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Editorial Comment

Dr Geetha Shantha Ram, Executive Editor

It is with great pride that we present this special issue of the Asia Pacific Journal of Developmental Differences (APJDD), commemorating a decade of publication under the auspices of the Dyslexia Association of Singapore. As we reach this remarkable milestone, we are delighted to witness the journal's steady growth, it's expanded scope to include a diverse range of developmental differences and its commitment to fostering advancements in both research and practice.

Since its inception, APJDD has been dedicated to addressing major issues related to learning disabilities and developmental differences, providing a platform for scholars, academics, and professionals from around the world to share their insights and findings. Over the years, we have evolved to embrace a broader spectrum of developmental differences, acknowledging the significance of co-morbidities and the need for a holistic approach to supporting individuals with diverse learning needs. This evolution is a direct reflection of the Dyslexia Association of Singapore's revised mission. Key to our journal's success is the invaluable contribution of our esteemed scientific board of reviewers and the international editorial board, comprising eminent academics and professionals. Their expertise and dedication have allowed us to maintain the highest standards of ethics and professionalism in the field, ensuring that we publish cutting-edge research that impacts the lives of individuals with developmental differences positively.

In this 10th-anniversary edition, we are delighted to present seven outstanding articles that exemplify the breadth and depth of research on dyslexia conducted by academics and practitioners in Southeast Asia. These articles not only offer essential insights into the challenges faced by individuals with developmental differences but also propose innovative interventions and support strategies that can bring about tangible improvements in their lives.

Article 1, authored by Beth A. O'Brien, Tan Chee Soon, and Malikka Habib, investigates intervention studies within the field of learning disabilities, focusing on reading difficulties. The study provides critical insights into the challenges faced by teachers in addressing specific sound-symbol associations during interventions.

Article 2, by Fu Yu Kwok, Beth A. O'Brien, Stacey K. H. Tay, Monika Sobczak-Edmans, and Annabel S. H. Chen, explores brain network connectivity during verbal working memory in individuals with dyslexia. The findings shed light on the functional disconnection

between cerebral and sub-cortical regions, offering implications for improved diagnostic approaches and interventions.

Article 3, by Madinah Begum and Sujatha Nair from DAS, delves into bullying experiences among students with special educational needs (SEN) from a parental viewpoint. The study emphasizes the importance of parental and school support in reducing bullying rates among SEN students.

Article 4, by Suthasha Kelly Bijay and Shakthi Bavani d/o Sathiasilan, evaluates the impact of using Raz-Kids interactive electronic books (e-books) in early literacy intervention classrooms. The research highlights the potential benefits of incorporating e-books in improving comprehension skills and reading engagement among struggling readers.

Article 5, by Amrit Kaur Gill, examines the use of drama approaches to enhance communication skills in children with SEN, offering valuable insights for educators and teachers.

Article 6, by Hamadatun Najwa bte Yusuf Wahbi, investigates the challenges faced by English-Malay bilingual learners with dyslexia in acquiring the Malay language. The study suggests strategies for supporting bilingual learners with dyslexia.

Article 7, by Motohide Miyahara, Tessa Pocock, Isabelle Moebs, and Rie Konno, offers a comprehensive synthesis of subjective experiences related to activity and participation in individuals with Developmental Coordination Disorder (DCD)/Dyspraxia. The study underscores the importance of individualized evaluation and increased clinical resources to support activity and participation among individuals with DCD/Dyspraxia.

Each of these articles contributes significantly to the body of knowledge surrounding developmental differences and provides valuable insights for practitioners, educators, and researchers alike. As we continue to publish cutting-edge research, APJDD remains committed to making a positive impact on the lives of individuals with diverse learning needs. We extend our deepest gratitude to all the authors, reviewers, and readers for their invaluable contributions, which have enabled us to maintain the highest standards and advance knowledge in this critical field.

This 10th-anniversary edition celebrates the progress and achievements of the journal and highlights the continued dedication of the Dyslexia Association of Singapore and our esteemed contributors in advancing the understanding and support for individuals with developmental differences. As we look forward to the next decade of publication, we remain steadfast in our commitment to driving positive change and inclusivity in education for all.

ACKNOWLEDGEMENTS:

Before I conclude this introduction, I would be remiss not to express our heartfelt appreciation and gratitude to the Editor-in-Chief, Dr Angela Fawcett, who has been the guiding force behind APJDD since its inception. Dr Fawcett's vision, unwavering dedication, and exceptional leadership have played an instrumental role in shaping the journal into the esteemed publication it is today.

Under Dr Fawcett's stewardship, the journal has flourished, evolving to address a wider spectrum of developmental differences and becoming a beacon for ground-breaking research and insights in the field of education and learning disabilities. Her unwavering commitment to maintaining the highest international standards of ethics and professionalism has ensured that the journal remains a credible and trusted source of knowledge for researchers, practitioners, and educators worldwide.

Dr Fawcett's passion for advancing knowledge in the area of developmental differences has inspired the scientific board of reviewers, the international editorial board, and all contributors to strive for excellence in their work. Her mentorship and support have fostered a collaborative and supportive environment, encouraging researchers and practitioners to share their invaluable expertise and findings, further enriching the journal's content. We are profoundly grateful for Dr Fawcett's tireless efforts and immeasurable contributions to APJDD.

As we celebrate the 10th year of publication, we extend our heartfelt appreciation to Dr Angela Fawcett for her exceptional leadership and guidance, without which this journal would not have achieved the remarkable milestones it has. Her legacy in the field of developmental differences research will continue to resonate for years to come, and we are honoured to have had the privilege of working with her.

Thank you, Dr Angela Fawcett, for your dedication, passion, and unwavering commitment to advancing knowledge and creating a positive impact in the lives of those with developmental differences. Your leadership has been instrumental in shaping the journal's journey, and we look forward to continuing this meaningful endeavour under your guidance.

With utmost respect and gratitude, we would like to extend our sincere thanks to Professor Rod Nicolson for his invaluable contributions to the comments for the Asia Pacific Journal of Developmental Differences (APJDD). Professor Nicolson has been a research partner with Dr Angela Fawcett for nearly 40 years. Their collaboration has had a profound impact on the field of developmental differences. We are immensely grateful for Professor Nicolson's endorsement of APJDD, which has further solidified the journal's standing as a credible and influential publication in the realm of developmental research.

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Response and Non-response to Intervention for Reading Difficulties: What Role do Cognitive Correlates Play?

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Abstract

Within the field of learning disabilities many intervention studies find that treatment resisters remain despite gains in our understanding of best practices and effective treatment for reading development and disability. In this study we examine good vs. poor responders in an intervention study with 147 early primary grade students in a learning support programme. Students were assessed for reading accuracy and fluency after completion of a tablet-based reading intervention, and classified as responders vs. non-responders based on criterion-referenced scores for word reading accuracy and fluency. Differences between the two groups were evaluated for the rate of growth on literacy measures over the intervention phase, their cognitive attributes at pre-intervention, and their in-lesson performance on the tablet-based intervention activities. Findings show the responder group had initial superior performance on decoding and spelling measures, as well as broad abilities related to nonverbal reasoning, working memory, phonological awareness and rapid symbol naming. Further, the gap in performance on decoding and spelling measures increased over time, with the non-responder group showing some improvement in these skills, but to a significantly smaller degree than the responder group. Different approaches to phonics intervention in the study resulted in the same proportion of non-responders. Further, children's confusions with specific sound-symbol associations over the course of the interventions suggest potential challenges that teachers may highlight.

Keywords: reading disorder, learning disorder, treatment non-responders

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With population rates of about 5-15%, learning disorders related to reading account for large numbers of school-going children and a high degree of educational resources for supplemental support services (Wagner et al., 2021). As a result of this pressing demand, considerable research has been conducted over the past decades focusing on the characteristics, etiology and potential learning mechanisms involved in reading disorders (Peterson & Pennington, 2015; Snowling & Hulme, 2021). Although there has been much progress in reading science, contributing to improved approaches to intervention (National Reading Panel, 2000; Abadiano & Turner, 2003), a persistent finding across studies is the existence of treatment resisters, or non-responders. It has been estimated that as many as 30% of students at risk for reading difficulties may not benefit from generally early literacy interventions (Blachman, 1994; Juel, 1994; Torgesen et al., 1992). Students who do not respond to multiple tiers of research-based interventions require further specialized support (Austin et al., 2017).

This study focuses on groups of responders and non-responders from a previous investigation comparing phonics interventions targeting different grainsizes of phonology (phonemes vs. rimes vs. whole words) (O'Brien, Habib, & Onnis, 2019). While that study reported results in terms of the group performance across treatments, here we zero in on the non-responding children across the groups. We aim to find out what characterizes these children, whether certain treatment approaches may be more beneficial for them, and what their online performance looks like during the phonics intervention activities. The treatments utilized a technology-based platform, allowing a unique closer examination of their performance during the intervention phase, in addition to pre- and post-intervention assessments.

Characteristics of Non-responders

Most students can learn to read adequately from quality classroom reading instruction (Torgesen, 2000) or from supplemental small-group or individual reading interventions (Austin et al., 2017; Denton et al., 2006; Denton et al., 2013). However, there is a group of students with intractable reading difficulties. Children who are difficult to remediate scored below typical readers and children who were readily remediated on tests which evaluated phonological skills, suggesting that their persistent reading problems may be caused by phonological deficits (Vellutino et al., 1996).

Researchers have been interested in studying the characteristics of students who do not respond to effective literacy because identifying these characteristics could improve screening measures and selection of the most appropriate students for intensive interventions (Al Otaiba & Fuchs, 2002). Results of a longitudinal study that spanned over two years suggest that non-responsiveness to generally effective interventions may be an indicator of a long-term reading disability (Al Otaiba and Fuchs, 2006). This study found that almost 92% of the students who were non-responsive to reading interventions in kindergarten continued to be non-responsive in first grade. All except one of the non-

responders required an Individualized Education Plan (IEP) with reading goals when they were in third grade.

A review of 23 studies on children who did not benefit from early literacy interventions reported that poor phonological awareness characterized the majority of unresponsive students (Al Otaiba & Fuchs, 2002). Of the 21 studies reviewed that explored phonological awareness, 70% of them found that phonological awareness was related with non-responders. The review also reported other child characteristics which were associated with non-responsiveness to intervention, including phonological memory, rapid naming, general intelligence (IQ), attention, behaviour problems, and orthographic processing. Nelson, Brenner and Gonzalez (2003) extended the review by including an additional seven studies to those reviewed by Al Otaiba and Fuchs in their meta-analytic review. Based on 30 studies, they found that, in order of magnitude, rapid naming, phonological awareness, problem behaviour, alphabetic principle, memory and IQ appeared to predict responsiveness to early literacy interventions. Consistent with the earlier review (Al Otaiba & Fuchs, 2002), Nelson and colleagues found that rapid naming and phonological awareness were more strongly related to responsiveness to interventions than alphabetic principle, memory and IQ. Further converging evidence was provided by a study by Fletcher et al. (2011) which also found that phonological awareness was most related to inadequate response to reading intervention. Rapid naming, syntactic comprehension, working memory and listening comprehension made smaller contributions to the group comparison between adequate and inadequate responders. In a study on the neurocognitive predictors of response to intervention to GraphoGame, a computer- assisted reading intervention, phonological awareness was found to be the strongest predictor of response to the intervention (Wilson et al., 2021). Given the important role phonological awareness appears to play in treatment response, we consider whether it also may be a vital prerequisite for intensive practice with phonics activities in the current study.

Treatment Approaches Using Technology Assisted Reading Instruction

Students with reading difficulties require intensive and explicit instruction in phonological awareness and the alphabetic principle to develop word reading skills (Vellutino, 1991). These students benefit from one-to-one tutoring that can adapt to their individual needs (Cheung & Slavin, 2013). However, it is challenging for schools to provide such individualized practice due to a lack of instructional resources and adequately trained teachers (Torgesen et al., 2010). It has been proposed that computer aided instruction could be part of the solution to helping these students because of its ability to provide highly specialized instruction (Anderson-Inman & Horney, 2007; Stetter & Hughes, 2010) and to allow individualized repetition (Saine et al., 2011).

The findings of studies that investigated the efficacy of computer-assisted reading interventions have been mixed. A large-scale evaluation of five reading software

products found no statistically significant improvement in reading scores from computer-based instruction (Dynarski et al., 2007). Comprehensive models that use computer-assisted instruction did not produce significant positive effects (Cheung & Slavin, 2013). However, when computer-assisted instruction was provided as a supplement, instead of a replacement for teacher-led instruction, students performed significantly better in phonemic awareness, phonemic decoding, reading accuracy, rapid automatic naming and reading comprehension than control-group students (Torgesen et al., 2010). According to Torgesen et al. (2010), computer-assisted instruction that was tightly coordinated to extend knowledge and skills that had initially been taught by teachers is an effective way to provide reading instruction to young readers at risk for learning disabilities.

GraphoGame (later known as GraphoLearn), a computer-assisted reading intervention which uses systematic phonics to train the connections between spoken and written language, was first devised in the Finnish language. It has now been adapted for over 20 languages (Ahmed et al., 2020) but a recent meta-analysis of 19 GraphoGame studies in a range of languages measuring GraphoGame's impact on word-reading outcomes concluded that it was only effective in certain educational contexts, with effect sizes for word reading ranging from - 1.07 to 1.58 (McTigue et al., 2019). A study with Finnish-speaking beginning readers showed that those who received computer-assisted reading intervention using the GraphoGame program made significant gains in letter knowledge, decoding, accuracy, reading fluency and spelling (Saine et al., 2011). This could be because it is programmed to adapt task difficulty according to student performance. Also, students may find the game-like learning environment provided by GraphoGame to be a fun way to learn and may be more willing to practice (Saine et al., 2011). GraphoGame was subsequently extended to German and different versions were used with Austrian second and fourth graders and prereading students in Switzerland (Brem et al., 2010; Huemer et al., 2008). The Austrian students showed improvement in reading accuracy (Huemer et al., 2008) and the students in Switzerland made significant improvement in letter knowledge (Brem et al., 2010). An English version of GraphoGame was subsequently developed and its efficacy was demonstrated as a supplementary program for second graders who were identified as poor readers in the UK (Kyle et al., 2013). The experimental group made significant improvement in reading, spelling and phonological skills in comparison to the control group. Subsequently, a large-scale randomized controlled trial study of GraphoGame Rime was conducted in the UK (Worth et al., 2018). The study did not yield evidence that the intervention resulted in improved reading outcomes over business-as-usual instruction. However, the sample was reanalysed by Ahmed et al. (2020) for the "top half " of GraphoGame Rime players only (designated adequate responders). When this group of students were compared with the full sample of control students, significant gains were made on a nonword measure by those who received the GraphoGame intervention compared to those in the business-as-usual group.

GraphoGame has also been found to be effective in improving foundational literacy among English Language Learners (ELLs). When the English version of GraphoGame was used with first and second grade English ELLs, in India (Patel et al., 2021), students in the experimental group showed significantly greater and faster development on in-game assessments of letter-sound knowledge, rime unit recognition, and word recognition compared to those in the control group.

While educational computer games can greatly increase the amount of exposure and practice that struggling learners have with the content to be learned (Aravena et al., 2013) (in this case grapheme-to-phoneme correspondences), the use of such technology-based interventions have not been examined from the perspective of treatment responders and non-responders. The current study aims to fill this gap, by conducting an examination of students who responded to a pull-out learning support program coupled with experimental technology-based applications that supplemented the program. Contrasting these responders to students who did not respond will provide valuable information about how to predict which children may require different types or degrees of intervention. Also, findings may help educators to develop interventions that are targeted to specific needs of individual students.

Thus, the objectives of the current study are:

1. To compare the rate of growth on literacy measures between responders and non-responders
2. To identify the role played by cognitive correlates in student response to reading interventions
3. To investigate whether a specific intervention approach yields more responders
4. To identify problematic areas of learning revealed by performance on the technology-based activities

METHOD

Participants

The participants include 148 students (M = 6.75 years old) in Singapore public schools (136 in primary grade 1 and 12 in primary grade 2) who were identified as at risk for reading difficulties at primary school entry and who were enrolled in a learning support programme within their school. They further received supplementary experimental interventions in a randomized-controlled design, contrasting three approaches, described below and in O'Brien, Habib, & Onnis, (2019). Random assignment to treatment groups was conducted with matched sets of students based on baseline measures of reading ability, to ensure that the groups did not differ in overall ability.

Responder/Non-responder Classification

Subsequently for this study, participants were categorized as treatment responders and non-responders based on their pretest and post-test scores on two measures: (1) word reading accuracy (Woodcock Johnson Test of Achievement 3rd Edition, WJIII) and (2) word reading fluency (Test of Word Reading Efficiency, TOWRE-2). WJIII word reading scores were converted to grade equivalents based on the published manual. A non-responder was defined as a child whose pretest and post-test scores were below their grade level; a responder was defined as a child who scored below grade level at pretest, but who achieved a score at or above their grade level on the post-test. TOWRE-2 sight word reading scores were converted to standardized scores (z) based on locally developed norms (Chen et al., 2016). Children who scored 1 standard deviation (z=–1) or more below the mean for their age-group on both pretest and post-test assessments were defined as non-responders. Children who scored 1 standard deviation or more below the mean at pretest, but within 0.5 standard deviation of the mean (z=–0.5 or above) at post-test were defined as responders. The final classification was determined as such: Responders included children who were defined as a responder with either (1) or (2); if the child did not respond to either (1) or (2) then they were included in the non-responders group. From this process we found 77 responders and 66 non-responders in this study, 133 in grade 1, and 10 in grade 2. (71 responders, 45 non-responders according to reading accuracy criterion (1); and 33 responders, 76 non-responders according to reading fluency criterion (2)).

Measures

Baseline Assessments

Reading ability was assessed with the British Ability Scales – Third Edition (BAS-III, Elliot & Smith, 2012) word reading task. Words are presented in order of increasing difficulty, and test administration is discontinued after a given number of errors (8 out of 10).
Nonverbal cognitive ability was assessed with the Matrices and Quantitative reasoning subtests of the BAS-III (Elliot & Smith, 2012). Matrices involves choosing from a set of 4-6 pictures the correct one that completes a matrix of figures (e.g., shapes). Administration is discontinued after 3 consecutive trials with errors. Quantitative reasoning involves completing a sequence of numbers according to the relationship between a given pair of numbers shown. Test administration is discontinued after 3 consecutive trials with errors.

Working memory was assessed with the Memory for Digits subtest of the Comprehensive Test of Phonological Processing (CTOPP-2; Wagner et al., 2013). For this task, one repeats a series of digits in reverse order. The span of the series increases over trials, and administration is discontinued after three consecutive errors.

Implicit learning was assessed with a visual statistical learning task adapted from Arciuli &

Simpson (2011) and Raviv & Arnon (2018). First, during a training phase, a series of cartoon aliens are presented (via a tablet) with an embedded sequence of 4 triplets. During this phase, the cover task is to pay attention and press a button when an alien is repeated. After training, a 2 alternative-forced choice task is presented where one identifies which triplet of aliens was seen together previously, and total correct response out of 32 trials is recorded.

Vocabulary was assessed as a measure of language proficiency with a receptive task (BLAB; Rickard Liow & Sze, 2009) where the child chooses which image out of 4 matches the meaning of an aurally presented word. All 80 items are administered.

Rapid symbol naming was assessed with the CTOPP-2 RAN Letters subtest (Wagner et al., 2013). This task involves naming all the symbols presented on a printed card in 4 rows by 8 columns. The time to complete all items is recorded, along with errors.

Phonological awareness was assessed with the CTOPP-2 Elision subtest (Wagner et al., 2013). For this task, an aurally presented word is repeated, then the child is asked to say the word after deleting a designated part (e.g., syllable, onset, phoneme). Corrective feedback is given for the first ten items, and administration is discontinued after 3 consecutive errors.

Orthographic awareness was assessed with measures of orthographic choice and wordlikeness choice (Cunningham et al., 2001). Orthographic choice involves selecting the correctly spelled word in a pair of similar sounding word-pseudowords (e.g., rain-rane). All 23 trials are administered. The wordlikeness task involves selecting which of two pseudowords looks more like a real word (e.g., beff-ffeb). All 19 trials were administered.

Pretest and Post-test Assessments for Responder Classification

As noted above, classification into responder and non-responder groups was made with scores on the following tests.

Reading Accuracy was evaluated with the Woodcock-Johnson III word reading subtest (WJIII, Woodcock et al., 2007). The student reads aloud printed words, and administration is discontinued after six incorrect responses. The total number correct is tallied, and these scores are converted to grade equivalents based on the published norms (Woodcock et al., 2007).

Reading Fluency was assessed with the Test of Word Reading Efficiency (TOWRE-2, Torgesen et al., 2012) sight word subtest. After practice trials, the student read as many words as possible within a 45 sec time limit. The total number correct within the time limit was converted to z-scores based on a local normative sample (Chen et al., 2016).

Repeated Measures Literacy Assessments

Children were evaluated at four time points: before the intervention (pretest), at the midpoint during the intervention (after the first 7 weeks – mid-test), immediately after the intervention (post-test), and three months after the commencement of the intervention (follow-up).

Decoding accuracy was assessed with the WJIII (Woodcock et al., 2007) Word attack subtest. The student reads pseudowords aloud, and administration is discontinued after six incorrect responses. The total number correct per is tallied.

Decoding fluency was assessed with the TOWRE-2 (Torgesen et al., 2012) Phonemic decoding subtest. After the practice trial, the student reads as many pseudowords as possible within a 45 second time limit. The total number correct is scored within the time limit.

Spelling was assessed with a word list based on the BAS-III (Elliot & Smith, 2012), with additional items including morphologically and orthographically challenging words. Words were dictated, read in a sentence, and repeated. The first ten items were administered, then administration was discontinued after eight errors in the second block of trials. Total correctly spelled words were taken as the final score.

Experimental Intervention Conditions

Children took part in supplementary interventions during their learning support classes. The interventions involved gamelike activities rendered on iPad tablets, and children worked individually on their own iPad while listening to instructions and feedback through earphones. The intervention lessons involved 10 minutes of play 5 times per week over two 7 week periods during the second and third school terms (February to October). Matched sets of 3 children with regard to their baseline reading ability (BAS-III) were randomly assigned to one of the three intervention conditions: Phonics-phoneme, Phonics-rime, or Word-level approaches. Each condition focused attention in the activities to a different grainsize for learning sound-symbol relationships for reading English – from individual phonemes, to rime patterns, to whole words (refer to O'Brien, Habib, & Onnis, 2019).

The ***Phonics-phoneme condition*** involved 7 weeks of activities with Seeword reading (Seward et al., 2014; O'Brien, Seward, & Zhang, 2022a), and 7 weeks with GraphoLearn-Phoneme activities (Lyytinen et al., 2004; Saine et al., 2011).

The ***Phonics-rime condition*** involved 7 weeks of activities with Seeword reading (Seward et al., 2014; O'Brien, Seward, & Zhang, 2022a), and 7 weeks with GraphoLearn-Rime activities (Lyytinen et al., 2004; Saine et al., 2011).

The ***Word-level intervention*** emphasized decoding whole words through a different activity/game each day in the week (O'Brien & Yeo, 2022b). Children were asked to tap pictures that match a printed word in meaning, including single or multiple matching of words to pictures, and flash cards, where they read aloud and recorded their responses. In later weeks, activities included a choice task to match phrases to pictured meanings or building sentences from a word bank.

DATA ANALYSIS

The groups of identified responders and non-responders, across all the intervention conditions, were compared on different assessments to address the research questions. First, to examine group differences in growth in literacy across the intervention, between group repeated measures MANOVAs are performed on dependent measures of decoding accuracy, decoding fluency, and spelling across four timepoints (pretest, mid–treatment, post-test, and follow-up). Due to missing data of selected tests (e.g., due to child absences) each dependent measure was run in a separate MANOVA to maximize sample size. Child age was covaried in each analysis.

Second, to examine group differences in cognitive attributes, a between-group profile analysis is conducted with cognitive measures (nonverbal reasoning, working memory, implicit learning), language (vocabulary), and literacy related measures (phonological awareness, rapid naming, orthographic awareness). To identify the attribute or attributes that best predict responder/non-responder status, logistic regression analysis is also run with stepwise sets of the cognitive, language, and literacy predictors.

Third, to examine which intervention approach might yield more treatment responders, a chi-square test is conducted, comparing proportions of responders and non-responders across the three experimental intervention conditions (Phonics-phoneme, Phonics-rime, and Word-level conditions).

Finally, an examination of data collected during the in-lesson activities of the Grapholearn program for the phonics intervention conditions serves as a more fine-grained analysis of responder/non-responder differences. In this case, using confusion matrices of sound-symbol correspondences, we dissect particular points of confusion that may characterize the non-responder group.

