences & Disorders

Volume 7 | Issue 3 Article 9

2023

Using a Refutation Text to Increase Dyslexia Knowledge in CSD Undergraduates

Dorothy Shiver
University of Georgia, dorothy.tam25@uga.edu

Hannah Krimm
University of Georgia, hannah.krimm@uga.edu

DOI: 10.61403/2689-6443.1292

Using a Refutation Text to Increase Dyslexia Knowledge in CSD Undergraduates

Abstract

The purpose of this study was to examine the effect of a refutation text on conceptual knowledge of dyslexia among pre-professional undergraduate students in communication sciences and disorders (CSD). Undergraduate students (n = 60) majoring in CSD were randomly assigned to two groups. They completed a pre-test to evaluate their conceptual knowledge of dyslexia, then read a text about dyslexia. There were two texts: a refutation text and a control text. After reading the text, students completed a post-test to evaluate their conceptual knowledge of dyslexia. Four weeks after completing the post-test, students completed a maintenance test. The refutation text facilitated greater conceptual change about dyslexia than the control text in the short term (i.e., from pre-test to post-test). For both groups, participants' conceptual knowledge of dyslexia decreased between the post-test and maintenance test. However, for both groups, conceptual knowledge of dyslexia was higher at the maintenance time point than it was at the pre-test time point. Refutation texts may be a viable option for facilitating conceptual change among pre-professional speech-language pathologists.

Keywords

dyslexia, undergraduate, refutation text

A *misconception* is a belief that opposes broadly accepted scientific explanations (Tippett, 2010). Misconceptions about human behavior are particularly resistant to change due to people's existing, intuitive explanations and to oversimplified explanations of scientific findings in the media (Stanovich, 2013). However, misconceptions can be revised by explicitly addressing them and refuting them with scientific evidence. One effective approach for revising misconceptions is having students read a specific type of expository text known as a refutation text (Schroeder & Kucera, 2022). Because misconceptions are prevalent among speech-language pathologists and other educators and may lead to implementation of non-evidence-based practice (McDaniel et al., 2023; Washburn et al., 2011), the purpose of this study was to examine the effect of a refutation text for revising misconceptions about dyslexia among undergraduate students majoring in Communication Sciences and Disorders (CSD).

Refutation Texts. A refutation text follows a specific structure that includes elements of argumentation to facilitate modification of readers' misconceptions. First, there is a statement of a commonly held misconception. Then, there is a cue that alerts the reader to an alternative explanation. Finally, there is an explicit contradiction of the misconception with an emphasis on the currently accepted scientific explanation (Guzzetti, 2000; Maria & MacGinitie, 1987; Tippett, 2010). For example, a refutation text about dyslexia reads:

> [Many people] might think that students with dyslexia see letters and words backwards [misconception]. But that is not what has been shown by research [cue]. In actuality, dyslexia is primarily a language-based reading disability, not a visual-based disability [refutation]. (Peltier et al., 2020b; p. 1)

Reading refutation texts facilitates greater long-term conceptual change than reading traditional expository texts (Guzzetti et al., 1993; Tippett, 2010). Tippett (2010) summarized the research on refutation texts with the following conclusions:

1. Refutation texts are more effective than traditional expository texts for changing students' misconceptions about science concepts in students in grades 3-10.
2. Refutation texts are at least as effective as traditional expository texts for changing misconceptions about science concepts in eleventh and twelfth grade students.
3. Although refutation texts may not always be more *effective* than traditional texts for changing misconceptions, they may be more *efficient*; college students who read refutation texts spend less time reading than students who read traditional expository texts and demonstrate similar levels of conceptual change (Broughton et al., 2007).

Most research on refutation texts has been conducted in science education for primary and secondary students. Little work has been done to examine the effectiveness of refutation texts for revising misconceptions among post-secondary students on topics outside of physical science. However, Peltier and colleagues (2020b) wrote a refutation text to address common misconceptions about dyslexia. Using this text, Peltier and colleagues (2020c) demonstrated the effective reconstruction of misconceptions about dyslexia among 97 undergraduate preservice teachers. They used a between-subjects pre-test, post-test, maintenance design to assess changes in conceptual knowledge of dyslexia. After completing a pre-test of dyslexia knowledge, participants were randomly assigned to read the refutation text (Peltier et al., 2020b) or a control text titled "Dyslexia Basics" published for the public by the International Dyslexia Association (2020). Participants who read the refutation text outperformed those who read the control text on

an immediate post-test about dyslexia and on a delayed post-test (i.e., maintenance test) four weeks after the post-test. The refutation text can be accessed online (https://doi.org/10.17605/OSF.IO/FBYHT).

Misconceptions about Dyslexia. Peltier and colleagues (2020c) investigated the use of a refutation text for revising misconceptions about dyslexia because several studies have documented the prevalence of misconceptions about dyslexia among educational professionals and the public (e.g., Castillo & Gilger, 2018; Ness & Southall, 2010; Wadlington & Wadlington, 2005). Many people erroneously assume that dyslexia is caused by environmental or psychological factors, poor intelligence, lack of motivation, and/or a visual deficit. People overwhelmingly believe that seeing and/or writing letters backwards is a telltale symptom of dyslexia (Castillo & Gilger, 2018; Wadlington & Wadlington, 2005). This misconception likely delays or prevents identification of children with dyslexia.

Castillo and Gilger (2018) investigated public perceptions about dyslexia by asking 623 adults recruited via Amazon's Mechanical Turk (MTurk) (http://www.mturk.com) to complete a survey on characteristics and possible causes of dyslexia. Almost all the participants (97%) had heard of dyslexia and 15% indicated that they have dyslexia or have a family member with dyslexia. Participants identified characteristics of dyslexia and recognized that dyslexia manifests as trouble with reading, writing, and spelling, but many also erroneously believed that "trouble with vision" is sometimes an indicator of dyslexia.

Like the public, preservice teachers appear to possess a rudimentary understanding of dyslexia that involves many misconceptions (Ness & Southall, 2010; Peltier et al., 2020c; Wadlington & Wadlington, 2005). The most common misconception among pre-service and in-service professionals is that dyslexia results from a visual-perception deficit (Ness & Southall, 2010; Washburn et al., 2011). Teachers' misconceptions likely are due to a lack of essential information about dyslexia and scientifically based reading instruction in teacher preparation programs (Wadlington & Wadlington, 2005).