RESULTS

Research Question 1

Data from the responder and non-responder groups (across all the intervention conditions) were submitted to 2 (between group) by 4 (repeated measures over time) mixed MANOVAs, with age covaried. First, the MANOVA for decoding accuracy (word

attack) revealed a significant Group X Time interaction, $F_{(2.2, 282.7)} = 10.78$, $p < .001$, $\eta 2 = 0.079$. There were 55 non-responders and 74 responders with full data for this analysis. As shown in Figure 1a, the groups showed an initial difference in word attack scores at pre-test, and this gap widened over time, through to the follow-up point. Post-hoc pairwise comparisons revealed that the groups differed significantly at each time point (with Bonferroni adjustment, all p's < 0.001), with the responder group consistently outperforming the non-responder group. Further, while simple effects analysis showed that each group improved performance over time, the responder group showed a larger effect over time than the non-responder group ($F_{(3, 124)} = 82.77$, $p < 0.001$, $\eta 2 = 0.667$, $F_{(3, 124)} = 20.87$, $p < 0.001$, $\eta 2 = 0.336$, respectively).

The MANOVA for decoding fluency also revealed a Group X Time interaction that was significant, $F_{(2,231)} = 17.61$, $p < .001$, $\eta 2 = 0.13$. There were 49 non-responders and 70 responders with full data for this analysis. Similar to decoding accuracy, the groups showed an initial difference while the responder group showed stronger growth over time (Figure 1b). The responder group performed significantly better at each time point according to post-hoc pairwise comparisons (with Bonferroni adjustment, all p's < 0.001). Simple effects analysis also showed that responder group had a larger improvement over time than the non-responder group ($F_{(3, 114)} = 97.12$, $p < 0.001$, $\eta 2 = 0.719$, $F_{(3, 114)} = 16.92$, $p < 0.001$, $\eta 2 = 0.308$, respectively).

Finally, comparing the groups on spelling performance, the MANOVA for spelling scores showed a significant Group X Time interaction, $F_{(2.1, 227.4)} = 52.21$, $p < .001$, $\eta 2 = 0.320$. There were 47 non-responders and 67 responders with full data for this analysis. The initially small advantage of responders at pre-test was expanded over time, with bigger gains in spelling for the treatment responders (Figure 1c). Responders outperformed non-responders at each time point (all p's < 0.001 with Bonferroni adjustment). Simple effects analysis also revealed a larger improvement over time for the responder group compared to the non-responder group ($F_{(3, 109)} = 214.16$, $p < 0.001$, $\eta 2 = 0.855$, $F_{(3, 109)} = 27.74$, $p < 0.001$, $\eta 2 = 0.433$, respectively).

Thus, the responder group showed broad increased literacy gains across all three of the literacy measures, decoding accuracy, decoding fluency, and spelling, as compared to the non-responder group. In addition, it can be seen that this group started out at the pre-intervention test point, with better scores than the non-responder group. This initial gap between the groups increased over time for each literacy measure.

Research Question 2

Examining group differences on cognitive attributes between the responder and non-responder groups (54 non-responders, 62 responders across all the intervention conditions), a profile analysis showed that the groups differed in the pattern of their scores across these variables, $F_{(1, 114)} = 17.35$, $p < .001$. Univariate between-group effects

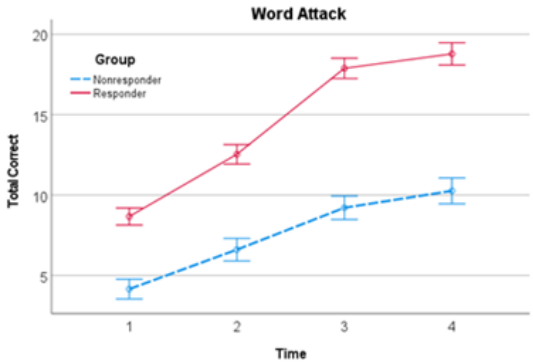

Figure 1a.

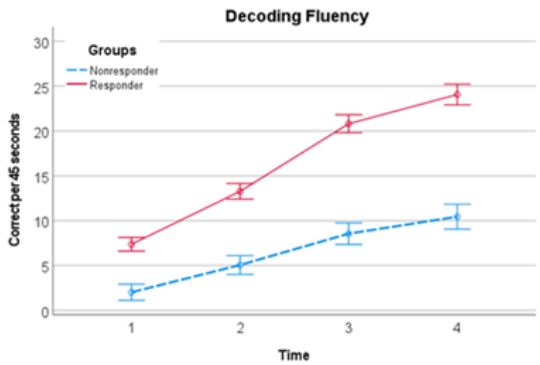

Figure 1b.

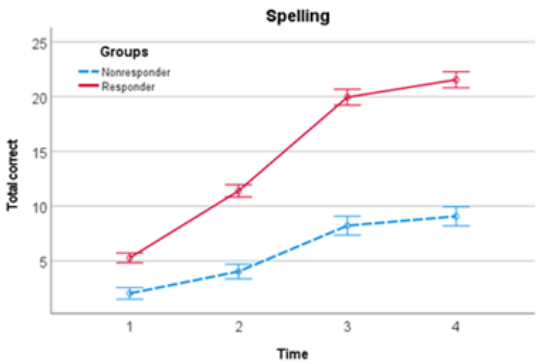

Figure 1c.

Figure 1. Performance by Responder group (solid line) and Non-responder group (dashed line) over time (1- pretest, 2- mid-test, 3- post-test, 4- follow-up) for decoding accuracy (a), decoding fluency (b), and spelling (c).

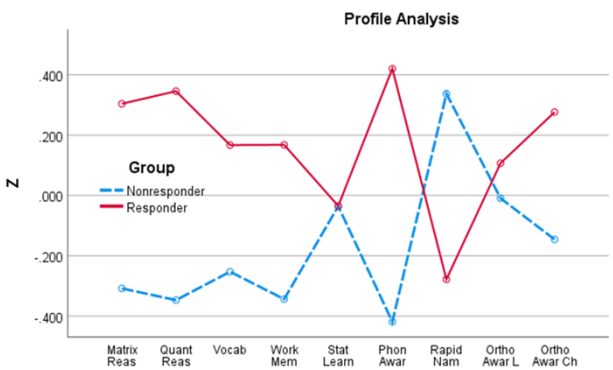

Figure 2. Mean performance (z-scores) per Responder (solid line) and Non-responder groups (dashed line) across cognitive, language and literacy measures. Nonverbal measures (BAS-III Matrix Reasoning, Quantitative Reasoning), vocabulary (BLAB), verbal memory (CTOPP-2 Memory for Digits), statistical learning, phonological awareness (CTOPP-2, Elision), rapid naming (CTOPP-2 RAN letters), and orthographic awareness (wordlikeness, orthographic choice).

were examined (using $\alpha = 0.0056$ with Bonferroni correction), and revealed that there were significant between group differences for cognitive assessments of nonverbal matrix reasoning, $F_{(1, 114)} = 11.96$, $p < .001$, nonverbal quantitative reasoning, $F_{(1, 114)} = 14.88$, $p < .001$, and working memory, $F_{(1, 114)} = 8.46$, $p = .004$, while the groups did not differ for statistical learning. In terms of the literacy measures, the groups also differed significantly in phonological awareness, $F_{(1, 114)} = 23.60$, $p < .001$, and rapid naming, $F_{(1, 114)} = 9.81$, $p = .002$. Group differences did not reach significance for orthographic choice and word-likeness measures, nor for English receptive vocabulary (p's > .005). As shown in Figure 2, in each case of the group differences, the responder group showed stronger skills at baseline.

To further examine the relative contribution of these sets of competencies to differences in responder and non-responder groups, a logistic regression was conducted next, with children's responder/non-responder status as the dependent variable. The predictors were entered in blocks as follows: (1) nonverbal reasoning (quantitative and matrix reasoning), (2) verbal proficiency (English vocabulary), (3) memory (working memory, implicit memory-statistical learning), and (4) pre-literacy (phonological awareness, rapid naming, orthographic awareness – word likeness, orthographic choice). In the first block, adding nonverbal reasoning, improved the fit over the null model with intercept-only, $\chi 2 (8) = 18.84$, $p = 0.016$. In this model the sensitivity (true positive rate of correctly identifying non-responder status) was 55.6 percent, while the specificity (true negative rate of correctly identifying responder status) was 75.8 percent. Adding verbal proficiency (vocabulary) in the second block did not improve model fit, $\chi 2(8) = 14.99$, $p = 0.059$, nor did the addition of memory (working memory, statistical learning) in the third

Table 1. Logistic regression predicting Responder/Non-responder group status

Final Model Entered Variables	step	B	S.E.	Wald	df	Sig.	Odds ratio	CI Lower	CI Upper
Matrix Reas	1	-0.010	0.064	0.022	1	0.882	0.990	0.873	1.124
Quant Reas	1	0.098	0.082	1.448	1	0.229	1.103	0.940	1.295
Vocab	2	0.011	0.024	0.203	1	0.652	1.011	0.964	1.060
Work Mem	3	0.023	0.049	0.217	1	0.641	1.023	0.930	1.125
Stat Learn	3	0.008	0.063	0.017	1	0.896	1.008	0.891	1.141
Phon Awar	4	0.112	0.058	3.796	1	0.051	1.119	0.999	1.252
Rapid Nam	4	-0.056	0.024	5.370	1	0.020	0.946	0.902	0.991
Ortho Awar L	4	0.025	0.120	0.042	1	0.837	1.025	0.810	1.297
Ortho Awar Ch	4	0.060	0.067	0.819	1	0.365	1.062	0.932	1.210

block, $\chi 2(8) = 6.59$, $p = 0.582$. With all variables in the first three blocks, sensitivity improved (63%) but specificity declined (72.6%). The final block, including pre-literacy variables (phonological awareness, rapid naming, and orthographic awareness) marginally improved the model fit, $\chi 2(8) = 15.39$, $p = 0.52$, but this model improved both the sensitivity rate (64.1%) and the specificity rate (80.6%). Of all the variables in the full model, only rapid naming contributed significantly to the group prediction of responders vs. non-responders ($p = .020$), while there was a trend for phonological awareness ($p = .051$). Parameters for the final model are shown in Table 1.

Thus, in spite of the groups differing in a range of skills, including the cognitive, verbal, and memory skills, it is the pre-literacy skills that best predicted response to intervention in this sample of children with reading disorders – and specifically, the two best predictors that are widely recognized in the literature on reading disorders for English.

Research Question 3

To see whether any of the three interventions in this RCT study resulted in better response to intervention, a Pearson chi-square was conducted comparing responder to non-responder ratios across the three intervention conditions. There was no significant difference in incidence of responders relative to non-responders across the three experimental intervention conditions, $\chi 2(2) = 0.061$, $p = 0.970$ (see Figure 3). This means that there was no particular advantage for any of the interventions over the others in terms of addressing non-responders more effectively.

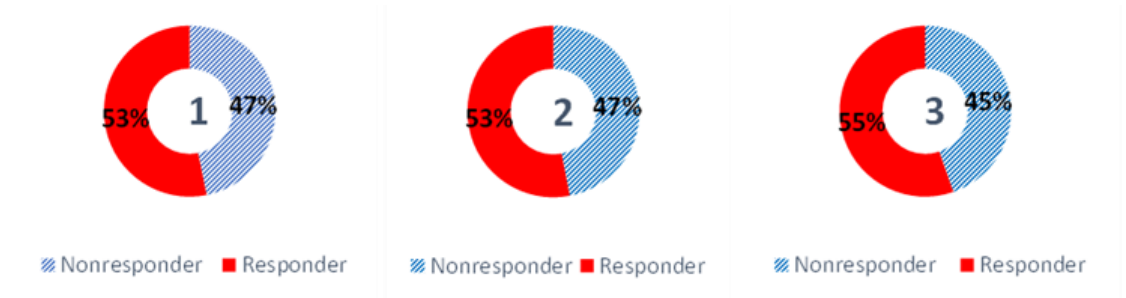

Figure 3. Percent Responders and Non-responders per intervention condition.
Condition 1 – Phonics-Phoneme, Condition 2 – Phonics-Rime, Condition 3 – Word-level interventions.
Responders (overall N= 77), Non-responders (overall N= 66).

Research Question 4

Examining differences of non-responders compared to responders at a finer timescale, the data from their online performance of the activities across the Grapholearn lessons was examined for the two phonics intervention groups. There were 26 responders and 23 non-responders in the Phonics-Rime condition, and 25 responders and 22 non-responders in the Phonics-Phoneme condition.

First, for each intervention group, letter-confusion matrices were generated over the completed set of activities that were derived across all the participants. These matrices are shown in Figures 4a and 4b, and display the level of confusions (percent) for each pairing of the correct letter representing an aurally presented phoneme ("target", y-axis) with "distractor letters" (x-axis). Shading represents the degree of confusion, with darker cells showing higher levels of confusion. Confusions exceeding 10% are marked with symbols.

Of interest, across both intervention conditions there are similar confusion types. As seen in Figures 4a and 4b, /ɛ/ ('e') is strongly confused with the letter 'a'.

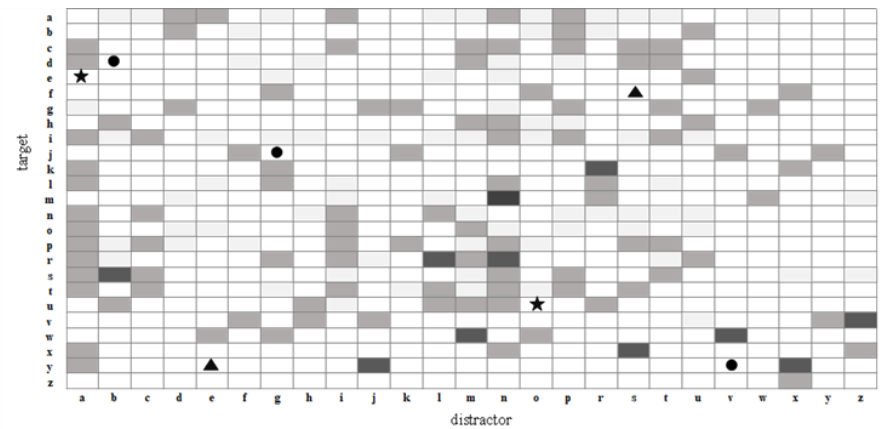

Figure 4a.

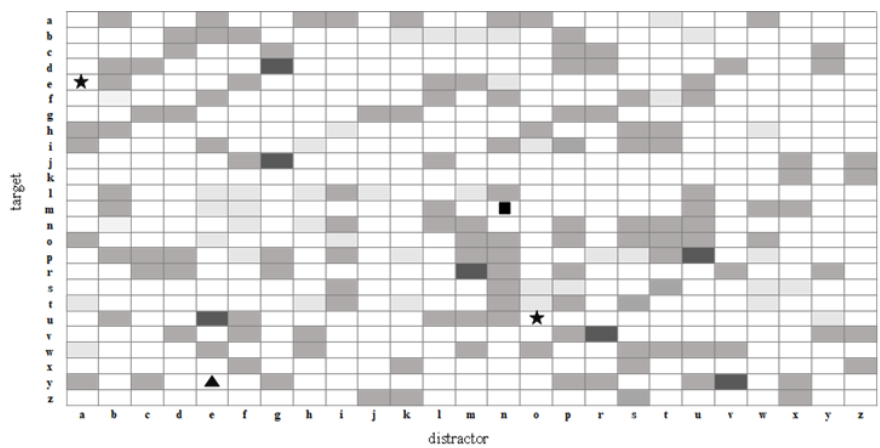

Figure 4b.

Figure 4. Confusion Matrix across all students in Phonics-rime condition (a) and in the Phonics-phoneme condition (b). Darker colours indicate more confusion. Confusions exceeding 10% are marked with symbols. There are two main categories of letters' similarity: phonetic similarity (marked with a "star") and visual similarity (marked with a "circle). It is also possible that both (marked with a "square") or neither categories are occurring (marked with a "triangle").

This can be concluded to be the most challenging sound-letter pair for the students, plausibly because both acoustic and visual similarity compromise building the connection. Also the vowel /ʊ/ ('u') is often mixed-up with the letter 'o'. The children also showed difficulties in mapping /dʒ/ with 'j' rather than the target 'g'. Other notable confusions involve the target for /f / ('f') confused with 's', and 'd'-'b' confusions in the Phonics-rime group and 'm'-'n' confusions in the Phonics-phoneme group.

Examining these high occurrence confusions further, we tallied the number of confusions made per responder/non-responder group within the Phonics intervention conditions (Rime, Phoneme). These breakdowns are shown in Figures 5 a, b and c for the letter confusions in student responses noted above. For e-a (Figure 5a) and u-o letter confusions (Figure 5b), trials involving matching isolated phonemes to single letters appear on the left bars, while trials involving matching the phoneme within rime patterns are shown in the middle bars.

Finally, errors related to incorrect vowel pairs are shown in the bars on the right. Most e-a confusions occurred on trials where the /ɛ/ is presented within rimes (middle bars) for both responders and non-responders, although a sizable number of these confusion errors also occurred when /ɛ/ was presented as an isolated phoneme to match to its letter (left bars).

For u-o confusions (Figure 5b) the isolated presentation of /ʊ/ presented the biggest challenge for the non-responders in both intervention conditions. These non-responders were less affected when /ʊ/ was presented in the context of a rime pattern (lesser confusions), and the non-responders in the Phonics-Rime condition were even less affected by the u-o confusion in this case (middle bar, black segment). The non-responder group was affected to a similar degree by the vowel pair representations of this phoneme (e.g., 'ou' as in a rime pattern), whereas the responder group was less so (right bars).

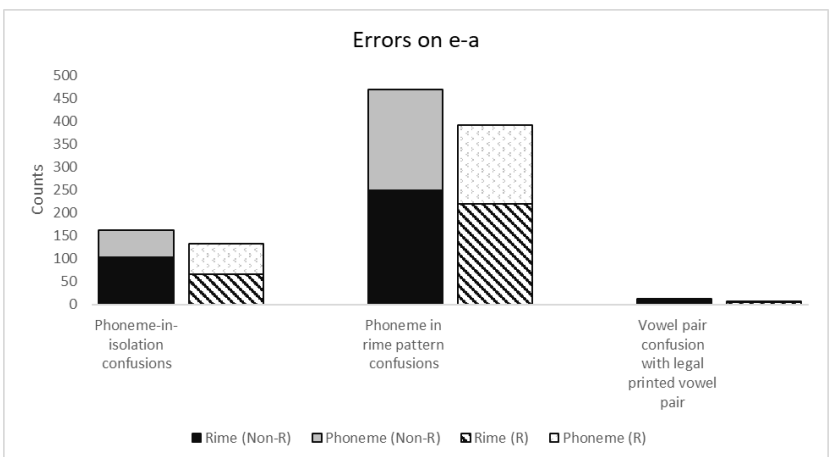

Figure 5a.

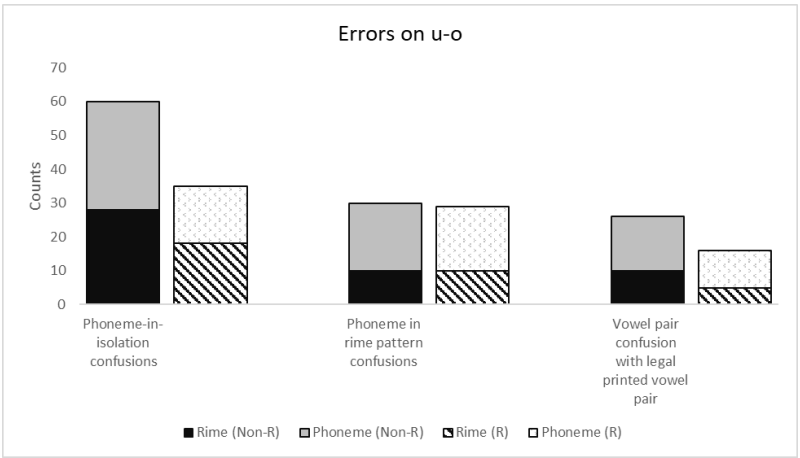

Figure 5b.

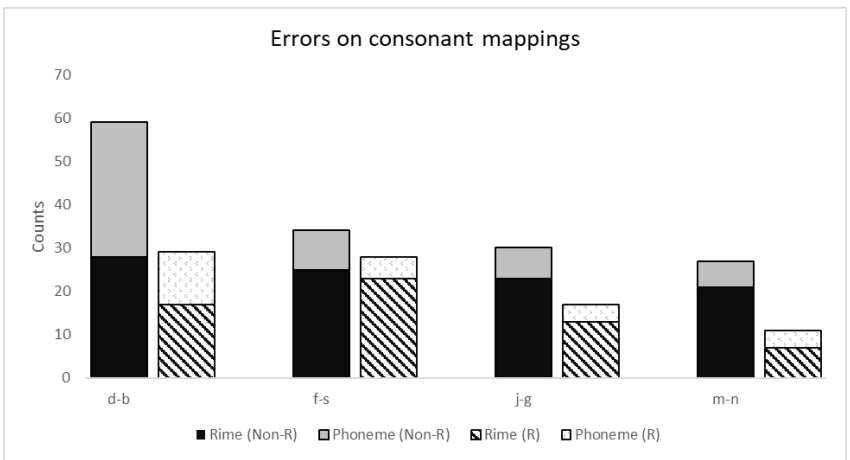

Figure 5c.

Figure 5. Total number of confusions by non-responders (solid bars) and responders (patterned bars), split by intervention conditions (Phonics-Rime – dark, Phonics-Phoneme – light). (a) Left bars show errors made on single sound-letter mapping, middle bars errors are on /u/ occurring within rime patterns (uck-ock, ug-og), and right bars are errors of target vowel pairs (ou) within rime patterns (oun -uon, ouse-uuse, ould-uold). (b) Left bars show errors made on single sound-letter mapping, middle bars errors are on /e/ occurring within rime patterns (et-at, ep-ap), and right bars are errors of target vowel pairs (ee) within rime patterns (eed-aad, een-aan). (c) Total number of confusions between consonant targets and distractors. Target sounds were presented in isolation.

Finally, for the confusions of consonants (Figure 5c), those in the Phonics-Rime condition had more difficulties in each case with mapping the correct letter to the aural sound when the phoneme was given in isolation. Compared to the responders, the non-responders made more of these errors, and this difference was most exaggerated in the d-b confusion (left bar), and secondly in the f-s confusion, followed by the m-n and j-g confusions (right bars).

DISCUSSION

This study examined the performance of students who received a pull-out learning support program that was supplemented with experimental technology-based applications. The interventions focused on either the phoneme, rime or whole word unit. It compared the rate of growth on literacy measures between good treatment responders and poor treatment responders and identified the difference on cognitive attributes between the two groups.

In the current study, the responder group initially started with a wide range of skills that were more advanced than the non-responder group. These included nonverbal reasoning, short term memory, phonological awareness and rapid naming. This group also started with relatively better decoding accuracy and fluency and spelling. These findings are consistent with earlier studies on responsiveness to intervention that reported that when compared with non-responders, responders were characterized by initial superior performance on rapid naming, phonological awareness, memory (Al Otaiba & Fuchs, 2002; Fletcher et al., 2011; Nelson et al., 2003). This is also in line with the study on GraphoGame by Wilson et al. (2021) which found that existing phoneme awareness skill is predictive of response to the computer-assisted reading intervention.

Another finding of this study was that the gap between the responders and the non-responders increased over time on measures on decoding accuracy and fluency and spelling. A review of various studies that investigated the effect of intervention on rate of growth in reading reported a mean effect size (ES) for reading measures ranging between .45 to .79 for treatment versus control conditions (Swanson & Hoskyn, 1998) and .82 to .95 for single-case design studies (Swanson & Sachse-Lee, 2000), in favour of children who were not at risk. In another synthesis, the magnitude of ES between responders and non-responders increased from 1.10 on the pretest to 1.28 on the post test on a word attack measure (Tran et al., 2011). These results provide support to the concept of a Matthew Effect which states that children with initially high levels of achievement should show a higher rate of progress in academic learning compared to children attending school with normal or low levels of initial achievement (Walberg & Tsai, 1983). The Matthew Effect was first applied to reading development by Stanovich (1986) who hypothesized that children who enter school with markedly underdeveloped phonological awareness have difficulty understanding the alphabetic principle and experience delays in breaking of the grapheme-to-phoneme code. Given the fact that pre-literacy skills (phonological awareness and rapid naming) skills are predictors of responsiveness to intervention in this study, it is important that children with reading difficulties be identified early and receive intervention with foundational skills even before they are exposed to formal reading instruction (Vellutino et al., 1996).

The different conditions of the supplemental technology-based interventions yielded the same proportion of responders, suggesting no advantage of focusing at a grainsize of

phoneme, rime or whole word units in terms of reducing non-responder rates. Besides considering pre-to-postest assessments, in terms of responder status, we were also able to examine data downloaded during the Grapholearn interventions for students who played these activities (Phonics-phoneme, Phonics-rime groups). This revealed the types of confusions that students tended to make in terms of the phoneme-grapheme mappings they were learning. It appears some of these confusions may be sound-based (e.g., matching single phonemes-with-letters that represent similar sounds). Additional confusions appear to be more print-based (such as orthographic errors related to selecting illegal vowel pairs, e.g., oun-uon, ouse-uuse, ould-uold, eed-aad, een-aan).