Common misconceptions about dyslexia have remained unchanged for more than a decade (Castillo & Gilger, 2018; Wadlington & Wadlington 2005). Several factors may contribute to the persistence of misconceptions about dyslexia, especially regarding a visual basis. First, misconceptions about dyslexia are so prevalent in popular culture that it may seem that the preponderance of evidence supports them; people adopt misconceptions from mere exposure (Hansen & Wänke, 2009). Second, some misguided professionals propagate misconceptions in the name of intervention. For example, clinics that appear highly professional and competent continue to offer programs intended to treat dyslexia using vision-based interventions despite clear guidance against such interventions from the American Academy of Pediatrics, Section on Ophthalmology, Council on Children with Disabilities, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, and American Association of Certified Orthoptists (2009). Third, a visual basis for dyslexia has face validity and logical appeal. Reading is accomplished in part by the eyes, so it seems reasonable to assume that the visual system would be involved in reading difficulties. The use of corrective lenses to improve vision is ubiquitous in our society, so using special lenses to treat dyslexia maps to a strong societal heuristic of treating visual difficulties with special lenses. Additionally, effective remediation for dyslexia requires the

interventionist to have considerable expertise in the structure and functions of the English language. Such expertise is sorely lacking among America's educators (Moats, 2009). It is much simpler and less expensive to "treat" dyslexia with special lenses than to ensure that educators are properly trained to teach reading effectively. Unfortunately, the persistence of misconceptions about dyslexia simply serves to delay or even prevent effective intervention for children who need it.

Dyslexia is a Language-Based Disorder. In contrast to these common ideas, decades of research evidence suggest that dyslexia is a language-based learning disability that typically results from a "core" phonological deficit; it does not involve a visual cause or visual symptoms (see Vellutino et al., 2004 for a review of the literature). Children with dyslexia tend to have difficulty acquiring phonemic awareness, which is the ability to identify and manipulate individual speech sounds. This difficulty sets the stage for subsequent difficulty matching letters and letter combinations to the sounds they represent, and, ultimately, difficulty decoding and encoding (i.e., spelling) words quickly and accurately (Vellutino et al., 2004). Among individuals with dyslexia, difficulty with accurate and fluent decoding and spelling often persists into adulthood (Adlof & Hogan, 2018; Cheema et al., 2023; Nergård-Nilssen & Hulme, 2014; Peterson & Pennington, 2015; Reis et al., 2020).

Adlof and Hogan (2018) describe dyslexia in the context of developmental language disorders and suggest that weaknesses in spoken language often coincide with dyslexia, even when such weaknesses are sub-clinical. These weaknesses include difficulties with phonological working memory (Wiseheart & Altmann, 2018), word learning (Alt et al., 2017), and word retrieval (Hanly & Vandenberg, 2010). Additionally, around 50% of students who are diagnosed with dyslexia also could be clinically diagnosed with developmental language disorder (McArthur et al., 2000; Snowling et al., 2020).

The SLP's Role in the Evaluation and Treatment of Dyslexia. Given that reading and writing are language-based skills, and that difficulties with reading and writing tend to co-occur with other language deficits, speech-language pathologists should be closely involved in identifying and educating children with dyslexia (Ehren & Ehren, 2001; Hogan, 2018). The scope of practice for speech-language pathologists (SLPs) specifically includes assessing and remediating literacy skills (American Speech-Language-Hearing Association, 2001), and in a clinical forum on dyslexia published in *Language, Speech, and Hearing Services in Schools*, Hogan (2018) references several publications that discuss the SLP's role in assessment and intervention of reading disabilities (e.g., Catts & Kamhi, 2004; Ehren & Ehren, 2001; Kamhi et al., 2001; Nelson, 2010; Schuele, 2017; Schuele & Larrivee, 2004; Spracher, 2000). Hogan (2018) encourages SLPs to (a) acknowledge their expertise relative to dyslexia, (b) share accurate information about dyslexia with parents and colleagues, (c) understand the relationships between dyslexia and other communication disorders, (d) promote responsible and appropriate use of the term dyslexia, and (e) support evidence-based interventions for children with dyslexia. Hogan (2018) expands upon each of these suggestions with information and resources for SLPs. Additional high-quality resources for those wishing to acquire accurate conceptions of dyslexia include "Dyslexia Myths" (Gaab Lab, n.d.), "Understanding Dyslexia: Myths vs. Facts" (National Center on Improving Literacy, 2020), and "7 Common Myths about Dyslexia" (Morin, n.d.).

Despite the role SLPs should play in identifying and treating dyslexia, many SLPs feel underprepared to do so and as many as 50% do not believe that literacy should be within the SLPs' scope of practice (Blood et al., 2010; Ehren & Ehren, 2001; Katz et al., 2010). Blood and colleagues (2010) surveyed 1,000 SLPs from 48 states about their existing knowledge, prior training, and perceived confidence for managing written language disorders. Results suggested a lack of clinical and academic training for addressing written language disorders and a resulting lack of confidence; only 28% of responding SLPs reported that they were confident in working with children with written language disorders. More recent data complement Blood and colleagues' (2010) findings. Krimm and colleagues (2021) reported considerable variability in SLP knowledge of the characteristics of dyslexia and a problematic belief in a causal visual deficit. Most SLPs who do feel confident addressing written language disorders and who do incorporate literacy skills into speech-language intervention report having sought additional training specific to written language disorders outside of their graduate program in speech-language pathology (Fallon & Katz, 2011).

To improve services for children with dyslexia, pre-professional programs should focus on improving educators' knowledge of the causes, identification, and intervention of children with dyslexia. Peltier and colleagues' (2020c) results suggest that a refutation text may be useful for reconstructing misconceptions about dyslexia among future SLPs. The study reported here extends the findings of Peltier and colleagues (2020c) to undergraduate students in CSD, with some methodological changes described in the Method section. We posed the following research questions:

1. Does the refutation text facilitate greater short-term conceptual change than the control text among CSD undergraduates?
2. Does the refutation text facilitate greater long-term conceptual change than the control text among CSD undergraduates?

Method

The study protocol was approved by the Institutional Review Board (IRB) at the University of Georgia. An experimental, between-subjects pre-test, post-test, maintenance design was used to examine conceptual change about dyslexia among CSD undergraduates.

Participants. Participants were 60 undergraduate students majoring in CSD who were enrolled in an introductory language disorders class. All participants identified as female, 97% were Caucasian/White, 3% were Asian, 2% were Hispanic/Latinx, and 1% were Black/African American. The mean age of all participants was 20.37 years (*SD* = 0.64 years).