The difficulties faced by students in both Phonics-phoneme and Phonics-rime conditions in confusing the vowel 'a' with 'e' is not surprising as the conflation of /e/ and /æ/ by speakers of Singapore English has been reported by a study by Deterding (2003). The lack of distinction between the vowel sounds /ɒ/ and /ʌ/ that was observed in both groups could be because these two vowels are often produced with almost the same quality and are differed mainly in terms of length (Deterding, 1997). In Singapore English, the lack of distinction between the long and short vowel pairs has been well-documented (Bao, 1998; Brown, 1988; Deterding & Poedjosoedarmo, 1998; Low & Brown, 2005). Another noteworthy confusion between commonly mixed letters 'f' and 's' may be related to letter f sometimes being pronounced phonetically as /fer/ in the Singapore context.

Further, the confusion between consonant letters (d-b, m-n, j-g) among students in the study provides evidence to support the letter-confusability hypothesis, which states that if the letter is visually confusable, students may have more difficulty identifying the lower-case letter correctly (Huang & Invernizzi, 2014). Some researchers have suggested that visual confusability of the letter is a major factor determining children's ability to recognize lower case letter successfully (Treiman & Kessler, 2003; Treiman et al., 2006).

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

It is important to consider several limitations in this study. Firstly, with regard to intervention intensity, the total duration of the intervention was limited. Each student spent less than 12 hours in total on the games (10 minutes of play 5 times per week over two 7-week periods). A study with a longer duration that allows students to complete all 25 streams in the game would increase the likelihood that the students would have learned the phonics "rules" of English, and in this way would more accurately assess the predictors of response to the intervention. In addition, the interventions in this study were given as a supplement to the pull-out reading instruction in the school, following earlier findings of successful computer-assisted instruction provided as a supplement to teacher-led instruction (e.g., Torgesen et al., 2010). However, the role of teachers in computer-assisted intervention needs further investigation. The students in this study played the tablet-based games relatively independently with minimal support from their teachers. Yet studies with high adult interaction produced an average positive effect size (g = 0.48)

(McTigue et al., 2019), suggesting higher levels of active engagement may be needed even with supplementary game-based learning. Indeed, one challenge with the adaptive Grapholearn game was that some students took more attempts to master the different levels. Calibrating task difficulty and cognitive load may be necessary to maintain student engagement, and teachers likely play a more effective role in this than the computer algorithm. Future research could consider ways teachers can monitor the data of their students' progress and how teachers would use this data to adapt an individual student's learning plan on such platforms as Grapholearn. Further, while computer-administered instruction allows children to recognize items presented aurally, there is little feedback to students regarding their pronunciation of the letter sounds or words. Teachers would play a very important role in providing this feedback.

Secondly, as a re-examination of treatment response to different intervention conditions, the treatment by responder-status subgroups here were too small to test for interaction effects. There did not appear to be any pattern suggesting that the confusion errors by Phonics-phoneme and Phonics-rime groups differ by responder status, as it was noted in the previous study with these children (O'Brien, Habib, & Onnis, 2019) that treatment group effects for confusion errors might be moderated by individual learner differences. Here there was only a main effect, whereby both responders and non-responders appear to show that the Phonics-rime intervention accounted for more of the confusion errors overall (the dark segments in the bar plots, Figures 5a-c), with a few exceptions where the Phonics-phoneme intervention showed equal or more error rates (u-o, d-b). Thus, further study with larger subsamples is needed to conclusively understand the relation of individual differences and treatment approach to confusion types. The current study has also shown that letter confusion may be dependent on the context as the errors made by students may be influenced by oral language used around them. Hence, it would be necessary for further research to investigate how a computer-assisted reading intervention can be adapted to different linguistic contexts to enhance its effectiveness.

IMPLICATIONS

This study found that vocabulary was not a predictor of whether a student would be able to progress through the Grapholearn game, consistent with the finding by Wilson et al. (2021). This suggests that students with limited vocabulary can benefit from this type of game-based intervention. However, phonological awareness and rapid naming were the most important predictors of response to the intervention. This reinforces the importance of these two early predictors of reading success, and also suggests that initial work on foundational phonological skills may be required to prepare children before game-based learning.

This study also points to an important role for teachers in the administration of supplemental, game-based intervention programs. In harnessing the potential of

computer-based interventions for individualized learning, teachers are best positioned to effectively integrate such interventions into their instruction so as to ensure that there is alignment between what is learned in the computer-based intervention and what is instructed in the classroom (Muralidharan et al., 2019). Teachers can also learn how they can interpret the progress monitoring data generated by such intervention programs, and provide individualized instruction while giving feedback to struggling students. They may also use the data gathered by the programs to identify and address common problematic confusions faced by students.

CONCLUSION

Non-responder groups, as in the current study, present a puzzle in reading intervention research. Following previous findings, the current non-responder group showed initially poor literacy skills, phonological awareness and rapid naming, along with weaker skills in verbal memory. This may dampen their progress after intensive intervention. Beyond simply extended practice, these students may need closer guidance in the type of practice employed, including by technology-based literacy apps. Considering the weaker skills that the non-responder group had at baseline, they may require practice that involves a lesser cognitive load. For example, in the adaptive games employed in the Grapholearn app, children advanced to more challenging trials and content once they mastered the previous level (at 80% correct performance). More difficult trials included selecting amongst more distractor letters to map to the given phoneme. For non-responders it may be beneficial to use the simpler levels where they have to choose between two print alternatives rather than multiple responses to map to each sound. While adaptive games are heralded as one way to individualize instruction and practice, the use of an adaptive game format also may have to be recalibrated to maintain students' engagement while increasing the challenge level of the tasks.

Regarding the responder group in the present study, responder status included fluency gains, and many of the students (41%) achieved word reading fluency in line with typical developing peers. This is encouraging, considering that intervention studies show less tractable effects for fluency and speed of decoding words and reading text, in contrast to reported strong effects on decoding accuracy (Torgesen et al., 2001). The present results suggest the interactive apps can supplement students learning and fluency through extended practice.

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Effective Network connectivity during Verbal Working Memory: Understanding the Effect of Cross-sectional Neurodevelopment changes and the Influence of Dyslexia

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Abstract

Functional neuroimaging studies have advanced current understanding of changes in patterns of neuronal activation during verbal working memory with specific cerebrocerebellar functional networks identified. However, research examining the influence of typical and atypical neurodevelopment and task-related characteristics on functional connectivity in the context of verbal working memory is sparse. Thus, the present study conducted a two-fold investigation to elucidate the differences in effective network connectivity in typically developing children and that of young adults. Thereafter, the study compared the effect of dyslexia on the network connectivity patterns. Thirty-five young adults, ten neurotypical children and ten children with dyslexia underwent fMRI scanning while performing a modified Sternberg working memory task. Dynamic causal modelling (DCM) was employed to analyze the effective connectivity between co-activated brain regions. Results showed that (i) young adults and neurotypical children had patterns of activation for working memory with similar network connectivity, however (ii) children with dyslexia had a better fit for effective network connectivity models without cortical-subcortical modulatory connectivity. These findings provide a significant contribution to our present understanding of the effect of cross-sectional neurodevelopment and the impact of dyslexia on the effective network connectivity during verbal working memory.

SUMMARY

This paper investigates how brain regions are connected while we try to hold and maintain verbal information briefly in our minds (verbal working memory). We examined this in both adults and children, and how reading difficulties (dyslexia) affect this process using a functional Magnetic Resonance Imaging (fMRI). fMRI is a non-invasive brain scan that can show changes in brain activity during a task. We examined the connectivity of these brain networks between 35 young adults and compared them to brain networks seen in 10 typically developing children. We also examined how the network connections are different in 10 children with dyslexia. The findings of this study may provide insights to understand dyslexia better. It can help improve our ability to diagnose the condition, and develop precise ways to help children struggling with reading.

Keywords: verbal working memory, fMRI, dynamic causal modelling, children, effective connectivity, dyslexia

INTRODUCTION

Verbal working memory is a fundamental building block for complex cognitive processes which are pertinent for knowledge acquisition. The phonological loop plays a central role in verbal working memory, which is a key component in reading. It functions as a temporary storage for the manipulation of verbal information and has been postulated to comprise of two subcomponents—the phonological store and the phonological output buffer (Baddeley & Hitch, 1974).

Functional neuroimaging studies have been instrumental in identifying neuronal regions which are selectively activated during verbal working memory. Vallar and Papagno (2002) postulated that auditory input is analyzed and relayed to the short-term store in the inferior parietal lobe (IPL). These inputs are then passed on to the phonological output buffer, located in the premotor cortex, which can result in a spoken output or a rehearsal process that recycle information (Vallar & Papagno, 2002). Building on these findings, Chen and Desmond (2005a, 2005b) provided evidence of two cerebrocerebellar networks underlying verbal working memory— a phonological storage system that connects the left IPL to the right inferior cerebellum, and an articulatory control system which connects the left inferior frontal gyrus (IFG) to the right superior cerebellum.

Importantly, these studies have also highlighted the need to elucidate the effect of neurodevelopment in brain activation patterns observed during verbal working memory. Crone and colleagues (2006) reported that although children and adults exhibited similar activation profiles in the ventral lateral prefrontal cortex (VLPFC) during the maintenance phase of an object working memory (WM) task, children failed to recruit the right dorsal lateral prefrontal cortex (DLPFC) and bilateral superior parietal cortex if additional manipulation demands were added on during the delay phase. These findings indicate that the fronto-parietal regions in verbal working memory networks could be less functionally developed in children relative to adults. They also suggest that the effect of neurodevelopment in brain activation may only be observable in tasks that place greater demands on working memory.

To further understand the effect of brain maturation and working memory task demands on neural activation patterns, O'Hare and colleagues (2008) explored developmental differences among three distinct age groups—children, adolescents, and young adults—using the Sternberg verbal working memory task paradigm (Sternberg, 1966). They found that participants across all three groups engaged the cerebro-cerebellar network. However, significant age-related differences were found in relation to working memory load-dependency. In particular, while children displayed increasing activation in the left ventral prefrontal cortex only, this pattern was observed in the right prefrontal, left parietal, bilateral superior cerebellum (VI/Crus I), and right inferior cerebellum (VHA/VIIB) regions in adolescents and young adults. Results from the study reinforced the

findings in earlier studies by demonstrating that the neural basis of verbal working memory load-dependency changes with maturation.

A key limitation of functional neuroimaging studies is that network shift (i.e., a change in functional network pathways) is not accounted for. This is significant because network shift could occur due to connectivity between network components, as opposed to mere changes in activation at specific cortical or subcortical regions. This is evident in studies showing task-dependent alteration in the interaction between network components, which was postulated to be independent of the level of brain activation (Bitan et al., 2005; Friston, 2011). As a result, recent research has moved beyond the study of co-activated regions during verbal working memory and ventured towards examining network connectivity—typically quantified using functional or effective connectivity analysis techniques. Functional connectivity is defined as the temporal correlations between spatially remote neurophysiological events, while effective connectivity is defined as the influence one neuronal system exerts over another (Friston, 1994). Dynamic Causal Modeling (DCM) and structured equation modeling (SEM) are the most commonly used methods for analyzing the effective connectivity between co-activated brain regions. However, DCM has two methodological advantages over SEM. Specifically, DCM models the dynamics between a network of neuronal regions, thereby providing greater clarity on the functioning of neural network (Daunizeau, David, & Stephan, 2011). Furthermore, DCM is not constrained by the temporal precedence of one time series in a particular area relative to another (unlike multivariate autoregressive models); dependence on time lag may pose difficulties because the nature of fMRI data may obscure modeling accuracy (Friston, Moran, & Seth, 2013).

To date, limited research has examined the impact of brain maturation and task demands on functional connectivity within the networks associated with verbal working memory. Finn and colleagues (2010) examined functional network connectivity between mid and late adolescence and found differences in the prefrontal and hippocampal regions. A later study by van den Bosch and colleagues (2014) examined neurodevelopmental changes across three age groups—children, young adolescents and older adolescents—using a region of interest approach as opposed to a data-driven approach. The seed-based functional connectivity analyses found age-related differences between children and adolescents in the first load-dependent network and between children and older adolescent in the second load-dependent network: (i) the left motor and right cerebellum, which have been linked with motor coordination, and (ii) the left prefrontal cortex, left parietal lobe and right cerebellum, which play a role during load-dependent verbal working memory (van den Bosch et al., 2014). Few studies have examined the working memory network using the effective connectivity approach. However, Sobczak-Edmans and colleagues (2018) employed DCM to investigate the effective cerebrocerebellar connectivity pathway during verbal working memory in adults. Bayesian model selection (BMS) was used to compare eight permutated dynamic causal models. They found the best fitting model had modulatory effects from the left inferior

frontal gyrus (IFG) to the left inferior parietal lobule (IPL) via the pons to the right superior cerebellum, as well as from the left IPL via the pons to the right inferior cerebellum.

Impairments in verbal working memory have been identified as a core deficit of dyslexia. Despite the growing body of literature documenting observations of behavioural deficits in verbal working memory in children with dyslexia (de Jong, 1998; Peng & Fuchs, 2016; Swanson, Zheng, & Jerman, 2009) (see also supplementary document for theories of dyslexia), little is known about the functional neuroanatomy underlying this impairment in individuals with dyslexia. To elucidate the role of verbal working memory in dyslexia, several studies have attempted to understand the neuroanatomical basis of the phonological loop within the context of its role in verbal working memory.

Despite differences in participant age, analytical approaches, and regions of interest across studies, existing studies of network connectivity have demonstrated an age-related increase in activations at regions of interest [right prefrontal, left parietal, superior cerebellum bilaterally (VI/Crus I), and right inferior cerebellum (VHA/VIIB) associated with the load-dependent verbal working memory. To the best of our knowledge, however, no study has attempted to understand the effective network connectivity during verbal working memory in typically developing children. Building upon the work by Sobczak-Edmans and colleagues (2018), this study investigated the effective connectivity network in typically developing children. Importantly, it explored the cross-sectional neurodevelopmental changes in effective network connectivity during verbal working memory between children and young adults. By examining how the different regions involved in verbal working memory interact, a more granular understanding of the verbal working memory network in children may be attained.

With clearer knowledge of the typical neurodevelopmental trajectory of verbal working memory, the study then sought to further elucidate how dyslexia might affect the network in children. Despite emerging functional imaging studies conducted in the adolescence and adult population to examine the effect of dyslexia on the verbal working memory network, such studies have not been conducted in child populations. Hence the present study, provided a valuable preliminary insight into the effect of dyslexia on the verbal working memory network in children.

METHODS

Participants

Thirty-five young adults, ten typically developing children and ten children with dyslexia were included into the present study after the following exclusion criteria were applied: (i) excessive head motion (thresholds for children and adults were 5mm and 3mm respectively) and (ii) lack of functional activity at one or more regions of interest at an uncorrected threshold of $p < .05$. Additionally, children with dyslexia had to be formally

diagnosed with developmental dyslexia by a registered psychologist.

All child participants (Typically developing: six males, four females; Dyslexia: six males, four females) had no prior history of neurological or psychiatric conditions. All children were age matched and were between seven to ten years old (Typically developing: M = 7.8, SD = 1.03; Dyslexia: M = 8.2, SD = 0.79), and were studying in mainstream schools in Singapore. All children were right-handed, based on scores obtained on the Edinburgh Handedness Inventory (EHI). Recruitment and selection procedures and data on key demographic variables for the adult subsample can be found in supplementary document entitled "method supplement".

Ethics approvals were obtained from the relevant Institutional Review Board. Informed consent was obtained from adult participants and the parents of child participants, and child participants provided assent.

Task Description

All participants completed 40 trials (20 high-load and 20 low-load) of a modified Sternberg working memory task (Sternberg, 1966). The young adults completed the alternating blocks of high-load and low-load task in two runs while the children completed it in four runs. The task was programmed using E-Prime version 2.0 (Psychology Software Tools, Inc, Pittsburgh, US). Visual stimuli were presented on either a Toshiba Portege computer, or a Fujitsu Lifebook computer (Fujitsu, Tokyo, Japan). Supplementary figure S1 summarizes the sequence of events for each trial in the task for both children and adults as well as a detailed account of the task.

Behavioral Data Analysis

Paired-sample t-tests were conducted to investigate the effects of stimulus load on accuracy rate and reaction time in the typically developing children subsample. To examine behavioural differences between children and adults, a two-way repeated measures analysis of variance (ANOVA) with load (low, high) as the within-subjects variable and group (children, adult) as the between-subjects variable was conducted.

Neuroimaging Data

Multiband echo planar imaging

A general limitation in many fMRI studies, especially pediatric studies, is the lack of sufficient statistical power, which decreases the ability to detect true effects. Circumventing this problem by increasing the sample size is challenging in pediatric studies owing to reasons such as high imaging cost, high drop-out rates, and the possibility of situations where it is impractical to increase scan time.

With that in mind, the image acquisition parameters for the collection of pediatric samples were set up differently from the adult population (see supplementary document "supplementary imaging methodology") for optimal acquisition of whole brain data in the pediatric population. Multiband echo planar imaging [17] (EPI) was utilized to reduce scan time and improve statistical power [18]. The multiband EPI approach enabled the simultaneous acquisition of excited slices, which contributed to a significant increase in the temporal resolution as the acceleration factor could be obtained from the number of simultaneously excited slices. In the present study, an acceleration factor of four was utilized to simultaneously acquire four slices at each time point. As such, 200 volumes per subject were obtained in each run, yielding a total of 800 volumes per subject across four runs.

Pediatric MRI Data Acquisition

Whole-brain MRI data was acquired in a 3-Tesla Siemens MRI scanner (Siemens Trio, Erlangen, Germany), equipped with a 32-channel birdcage head coil. To reduce head movements, foam padding was used to pack the participant's head within the head coil. A combination of localizer, structural and functional scans were done as part of the acquisition protocol. MPRAGE sequence was applied to obtain high resolution, T1-weighted structural scans in the sagittal plane with the ensuing parameters: TR=1950ms; TE=3.06ms; FOV=256mm; isotropic voxel size of $1mm^3$. For the functional scans, T2*-weighted EPI were obtained in the oblique axial plane with the following parameters: TR = 1000 ms; TE = 30 ms; 52 interleaved slices; flip angle = 90°; FOV = 200 mm; voxel size of 2.5 mm^3 with 0.5mm gap. To increase the signal measurements obtained from the subcortical regions, in particular the cerebellum, the acquisition plane was rotated 25° about the posterior vertical axis of the brainstem [2]. Additionally, the E-Prime software was employed to synchronize the collection of fMRI data with the behavioural task. Participants were also provided instructions before each run through the intercom system.

Functional Data Analyses

Functional image processing and analyses were done using the Statistical Parametric Mapping (SPM12) software package, version 6470 (www.fil.ion.ucl.ac.uk/spm). Images (functional and structural) were all DICOM converted and reoriented to the AC-PC line. Subsequently, preprocessing was done using a protocol comprising of slice timing correction, realignment, co-registration, normalisation and smoothing. High pass filtering at 128s was also used. To correct for temporal lag during image acquisition, slice timing correction was aligned to the middle slice of the EPI images. This was followed by the realignment of images to the first volume. Structural images were then co-registered to the EPI images before they were normalised to the Montreal Neurological Institute (MNI) space. Lastly, images were smoothed using a Gaussian kernel of 8mm full-width at half-maximum (FWHM).

To estimate the experimental effects, we applied general linear model (GLM) within SPM. Load-dependent contrast images (HL > LL) were computed individually, generating a total of 10 contrast images for each group. All trials (HL and LL) and movement parameters were included for the calculation. Both correct and incorrect trials were included in the statistical analysis, as a two-sample *t*-test was conducted and no significant activation differences were found between children with high accuracy (> 70%) and children with lower accuracy (<70%).

Group-level random effects analyses were conducted on task-specific contrasts with one-sample *t*-tests. Only clusters of voxels that survived the uncorrected thresholding of $p < 0.005$; $k=20$ were reported. According to Lieberman & Cunningham (2009), a combined intensity and cluster thresholding of $p < 0.005$; $k=20$ would be comparable to a false discovery rate (FDR) correction of $p < 0.05$. Additionally, to determine if activations at the regions of interests would still be observed with a more stringent thresholding, a cluster-level thresholding of $p < 0.05$, FWE corrected with a cluster-defining primary threshold of uncorrected $p < 0.001$ was applied (Woo, Krishnan, & Wager, 2014).

Cortical and subcortical activations were superimposed onto the MNI template brains, respectively, and their anatomical labels were determined using the Anatomical Automatic Labelling (Tzourio-Mazoyer et al., 2002; AAL) within WFU PickAtlas tool (Maldjian, Laurienti, Kraft, & Burdette, 2003).

A similar imaging data analysis pipeline was used for the adult data. Details of the procedures can be found in the paper by Sobczak-Edmans and colleagues (2018).

Dynamic Causal Modeling

DCM10, as implemented in SPM12 (v6470) (Functional Imaging Laboratory, UCL, UK), was used for the analysis of effective connectivity. DCM is a non-linear system recognition process, which makes use of Bayesian methods in parameter estimation for drawing inferences about the underlying brain connectivity between neuronal regions and examining how experimental conditions may alter the neural connectivity. Three sets of parameters were estimated using DCM: intrinsic connectivity between region (A parameters), modulatory connectivity (B parameters) and driving input from the experimental task (C parameters) using the ensuing model specification criteria. Slice timing for each of the VOIs was specified as the middle slice, as per Kiebel and colleagues (2007) recommendation that the slice timing selected should be similar to the reference slice indicated at the slice timing correction step of preprocessing. Echo time was set at 0.03s while bilinear modulatory effects were selected. Other criteria set were such as one state per region and no stochastic effects.

Based on previous literature in the field of verbal working memory and language (Baddeley, 2003; Chen & Desmond, 2005a, 2005b; Wu et al., 2014), eight a priori regions-

of-interest (ROI) were selected from the left cerebral and right cerebellum: left inferior occipital gyrus (IOG) (BA 17/18), left fusiform gyrus (FG) (BA 37), left inferior frontal gyrus (IFG) (BA 44/45/47), left inferior parietal lobule (IPL) (BA 40), thalamus, pons, right superior cerebellum (VI/CrusI) and right inferior cerebellum (VIIB/ VIIIA). An anatomical mask was created for each of the ROI using the WFU PickAtlas toolbox (Maldjian et al., 2003) available in SPM12 (v6470), an anatomical mask was created for each of the regions.

With the base model (see supplementary figure S2) established using the eight a priori ROIs, eight modulated pathway models were proposed. For the visual input and analysis, the model postulated that activity in the IOG—involved for primary visual analysis—was modulated by visual stimulation at the driving input region. Intrinsic connectivity between the IOG and the FG, which has a pertinent role in secondary visual analysis, was also proposed in the present model based on the previous findings by Wu and colleagues (2014). In their study examining age-related effective connectivity during a homophone judgment task, Wu et al. (2014) found clear preferences across age groups for models with driving input on the IOG as opposed to both the IOG and FG. Their study also demonstrated a positive intrinsic connection from the IOG to FG. The remaining portion of the model, which is responsible for the phonological processing, is postulated based on the two cerebro-cerebellar networks—an articulatory control system, which connects the left IFG to the right superior cerebellum and a phonological storage system that connects the left IPL to the right inferior cerebellum, as established by Chen & Desmond (2005a) The cerebro-cerebellar networks were further validated by a recent study examining the contralateral cerebro-cerebellar white matter pathways for verbal working memory using diffusion spectrum imaging (Sobczak-Edmans et al., 2018).

From the base model, eight possible pathways were considered (see supplementary figure S3). Modulatory effects are represented by the bolded lines and intrinsic effects are represented by dotted lines. Model 1 and Model 2 were proposed based on the phonological loop (Baddeley, 2003a). Here, we examined the bilateral modulatory effects from the IFG to the IPL and the IPL back to the IFG (Model 1) and Model 2 with only modulatory effects from the IFG to the IPL. The next six models were postulated based on the two cerebro-cerebellar networks established by Chen and Desmond (2005a). Here, we considered the modulatory effects of verbal working memory task load on either the frontal/ superior cerebellar articulatory control system (Model 3 and 4) or the parietal/ inferior cerebellar phonological storage system (Model 5 and 6). Lastly, two more models (model 7 and 8) with the combination of modulatory effect on the two cerebro-cerebellar pathways were considered. This resulted in a total of eight models for comparison.