Materials.

Refutation Text (Peltier et al., 2020b). We used the refutation text created by Peltier and colleagues (2020b). According to Peltier and colleagues (2020c), the refutation text was designed to incorporate the effective components of refutation texts (Sinatra & Broughton, 2011). It includes (a) an explicit statement of a misconception (e.g., "many people think dyslexia is a visual or perceptual difficulty;" Peltier et al., 2020b, p. 1), (b) a statement of why experts consider the misconception to be inaccurate (e.g., "but that is not what has been shown by research;" Peltier et al., 2020b, p. 1), (c) the alternative to the misconception, which is accepted by experts in the field

(e.g., "in actuality, dyslexia is primarily a language-based reading disability, not a visual-based disability;" Peltier et al., 2020b, p. 1), and (d) evidence for why experts accept the alternative (e.g., "people with dyslexia … perform more poorly on tasks that require analyzing, synthesizing, and manipulating phonemes;" Peltier et al., 2020b, p. 1). The refutation text can be accessed online (https://doi.org/10.17605/OSF.IO/FBYHT).

Control Text (International Dyslexia Association [IDA], 2020). We used the "Dyslexia Basics" article (IDA, 2020) as the control expository text for this study. This text is authored by experts in the field of dyslexia and published on IDA's website to provide information about dyslexia to the public. We removed some content from the published text to ensure that it was comparable to the refutation text in content, length (control text 1262 words; refutation text, 1271 words), and Flesch-Kincaid readability level (control text, 13.3; refutation text 12.8). The control text can be accessed online (https://dyslexiaida.org/dyslexia-basics/).

Dyslexia Knowledge Questionnaire. We adapted the Dyslexia Knowledge Questionnaire (DKQ) used by Peltier and colleagues (2020c) for this study. The Dyslexia Knowledge Questionnaire (DKQ; Peltier et al., 2020a) is a questionnaire on which participants are asked to rate on a Likert scale the extent to which they think *an expert in dyslexia* would agree with 20 true and false statements about dyslexia. Some items were collected from previous instruments that measure knowledge of dyslexia (e.g., Wadlington & Wadlington, 2005); others were created by Peltier et al., (2020a) based on the dyslexia literature. Peltier et al., (2020c) revised items as needed based on feedback from an expert in the field of dyslexia. The DKQ can be accessed online (https://doi.org/10.17605 /OSF.IO/8AYVX).

We made the following adaptations to the DKQ for this study. We asked students to rate the extent to which *they*, the participant, rather than a dyslexia expert, agreed with the statements provided. Additionally, participants responded using a visual analog scale rather than a Likert scale to maximize variance and to maximize sensitivity to change in the study data (Briggs & Closs, 1999; Pfennings et al., 1995).

Procedures. Participants were recruited during one regularly scheduled face-to-face meeting of an undergraduate language disorders class taught by a CSD faculty member who was not involved in this study. The course includes several "learning lab" activities that students complete in and out of class. Students were assigned to complete the study activities as an in-class learning lab and were able to opt-in to allow their performance to be analyzed for research. The first author, who was a speech-language pathology graduate student at the time of data collection, read a recruitment script to the class before they began the activities. She introduced herself, explained the study activities, and informed the students that they could opt-in to participate in the research study. Neither author was the instructor of record for the course; the second author presented study results to the class and delivered a guest lecture about dyslexia after maintenance data had been collected.

Data were collected using Qualtrics during (a) the regularly scheduled class during which participant were recruited and (b) outside of class at a maintenance time point four weeks after the post-test. Participants completed our adapted version of the DKQ as a pre-test, were randomly assigned to read the refutation text (n = 31) or the control text (n = 29), then completed our version of the DKQ again as a post-test. The order of question administration was randomized for each

time point. Demographic questions were placed at the end of the post-test to guard against stereotype threat (Spencer et al., 2016). Four weeks after completing the post-test, all students in the class received an email that prompted them to complete our version of the DKQ once more as a maintenance test.

Scoring. Responses on the DKQ were assigned numerical values according to an underlying metric in Qualtrics and scores were calculated automatically using Excel. Values ranged from 0 (strongly disagree) to 100 (strongly agree). False statements were reverse coded so that participants received more points for accurately disagreeing with false statements than for incorrectly agreeing with false statements. For example, if a participant's response to a false statement was assigned a numerical value of 10 (strongly disagree), the item was scored as 90 (i.e., 100 minus 10) to indicate strong knowledge of dyslexia indicated by correct disagreement with a false statement. Scores across items were averaged to yield a dyslexia knowledge score for each participant at each time point.

Results

After listwise deletion of students who did not complete all three tests, the final sample included 60 participants. There were seventy-four students who completed the pre-test and post-test, and sixty-nine students who completed the maintenance test. Five students who completed the pre-test and post-test did not complete the maintenance test and were excluded from analysis. These students reported similar demographics to the included participants (white females ages 20-22) and their pre-test and post-test scores were within the range calculated from the 60 participants who completed all three tests (pre-test range 48.5 to 61.5, post-test range 53.1 to 93.5). Nine students completed the maintenance test who did not complete the pre-test and post-test. Presumably, these students had been absent from class the day of pre-test and post-test data collection. Students who completed only the maintenance test were excluded from analysis. Table 1 displays descriptive statistics and Figure 1 illustrates mean group performance over time.

Table 1

Descriptive Statistics

Time	Mean	*SD*	Range
Pre-test	54.63	6.73	41.85 - 75.45
Experimental	54.57	6.82	41.85 - 70.25
Control	54.69	6.76	41.95 - 75.45
Post-test	79.28	12.85	43.85 - 100.00
Experimental	88.10	7.98	66.30 - 100.00
Control	69.86	10.08	43.85 - 86.90
Maintenance	65.80	13.21	44.40 - 96.25
Experimental	68.05	13.51	48.80 - 96.25
Control	63.38	12.66	44.40 - 90.55

Data were first analyzed using a two-way mixed ANOVA. Levene's test suggested that the assumption of homogeneity of variance was met ($p > .05$). However, Mauchly's test of sphericity

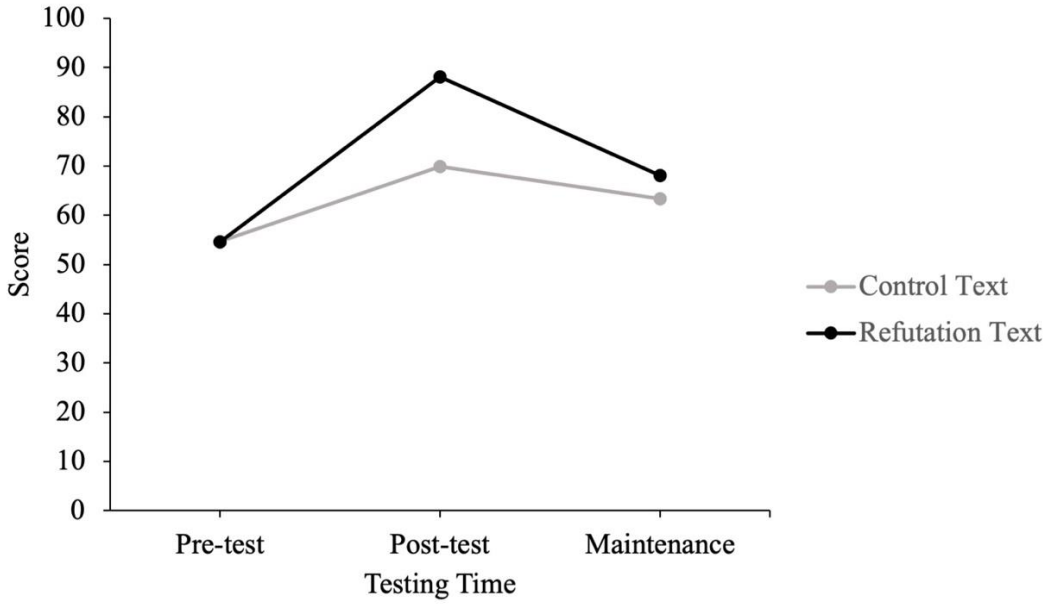
suggested that the sphericity assumption was violated for the main effect of time ($p < .05$) and for the group-by-time interaction ($p < .05$). Thus, the Greenhouse-Guyser correction was applied. There was a statistically significant main effect of time, $F(1.73, 100.56) = 133.74$, $p < .01$; $\eta^2 = 0.51$; a statistically significant main effect of group, $F(1, 58) = 15.56$, $p < .01$; $\eta^2 = 0.13$; and a statistically significant time-by-group interaction, $F(1.73, 100.56) = 20.43$, $p < .01$; $\eta^2 = 0.14$. Follow-up *t*-tests with a Bonferroni correction for multiple comparisons (five *t*-tests, $\alpha = .01$) were conducted.

Research Question 1: Does the refutation text facilitate greater short-term conceptual change than the control text among CSD undergraduates? Follow-up independent samples *t*-tests indicated that there was not a statistically significant difference between groups at the pre-test time point, $t(57.8) = 0.07$, $p > .01$; Cohen's $d = 0.02$. There was a large, statistically significant difference between groups at the post-test time point, $t(53.33) = 7.74$, $p < .01$; Cohen's $d = 2.01$; the experimental group performed better than the control group at the post-test time point.

Research Question 2: Does the refutation text facilitate greater long-term conceptual change than the control text among CSD undergraduates? A follow-up independent samples *t*-test indicated there was a small but not statistically significant difference between groups at the maintenance time point, $t(57.99) = 1.38$, $p > .01$; Cohen's $d = 0.36$.

Figure 1

Mean Group Performance Over Time



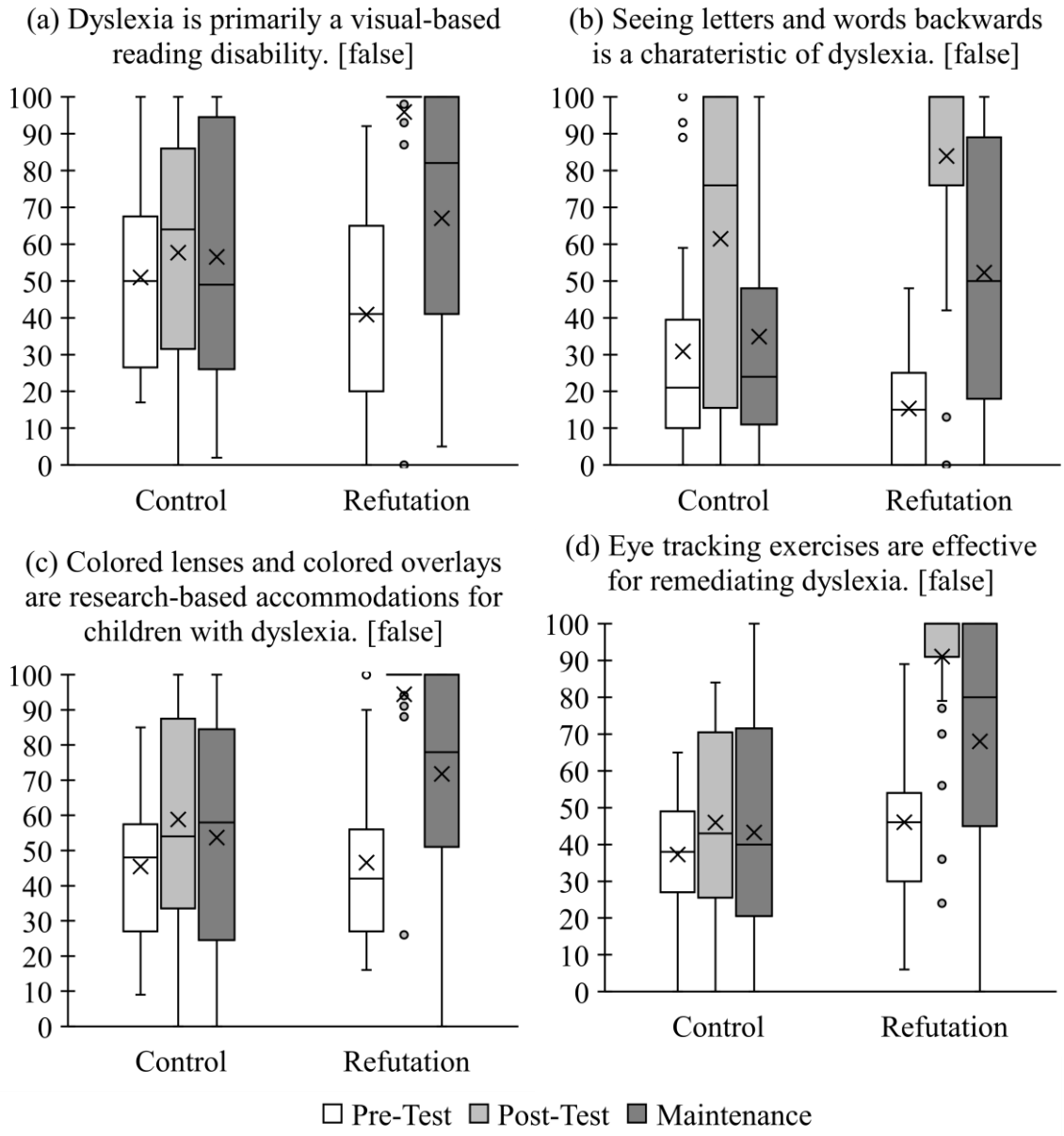
Ad Hoc Comparisons. Ad hoc paired samples *t*-tests indicated that the experimental group performed statistically significantly better at the maintenance time point than they did at the pre-test time point, and the effect was large, $t(30) = 5.23$, $p < .01$; Hedge's $g = 1.26$). The control group