Using the eight postulated pathway models, Bayesian model selection (Stephan, Penny, Daunizeau, Moran, & Friston, 2009) was conducted to compare the different models. Specifically, random-effect analysis (RFX) was utilized as it accounts for between subject

variability unlike fixed-effect analysis (FFX). RFX-BMS estimates the parameters of a Dirichlet distribution, which includes the probability for all the models included into the analysis. This allows for the computation of the likelihood that a specific model is representative of the network pathway of a randomly chosen individual, as well as the exceedance probability (xp) of a particular model having a higher probability than the other models considered in the model space. Based on the exceedance probability of each of the models at group level, the model with the highest exceedance probability was selected as the model that best predicts the data and is referred to hereafter as the most optimal model. For the most optimal model, one-sample *t*-tests, Bonferroni corrected, were conducted to test the significance of the parameter estimates.

To obtain the peak coordinate for each of the ROIs, the anatomical masks were then applied individually to the group activation map with a threshold of $p < 0.005$ and $p < 0.001$ (uncorrected) used for child and adult participants respectively. The peak coordinates of the VOIs for the adult subsample can be found in our earlier paper (Sobczak-Edmans et al., 2018), while the pediatric subsample were as follows (typically developing; dyslexia): FG (x = -38, y = -66, z = -17; x = -43, y = -81, z = -17), IFG (x = -39, y = 9, z = 11; x = -48, y = 14, z = 33), IOG (x = -30, y = -96, z = -12; x = -43, y = -79, z = -15), IPL (x = -28, y = -56, z = 46; x = -28, y = -59, z = 48), thalamus (x = 0, y = -14, z = 6; x = -13, y = -9, z = 11), iCERE (x = 33, y = -71, z = -52; x = 8, y = -64, z = -32), sCERE (x = 18, y = -76, z = -20; x = 35, y = -61, z = -27) and pons (x = -3, y = -39, z = -35; x = 0, y = -36, z = -42). At the individual level, the activation maps were thresholded at p < 0.5 (uncorrected) and the ROI masks were applied. Volumes of interest (VOIs) were then created using 8mm radius spheres centered at the peak coordinates and within the respective ROI masks. Regional responses were extracted based on the eigenvariates of the activated voxels within the respective VOIs. The distance between the centers of the individual VOIs and the peak coordinate was controlled within 10 mm.

RESULTS

In-scanner Behavioral Data

Results of the repeated-measures ANOVA analysis used to examine the age-related differences in accuracy rates between typically developing children and adults (see supplementary Figure S4 and supplementary Table S1). When comparing typically developing children to adults, an effect of Group on accuracy, $F(1, 39) = 91.8$, $p < .001$ was found. Adults displayed significantly better accuracy than children. There was an effect of Load on accuracy, $F(1, 39) = 54.8$, $p < .001$. Both adults and children responded less accurately to high load stimuli than low load stimuli. A significant Group X Load interaction effect was observed, $F(1, 39) = 19.3$, $p < .001$. Inspection of estimated marginal means revealed that high-load stimuli adversely affected children's response accuracy to a greater degree than that of adults.

Significant main effects for group ($p < 0.001$) and load ($p < 0.001$), as well as a significant interaction effect ($p < 0.001$) was found. This indicates that the decrease in performance from low to high load is greater for children than for the adult group.

Similar analyses were performed to examine the differences in reaction time (see supplementary Figure S5 and supplementary Table S2). When comparing typically developing children to adults, an effect of Group on RT, $F(1, 39) = 92.8$, $p < .001$ was found, indicating that adults displayed significantly shorter reaction times than children. There was also an effect of Load on RT, $F(1, 39) = 180$, $p < .001$. Both adults and children took significantly longer to react to high load stimuli than low load stimuli. No Group X Load interaction effect was observed, $F(1, 39) = .212$, $p = .65$ (*ns*).

Similarly, to understand differences in behavioural performance between typically developing children and children with dyslexia, repeated-measures ANOVA analyses were performed (see supplementary Figure S6 and supplementary Table S3). There was no effect of Group on response accuracy, $F(1, 18) = 2.07$, $p = .167$ (*ns*), indicating that there were no differences in accuracy rates between children with dyslexia and typically developing children. There was a significant effect of Load on response accuracy, $F(1, 18) = 32.9$, $p < .001$, indicating that children responded poorer to high load stimuli than to low load stimuli. No Group X Load interaction effect was observed, $F(1, 18) < 1$, $p = .93$ *(ns*).

No significant main effect for accuracy between TD and RD was observed. However, a main effect for load was found whereby both TD and RD showed better performance for low compared to high load. There was no significant interaction, which indicated that the decrease in performance from low to high load was not significant between the TD and RD.

Repeated-measures ANOVA analysis was also conducted on reaction time (see supplementary Figure S7 and supplementary Table S4). There was no effect of Group on reaction time, $F(1, 18) = .478$, $p = .50$ *(ns)*, indicating that children with dyslexia and typically developing children displayed similar reaction times. There was a significant effect of Load on reaction time, $F(1, 18) = 40.1$, $p < .001$. Children took longer to respond to high load stimuli than low load stimuli. A significant Group X Load interaction effect was observed, $F(1, 18) = 11.6$, $p = .003$. Stimuli load had a differential effect on reaction time between the two groups of children. Comparison of marginal means revealed that high-load stimuli adversely affected typically developing children's reaction time to a greater degree compared to children with dyslexia.

Functional Data

In line with previous studies examining the underlying neural activation in typically

developing children during verbal working memory (O'Hare et al., 2008; Thomason et al., 2009), the present study found load-dependent activation at the left prefrontal region and the right inferior and superior cerebellum (see supplementary Figure S8).

In children with dyslexia, neural activity was observed at the left prefrontal region and the right inferior and superior cerebellum, which are involved in verbal working memory network (see supplementary Figure S9)

To understand the functional differences between children with dyslexia and typically developing children, a two-sample *t*-test with the following two contrasts were conducted: (1) typically developing children > children with dyslexia (TD > RD) and (2) children with dyslexia > typically developing children (RD >TD). For the first contrast (TD > RD), significant activation difference was found at both the right inferior and superior cerebellum (see supplementary Figure S10). For the second contrast examining RD > TD, no voxel survived the Liebermann recommended threshold of $p < 0.005$, $k = 20$.

Effective Connectivity

Bayesian Model Selection (BMS) was done across all eight models, for each of the groups respectively. Results indicated that the data obtained from the adult population showed a better fit for model 8 (xp = 0.9802) (see Figure 1), in which the connectivity between the following regions were modulated by the verbal working memory task: (1) connections from the IFG to the IPL, (2) IFG to superior cerebellum and (3) IPL to inferior cerebellum. Significantly lower exceedance probability was observed for the other models: Model 1 (xp=0.000), Model 2 (xp=0.000), Model 3 (xp=0.008), Model 4 (xp=0.000) Model 5 (xp=0.000), Model 6 (xp=0.000) and Model 7 (xp=0.0189).

Parameter estimates of the driving input, intrinsic connection and modulatory effects within the most optimal model are summarized in Figure 1. One-sample *t*-tests, Bonferroni corrected at the alpha level of 0.05 were implemented to determine if the parameter estimates were significant. All the parameter estimates were found to be significant.

The number alongside the connections or modulation summarizes the M(SD) of parameter estimate (in Hertz). Bolded parameter estimates represent the modulatory parameter estimates. The significance of parameter estimates was examined using one-sample t-tests, with Bonferroni correction for multiple comparisons at the alpha level of 0.05. All parameter estimates were statistically significant. Black dash-arrows indicate modulatory connections, whereas dotted arrows indicate intrinsic connections, and the blue arrow indicates driving input from the visual stimuli. FG: left fusiform gyrus; IOG: left inferior occipital gyrus; IFG: left inferior frontal gyrus; IPL: left inferior parietal lobule. Both superior and inferior cerebellum are right lateralised while thalamus and pons are bilateral.

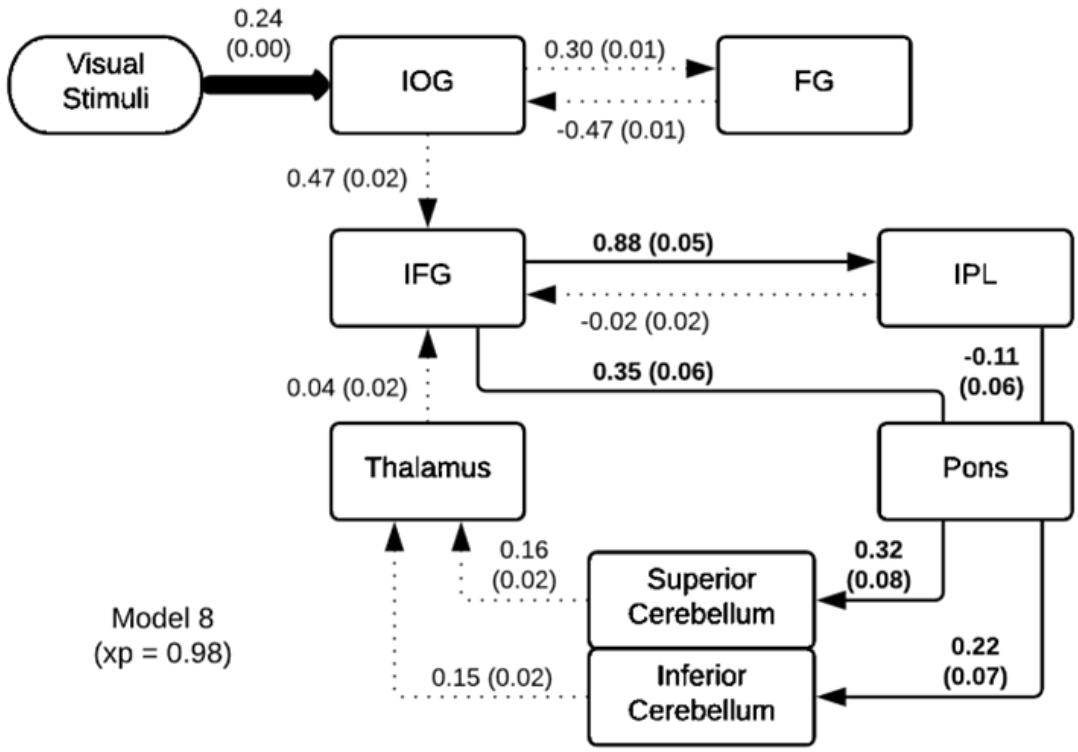

Figure 1. DCM parameter estimate for the most optimal model (Model 8) in adults.

Thereafter, BMS analysis was conducted on all eight models to examine which model best accounted for the data acquired from typically developing children. Data obtained indicated a better fit for model 8 (xp = 0.7504) (see supplementary Figure S11) in which verbal working memory task modulated the connections from the IFG to the IPL, IFG to superior cerebellum and IPL to inferior cerebellum. The exceedance probabilities for the other models were as follows: Model 1 (xp=0.0122), Model 2 (xp=0.0119), Model 3 (xp=0.0130), Model 4 (xp=0.0594) Model 5 (xp=0.0124), Model 6 (xp=0.0131) and Model 7 (xp=0.1276).

Parameter estimates of the driving input, intrinsic connections, and modulatory effects within the most optimal model (Model 8) are summarized in Figure 2. One-sample t-tests, Bonferroni corrected at the alpha level of 0.05 were performed to examine if the parameter estimates were significant. All the parameter estimates were significant.

The number alongside the connections or modulation summarizes the M(SD) of parameter estimate (in Hertz). Bolded parameter estimates represent the modulatory parameter estimates. The significance of parameter estimates was examined using one-sample t-tests, with Bonferroni correction for multiple comparisons at the alpha level of

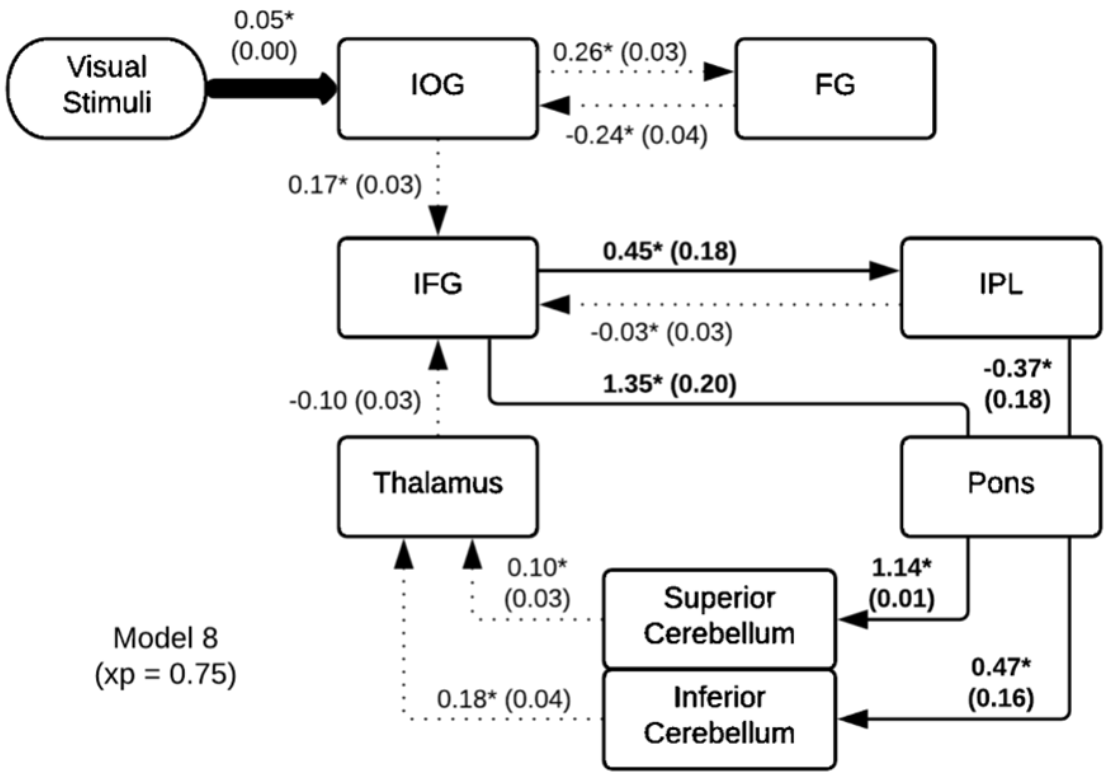

Figure 2. DCM parameter estimate for the most optimal model that fits the data obtained from typically developing children.

0.05. Significant parameter estimates were denoted by an asterisk (*). Black dash-arrows indicate modulatory connections, whereas dotted arrow indicates intrinsic connections, and the blue arrow indicates driving input from the visual stimuli. FG: left fusiform gyrus; IOG: left inferior occipital gyrus; IFG: left inferior frontal gyrus; IPL: left inferior parietal lobule. Both superior and inferior cerebellum are right lateralised while thalamus and pons are bilateral.

Similarly, BMS analysis was conducted for children with dyslexia. Data obtained from the children with dyslexia indicated a slightly better fit for model 2 (xp = 0.29) (see supplementary Figure S12), in which the verbal working memory task modulated the connections from the IFG to the IPL. The exceedance probabilities for the other models were as follows: Model 1 (xp=0.0962), Model 3 (xp=0.1098), Model 4 (xp=0.2055), Model 5 (xp=0.0828) Model 6 (xp=0.0944), Model 7 (xp=0.0614) and Model 8 (xp=0.1615).

Parameter estimates of the driving input, intrinsic connection and modulatory effects within the most optimal model are summarized in Figure 3. One-sample t-tests, Bonferroni corrected at the alpha level of 0.05, were performed to examine if the parameter

estimates were significant. All the parameter estimates were significant with the exception of the intrinsic connectivity from the left IPL to the left IFG, the left IPL to the right inferior cerebellum via the pons and the left IFG to the right superior cerebellum via the pons.

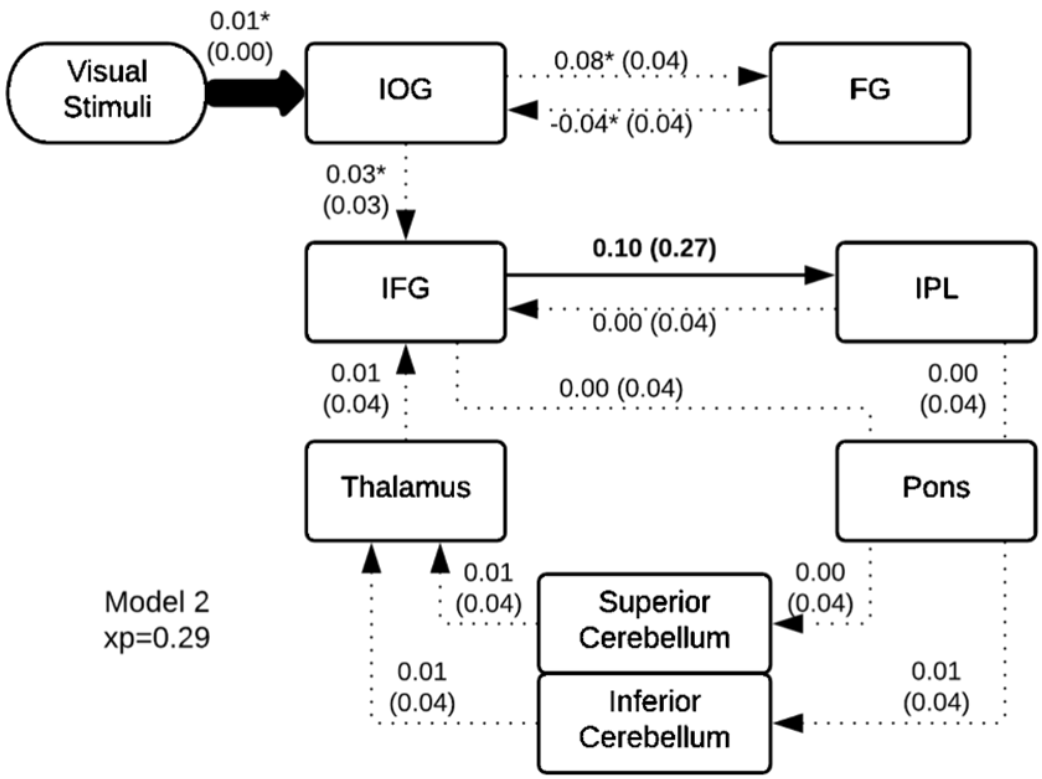

Figure 3. DCM parameter estimate for the model 2 using data obtained from the children with dyslexia.

The number alongside the connections or modulation summarizes the M(SD) of parameter estimate (in Hertz). Bolded parameter estimates represent the modulatory parameter estimates. The significance of parameter estimates was examined using one-sample t-tests, with Bonferroni correction for multiple comparisons at the alpha level of 0.05. Significant parameter estimates were denoted by an asterisk (*). Black dash-arrows indicate modulatory connections, whereas dotted arrows indicate intrinsic connections, and the blue arrow indicates driving input from the visual stimuli. FG: left fusiform gyrus; IOG: left inferior occipital gyrus; IFG: left inferior frontal gyrus; IPL: left inferior parietal lobule. Both superior and inferior cerebellum are right lateralised while thalamus and pons are bilateral.

To understand if the data obtained from children with dyslexia fit better with the models that have only cortical-cortical modulatory connectivity (i.e., model 1 and 2) or models with both cortical-cortical as well as cortical-subcortical modulatory connectivity (i.e., model 3, 4, 5, 6, 7 and 8), model space partitioning was utilized to compare two different families of models. The result indicated that the data obtained from the children with dyslexia had a better fit for the models with cortical modulatory connectivity (xp = 0.61) as opposed to the models with both cortical-cortical and cortical-subcortical modulatory connectivity (xp = 0.38).

DISCUSSION

Verbal working memory plays a vital role in many complex cognitive processes, including the ability to read. However, little is known about the neurodevelopmental changes that occur for verbal working memory in children when compared with adults; particularly, in terms of network connectivity. Thus, the present study sought to systematically elucidate the impact of cross-sectional neurodevelopment on the network connectivity during verbal working memory, and the effects of developmental dyslexia on the network connectivity using dynamic causal modeling. Results revealed that, during verbal working memory, typically developing adults and children were most likely to show use of a cerebro-cerebellar network, while children with dyslexia demonstrated an effective network connectivity pathway that mainly involved the cerebral networks.

The influence of cross-sectional neurodevelopment on the verbal working memory network

Although behavioral data showed that the Sternberg verbal working memory task was more difficult for children than adults, children displayed less activation in the cortical regions (specifically, left IFG, left IPL) compared to adults. At first glance, these findings seem inconsistent with previous research (e.g., Finn et al., 2010, van den Bosch et al., 2014), since the level of brain activation is expected to be positively correlated with the cognitive demands of the task. However, this may be accounted for by two reasons. Firstly, the study included 35 adults with a total of 14,000 functional volume as compared to 10 children with 8000 functional volumes. As such, the statistical power may have been affected. Secondly, the degree of functional maturation should be considered. It is known that the process of myelination—reflective of functional maturation—progresses from the subcortical to the cortical regions (Sowell, Thompson & Toga, 2004). Given that these cortical regions may not be fully developed in children, the expected degree of activation in the left IFG and left IPL may therefore not have been observed. Importantly, children exhibited greater activation than adults in the non-cortical regions of interest (right inferior and superior cerebellum). These findings provide complementary evidence in line with the functional maturation process. In summary, data from the comparison of adults and typically developing children suggest that increased modulatory effective connectivity observed in children in both the cerebral and cerebellar pathways is

reflective of task demands, as well as the course of maturation of both cortical and subcortical regions and white matter pathways.

The effect of dyslexia on the verbal working memory network in children

In addition to the in-scanner verbal working memory task, prior to the scanning session, children were administered a brief neurocognitive test (see supplementary materials). Differences were observed between children with dyslexia and their typically developing peers on both the brief neurocognitive test, and the in-scanner Sternberg verbal working memory task paradigm. Children with dyslexia generally demonstrated poorer reading ability in the brief neurocognitive test than their typically developing counterparts—the former performed significantly poorer in the reading domain, and marginally poorer in the pseudoword phonological awareness and verbal working memory domains. These results indicate a generalized reading deficit and specific weakness in phonological awareness and verbal working memory in children with dyslexia. The above findings were partly similar to those obtained by Norton and colleagues (2014), revealing trends of weaker phonological awareness and verbal working memory—albeit only marginally significant—in children with dyslexia. Taken together, the studies highlight the importance of both the superior and inferior cerebellum in verbal working memory and rapid automatized naming.

For the in-scanner verbal working memory task, both children with dyslexia and typically developing children showed significantly lower mean accuracy and higher mean reaction time for high load conditions versus low load conditions. Additionally, while children with dyslexia had longer reaction times relative to their typically developing peers in the low load condition, children with dyslexia had shorter reaction times relative to their typically developing peers in the high load condition. The reduced reaction time observed during the high load condition could be attributed to difficulty with task mastery. This is plausible considering the low response accuracy rates for children with dyslexia—close to chance levels (57.5%). As such, the condition of load may not have affected children with dyslexia as much as their typically developing peers.

Children in both groups displayed distinct patterns of cerebro-cerebellar activation. It must be noted that there was some similarity in the regions activated. These included the regions sub-serving the frontal/superior cerebellar articulatory control system, and the parietal/inferior cerebellar phonological storage system (Chen & Desmond, 2005a), all of which have been established in the cerebro-cerebellar verbal working memory network of adults. However, children with dyslexia showed less activation than their typically developing peers in the right inferior and superior cerebellum. Typically developing children had increased activation in the right inferior cerebellum.

Findings pertaining to reduced activation at the right inferior and superior cerebellum among children with dyslexia were similar to some studies (Baillieux et al., 2009; Norton

et al., 2014), but different from others (Feng et al., 2017; Linkersdörfer et al., 2012). Study-related differences could have resulted in the lack of concurrence in cerebellar activation findings across studies. For example, the study by Feng and colleagues (2017) was conducted on children who were native Mandarin speakers. However, differential functional activation patterns for alphabetic words and Chinese characters have previously been reported (Kwok, 2013). Notwithstanding, other study-related differences—such as the characteristics of the study sample, task paradigms, and scanning parameters—may also have contributed to mixed findings observed.

Effective connectivity network data revealed that, in contrast to both typical adults and children, children with dyslexia displayed a slightly better fit for Model 2, which includes a very weak unilateral modulatory effect (.10) from the left IFG to the left IPL. This finding is in line with an earlier study Cao et al.(2008), where only typically developing children showed positive correlation between reading skills and the increasing unilateral modulatory effect from the inferior frontal gyrus to the inferior parietal lobule—suggesting that children with better reading ability are more proficient in top-down modulation involving the integration of orthographic and phonological information. However, it may be important to note that the weak modulatory unilateral modulatory effect from the left IFG to the left IPL found in our study may possibly be attributed to the differences in the extent of brain maturation between study samples. The mean age of the participants in the study by Cao and colleagues was 12.4 years (range: 8.9—14.11), whereas those in the present study were much younger—mean age: 8 years (range: 7.8-10.2).

Nonetheless, it is important to note that the data obtained from children with dyslexia did not indicate a clear fit for model 2, as the exceedance probability for the other models were all within a narrow range. Thus, it may be argued that children with dyslexia have yet to develop a specialized verbal working memory pathway. The slightly better fit obtained for model 2 does not negate the possibility that children with dyslexia could have utilized other network pathways.