also performed statistically significantly better at the maintenance time point than they did at the pre-test time point, also with a large effect, $t(28) = 4.23$, $p < .01$; Hedge's $g = 0.86$.

Ad Hoc Item Analysis. Differences between groups were highlighted by participant responses to false statements that involve the assumption of a visual deficit in children with dyslexia. Figure 2 illustrates the distribution of responses for each group across time for selected statements.

Figure 2

Distribution of Responses by Group and Time for Selected Statements



For additional item analysis, responses were dichotomized as correct or incorrect; responses greater than 50 were scored as correct and responses less than 50 were scored as incorrect. Table 2 displays the percent of participants in each group that responded correctly to each statement at each time point. The percent of *total* participants who responded correctly ranged from 8% to 95% at pre-test, 47% to 100% at post-test, and 37% to 97% at maintenance. As can be expected with learning data at maintenance, the percentage of participants who accurately responded to each statement decreased between post-test and maintenance for all statements except one (dyslexia should be diagnosed by an eye doctor). The range of decrease was 2% to 40%. There was a moderate, statistically significant negative correlation, $r(18) = -0.54$, $p < .05$ between the percentage of the sample that responded correctly at pre-test and the magnitude of the decrease from post-test to maintenance; the statements that were more resistant to the decrease were the same statements that most participants responded to correctly at pre-test. For example, 95% of the participants agreed with the statement "Students with dyslexia need explicit, systematic, direct instruction in phonemic awareness and phonics" at pre-test. At post-test, 100% of participants agreed with this statement and at maintenance 95% agreed.

Discussion

The purpose of this study was to determine the effect of reading a refutation text on knowledge of dyslexia among undergraduate CSD students. We hypothesized that the refutation text would facilitate significantly more conceptual change than the control text, and that knowledge gains would persist on a maintenance test. Results suggested that the refutation text facilitated greater change in knowledge of dyslexia than the control text in the short term (i.e., on a post-test immediately after reading the text). However, the difference between groups did not persist statistically at the maintenance time point. For both groups, knowledge of dyslexia decreased between the post-test and maintenance time points. However, both groups scored significantly higher at the maintenance time point than they did at the pre-test time point.

Our results are consistent with Peltier et al., (2020c)'s findings on the effect of the refutation text for pre-service teachers. Peltier et al. (2020c) reported that participants who read the refutation text scored significantly higher at post-test than participants who read the control text. However, in Peltier et al., (2020c)'s sample, the statistically significant effect persisted at the maintenance time point. In our sample, there was a small difference between groups at the maintenance time point, but it was not statistically significant.

A few factors could have produced the lack of statistically significant difference between groups at the maintenance time point in this study. First, there were 97 participants in the Peltier et al., (2020c) sample; our smaller sample of 60 may have been underpowered to detect a small effect. Second, the method of data collection could have affected our results for dyslexia knowledge at the maintenance time point. Like participants in Peltier et al., (2020c), participants in this study completed the pre-test, assigned reading, and post-test during a regularly scheduled class meeting. However, Peltier et al., (2020c) also administered the maintenance test during class. We administered the maintenance test outside of class. Removing participants from the context of the activity may have decreased motivation to participate and/or attention to the task and could have impacted scores.

Table 2

Percent of Participants in Each Group Who Responded Correctly to Each Statement on the Dyslexia Knowledge Questionnaire (Peltier et al., 2020b) at Each Time Point.

			Pre-Test		Post-Test		Maintenance	
	Statement	T/F	Cont	Reft	Cont	Reft	Cont	Reft
1.	After effective reading intervention, the activation patterns in the brain of a student with dyslexia can change.	T	0.76	0.81	0.72	0.94	0.83	0.81
2.	Colored lenses and colored overlays are research-based accommodations to help students with dyslexia.	F	0.34	0.32	0.52	0.94	0.55	0.77
3.	Difficulty with processing sounds in language is one of the major deficits found in dyslexia.	T	0.55	0.74	0.97	1.00	0.76	0.81
4.	Dyslexia identification has a clearly well-defined cut-off. Students either have dyslexia or they do not.	F	0.72	0.94	0.83	0.77	0.90	0.71
5.	Dyslexia is not hereditary.	F	0.59	0.71	0.93	0.94	0.72	0.74
6.	Dyslexia is primarily a language-based reading disability.	T	0.59	0.68	0.90	1.00	0.86	0.90
7.	Dyslexia is primarily a visual-based reading disability.	F	0.48	0.29	0.52	0.97	0.48	0.65
8.	Dyslexia is recognized as a type of specific learning disability that can receive special education services by the federal government.	T	0.93	0.77	1.00	0.97	0.86	0.87
9.	Dyslexia should be diagnosed by an eye doctor.	F	0.90	0.90	0.90	1.00	0.97	0.97
10.	Even after effective intervention, the brain activation patterns of students with dyslexia remain unchanged.	F	0.55	0.61	0.66	0.97	0.69	0.74
11.	Eye tracking exercises are effective in remediating dyslexia.	F	0.17	0.29	0.38	0.94	0.34	0.68
12.	In some public schools, dyslexia is not recognized as a learning disability eligible for special education services.	F	0.28	0.29	0.72	0.97	0.48	0.61
13.	Parents with dyslexia are likely to have children with dyslexia.	T	0.62	0.61	0.97	0.97	0.72	0.81
14.	School psychologists can identify students with dyslexia.	T	0.52	0.45	0.55	0.84	0.52	0.71
15.	Seeing letters and words backwards is a characteristic of dyslexia.	F	0.17	0.00	0.62	0.87	0.24	0.48
16.	Students with dyslexia do not see words jumping around on the page.	T	0.48	0.45	0.62	0.90	0.62	0.65
17.	Students with dyslexia need explicit, systematic, direct instruction in phonemic awareness and phonics.	T	0.90	0.90	1.00	1.00	0.93	0.94
18.	Students with dyslexia should be taught how to read using the whole-word method.	F	0.52	0.32	0.59	0.87	0.48	0.42
19.	There is not a well-defined cutoff between students with low-average reading difficulties and those with dyslexia.	T	0.72	0.48	0.79	0.65	0.83	0.48
20.	Visual-perceptual deficiencies are not components of the dyslexia diagnosis.	T	0.24	0.13	0.24	0.68	0.41	0.42

Note. T = True; F = False; Cont = Control text, Reft = Refutation text.

Tippett (2010) reviewed 20 years of research on refutation texts, including 31 studies of refutation texts. The body of literature includes several studies that indicate maintained conceptual change at a delayed posttest within a range of six weeks to two months after reading a refutation text (Frède, 2008; Hynd et al., 1994; Hynd et al., 1997; Maria & Johnson, 1990; Mason & Gava, 2007). However, most of the studies analyzed by Tippett (2010) involved young children in science education. Only two studies involved college students. It is possible that misconceptions are more deeply engrained among college students than among elementary school children, thus making college students more susceptible to a return to their pre-test knowledge levels without ongoing reminders of the newly acquired information from a refutation text.

Additionally, Marshall (1989) investigated sequence effects for presentations of information related to scientific concepts with college students. Presenting activities related to the scientific concepts *before* providing students with the refutation text was more effective in altering misconceptions than presenting class activities *after* students read the refutation text (Marshall, 1989). Tippett (2010) suggests that these findings may indicate prior knowledge activation during preemptive instructional activities, potentially leading to increased conceptual change. In this study, participants read the refutation text or control text before class activities related to dyslexia. Providing class instruction prior to assigning a refutation text may effectively alter misconceptions in college students in the long term.

Finally, Tippett (2010) provides an analysis of grade level trends for 22 studies that directly compared use of refutation text to non-refutation text. Reading refutation texts was more effective in promoting conceptual change for participants in grades 3 through 10 as compared to participants in kindergarten through grade 2 and grade 11 or higher. This developmental trend indicates an opportunity for continued refinement in the optimal use of refutation texts in undergraduates. It is possible that misconceptions are more malleable among children in late elementary and middle school and that presentation of refutation texts may need to be altered slightly for use with undergraduates.

Using Refutation Texts in Undergraduate Education. Previous research addresses refutation texts in science education for young children. This study, combined with results from Peltier et al. (2020c), suggests that refutation texts may also be useful for correcting misconceptions among pre-professional undergraduates in education-related fields. The combined efforts of previous research on refutation texts and the findings of the current study suggest that refutation texts may be a useful tool for altering misconceptions about dyslexia in undergraduate education programs. Addressing misconceptions about dyslexia with refutation texts can bring awareness to undergraduates' misconceptions and replace them with scientific evidence more effectively than a traditional expository text.

Because the use of refutation texts is relatively new in higher education for pre-service SLPs, we know of no existing refutation texts beyond Peltier et al., (2020b) to recommend for incorporation into teaching in CSD programs. However, refutation texts may be useful for prompting conceptual change about other topics within speech-language pathology for which misconceptions abound, such as autism spectrum disorder and specific language impairment (McDaniel et al., 2023). It may be useful for professionals who teach undergraduate CSD courses to write and evaluate the

use of refutation texts to address these misconceptions. Texts should follow the misconception-cue-scientific explanation structure and should be limited in length.

Another way to capitalize on the effectiveness of refutation texts is to incorporate the refutation argument structure into other classroom activities, such as into a refutation lecture. Refutation lectures are more effective than traditional lectures and can even prompt conceptual change for misconceptions that are not directly addressed in the lecture (Menz et al., 2021). Incorporating refutation arguments into teaching may facilitate an increase in empirically based knowledge among SLPs, which could lead to more widespread implementation of evidence-based practice in the field.

Future Directions. The purpose of reframing misconceptions about dyslexia and replacing them with scientifically based knowledge is to improve service delivery for individuals with dyslexia; that is, to incorporate evidence-based practice for the identification, assessment, and intervention for individuals with dyslexia. Future research should examine whether the modification of misconceptions towards scientifically accepted knowledge about dyslexia results in changes in professional practice.

Additionally, although this study demonstrates the effectiveness of a refutation text in the short term, future research should examine strategies that may enhance long-term retention. One such strategy is repeated testing (i.e., the testing effect), which emphasizes repeated retrieval of information from memory rather than studying the same information several times. Roediger and Butler (2011) reviewed research suggesting that repeated testing produces greater learning and long-term retention that can promote knowledge transfer to different settings. Strategies that maximize the testing effect include (a) using expanding-interval retrieval schedules (Landauer & Bjork, 1978), (b) providing feedback with correct answers after retrieval attempts (Bangert-Drowns et al., 1991; Kulhavy & Stock, 1989), and (c) providing delayed feedback after a retrieval attempt (Roediger & Butler, 2011). Retention strategies such as repeated testing should be considered in future research involving reframing misconceptions with refutation texts.

Finally, in this study we expanded the research efforts of Peltier et al. (2020c) to alter the misconceptions about dyslexia among preservice teachers by applying the same concept of conceptual change to pre-professional CSD students. Because SLPs serve a role in the remediation and treatment of dyslexia (ASHA, 2001), future research should continue to pursue the reconstruction of misconceptions about dyslexia among SLPs.

Disclosures

Hannah Krimm receives a salary from the University of Georgia. The authors have no non-financial conflicts of interest to disclose.