Although children with dyslexia did not show a clear fit for any model, further analysis using model space partitioning analysis indicated that the data obtained from the children with dyslexia displayed a better fit for models with cortical-cortical modulatory connectivity as opposed to models with both cortical-cortical and cortical-subcortical modulatory connectivity. The finding concurs with previous research (Linkersdörfer et al., 2012, Stoodley, 2014) documenting reduced activation in both the right superior and inferior cerebellum of children with dyslexia during language processing.

In summary, there are differences in network connectivity between children with dyslexia and those with typical reading development. These have important implications in relation to the advancement of our understanding of dyslexia. Specifically, while connectivity between cortical regions may account for some of the deficits associated

with dyslexia, the connectivity between cortical and subcortical regions cannot be overlooked.

The cerebro-cerebellar network connectivity theory of dyslexia

In light of the above, we propose an alternative theory: the cerebro-cerebellar network connectivity theory of dyslexia. This theory is a more elaborate than the traditional cerebellar deficit theory of dyslexia and postulates that the core deficits of dyslexia—such as phonological awareness, verbal working memory, rapid automatizing, as well as less widespread deficits such as motor deficits—can be accounted for by the differences in the cerebro-cerebellar effective connectivity. Notably, it also builds upon existing theories of dyslexia. Researchers in the field of dyslexia have postulated various theories to account for the deficits observed as documented in the supplementary literature review section. In a nutshell, the most widely accepted theory is the phonological deficit theory (Stanovich, 1988), which holds that the difficulties children have in the mapping of grapheme to phoneme is accountable for the reading deficits observed. This was subsequently expanded upon with the postulation of the double-deficit theory (Wolf & Bowers, 1999) that suggests that both phonological deficit and rapid automatised naming are independent core deficits associated to the reading deficits in children with dyslexia. The theory posits that children with dyslexia may have either or both deficits; children with both deficits would display more pronounced reading difficulties. Separately, the cerebellar theory of dyslexia (Nicolson et al., 2001) tried to account for a wider range of deficits, such as automatisation and motor skills in addition to phonological awareness, which was thought to be related to the dysfunction of the cerebellum. While studies have shown varying support for existing theories of dyslexia, they all do not fully account for the wide-spread challenges observed in individuals with dyslexia.

Tapping on previous studies that have established the cerebro-cerebellar network pathway during verbal working memory in young adults (Chen & Desmond, 2005a, 2005b) as well as the functional and effective connectivity between cortical regions during language processing in children with dyslexia (Cao et al., 2008; Quaglino et al., 2008; Richards & Berninger, 2008), we develop a framework to understand dyslexia from the cerebro-cerebellar circuitry. The present study provided new evidence by elucidating differences in the effective connectivity between cortical and subcortical regions in adults, typically developing children and children with dyslexia using an established cerebro-cerebellar verbal working memory network (Chen & Desmond, 2005a). It was found that children with dyslexia, in contrast to typically developing children, do not engage typical adult-like cerebro-cerebral effective connectivity but instead engage cortico-cortical effective connectivity during verbal working memory.

As such, the cerebro-cerebellar network connectivity theory of dyslexia contributes a unifying framework to previously disjointed findings of behavioral working memory

deficits and cerebellar activation anomalies. Its recognition of the importance of understanding brain functions collectively as a network, rather than focusing on neuronal activations at isolated brain regions, extends our understanding of reading deficits. In particular, it is important to consider not only the connectivity between cortical regions, which may account for some of the deficits observed in children with dyslexia, but also the connectivity between cortical and subcortical regions.

Nonetheless, the cerebro-cerebellar network connectivity theory is not without its limitations. While the present study has provided evidence that children with dyslexia show reduced connectivity between the cerebral and cerebellar regions during the Sternberg's verbal working memory task, it has yet to be tested with other types of tasks, including that of motor skills. Therefore, the current specific identified connectivity model cannot fully account for all behavioral deficits observed in children with dyslexia, such as fine motor skills and coordination. However, the topographical cerebro-cerebellar projections (e.g., E, Chen et al. 2014; Stoodley et al., 2000) have shown specificity of the cerebellar involvement in various cognitive and motor coordination. Thus, it is possible to use the cerebro-cerebellar framework to examine deficits related to this network using network connectivity techniques. Despite this, our current model and the larger proposed theory provides a more comprehensive explanation for both the aberrant activation as well as the atypical network connectivity pathway during the processing of two of the core deficits—phonological awareness and verbal working memory in individuals with dyslexia.

The present study is the first to document a difference in cortical to subcortical connectivity in the verbal working pathway exhibited by children with dyslexia. These results, coupled with previous anatomical connectivity findings, provide substantial evidence pointing towards a differential connectivity pathway between the cortical and subcortical regions. The proposed theory therefore represents an advancement in current understanding of the verbal working memory deficits observed in children with dyslexia. Future studies are needed to examine if the theory's postulations apply to other aspects of cognition associated with dyslexia, such as rapid automatized naming.

LIMITATIONS

There were several limitations in the present study. First, the number of child participants was modest. This was due to various factors, such as parents' reluctance towards their children undergoing a MRI scan, availability of scanning slots, participant attrition, and the lack of functional activation at one or more regions of interest. This may have contributed the lack of activation found in children and the variability in preferred connectivity model pathway. The use of the multiband EPI sequence in the data analyses may have mitigated this statistical limitation to some extent. Notwithstanding, future research with larger sample sizes are needed for conclusive replicability.

Second, the use of block design instead of the event-related design did not allow discrete mental processes involved during verbal working memory (encoding, maintenance, and retrieval) to be studied. Additionally, all responses, regardless of their accuracy, were included in the analyses. To ensure this did not compromise the validity of findings obtained, preliminary event-related analyses were conducted to ensure that there were no statistically significant functional differences between trials that were answered correctly versus those that were erroneous during the pilot phase. Despite these drawbacks, block design was favored over event-related design in this study, as it affords two advantages over the latter. Specifically, the use of block design minimized the length of the runs and the overall scan time, and maximized the power of the signal for children, where head motion leading to dropout is a major concern. Nonetheless, future studies with event-related task paradigm are warranted to understand the specific components that are observed during task modulation.

Third, it may be argued that the Sternberg verbal working memory task was too challenging for children. To address this, pilot testing was done to determine task suitability. Children showed no differential performance statistically across the number of stimuli utilized (4, 5 or 6). As such, six letters were used for the study to make the task more comparable to the adult study. Moreover, timings for the presentation of stimuli, encoding, maintenance and retrieval were also examined. Based on the pilot sample's feedback and performance (reaction and accuracy), timings for the different components were adjusted to ensure that children could attain an accuracy of above 80%.

In conclusion, no study to date has attempted to understand the effective network connectivity during verbal working memory in typically developing children. The current study is the first to examine the neural networks involved during verbal working memory by using the Sternberg task paradigm. The findings have significant implications in two broad areas. First, they reinforced the role of cerebellum in verbal working memory. Second, they shed new light on how the differences in the cerebro-cerebellar network connectivity pathway may be an added dimension to the deficits observed in children with dyslexia. It is hoped that the present findings would serve as a platform for future research on the cerebro-cerebellar circuitry in dyslexia, and that this strand of research would culminate in the development of more targeted and effective interventions for dyslexia.

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SUPPLEMENTARY LITERATURE REVIEW

Theories of dyslexia

Three main theories have attempted to elucidate the reading deficits seen in dyslexia: the (i) phonological theory (Stanovich, 1988), (ii) cerebellar theory (Nicolson & Fawcett, 2001) and (iii) magnocellular theory (Stein & Walsh, 1997). For the purpose of the article, only the phonological theory (including its extension, the double-deficit hypothesis) and the cerebellar theory will be discussed in greater detail in the subsequent paragraphs. However, in short, the magnocellular theory postulates that the magnocellular channel of the visual system is impaired in individuals with dyslexia, which leads to impaired visual, sensory and motor systems (Stein, 2001). As the focus of the article is on the cerebro-cerebellar effective network, the magnocellular theory will not be elaborated further.

Phonological theory of dyslexia.

The phonological theory postulates that phonological impairment is the single dominant cause of dyslexia (Stanovich, 1988). Phonology is associated with speech sounds used in languages. Individuals with phonological awareness display proficiency in grapheme-phoneme mapping (the mapping of speech codes to speech sounds). Behaviourally, studies have constantly shown that competent readers have higher levels of phonological awareness than poor readers, thereby highlighting the importance of phonological awareness in the acquisition of reading skills (Fletcher et al., 1994; Shankweiler, Liberman, Mark, Fowler, & Fischer, 1979; Stanovich & Siegel, 1994)

Reduced phonological awareness in individuals with dyslexia has been associated with specific cognitive impairments in the representation, storage and/or retrieval of speech, all of which are governed by the phonological loop. Therefore, the phonological theory of dyslexia was postulated to account for the clear relationship between cognitive deficits and observed behavioural difficulties (Ramus, 2003). According to the theory, phonological impairment of individuals with dyslexia leads to poor reading ability because the acquisition of grapheme-phoneme correspondence is necessary for gaining mastery in reading an alphabetic system (Ramus et al., 2003).

Apart from the aforementioned behavioural deficits, proponents for the phonological theory have also found aberrant neuronal activation through the utilisation of imaging techniques. Differential activations have been predominantly observed in the left IFG, left STG and the left IPL. These regions sub-serve the different cognitive functions involved in phonological processing, as described in detail in the previous section.

In summary, research has provided both behavioural as well as neuroimaging evidence supporting the phonological theory. From a behavioural perspective, children with dyslexia experience problems with tasks requiring phonological awareness such as

spelling and reading (Ho & Bryant, 1997; Swan & Goswami, 1997). Findings also indicate that children with dyslexia display a deficit in both rapid automatised naming and verbal working memory, which suggests a more basic phonological deficit (Baddeley, 1986; Ramus, 2003; Snowling, 2000). From a neurological standpoint, children with dyslexia are found to have decreased activation in the left IFG, and brain imaging studies have found that the basis of phonological deficits lies primarily in Brodmann areas 44/45—which includes regions such as Broca's area and the IFG (Cao et al., 2006; Paulesu et al., 2001; Paulesu et al., 1996; Richlan et al., 2009).

Despite the wide consensus, critics of the phonological theory point out that the theory is unable to account for the range of deficits observed in children with dyslexia that are unrelated to phonetic decoding difficulties, such as impairments in the short-term memory, visual processing, as well as gross and fine motor coordination (Ramus et al., 2003). In view of the limitations of the phonological theory and the need to more holistically account for the array of deficits associated with dyslexia, an extension of the phonological theory has been proposed—the double-deficit hypothesis (Wolf & Bowers, 1999).

Double-deficit hypothesis.

The double-deficit hypothesis (Wolf & Bowers, 1999), an extension of the phonological theory, posits that both rapid automatised naming (RAN) and phonological awareness (PA) impairments are independent core deficits that can cause reading difficulties seen in many individuals with dyslexia. According to the theory, individuals with both these deficits display more pronounced impairments in reading than their counterparts, who possess only a single deficit (Wolf & Bowers, 1999).

Behaviourally, studies have shown that RAN is associated with the speed of an individual's ability to name consecutively presented visual stimuli, reflective of the automaticity process that is essential for reading (Norton & Wolf, 2012). Children with dyslexia have largely been observed to display difficulties with lexical retrieval (rapid automatised naming), making it one of the core deficits (Ramus & Szenkovits, 2008).

The first neuroimaging study examining the double deficit hypothesis discovered that the networks related to PA and RAN were independent of each other (Norton et al., 2014). Findings from the study also indicated that the left fronto-parietal network were associated with PA, while the right cerebellum Lobule VI was involved in RAN (Norton et al., 2014). Additionally, converging behavioural and neuroimaging findings from the study indicated that children with PA deficit, RAN deficit and double (PA + RAN) deficit displayed differential performance and neural activation.

In contrast, a meta-analysis conducted by Vukovic & Siegel (2006) reviewed studies examining the double-deficit hypothesis and found converging findings of a significant

association between phonological processing and RAN. This suggests that more evidence is required to substantiate the theory's postulation of RAN and phonological impairments as two independent core deficits (Vukovic & Siegel, 2006).

Cerebellar Theory of Dyslexia.

Despite extensive research on the phonological deficits observed in dyslexia, it is thought that the theory of a single dominant cause in phonological awareness fails to account for the full range of difficulties that individuals with dyslexia face, such as impairments in fine motor skills and motor coordination where cerebellar dysfunction is implicated (Fawcett, Nicolson, & Dean, 1996). Therefore, the cerebellar theory (Nicolson & Fawcett, 1990) postulates that the cerebellums of individuals with dyslexia are mildly dysfunctional, resulting in the abovementioned phonological and motor deficits.

In terms of phonological deficits, the cerebellar theory postulates that the cerebellum impairment causes difficulties in articulation leading to language-based problems in phonological awareness and rapid processing as emphasised in the phonological theory. Cerebellum impairment was also postulated to affect kinestatic abilities such as balancing and motor skills (Fawcett et al., 1996; Nicolson, Fawcett, & Dean, 2001; Ramus, 2003). Impairments in motor skills of children with dyslexia are evident through difficulties in performing tasks such as speed of tapping, heel-toe placement, rapid successive finger opposition, accuracy in copying, and learning and execution of motor sequences (Denckla & Rudel, 1976; Nicolson, Fawcett, & Dean, 2001).

Support for the cerebellar theory comes from research findings indicating deficiency in phonological awareness. In addition, motor skills deficiencies—including motor, time estimation and balance tasks—that are evident amongst some individuals with dyslexia, can be explained by the cerebellar theory but not solely by the phonological theory (Fawcett & Nicolson, 1999; Fawcett et al., 1996; Nicolson & Fawcett, 2006).

However, critics such as Rochelle and Talcott (2006) pointed out that impaired balance, as accounted for by the cerebellar theory, should not be a determinant of dyslexia. The study found that impaired balance in individuals with dyslexia was attributed to the presence of other developmental disorders such as attention-deficit/hyperactivity disorder (ADHD; Rochelle & Talcott, 2006). Additionally, although phonological deficits are established as a core impairment in individuals with dyslexia, it is not well understood if the neurological causes underlying these deficits can indeed be attributed to the impairment in articulation brought about by the dysfunction in the cerebellum. This, in turn, is postulated to lead to language-based difficulties involving phonological processing.

In summary, both behavioural and functional imaging findings have provided substantial evidence documenting differential activation in the cerebellums of individuals with

dyslexia. Studies have also established the role of the cerebellum in higher cognitive processes such as language and verbal working memory (E, Chen, Ho, & Desmond, 2012), which have been identified as a core deficit in individuals with dyslexia. However, it remains debatable if deficits in kinesthetic abilities (e.g., motor coordination) should be considered as a core deficit and included into the theory.

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SUPPLEMENTARY FIGURES

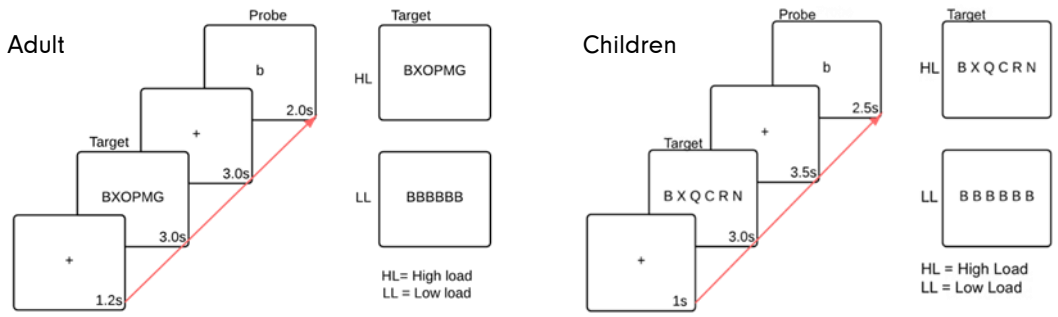

Figure S1. Sternberg's verbal working memory task paradigm.

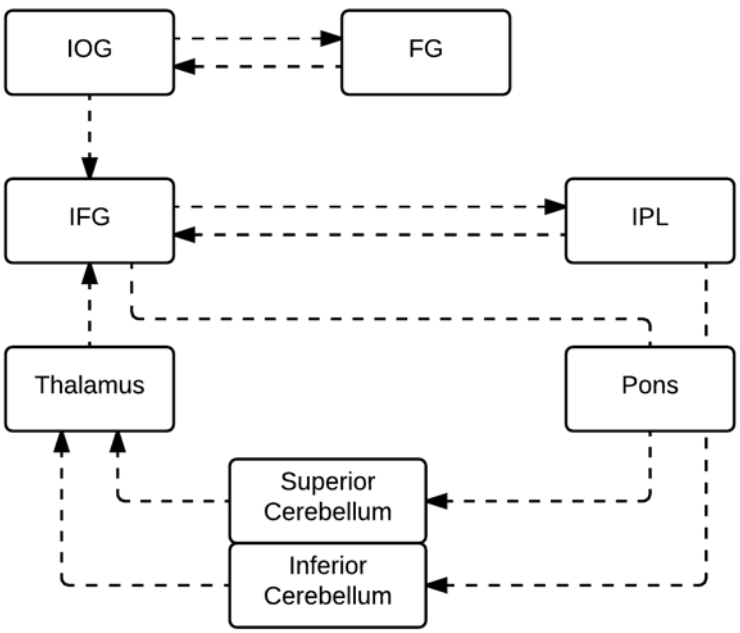

Figure S2. Base model for verbal working memory model. Cortical regions that were left-lateralised included the IOG, FG, IFG and IPL. Subcortical regions that were right-lateralised comprised of both the superior and inferior cerebellum. Both bilateral pons and thalamus were included.

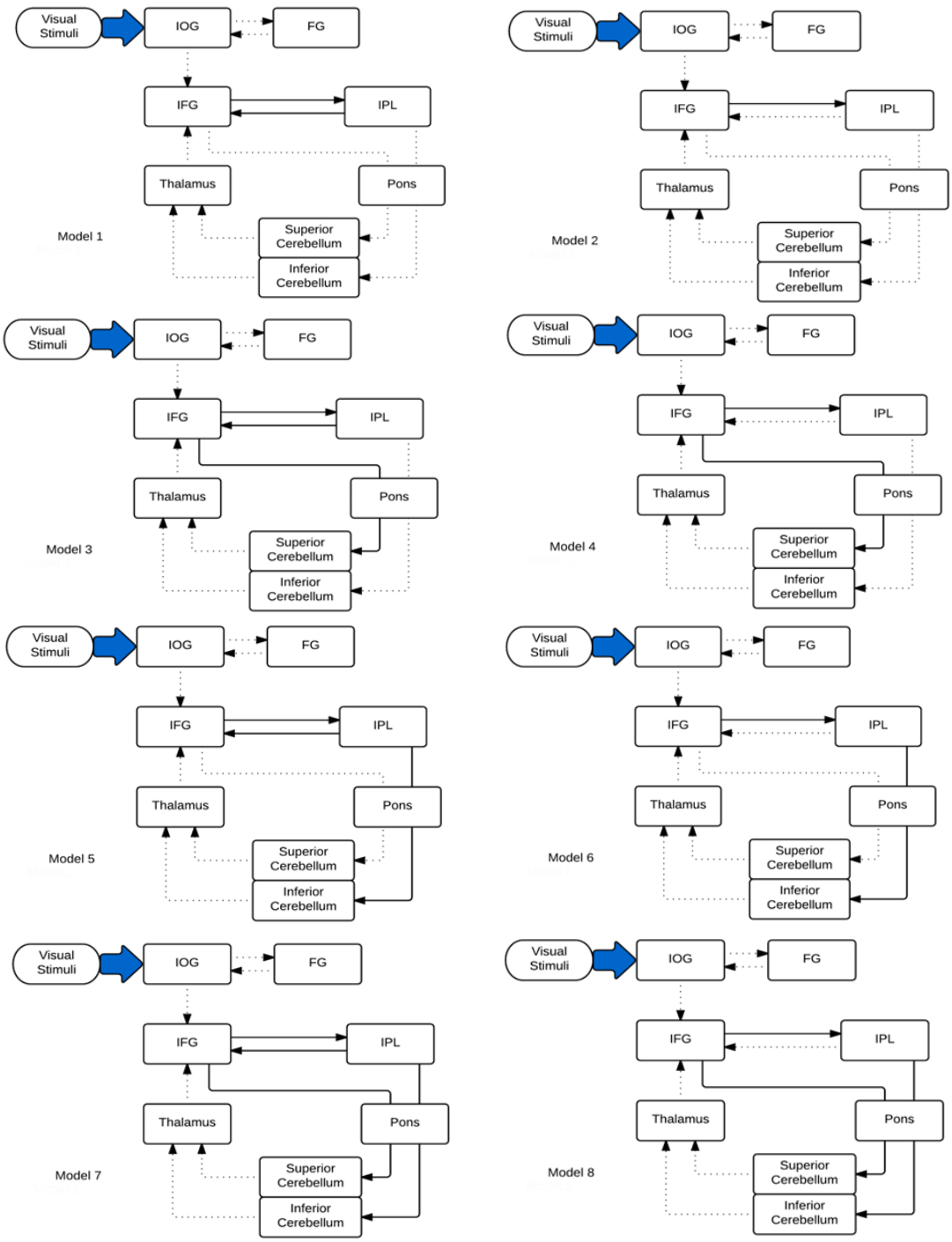

Figure S3. Proposed networks for verbal working memory model. Black solid lines indicate modulatory connections, whereas dotted lines indicate intrinsic connections and the large blue arrow indicates driving input from the visual stimuli

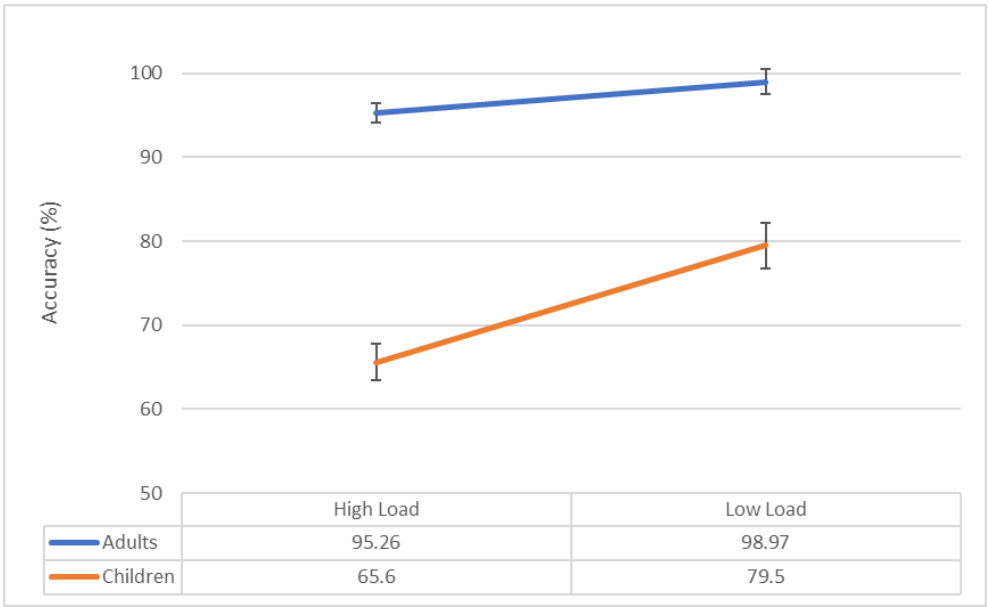

Figure S4. Interaction effect and mean accuracy by stimuli load, for adults and typically developing children. Significant main effects for group ($p<0.001$) and load ($p<0.001$), as well as a significant interaction effect ($p<0.001$) was found. This indicates that the decrease in performance from low to high load is greater for children than for the adult group.

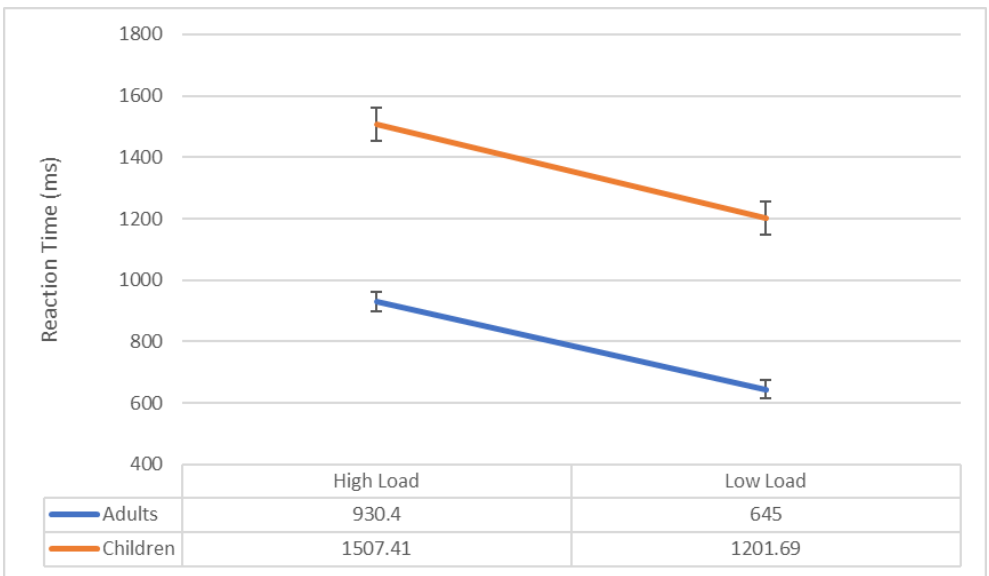

Figure S5. Interaction and mean reaction time by stimuli load, for adults and typically developing children. Significant main effect for group and for load ($p<0.001$) was found. However, the interaction effect is not significant. This indicates that the increase in reaction time from low to high load did not differ between the adults and children.