References

Adlof, S. M., & Hogan, T. P. (2018). Understanding dyslexia in the context of developmental language disorders. *Language, Speech, and Hearing Services in Schools, 49*(4), 762-773. https://doi.org/10.1044/2018_LSHSS-DYSLC-18-0049

Alt, M., Hogan, T., Green, S., Gray, S., Cabbage, K., & Cowan, N. (2017). Word learning deficits in children with dyslexia. *Journal of Speech, Language, and Hearing Research, 60*(4), 1012-1028. https://doi.org/10.1044/2016_JSLHR-L-16-0036

American Academy of Pediatrics, Section on Ophthalmology, Council on Children with Disabilities; American Academy of Ophthalmology; American Association for Pediatric Ophthalmology and Strabismus; and American Association of Certified Orthoptists. (2009). Learning disabilities, dyslexia, and vision. *Pediatrics, 124*(2), 837-844. https://doi.org/10.1542/peds.2009-1445

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]. www.asha.org/policy.

Bangert-Drowns, R. L., Kulik, C.-L. C., Kulik, J. A., & Morgan, M. (1991). The Instructional Effect of Feedback in Test-Like Events. *Review of Educational Research, 61*(2), 213–238. https://doi.org/10.3102/00346543061002213

Blood, G., Mamett, C., Gordon, R., & Blood, I. (2010). Written language disorders: Speech-language pathologists' training, knowledge, and confidence. *Language, Speech, and Hearing Services in Schools, 41*(4), 416-428. https://doi.org/10.1044/0161-1461(2009/09-0032)

Briggs, M., & Closs, J. S. (1999). A descriptive study of the use of visual analogue scales and verbal rating scales for the assessment of postoperative pain in orthopedic patients. *Journal of Pain and Symptom Management, 18*(6), 438–446. https://doi.org/10.1016/S0885-3924(99)00092-5

Broughton, S., Sinatra, G., & Reynolds, R. (2007, August). *Attention allocation, background knowledge and the refutation text effect* [Paper presentation]. 12th Biennial Conference of the European Association for Research on Learning and Instruction, Budapest, Hungary.

Catts, H. W., & Kamhi, A. G. (2004). *Language and reading disabilities* (2nd ed.). Allyn & Bacon.

Castillo, A., & Gilger, J. W. (2018). Adult perceptions of children with dyslexia in the USA. *Annals of Dyslexia, 68*, 203-217. https://doi.org/10.1007/s11881-018-0163-0

Cheema, K., Fleming, C., Craig, J., Hodgetts, W. E., & Cummine, J. (2023). Reading and spelling profiles of adult poor readers: Phonological, orthographic and morphological considerations. *Dyslexia, 29*, 58-77. https://doi.org/10.1002/.dys.1731

Ehren, B., & Ehren T. (2001). New or expanded literacy roles for speech-language pathologists: Making it happen in the schools. *Seminars in Speech and Language, 22*(3), 233-243. http://doi.org/10.1055/s-2001-16146

Fallon, K., & Katz, L. (2011). Providing written language services in the schools: The time is now. *Language, Speech, & Hearing Services in Schools, 42*, 3-17. https://doi.org/10.1044/0161-1461(2010/09-0068)

Frède, V. (2008). Teaching astronomy for pre-service elementary teachers: A comparison of methods. *Advances in Space Research, 42*(11), 1819–1830. https://doi.org/10.1016/j.asr.2007.12.001

Gaab Lab. (n.d.). *Dyslexia myths.* https://www.gaablab.com/dyslexia-myths.

Guzzetti, B. (2000). Learning counter-intuitive science concepts: What have we learned from over a decade of research? *Reading and Writing Quarterly, 16*(2), 89–98. https://doi.org/10.1080/105735600277971

Guzzetti, B., Snyder, T., Glass, G., & Gamas, W. (1993). Promoting conceptual change in science: A comparative meta-analysis of instructional interventions from reading education and science education. *Reading Research Quarterly, 28*, 117–155. https://doi.org/10.2307/747886

Hanly, S., & Vandenberg, B. (2010). Tip-of-the-tongue and word retrieval deficits in dyslexia. *Journal of Learning Disabilities, 43*(1), 15-23. https://doi.org/10.1177/0022219409338744

Hansen, J., & Wänke, M. (2009). Liking what's familiar: The importance of unconscious familiarity in the mere-exposure effect. *Social Cognition*, *27*(2), 161-182. https://doi.org/10.1521/soco.2009.27.2.161

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

Hynd, C., Alvermann, D., & Qian, G. (1997). Preservice elementary school teachers' conceptual change about projectile motion: Refutation text, demonstration, affective factors, and relevance. *Science Education*, *81*(1), 1-27. https://doi.org/10.1002/(SICI)1098-237X(199701)81:1<1::AID-SCE1>3.0.CO;2-M

Hynd, C., McWhorter, J., Phares, V., & Suttles, C. (1994). The role of instructional variables in conceptual change in high school physics topics. *Journal of Research in Science Teaching, 31*(9), 933–946. https://doi.org/10.1002/tea.3660310908

International Dyslexia Association. (2020). *Dyslexia basics.* https://dyslexiaida.org/dyslexia-basics/

Kamhi, A., Allen, M., & Catts, H. (2001). The role of the SLP in improving decoding skills. *Seminars in Speech and Language*, *22*(3), 175–185. https://doi.org/10.1055/s-2001-16144

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)

Krimm, H., McDaniel, J. C., Malamud, H., & Schuele, C. M. (2021). *Speech-language pathologists' knowledge of dyslexia* [Poster presentation]. Symposium for Research in Child Language Disorders, Virtual.

Kulhavy, R. W., & Stock, W. A. (1989) Feedback in written instruction: The place of response certitude. *Educational Psychology Review, 1(4)*, 279–308 https://doi.org/10.1007/BF01320096

Landauer, T. K., & Bjork, R. A. (1978). Optimum rehearsal patterns and name learning. In M .M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory* (pp. 625–632). Academic Press.

Maria, K., & Johnson, J. M. (1990). Correcting misconceptions: Effect of type of text. *National Reading Conference Yearbook*, *39*, 329-337.

Maria, K., & MacGinitie, W. (1987). Learning from texts that refute the reader's prior knowledge. *Literacy Research and Instruction*, *26*(4), 222-238. https://doi.org/10.1080/19388078709557912

Marshall, N. (1989). Overcoming problems with incorrect prior knowledge: An instructional study. *National Reading Conference Yearbook*, *38*, 323-330.

Mason, L., & Gava, M. (2007). Effects of epistemological beliefs and learning text structure on conceptual change. In S. Vosniadou, A. Baltas, & X. Vamvakoussi (Eds.), *Reframing the conceptual change approach in learning and instruction* (pp. 165–196). Elsevier Science.