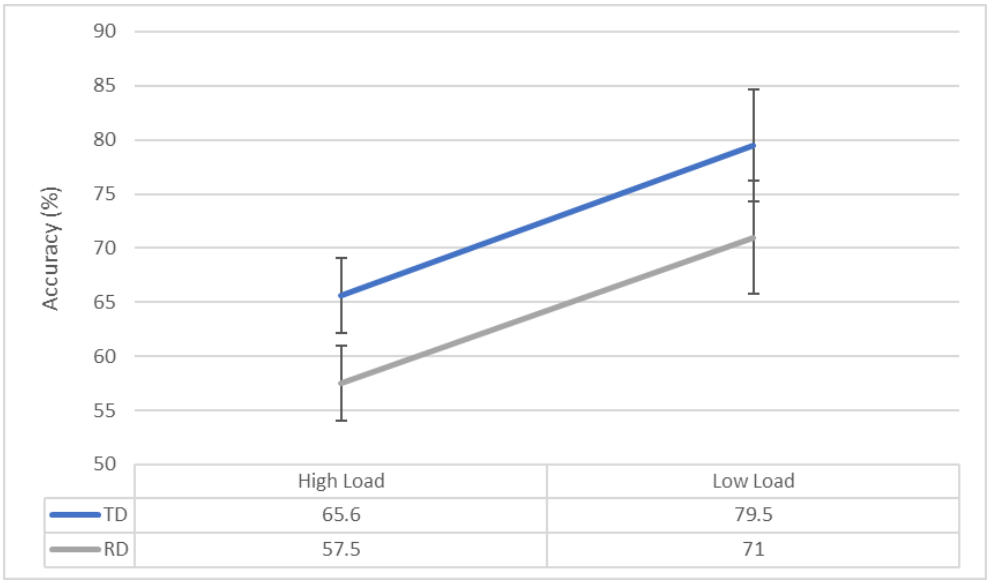

Figure S6. Interaction effect and the mean accuracy by stimuli load, for typically developing children (TD) and children with dyslexia (RD). No significant main effect for accuracy between TD and RD was observed. However, a main effect for load was found whereby both TD and RD showed better performance for low compared to high load. There was no significant interaction, which indicated that the decrease in performance from low to high load was not significant between the TD and RD.

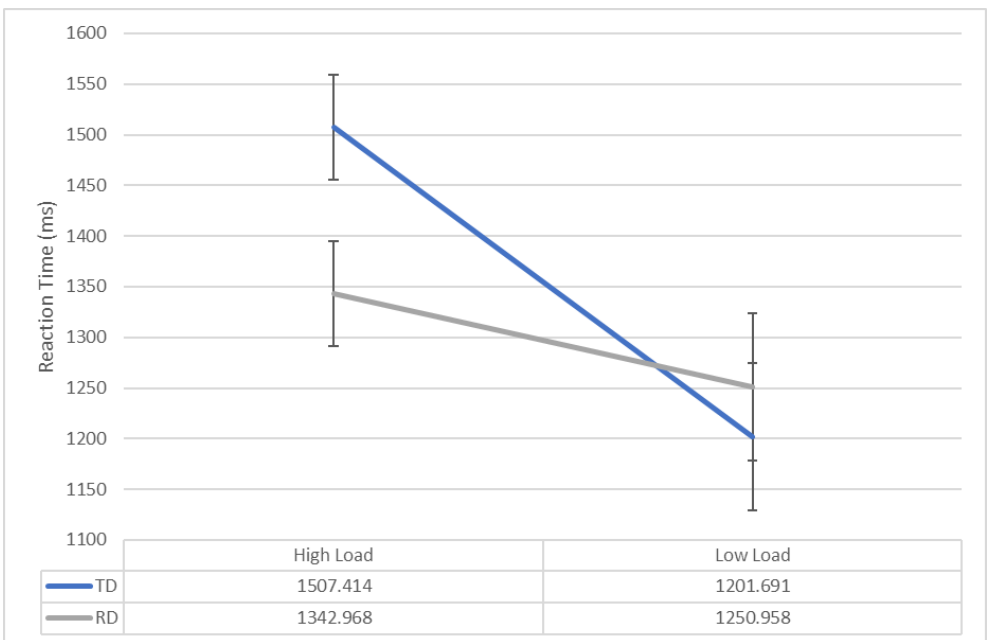

Figure S7. Interaction effect and the mean reaction time by stimuli load, for typically developing children and children with dyslexia. There was no significant main effect for reaction time between the groups. However, a main effect for slower reaction time in the high load condition was found. A significant interaction effect ($p<0.001$) was also found whereby the TD group was faster than RD in low load, but slower than RD for high load.

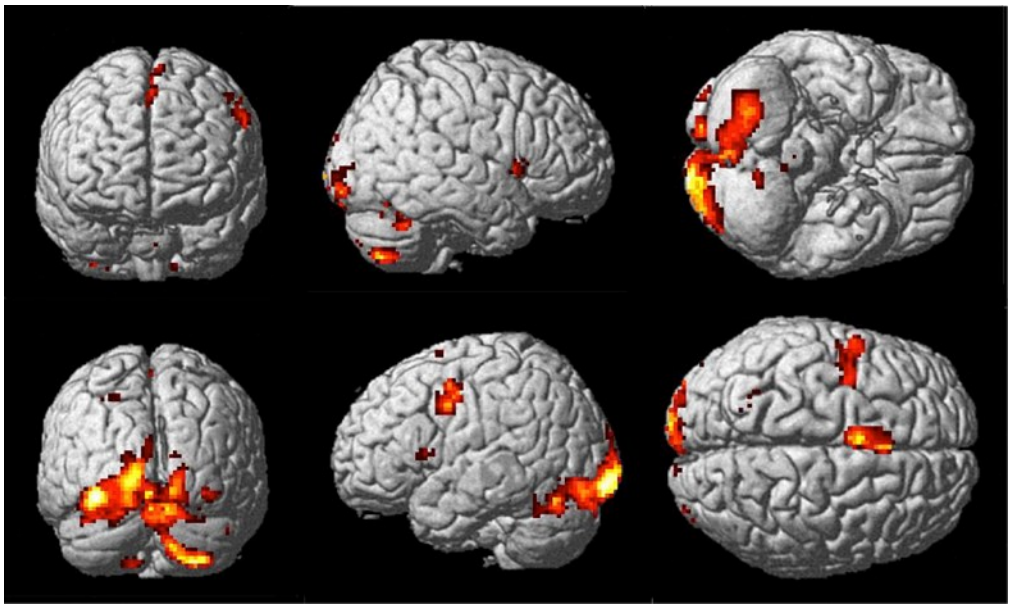

Figure S8. Brain activation map for the Sternberg verbal working memory task (High Load > Low Load) in typically developing children. The axial, coronal and sagittal views showed the activation at the group maxima for the ROIs. Activation was thresholded at p< 0.005; k=20.

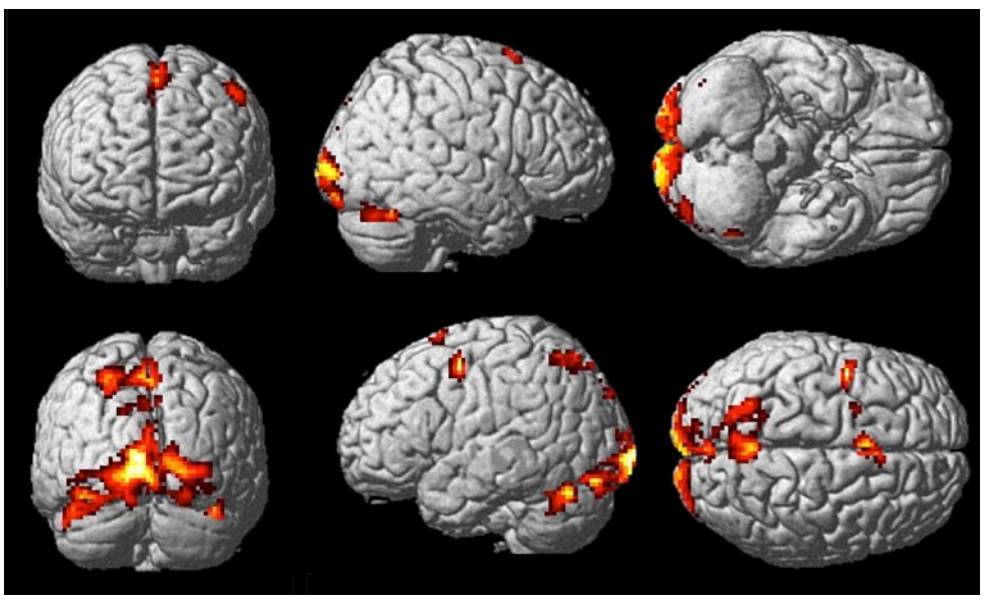

Figure S9. *Brain activation map in children with dyslexia for the Sternberg verbal working memory task (High load > Low load). The axial, coronal and sagittal views showed the activation at the group maxima for the ROIs. Images were thresholded at p< 0.005 (uncorrected) with minimum cluster ≥ 20 voxels*

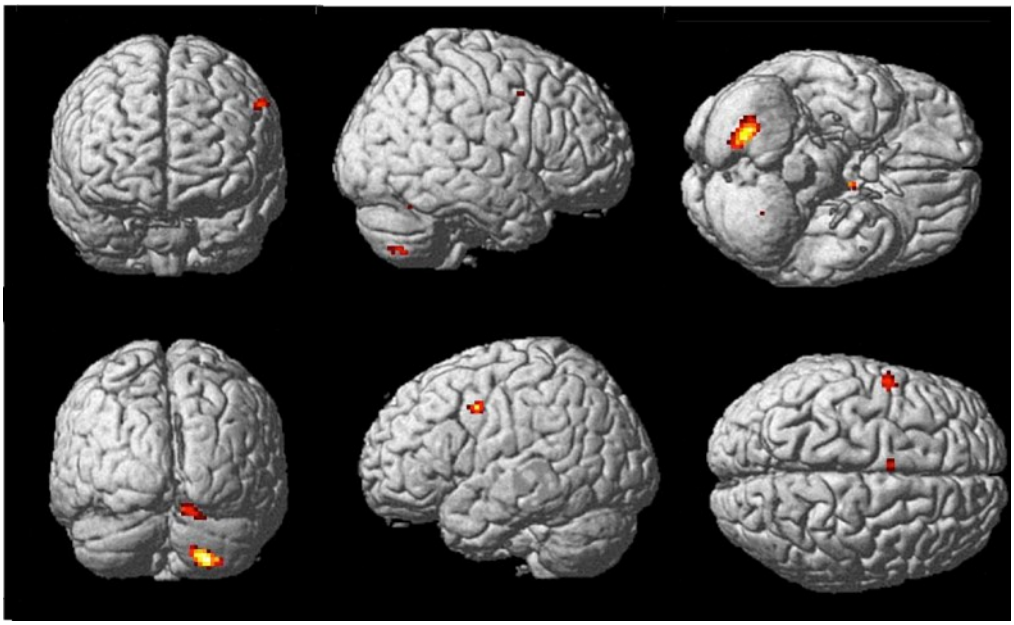

Figure S10. TD > RD brain activation map for the Sternberg verbal working memory task (High Load > Low Load). The axial, coronal and sagittal views showed the activation at the group maxima for the ROIs. Activation was thresholded at $p < 0.005$ (uncorrected) with minimum cluster with minimum cluster ≥ 20 voxels

SUPPLEMENTARY TABLES

Table 1. Repeated-measure ANOVA analysis on accuracy rates.

	df1	*df2*	*F*	*p*	η
Main Effects					
Group	1	39	91.8	.000***	.70
Load	1	39	54.8	.000***	.58
Interaction Effects					
Group X Load	1	39	19.3	.001**	.32

Note. *** p < .001; ** p < .01. Group represents both adults and children while load refers to high load/ low load.

Table S2. Repeated-measures ANOVA analysis on reaction time.

	df1	*df2*	*F*	*p*	η
Main Effects					
Group	1	39	92.8	.000***	.70
Load	1	39	180	.000***	.82
Interaction Effects					
Group X Load	1	39	.212	.65	.05

Note. *** p < .001. Group represents both adult and children while load refers to high load/ low load.

Table S3. Repeated-measure ANOVA analysis on accuracy rates in children when performing the Sternberg's verbal working memory task.

	df1	*df2*	*F*	*p*	η
Main Effects					
Group	1	18	2.07	.167	.10
Load	1	18	32.9	.000***	.64
Interaction Effects					
Group X Load	1	18	.007	.93	.00

Note. *** p < .001. Group represents both children with dyslexia and typically developing children while load refers to high load/ low load.

Table S4. Repeated-measure ANOVA analysis on reaction time in children during Sternberg's verbal working memory task.

	df1	*df2*	*F*	*p*	η
Main Effects					
Group	1	18	.478	.50	.03
Load	1	18	40.1	.000***	.69
Interaction Effects					
Group X Load	1	18	11.6	.003**	.39

Note. *** p < .001; ** p < .01. Group represents both children with dyslexia and typically developing children while load refers to high load/ low load.

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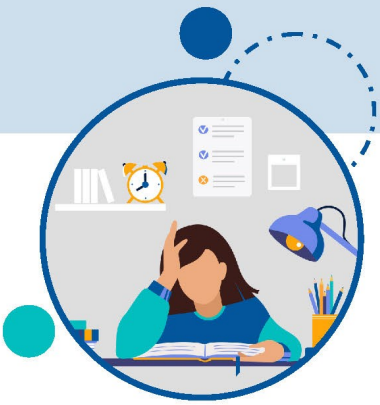

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Understanding Bullying Experiences among SEN students: A Parental Perspective

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Abstract

A total of 185 parents of students studying at Dyslexia Association of Singapore (DAS) were given online questionnaires, asking them about their children's prior experiences with bullying and what they felt could be done to eliminate it. For qualitative data, we first devised common responses that parents had for each question, then recorded the frequency of those responses. Afterward, we tabulated and analysed quantitative and qualitative data and charted all data for easier representation.

The data was examined in relation to gender and age. The findings indicate that students are most affected by verbal, indirect, and peer victimization, and the majority of the bullying lasted for years. Findings from this study also advocate that raising awareness and training for parents and schools would help prevent bullying among SEN students. Moreover, our data show that support from parents and schools was the most critical factor in helping to reduce bullying rates. Lastly, it was found that males experienced higher rates of bullying than females for all types of bullying.

Keywords: Bullying Prevalence, SEN Students, Bullying Intervention, School and Parental Support, Parents' Perspective, Raising awareness, Dyslexic students, Bullying and SEN Education

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INTRODUCTION: THE PROBLEM AND ITS BACKGROUND

Bullying is a pervasive social issue that causes physical, emotional, social, and educational harm among peers. According to Juvonen and Graham (2014), bullying is the systematic abuse of power among peers that harms the victim. A bully is a person who is physically stronger or socially prominent and abuses their power to threaten, demean, or belittle their victim. The power imbalance between the bully and the victim distinguishes bullying from conflict (Emmery et al., 2018.. According to Smith et al. (2019), bullying is characterized by three key features: power imbalance, intention to harm, and repetition. These features have been consistently identified in research and are widely acknowledged as essential components in understanding and recognising bullying incidents.

In recent years, there has been increasing awareness of disablist bullying, which is the harassment that people with special educational needs with or without disabilities (SEN/D) experience due to their condition (González-Calatayud, Roman-García, & Prendes-Espinosa, 2021). Individuals with or without disabilities can perpetrate disablist bullying, and it can take many forms, including physical, verbal, and social harassment. Like traditional bullying, disablist bullying must involve repetition, intentionality, and an imbalance of power between the bully(s) and the victim.

While research on disablist bullying is limited, studies suggest that it is a prevalent issue that has detrimental effects on the well-being and development of individuals with SEN/D (Huang & Yan, 2019; Whitson & Triche, 2018). Disablist bullying can result in adverse outcomes, such as low self-esteem, social isolation, academic difficulties, and mental health problems (Görzig & Albdour, 2020). Therefore, it is essential to understand and address disablist bullying to ensure the safety and well-being of all individuals in educational settings.

Research has consistently shown that children and young people with special educational needs (SEN) are particularly vulnerable to bullying, with alarming statistics indicating that 82% of individuals with learning disabilities have experienced such victimization (Bullying and SEN, n.d., para. 1). Children who have special needs (SEN) are at an even greater risk of being bullied. SEN students are perceived as being different from their peers, which can make them a target for bullies. Students with SEN also have difficulties in communicating and expressing themselves; they lack social cues, which makes them easy targets for bullies. Most SEN students may not be able to stand up for themselves as they might also lack self-confidence.

This article focuses on the prevalence of bullying among SEN students – focusing on the subgroup of dyslexia, and examines its different forms, distinguishing between overt and covert manifestations. By shedding light on these aspects, the study aims to enhance our understanding of the complex nature of victimization experienced by dyslexic students,

highlighting the urgency for targeted interventions and inclusive environments that promote their well-being and social inclusion.

Special Educational Needs (SEN) and Dyslexia

SEN refers to a diverse range of educational needs that require additional support and interventions beyond what is typically provided in mainstream educational settings. Students with SEN have unique learning requirements due to various factors such as disabilities, learning difficulties, or developmental delays. These needs can affect their academic progress, social interaction, and overall well-being (Farrell, 2013; Lindsay, 2013; Norwich, 2015).

Dyslexia is a specific subgroup within SEN. It is a specific learning difficulty that primarily affects a person's reading and writing abilities. Individuals with dyslexia may have difficulty with phonological processing, which involves recognising and manipulating the sounds of language. This can lead to challenges in decoding words, spelling, and reading fluency. Dyslexia is neurobiological in nature and is not related to intelligence or lack of educational opportunities. It is estimated that approximately 10% of the population worldwide may have dyslexia (Snowling, 2013; Vellutino et al., 2013; Peterson & Pennington, 2015; Shaywitz, 2018).

Within the context of SEN, dyslexic students represent a distinct subgroup with specific learning needs related to reading and writing. These students require targeted interventions and accommodations to support their literacy development and overall educational progress. Understanding the experiences and challenges faced by dyslexic students in relation to bullying is essential for designing effective interventions and creating inclusive environments that meet their unique needs (Graham, 2013; Hertzog & Childs, 2013; Görzig & Albdour, 2020). Hence, the focus of this study was dyslexic students from the Dyslexia Association of Singapore (DAS).

Overt and Covert Bullying

Overt Bullying is characterized by observable physical acts that are easily witnessed and can cause immediate harm to the victim. Examples of overt bullying include hitting, punching, shoving, or kicking (Swearer, Espelage, & Napolitano, 2012; Volk et al., 2014). These aggressive behaviors are explicit and often involve direct physical contact, making them more visible and recognisable forms of bullying.

Covert Bullying encompasses subtle and less noticeable acts of victimization that are equally harmful and can inflict emotional distress on the target. Covert bullying is often more challenging to detect as it occurs behind the scenes and may lack physical aggression. Instead, it involves psychological manipulation and social exclusion tactics. Examples of covert bullying include spreading rumors, gossiping, manipulating

friendships, and enforcing social isolation (Waasdorp & Bradshaw, 2015; Wolke et al., 2013).

The distinction between overt and covert bullying is crucial for understanding the various forms of victimization experienced by students. While overt bullying is more overtly aggressive and physical, covert bullying relies on psychological tactics to cause anguish and distress for the victim (Salmivalli, 2010). Recognising both forms of bullying is essential for effective prevention and intervention strategies to address the different ways victimization can be experienced.

Students with SEN, especially dyslexia, are particularly susceptible to overt and covert forms of bullying due to their perceived differences and vulnerabilities. Overt bullying targeting dyslexic students can manifest through physical acts such as hitting, pushing, or kicking, which can directly harm these students physically and emotionally (Rieffe et al., 2012; Rose et al., 2012). Covert bullying, on the other hand, poses a unique challenge for SEN students as it involves subtle tactics like gossiping, spreading rumors, and social exclusion, which can be incredibly distressing for individuals who struggle with social cues and communication difficulties (Cappadocia et al., 2012; Humphrey & Symes, 2011). The impact of overt and covert bullying on dyslexic students can be severe, leading to heightened social isolation, decreased self-esteem, and hindered academic progress (Espelage et al., 2013; Sutherland & Sullivan, 2017). Recognising and addressing overt and covert bullying experienced by dyslexic students is crucial in creating inclusive and supportive environments that promote their well-being and ensure equal participation in education. Addressing and mitigating the occurrence and effects of both forms of bullying experienced by dyslexic students is essential in creating inclusive and supportive environments that promote their overall well-being and ensure their equal participation in education.

Therefore, it is crucial to consider the experiences of dyslexic students within the broader context of SEN research on bullying. By recognising the specific vulnerabilities and challenges faced by dyslexic students, interventions and policies can be tailored to address their unique needs and provide the necessary support effectively. Understanding the prevalence, nature, and impact of bullying incidents targeting dyslexic students is paramount in designing evidence-based interventions that promote safe and inclusive learning environments. Additionally, investigating the existing support systems and evaluating their effectiveness will aid in identifying areas for improvement and ensuring the well-being and academic success of dyslexic students in educational settings.

Statement of the Problem

The primary objective of this research is to investigate the prevalence and nature of bullying experienced by students with dyslexia. Specifically, we aim to explore the frequency and severity of bullying incidents encountered by dyslexic children and the

types of bullying they may have been subjected to, such as verbal, physical, or relational aggression. Additionally, we seek to understand the factors contributing to bullying incidents targeting dyslexic students, including the role of peer attitudes, school climate, and awareness of dyslexia among students and staff.

Furthermore, this study aims to examine the support systems for dyslexic students who have experienced bullying. We will investigate the availability and effectiveness of interventions and strategies employed by schools to address bullying and support the well-being of dyslexic students. This includes exploring the role of educators, parents, and peers in providing support and identifying any barriers or challenges that may impede the implementation of effective anti-bullying measures.

By addressing these research questions, we seek to gain comprehensive insights into the bullying experiences of dyslexic students and evaluate the adequacy of existing support systems. The findings from this study will contribute to a better understanding of the specific challenges faced by dyslexic students about bullying and inform the development of targeted interventions and policies to create safe, inclusive, and supportive environments that promote their well-being and ensure their equal participation in education.

The Motivation Behind this Study

The motivation for conducting this study arose from two deeply concerning incidents that highlighted the urgent need to address bullying and violence experienced by dyslexic students.

In the first case, a distressing event unfolded involving a 13-year-old student who faced cyberbullying, physical violence, and verbal assaults solely due to her dyslexia. The severity escalated to the point where her peers taunted her with suggestions of self-harm (Lee, 2020). These distressing experiences occurred in 2020, just before Singapore entered a "circuit-breaker" phase, which necessitated a transition to Home Based Learning (HBL) and the cessation of regular activities.