McArthur, G., Hogben, J., Edwards, V., Heath, S., & Mengler, E. (2000). On the "specifics" of specific reading disability and specific language impairment. *Journal of Child Psychology and Psychiatry, 41*(7), 869–874. https://doi.org/10.1111/1469-7610.00674

McDaniel, J. C., Krimm, H., & Schuele, C. M. (2023). Speech-language pathologists' endorsement of speech, language, and literacy myths reveals persistent research-practice gap. *Language, Speech, and Hearing Services in Schools, 54*(2), 550-568. https://doi.org/10.1044/2002_LSHSS-22-00087

Menz, C., Spinath, B., Hendriks, F., & Seifried, E. (2021). Reducing educational psychological misconceptions: How effective are standard lectures, refutation lectures, and instruction in information evaluation strategies? *Scholarship of Teaching and Learning in Psychology*. Advance online publication. https://doi.org/10.1037/stl0000269

Moats, L. (2009). Still wanted: Teachers with knowledge of language. *Journal of Learning Disabilities, 42*(5), 387-391. https://doi.org/10.1177/0022219409338735

Morin, A. (n.d.). *7 common myths about dyslexia.* https://www.understood.org/en/articles/common-myths-about-dyslexia-reading-issues

National Center on Improving Literacy. (2020). *Understanding dyslexia: Myth vs. facts.* http://improvingliteracy.org.

Nelson, N. W. (2010). *Language and literacy disorders: Infancy through adolescence*. Allyn & Bacon.

Nergård-Nilssen, T., & Hulme, C. (2014). Developmental dyslexia in adults: Behavioral manifestations and cognitive correlates. *Dyslexia*, *20,* 191-207. https://doi.org/10.1002/dys.1477

Ness, M. K., & Southall, G. (2010). Preservice teachers' knowledge of and beliefs about dyslexia. *Journal of Reading Education*, *36*(1), 36-43.

Peltier, T. K., Heddy, B. C., & Peltier, C. (2020a). *Dyslexia knowledge questionnaire*. https://doi.org/10.17605 /OSF.IO/8AYVX.

Peltier, T. K., Heddy, B. C., & Peltier, C. (2020b). *Refutation text.* https://doi.org/10.17605/OSF.IO/FBYHT.

Peltier, T. K., Heddy, B. C., & Peltier, C. (2020c). Using conceptual change theory to help preservice teachers understand dyslexia. *Annals of Dyslexia, 70*(1), 62-78. http://dx.doi.org/10.1007/s11881-020-00192-z

Peterson, R. L., & Pennington, B. F. (2015) Developmental dyslexia. *Annual Review of Clinical Psychology, 11,* 283-307. https://doi.org/10.1146/annurev-clinpsy-032814-112842

Pfennings, L., Cohen, L., & van der Ploeg, H. (1995). Preconditions for sensitivity in measuring change: Visual analogue scales compared to rating scales in a Likert format. *Psychological Reports, 77*(2), 475–480. https://doi.org/10.2466/pr0. 1995.77.2.475

Reis, A., Araújo, S., & Morais, I. S. (2020) Reading and reading-related skills in adults with dyslexia from different orthographic systems: A review and meta-analysis. *Annals of Dyslexia, 70,* 339–368. https://doi.org/10.1007/s11881-020-00205-x

Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences, 15*(1), 20-27. https://doi.org/10.1016/j.tics.2010.09.003

Schuele, C. M. (2017). The speech-language pathologist's role in reading and writing: In theory meets in reality. *Perspectives of the ASHA Special Interest Groups, 2*(1), 115–116. https://doi.org/10.1044/persp2.SIG1.115

Schuele, C. M., & Larrivee, L. (2004). What's my job? Differential diagnosis of the speech-language pathologist's role in literacy learning. *Perspectives on Language Learning and Education, 11*(3), 4–7. https://doi.org/10.1044/lle11.3.4

Schroeder, N .L., & Kucera, A. C. (2022). Refutation text facilitates learning: A meta-analysis of between-subjects experiments. *Educational Psychology Review, 34*, 957–987. https://doi.org/10.1007/s10648-021-09656-z

Sinatra, G. M., & Broughton, S. H. (2011). Bridging reading comprehension and conceptual change in science education: The promise of refutation text. *Reading Research Quarterly, 46*(4), 374–393. https://doi.org/10.1002/rrq.005

Snowling, M. J., Hayiou-Thomas, M. E., Nash, H. M., & Hulme, C. (2020). Dyslexia and developmental language disorder: Comorbid disorders with distinct effects on reading comprehension. *Journal of Child Psychology and Psychiatry, 61*(6), 672-680. https://doi.org/10.1111/jcpp.13140

Spencer, S. J., Logel, C., & Davies, P. G. (2016). Stereotype threat. *Annual Review of Psychology, 67*, 415-437. https://doi.org/10.1146/annurev-psych-073115-103235

Spracher, M. M. (2000). Learning about literacy: Speech-language pathologists play key role in reading, writing. *The ASHA Leader, 5*(1), 1-19. https://doi.org/10.1044/leader.SCM.05082000.1

Stanovich, K. E. (2013). *How to think straight about psychology* (10th ed.). Pearson.

Tippett, C. D. (2010). Refutation text in science education: A review of two decades of research. *International Journal of Science & Math Education, 8(*6), 951-970. https://doi.org/10.1007/s10763-010-9203-x

Vellutino, F., Fletcher, J., Snowling, M., & Scanlon, D. (2004). Specific reading disability (dyslexia): What have we learned in the past four decades? *The Association for Child and Adolescent Mental Health, 45*(1), 2-40. https://doi.org/10.1046/j.0021-9630.2003.00305.x

Wadlington, E. M., & Wadlington, P. L. (2005). What educators really believe about dyslexia. *Reading Improvement, 42*(1), 16-33.

Washburn, E. K., Joshi, M. R., & Binks-Cantrell, E. (2011). Are preservice teachers prepared to teach struggling teachers? *Annals of Dyslexia, 61*(1), 21-43. https://doi.org/10.1007/s11881-010-0040-y

Wiseheart, R., & Altmann, L. J. (2018). Spoken sentence production in college students with dyslexia: Working memory and vocabulary effects. *International Journal of Language & Communication Disorders, 53*(2), 355-369. https://doi.org/10.1111/1460-6984.12353