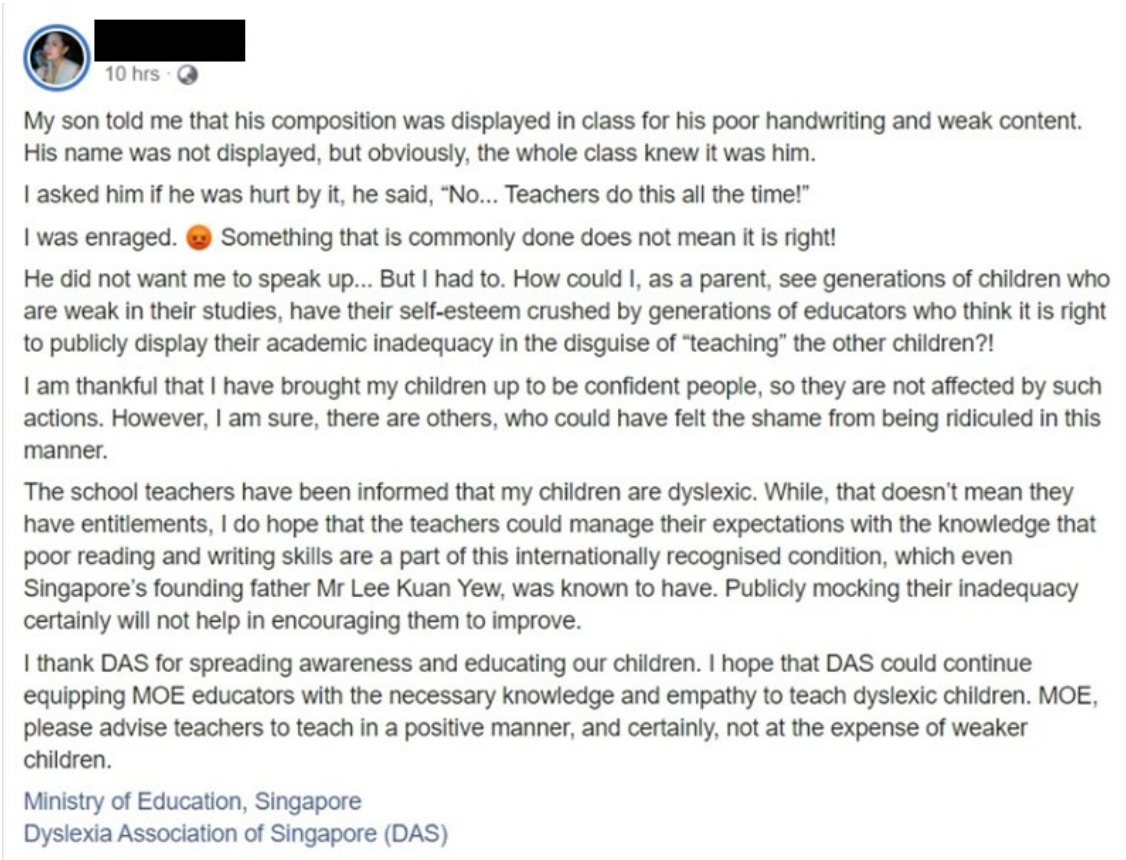
Remarkably, the HBL period provided temporary relief for the student as she no longer had to confront her bullies at school. Her well-being showed signs of improvement during this time. However, when the circuit breaker was lifted, and students were mandated to return to physical schooling, the student experienced an overwhelming level of stress, resulting in a suicide attempt through painkiller overdose (see Figure 1).

Fortunately, timely intervention from her mother enabled her to receive immediate medical attention and support. Moved by this harrowing incident, the student took the courageous step of writing to the Prime Minister, urging improvements in how schools and the Ministry of Education (MOE) respond to bullying and violence (Lee, 2020). It is

Figure 1. Mothership article on a student who was bullied. (Lee, 2020)

important to shed light on these incidents and conduct further research to understand the underlying issues better and develop effective strategies to address the challenges faced by dyslexic students in educational settings

In the second distressing incident, a parent wrote to the Straits Times forum page sharing how her son, who has dyslexia, experienced bullying and humiliation at the hands of his class teacher. The teacher publicly displayed her son's composition on the class notice board, intending to showcase it as an example of what not to do (see Figure 2). However, this act unintentionally exposed her son's work to the entire class, leading to embarrassment and shame. This incident sheds light on the lack of empathy and understanding for students with learning disabilities and the failure to create a safe and inclusive environment within the classroom.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My son told me that his composition was displayed in class for his poor handwriting and weak content. His name was not displayed, but obviously, the whole class knew it was him.

I asked him if he was hurt by it, he said, "No... Teachers do this all the time!"

I was enraged. 😡 Something that is commonly done does not mean it is right!

He did not want me to speak up... But I had to. How could I, as a parent, see generations of children who are weak in their studies, have their self-esteem crushed by generations of educators who think it is right to publicly display their academic inadequacy in the disguise of "teaching" the other children?!

I am thankful that I have brought my children up to be confident people, so they are not affected by such actions. However, I am sure, there are others, who could have felt the shame from being ridiculed in this manner.

The school teachers have been informed that my children are dyslexic. While, that doesn't mean they have entitlements, I do hope that the teachers could manage their expectations with the knowledge that poor reading and writing skills are a part of this internationally recognised condition, which even Singapore's founding father Mr Lee Kuan Yew, was known to have. Publicly mocking their inadequacy certainly will not help in encouraging them to improve.

I thank DAS for spreading awareness and educating our children. I hope that DAS could continue equipping MOE educators with the necessary knowledge and empathy to teach dyslexic children. MOE, please advise teachers to teach in a positive manner, and certainly, not at the expense of weaker children.

Ministry of Education, Singapore
Dyslexia Association of Singapore (DAS)

Figure 2. A screenshot of a Facebook post shared by a concerned parent regarding her son's bullying experience in school due to his dyslexia. (Facebook, n.d.). Unpublished work.

These incidents underscore the pressing need to explore and address the bullying and violence experienced by dyslexic students in educational settings. By conducting further research, we aim to gain deeper insights into the underlying factors contributing to such incidents and develop effective strategies to create safer, more inclusive, and supportive environments for dyslexic students.

Next, the article will delve into a comprehensive literature review, examining existing research and scholarly works that explore the prevalence, impacts, and interventions related to bullying and violence among students with dyslexia. This review will provide a solid foundation for understanding the broader context of the issue and inform the development of appropriate interventions and support mechanisms.

REVIEW OF RELATED LITERATURE

Literature Review

1. Rates of Incidences

Bullying is reported by one out of every five students (20.2%). 41% of victims believe that they will be targeted again. Of these victims, 13% were verbally bullied (e.g., teased, called names, insulted), 13% experienced relational bullying (e.g., gossips), 5% were physically abused (e.g., pushed, tripped, spit on), and 5% experienced exclusion and isolation. Body image, racial group, gender, impairment, religion, and sexual orientation were the most common causes of bullying. Moreover, male students are highly likely to be physically bullied as compared to female students (6% vs. 4%), whereas female students are highly likely to be victims of relational bullying – gossip (18% vs 9%) and exclusion (7% vs 4%; National Centre for Educational Statistics, 2019).

The prevalence of bullying differs across different research (9%-98%). A meta-analysis of 80 studies that examined bullying engagement percentages (bully and victim) among 12-18-year-old teenagers revealed that they experienced typical bullying at 35% and cyberbullying at 15% (Modecki, Minchin, Harbaugh, Guerra, and Runions, 2014). 49.8% of tweens (9 to 12 years old) reported being victims of school bullying,, while 14.5% of tweens indicated being cyberbullied (Patchin & Hinduja, 2020; Bullying statistics, n.d.).

2. Cause of Bullying

Warning Signs and Risk Factors

Prior research on potential risk factors of school bullying revealed that bullying is affected by various aspects that interact with one another (Xu et al., 2020). The crucial elements of a teenager's life are family, friends, and school, creating the social atmosphere that molds children's thoughts and actions (Erginoz etraits and situational factors. They found that individual traits associated with bullying were alcohol usage and poor emotional regulation. All five aspects of school bullying t al., 2015). Ethnicity, age, class rank, gender, alcohol and cigarette usage, and other personal factors are all linked to school bullying incidents (Silva et al., 2019).

Qian et al. (2019) analysed warning signs and risk factors for multiple types of school bullying (physical, verbal, relational, sexual, and possession) among Chinese middle school children, incorporating personal were associated with alcohol usage. Relational bullying was associated with strained familial connections, the father's alcoholism, and poor parenting. Physical, verbal, and relational bullying were associated with poor sense of stability and the unavailability of reliable people.

3. Bully and Victim Characteristics

Characteristics of Bullies

Bullies feel proud of themselves based on the social feedback they receive. Bullies may feel good about themselves and possibly disregard the harm they cause others when they receive positive social feedback paired with hostile attributional bias (Juvonen & Graham, 2014). Bullies place importance on control, and they are viewed as famous, influential, and ''awesome'' figures among their peers despite being disliked by their schoolmates. They tend to be the leaders of their cliques and teenage bullies resonate with those with similar tendencies and support one another in their violent actions (Menesini & Salmivalli, 2016).

The perpetrators of bullying have high social skills but lack social and interpersonal abilities. Despite their high social skills, they are limited in their ability to feel empathetic and compassionate on a mental and affective level – they have issues comprehending victims' emotions and opinions (Kaminaridi & Tsaliki, 2017).

Characteristics of Victims

The peer collective sustained and even fostered bullying when peers do not challenge bullies' hostile conduct. Bullies target victims who are ''safe'' and allow them to be empowered. They mainly target those easily subservient: those who are apprehensive, diffident, and sensitive. Longitudinal research has shown that embodying issues and lacking assurance in interpersonal relationships makes for highly targeted individuals. Bullies also target victims who respond aggressively. Unfortunately, this aggression is fruitless, causing them to become perfect victims for bullies due to their affective reactions. The victims from this group tend to have issues controlling their emotions and attention and share some of the plight of victims (Juvonen & Graham, 2014).

According to Brank et al. (2012), bullying victims are fragile, introverted, and apprehensive. Victims' academic performance is low, and they miss school to prevent bullying. Victimization can have a negative impact on achievement and contribute to absence. Victims are associated with numerous problems such as anxiety, depression, and poor self-regard, and they usually have few or no friends, face rejection or no acknowledgment from them, and have poor interpersonal relationships (Menesini & Salmivalli, 2016). They also were more likely than bullies to report suicide ideation, according to Skapinakis et al. (2011).

4. Family

In addition to the characteristics of bullies and victims, the family plays a vital role in encouraging a child's violent behaviour, especially the quality of relationships within the family.

Olweus (2009) states three significant aspects as vital for such violent behaviours. He first states that how parents react emotionally during a child's first years makes a difference. Cynicism, along with little compassion and engagement, can cause a child to react violently towards others.

Parents' tolerance level for their child's violent behaviour is the second deciding aspect. If strict expectations are not set, a youngster has a higher chance of becoming violent later in life.

The last aspect is the ineffective parenting practices embraced by parents. Physical discipline and intense emotional breakdowns are some examples of such tactics. Children reared in aggressive surroundings will exhibit intense manners of responding and demanding possessions. Children growing up in a domestic violence environment are more prone to victimize others (Baxendale, Cross, & Johnston, 2012).

The family framework and organisation, parents' didactical perceptions, the level and standard of disciplinary actions, and the affiliations between parent and child are all possible reasons for the advancement of violent attitudes and the formation of mutual affective and psychological systems that promote violent attitudes (Kaminaridi & Tsaliki, 2017).

5. Teachers and Schools' Attitudes Towards Bullying

It is essential to analyse teachers' attitudes and personalities that may affect how they react to bullying incidents. Teachers and schools are essential in eradicating the bullying climate in schools. Bullies and victims behaviours are affected by how teachers react to bullying incidents. Teachers are more likely to interfere when they have compassion for the victims and how serious they consider the situation to be. Such teachers are more likely to comprehend and sympathize with the victim's experience, and compassion has been associated with prosocial behaviour. Therefore, teachers with higher compassion are prone to view bullying seriously and take appropriate actions (Byers, Caltabiano & Caltabiano, 2011).

Davis & Nixon (2010) reported that students found the most helpful manner educators can help is by hearing and checking in with the student to check if the victimization has ended and to provide counsel. Moreover, informing the victims to address the issues on their own, informing them to change their behaviour or attitude, overlooking the issue, or scolding them for tale telling are among the most detrimental actions educators may take, according to students.

Research reveals that school bullying prevention initiatives can reduce bullying incidents by up to 25% ((McCallion & Feder, 2013). Rose & Monda-Amaya (2012) have suggested favourable bullying prevention measures for students with impairments, such as

educators and students participating in communal interplay that are both relevant and appropriate, boosting social aptitude and positive networks by giving incentives and utilizing suitable mediation tactics that promote social engagement and equip with tailored meditations for victims.

Teacher Bullying

Teacher bullying is a serious issue documented in research for decades. Teacher bullying of students, also known as "teacher-on-student" bullying, is a form of bullying that occurs within educational settings. According to the American Psychological Association (APA), teacher bullying of students has been linked to a wide range of negative adverse outcomes including academic underperformance, lower self-esteem, and higher levels of anxiety and depression (Smith, 2018). Studies have also found that teacher bullying can make students feel disempowered and disrupt the learning environment (Jones, 2020). Moreover, teacher bullying is often an indicator of a more significant problem within the school system. It can lead to students disengaging from the education process and feeling disengaged from the school community (Clark, 2019). Therefore, school systems need to create a safe learning environment where students can feel secure and supported by their teachers.

It refers to repeated negative behaviour by a teacher towards a student or group of students, which can include verbal abuse, exclusion, manipulation, and physical aggression (Salmivalli, 2010).

Research has shown that teacher bullying of students can have detrimental effects on the academic and psychological well-being of the targeted individuals. A study by Nansel et al., (2001) found that students who experience teacher bullying have lower academic achievement, lower self-esteem, and higher levels of absenteeism than those who do not experience teacher bullying. Another study by Kärnä et al. (2011) found that teacher bullying is associated with an increased risk for mental health problems such as anxiety and depression among students.

School administrators and policymakers need to take action to address teacher bullying of students. This can include implementing policies and procedures for reporting and addressing bullying, providing professional development for teachers on appropriate classroom management and positive discipline strategies, and fostering a culture of respect and support within the school community (Salmivalli, 2010).

Teacher bullying of students, also known as "teacher-on-student bullying," is a significant problem in schools. According to a study published in the Journal of Interpersonal Violence, "teacher bullying is a serious problem that affects the mental health and academic performance of students" (Nansel et al., 2001). Another study published in the Journal of Educational Psychology found that "teacher-on-student bullying is associated

with a range of negative outcomes for students, including increased absenteeism, lower academic performance, and decreased psychological well-being" (Limber et al., 2010). Furthermore, research has shown that teacher bullying can have long-term effects on students, such as decreased self-esteem and increased risk of mental health issues (Swearer et al., 2015). Schools need to take steps to address this issue, such as implementing policies and procedures for addressing teacher-on-student bullying and providing training for teachers on how to create a safe and inclusive classroom environment.

6. Cyberbullying

Cyberbullying is a growing form of harassment that can damage its victims. It is defined as "any form of bullying conducted through electronic technology" (Smith et al., 2008, p. 376). According to the National Academies of Science, Engineering, and Medicine (2016), cyberbullying occurs when a person or group uses electronic devices such as the internet, cell phones, and social media to intimidate, threaten, and harass another person. This type of bullying can have long-term effects on a person's mental and physical health, such as depression, anxiety, and increased risk of suicide (Gini & Pozzoli, 2019).

A study by the Cyberbullying Research Center (2018) found that 34% of students in grades 6-12 have reported experiencing cyberbullying. Additionally, a meta-analysis by Kowalski et al. (2014) found that victims of cyberbullying are at an increased risk for depression, anxiety, and suicidality. Furthermore, the anonymity and reach of the internet can make it difficult for victims to escape their bullies, as cyberbullying can occur at any time and place (Patchin & Hinduja, 2010). Therefore, it is essential to be aware of the dangers of cyberbullying and to take steps to protect students from this form of abuse. Educators, parents, and policymakers must work together to develop effective strategies to prevent and address cyberbullying.

It is important to note that the effects of cyberbullying can be severe, including depression, anxiety, and in some cases, suicide. Steps must be taken to address this issue, such as implementing policies and programs to prevent and respond to cyberbullying and providing support and resources for victims.

7. COVID Effects

Bullying is a serious issue that has been shown to adversely affect children's mental health and well-being (Nansel et al., 2001). The COVID-19 pandemic has had a significant impact on how children experience bullying, both in terms of the prevalence and the form it takes (Hosseinpour et al., 2020). Studies have shown that the shift to virtual learning environments has led to increased cyberbullying, with children experiencing bullying through online platforms such as social media and gaming

(Kowalski et al., 2020). Additionally, the isolation and stress caused by the pandemic may make children more vulnerable to bullying (Hosseinpour et al., 2020).

Research has also shown that the COVID-19 pandemic has negatively impacted children who were already at risk of bullying, such as those with disabilities or from marginalized communities (Hosseinpour et al., 2020). For example, a study by Hosseinpour et al. (2020) found that children with disabilities were more likely to experience bullying during the pandemic, both in person and online.

One study conducted by the Cyberbullying Research Center found that the percentage of students who reported being bullied online increased from 15% to 25% during the COVID-19 pandemic. Another study published in the Journal of Adolescent Health, found that the prevalence of cyberbullying victimization among adolescents increased from 11.5% to 15.5% during the pandemic (Yabara et. al, 2021)

Steps must be taken to address the issue of bullying during the COVID-19 pandemic, including the implementation of effective prevention and intervention strategies. This may include providing education and support to children, parents, and educators on how to recognise and respond to bullying, as well as increasing access to mental health resources for children who have been bullied (Hosseinpour et al., 2020).

8. SEN Students and Bullying

Bullying has been recognised as a social phenomenon,. In recent years there has been an increase in interest in the research of bullying among students with special educational needs (SEN) and other disabilities. Studies have highlighted the attributes prevalent in SEN students and children who are bullied, indicating the high possibility of SEN students being at high risk for bullying. Unfortunately, the literature is quite limited compared to bullying among school-age students and adolescents (Mishna, 2003i).

More than 5% of children from ages 0 to 14 have a disability as, estimated by World Health Organization (2011) in its World Report on Disability. Students with learning difficulties, conduct disorders, autism spectrum disorders, and developmental delays were some of the disabilities highlighted. They are deemed more likely to be bullied and remain same for an extended period. Prevalence rates differ when assessing distinct forms of disabilities: High levels of bullying victimization are experienced by 35.3% of students with behavioral and emotional disorders, 33.9% of students with autism, 24.3% of students with intellectual disabilities, 20.8% of students with health impairments, and 19% of students with specific learning disabilities (Rose & Espelage, 2012).

A research study conducted in the USA deduced that one out of every five (20.2%) students report being bullied (National Center for Educational Statistics, 2019). The

bullying incident rates with special educational needs (SEN) are much higher when compared to non-SEN students (Rose & Gage, 2016).

Various factors contribute to students with SEN being more vulnerable to bullying. Firstly, these students tend to form fewer friendships and are likelier to be isolated from their peer groups. When isolated, they are less protected and thus become easier targets to bully. At the same time, social isolation takes away opportunities for students with SEN to develop the ability to interact with others, further limiting their abilities to build social relationships (Kaukiainen et al., 2002).

Secondly, students with SEN generally have poorer social skills. This results in the students lacking social behaviour, which can help them to avoid becoming a victim of bullying, such as being able to read social cues accurately. Having poor social skills also causes the students to be more passive and timid, which may reinforce pre-existing bullying behaviours towards them (Rose, 2011).

Thirdly, due to the learning difficulties that students with SEN have, they are more likely to suffer from stigmatization, being viewed more negatively among their peers. This causes their peer groups to view them as "abnormal" and are more likely to reject them socially, making them more likely to become victims of bullying (Baumeister, 2008)
For students with SEN, suffering from bullying has severe consequences. Bullying victims cause them to be at a very high risk of poor academic performance due to their existing learning difficulties. Being bullied also often results in the students having more severe social deficits, including a poorer ability to communicate with others and less adept at showing empathetic behaviours. Lastly, it was also shown that students with SEN often become bullying perpetrators as a learned behaviour due to prolonged victimization (Rose, 2011).

Teachers tend to underestimate the extent of bullying of SEN students. Swearer et al.'s (2012) study revealed that teachers in Hong Kong tended to overvalue the social status of SEN students, causing them to misjudge the level of bullying they experienced. In addition, Bradshaw, Swayer, and O'Brennan (2007) illustrated that 71.4% of teachers estimated that only 15% or less of their students were bullied, in contrast to an incidence of 40.6%. This reiterates the point that teachers are unaware of the degree of the bullying SEN students suffer from.

10. Effects of Bullying

Victims of bullying are at high risk for mental health and emotional issues such as sleep disorders, anxiety disorders, depression, poor school performance, and leaving school. Individuals who play the role of victims and bully are more likely to have mental well-being and behavioral issues than those who are just bullied or tormented (Centers for Disease Control, 2019).

According to the National Centre for Educational Statistics (2019), bullying causes negative repercussions on how victims view themselves (27%), their affiliation with loved ones (19%), their academic performance (19%), and their physical health (14%). Moreover, Gini and Pozzoli (2013) indicated that victims are twice as likely as non-victims to suffer from unfavourable physical illnesses such as headaches and stomachaches.

Perren, Ettakal, & Ladd (201), found that youth who condemn themselves for being victims of bullying have a higher chance of being depressed, bullied for long-term, and emotionally disturbed. Furthermore, Patchin & Hinduja (2020) found that being cyberbullied for tweens caused negative emotions about themselves (69.1%), their friends (31.9%), their health (13.1%), and academic performance (6.5%).

11. Singapore and Bullying

Research on bullying in Singapore is limited, especially in SEN. However, there has been a rise in the cases of students being bullied in recent years. According to Singapore's Minister of State for Education, Sun Xueling, two cases of bullying per 1,000 primary schools and five cases per 1,000 secondary schools were reported in 2020 (Ong, 2021).

In a 2018 study conducted by the Organization for Economic Cooperation and Development (OECD) - which evaluates the quality of learning among 15-year-old students in 79 participating education systems, Singapore was also one of the participating countries. For this study 6098 Singapore students participated. They were selected from 168 public schools and 290 from nine private schools to take the computer -based test. It was discovered that 18.3 percent of the students have indicated that they have experienced some form of bullying. This is above the OECD average of 10.9 percent.

As of 2019, 80% of Singaporean students with special educational needs (SEN) study in mainstream schools. (Choo, 2019). Integrating students with SEN into mainstream schools is essential as it allows them to interact with other children in a typical social environment, training their social skills and enabling them to become more independent (Thompson et al., 1994). However, without protective measures and interventions, students with SEN become highly vulnerable in mainstream schools. This can be seen from how students with SEN are more susceptible to bullying than mainstream students (Whitney et al., 1992). Compared to children without SEN, students with SEN were more concerned about school safety and being hurt or bullied by their peers (Saylor & Leach, 2009).

Holt, Chee, Ng, and Bossler, (2013) analysed how the risk of suicide and absenteeism from school are related to online and physical bullying and how technology and several socio-demographic issues affects Singaporean youths. They found that aggression in

both settings is associated with the results and there are significant disparities in suicide ideation between the genders.

8. MOE's Zero Tolerance Policy

The Ministry of Education (MOE) in Singapore has implemented a zero-tolerance school bullying policy. This policy is based on the belief that every student has the right to feel safe and respected. Bullying is unacceptable behavior that must be addressed promptly and effectively.

According to the MOE's Anti-Bullying Framework (Ministry of Education, n.d, para. 4), "bullying is a repeated and intentional act that causes harm to others." This includes physical, verbal, and psychological forms of bullying and cyberbullying. The framework also notes that bullying can take many forms, including direct and indirect actions, and can occur in person or online.

The MOE's zero-tolerance policy on bullying includes several key elements, such as:

- Clear and consistent disciplinary actions for those who engage in bullying behaviour
- Support and resources for students who have been bullied
- Education and awareness-raising efforts to prevent bullying
- Collaboration with parents, schools, and community partners to address bullying.

One study conducted by the National Institute of Education (NIE) in Singapore found that the MOE's Anti-Bullying Framework has effectively reduced bullying in schools. The study found that the framework's emphasis on clear and consistent disciplinary actions, as well as its focus on providing support and resources for victims, has contributed to a decrease in the prevalence of bullying in Singaporean schools (Chua, Wong & Ang, 2016)

Another study published in the Journal of Educational Psychology found that the MOE's efforts to raise awareness about bullying and provide education on how to prevent it has effectively reduced bullying in schools. The study found that students who received education on bullying prevention were less likely to engage in bullying behavior and more likely to intervene when they witnessed bullying (Wang, Ang & Chua, 2019)

In conclusion, the Ministry of Education in Singapore has implemented a zero-tolerance policy on bullying in schools, based on the principle that every student has the right to feel safe and respected. The policy includes several key elements, such as clear and

consistent disciplinary actions, support and resources for victims, education and awareness-raising efforts, and collaboration with parents, schools, and community partners. Studies have shown that the MOE's efforts have been effectively reducing the incidence of bullying in Singaporean schools.

Current Study and Hypothesis

Thus far, there is still a lack of information on how dyslexic students are vulnerable to bullying compared to neurotypical students. Therefore, this research aims to determine the prevalence rates of bullying cases involving students with SEN in Singapore. This allows for a better overview of local bullying cases and would aid in finding out what needs to be done to prevent such cases. The study also hopes to identify the type and duration of bullying most commonly faced by DAS students, the impact of victimization, the intervention and support received and the actions to be taken moving forward.

Hence, it was hypothesized that dyslexic students are vulnerable to bullying and are likely to be bullied due to their learning differences. The hypothesis was then further divided into the following sub-categories:

a. SEN students, especially those with dyslexia do not receive enough support from schools or teachers to address the bullying incidents.

b. There is a lack of awareness about bullying and SEN in schools.

c. Educating parents, teachers, and students about SEN and bullying is necessary.

METHOD AND PROCEDURES

Methodology

Participants

The target participants were parents as we wanted to understand parents' perspectives on whether their dyslexic child is being bullied in school and schools' response towards the incidents. The survey was sent out to 3000 parents with children who were currently or used to be students of the Dyslexia Association of Singapore in September 2019 through email. Out of the 3000, 185 parents responded to the survey. The parents have children ages 5-16 and above (P1: 12.8%, P2: 8%, P3: 10.2%, P4:15%, P5: 13.9%, P6:18.7%, S1:8%, S2:7.5%, S3: 3.7%, S4:2.1%). The majority of their children were male (66%) compared to females (34%). 91% of them only had one child studying at DAS, whereas 9% had two or more children studying at DAS.

Data Collection

A questionnaire consisting of seven multiple-choice questions and fourteen open-ended questions was sent out to parents. The questionnaire questions were adapted from several bullying questionnaire surveys (Harbin, 2016; CDC, 2011; Retrospective Bullying Questionnaire, 1999). The survey was administered via google forms shared with the parents by our centre administrative staff. The team members then collected the responses after the deadline. There was one duplicate response, which was not counted in the analysis.

Procedure

Parents were contacted through email, and they were given three weeks to complete the questionnaire.

The multiple-choice questionnaires asked if the children were verbally, physically, indirectly, or cyber-bullied at school. They also asked if the children were bullied by their peers, teachers, or outside of school (e.g., siblings, uncle, aunts, etc). Parents were asked to rate from a range of Always to Never (refer to the Appendix A).

The open-ended questions were divided into two categories. The first category is based on the ''Perspectives of parents whose SEN children have encountered bullying'' and the second category is the '' Perspectives of parents whose SEN children have not encountered bullying''. Parents who mostly answered ''Sometimes'', ''Often'' or ''Always'' to the multiple-choice questions were directed to the first category. Parents who mostly answered ''Rarely'' or ''Often'' were directed to the second category.

In the first category, questions on the length of bullying incidents, reasons parents thought their child was bullied, if schools gave any help, how the child was coping after the incidents, and what actions needed to be taken to eliminate bullying were asked.

In the second category, questions on why parents believe their child was not targeted, if they agreed that SEN students are vulnerable to bullying, suggestions for parents whose child is being bullied, and if they feel enough is done to minimize bullying were asked.

Data Analysis

The completed questionnaires were subjected to thorough analysis by the research team. The multiple-choice data was initially processed using Google Forms, enabling efficient data collection and organisation. Subsequently, the information obtained was subjected to further analysis utilizing Hotjar data analysis tools. The aim was to extract meaningful insights and patterns from the multiple-choice responses.

In addition to the multiple-choice data, the open-ended responses were meticulously analysed. Hotjar, along with Text Analyzer, was employed to examine and interpret the rich qualitative information provided by the participants. This combination of tools allowed for an in-depth exploration of the open-ended data, enabling the identification of emerging themes, sentiments, and nuances within the participants' written responses.

The utilization of Google Forms, Hotjar data analysis, and Text Analyzer ensured a comprehensive and rigorous examination of both the quantitative and qualitative aspects of the collected data. This rigorous approach to data analysis enhances the validity and reliability of the study findings, enabling a deeper understanding of the research phenomenon.

Text Analyser

Text analysers are software tools that enable researchers to analyse unstructured data such as open-ended survey responses, social media posts, and customer feedback. These tools use natural language processing (NLP) algorithms to identify patterns, themes, and sentiments in large volumes of text data (Mohammad, 2018). Text analysers have become increasingly popular in research and business settings. They allow researchers and analysts to derive meaningful insights from qualitative data that might otherwise be difficult to quantify or interpret.

One widely used text analyser is the open-source software package cal led "Natural Language Toolkit" (NLTK). NLTK is a suite of libraries and programs for symbolic and statistical natural language processing tasks, including tokenization, stemming, and part-of-speech tagging (Bird, Klein, & Loper, 2009).

In the context of our study, the text analyser allowed us to investigate the common themes of each open-ended question in our survey. We used NLTK to preprocess and analyse the text data, identifying key terms and phrases that are indicative of the responses' themes were then incorporated into our analysis of hotjar data to gain a more comprehensive understanding of the information gathered.

HOTJAR

Hotjar is a user experience (UX) analytics and feedback tool that allows website owners to track visitor behavior and collect qualitative data through various methods such as heatmaps, session recordings, surveys, and polls (Hotjar, n.d.). Hotjar captures data from both desktop and mobile devices and provides insights into how users interact with a website, including where they click, how they scroll, and what they engage with (Hotjar Features, n.d.).

In the academic world, Hotjar is a valuable tool for qualitative data analysis in articles and research studies (Sharon, 2013). It provides valuable insights into user behavior and attitudes, which can be used to inform the design and development of digital products and services (Sharon, 2013; Sauro & Lewis, 2016). Additionally, it can be used to evaluate the effectiveness of existing digital products and services and identify improvement areas (Sauro & Lewis, 2016).

In conclusion, Hotjar is a powerful UX analytics and feedback tool that is valuable for academic research, providing insights into user behavior and attitudes that can inform the design and development of digital products and services (Sharon, 2013; Sauro & Lewis, 2016).

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

RESULTS

The study's results significantly supported the hypothesis that SEN students, especially those with dyslexia are vulnerable to bullying and are likely targets due to their learning differences. A significant number of participants shared their experiences with the types of bullying faced by their children and the type of support they received or did not receive from schools and teachers. Participants also expressed their concerns over the lack of awareness about SEN in schools and the need for education on special needs and bullying.

Types of Bullying

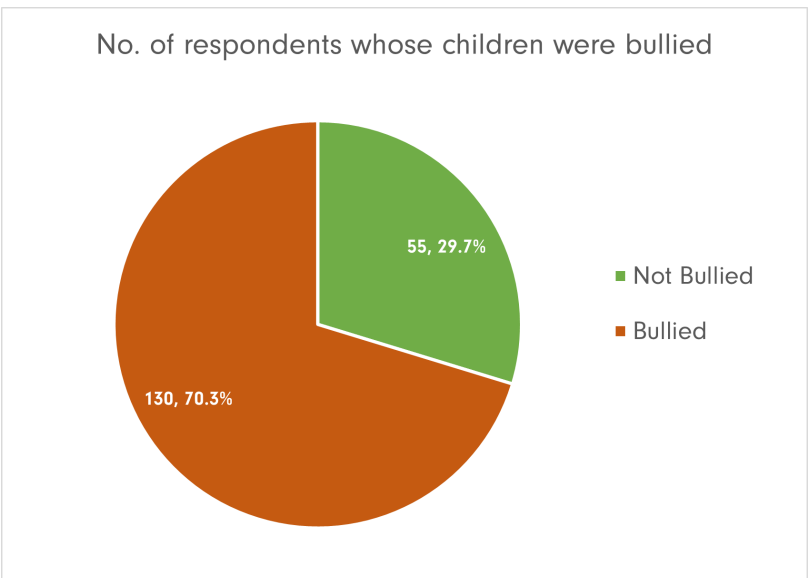

Figure 3: No respondents who indicated that their child was bullied.

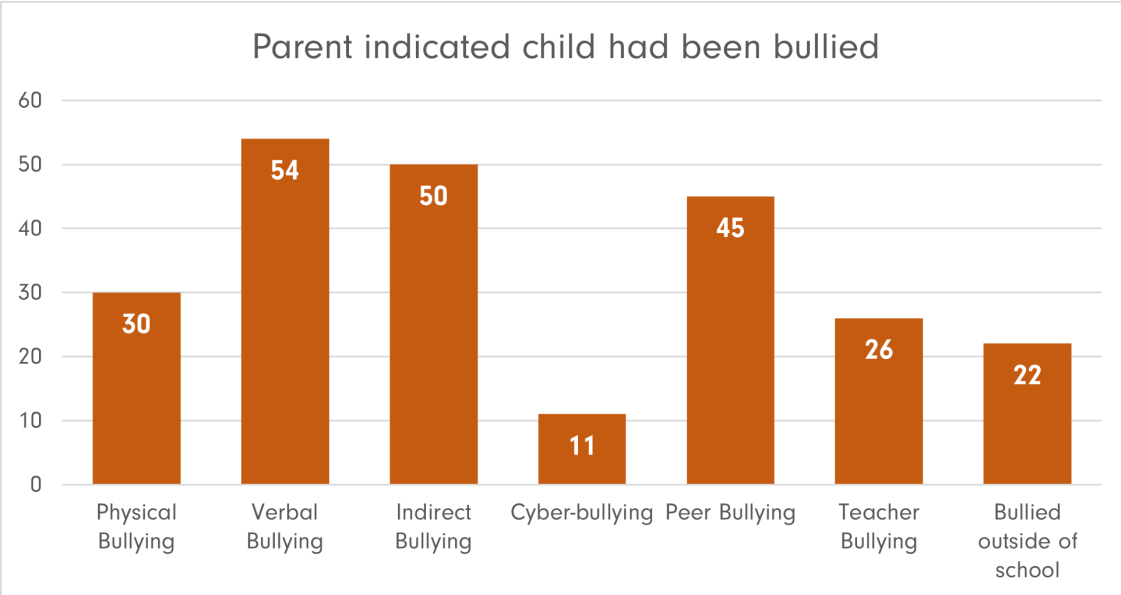

Figure 4: Summary of parent indicating that their child has been bullied.

As represented by Figure 3, 70.3% of the respondents indicated that their child had been bullied, and 29.7% indicated that their child had not been bullied.

Parents were then asked about the bullying their child faced in and out of school. Participants were asked to indicate if their children faced any physical bullying at school, verbal bullying at school, indirect bullying at school, cyber-bullying, bullying by their

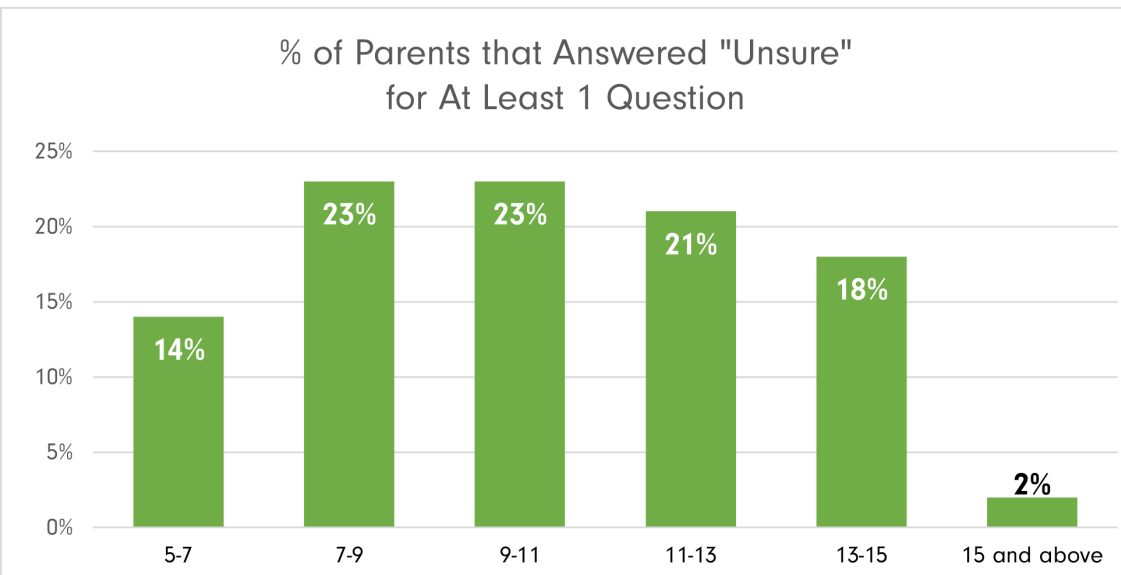

Figure 5: Significant number of parents answering ''Unsure''

peers, bullying by their teachers, and/or bullied outside of school. They were asked to rate from Never, Rarely, Sometimes, Often, Always, or Unsure.
It was found that the top three types of bullying faced by these children were Verbal Bullying (54%), Indirect Bullying (50%), and Peer Bullying (45%), as highlighted in Figure 4. Cyberbullying was also deemed the lowest form of bullying faced by children (11%). Figure 5 highlights that many parents are unsure if their child has been bullied in the seven areas mentioned above. The most significant percentage (23%) seems to be from the age group of parents with children 7-9 and 9-11, followed by 11-13 years old (21%).

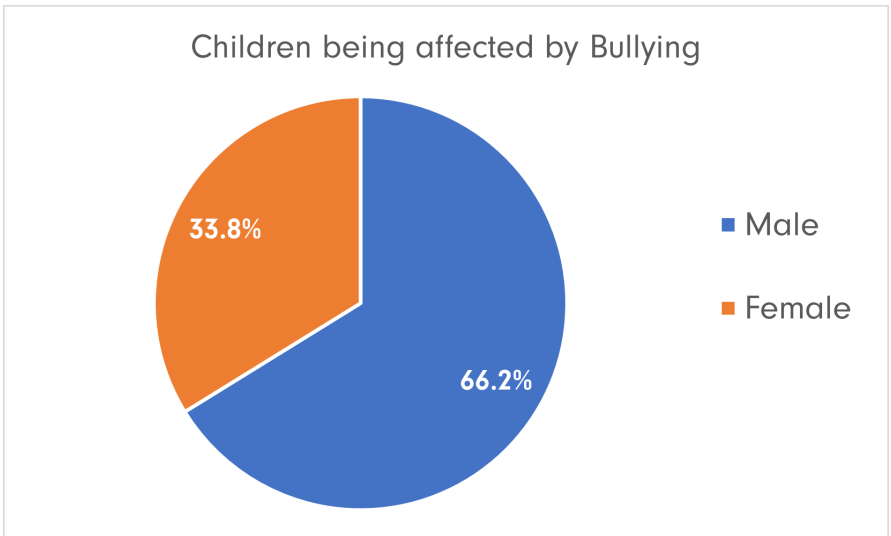

Figure 6: Gender-wise distribution of children affected by bullying

Figure 6 presents data on the gender of children affected by bullying. The results indicate that 66.2% of the children affected by bullying were male, while 33.8% were female. This finding aligns with previous research that has shown that boys are more likely to be victims of bullying than girls (Espelage & Swearer, 2020; Kowalski & Limber, 2013). However, it is essential to note that this gender difference may be influenced by various factors, including socialization, cultural expectations, and the types of bullying behavior that are more common among boys versus girls.

Duration of Bullying Incidents

According to the data presented in Figure 7, a notable portion of children experienced prolonged bullying episodes; specifically, 25% of the children were bullied for multiple years, while 16% reported being bullied more than twice. In addition, 10% of the children experienced bullying for several months, 4% experienced it only once, and 3% experienced it twice. Furthermore, a small percentage of children reported experiencing bullying for shorter periods, with 2% indicating it lasted only a few weeks.

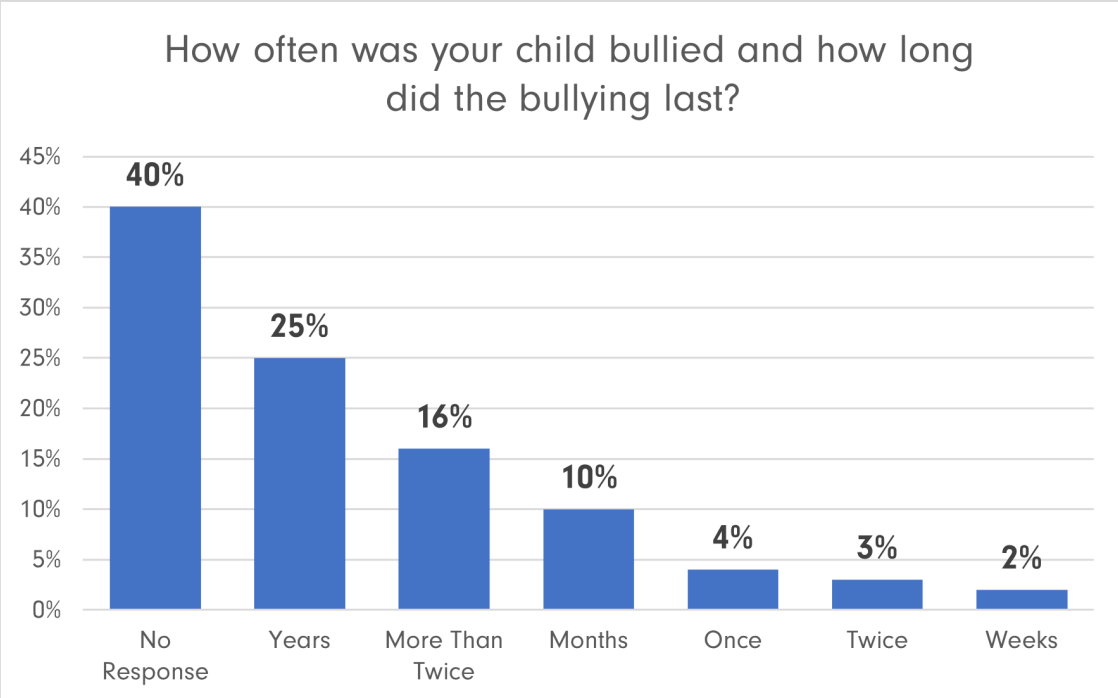

Figure 7: Frequency and Duration of Bullying Incidents Experienced by Children

Parents' Perspectives

Results of the survey indicate that children may be bullied for a variety of reasons, including difficulties with social cues (13%), low self-confidence (11%), low academic performance or forgetfulness (24%), a passive nature (27%), emotions that are easily triggered (5%), difficulty fitting in (9%), and difficulties with expression (10%). It is important to note that these are parent-reported reasons do not necessarily reflect the underlying causes of bullying. Nevertheless, these findings suggest that addressing underlying emotional and social issues, improving academic performance, and reducing forgetfulness may be essential factors in preventing bullying. Additionally, strategies that help children develop vital social skills and build self-confidence may prevent bullying.

Follow-up Actions after Bullying Incidents

It was found that 59% of the respondents reported the bullying incidents to the school staff, whereas 28% did not. Among those who reported bullying, only 13% reported that the school staff refused to acknowledge the bullying case and took no action to address it. On the other hand, 87% of the respondents reported that the school staff acknowledged the bullying case and took appropriate action to address it. These results highlight the importance of school staff intervention in addressing bullying incidents and the need to ensure that schools have effective reporting and response mechanisms to

Table 1: Reporting of Bullying and School Response: Parental Quotes

SCHOOLS IGNORED THE BULLYING.	THE SCHOOL ACKNOWLEDGED THE BULLYING
''School teachers usually dismiss such incidents and tell children to stop complaining.''	''Investigation is still ongoing. Teachers are very responsive.''
''I had emailed the Teachers and principal, but no effort was taken in it.''	''Usually, when it occurs, she will inform the teacher-in-charge immediately. However, the teacher will lecture the bully on the spot, and no follow-up to counsel my child or the bully after that. So the bullying will continue another day.''
''Sometimes, but I feel the teachers do not listen to her and feel she is always in the wrong.''	''Teacher asked for a written report, and action was taken. The bullies' parents were informed, and the boys apologized and signed a written contract that promised not always to harm my son. My son was taught how to deal with bullies in the future by the school counsellor and AED.''
''No, he did not approach anyone, or he might have and was told it was not an issue. The school even denied they had "bullying" issues - they insist they do not have bullies in St James. He had his pants pulled down by the other kids once, and the school mentioned nothing to me, but they were aware of the incident when I raised it.''	''She initially reported to the teacher, who responded by speaking to the bully to apologize. However, when it happened again, I took the time to go down to school and speak to the teacher. The teacher spoke to the child once again. I also spoke to the van driver, who feedback that d bully herself used to be a bully victim. All in all, the matter was resolved more or less. Moreover, now she is in Pri 3 and no longer sees d bully as much as in different sessions (the bully is 1 yr older).''

tackle this issue. It is also important to note that a significant proportion of bullying incidents may go unreported, indicating the need for increased awareness and support for victims to come forward and report such incidents.

Impact of Bullying on the Child

The data in this study indicate that a significant proportion of children experience bullying, and many may suffer adverse consequences Out of the total respondents, 27.64% of parents reported that their child had avoided school due to bullying, with fear and anxiety being a major factor. 8.18% of parents reported that their child had thought about hurting themselves or taking their own life as a result of bullying, with depression and low self-esteem being significant factors. However, when children received at least one type of support, such as familial support or professional support, they were more likely to cope well with the bullying. Among those who did not cope well, avoidance and withdrawal were common coping mechanisms towards distress, and they experienced behavior changes such as increased aggression and becoming less trusting or socially avoidant. These findings highlight the importance of addressing bullying and providing support to children who experience it, both in school and at home, to prevent the negative consequences that can result.

Overall, the data suggests that a significant proportion of children experienced negative outcomes due to bullying. A total of 27.64% of children avoided school due to bullying, and those who did reported feelings of fear, anxiety, and a lack of motivation. Additionally, 8.18% of children reported thinking about hurting themselves or taking their life due to the bullying, with low self-confidence and depression being common contributing factors. However, it's worth noting that the majority of children did not experience these severe outcomes, with 78.18% reporting no suicidal thoughts or attempts.

Regarding coping strategies, the results indicate that receiving support from family and friends can be helpful for children dealing with bullying, with 56% of children who received at least one type of support reporting that they coped well. However, only 25% of children who did not cope well reported receiving support, suggesting that more needs to be done to ensure that children are aware of the support available to them.

Finally, while some children reported increased aggression or behavior changes following the bullying, many also grew more resilient in the face of adversity. Overall, the data highlights the need for effective bullying prevention and support strategies to be implemented in schools and at home.

Strategies Recommended by Parents to Address Bullying

Bullying in schools has become an increasingly critical issue with negative effects on children's mental and physical health. To tackle this problem, various strategies have been proposed to prevent and manage bullying effectively. The results indicate that raising awareness is considered the most effective strategy for addressing bullying by

33% of respondents, followed by school involvement (26%) and parental involvement (22%).

In terms of school involvement, respondents believe that teaching children how to handle bullying (38%) and rehabilitating both bullies and victims (56%) are the most effective methods. Teachers play a crucial role in managing bullying cases (23%), followed by parents (12%), and students (65%). Respondents suggest that open communication with schools (37%) and with their child (36%) and encouragement to build confidence (14%) and resilience (9%) are the most useful strategies for parents of bullied children. Finally, a majority of respondents (37%) feel that more needs to be done to minimize bullying, with educating parents (11%) and teachers (16%) being the top two suggestions. Students (74%) have also been identified as a crucial population to educate about bullying. Overall, these findings indicate the importance of collaborative efforts between schools, parents, and students to prevent and manage bullying effectively.

The data suggests that raising awareness, school involvement, parental involvement, and mediation are the most common strategies for addressing bullying. The majority of respondents believe that schools should take an active role in preventing and addressing bullying, with 65% suggesting that schools should focus on educating students about how to handle bullying. Respondents also suggested that rehabilitating both bullies and victims (56%) and teaching children socioemotional skills (33%) are important approaches. Additionally, open communication between schools and parents (37%) and between parents and children (36%) was recommended. Encouraging children and building their confidence (14%), teaching resilience (9%), and helping children to excel in other areas (4%) were other strategies suggested by respondents. However, the data indicates that there is still work to be done to minimize bullying, as over half of the respondents (59%) believe that more needs to be done, either through training and education for parents and teachers (37%) or raising awareness (22%).

Understanding the Risk of Bullying among Students with SEN

The issue of bullying among students with special educational needs (SEN) is a growing concern in many educational settings. According to the data presented, the majority of respondents (70%) agreed that students with SEN are at greater risk of being bullied than children without learning disabilities. The main reasons cited for this were exclusion (21.21%) and being viewed as different (33.33%), which can lead to low self-esteem (15.15%) among students with SEN. These findings suggest that there is a need for greater awareness and education on how to prevent and address bullying among students with SEN. It is important for educators, parents, and students to work together to create a safe and inclusive learning environment for all students, regardless of their learning abilities.

In addition, the data shows that a significant number of respondents (23%) disagreed with the statement that students with SEN are at greater risk of being bullied, while 7% were unsure. This highlights the need for further research and discussion on the issue. It is possible that those who disagreed or were unsure may not fully understand the challenges that students with SEN face or the impact that bullying can have on their mental health and academic performance.

DISCUSSION

The present study highlights the prevalence and types of bullying experienced by school-aged children based on parental reports. The high percentage of parents reporting that their child has been bullied emphasizes the need for effective prevention and intervention strategies. The findings also indicate that verbal, indirect and peer bullying are the most common types of bullying, suggesting the need for interventions targeting these forms of aggression. The low prevalence of cyberbullying reported by parents could be due to under-reporting or a lack of awareness of this issue among parents.

Based on the data presented in the study, it becomes evident that children with special educational needs (SEN) are at a higher risk of experiencing bullying. This is consistent with previous research, which has found that children with disabilities or learning difficulties are more likely to be bullied than their non-disabled peers (Espelage & Swearer, 2003; Unnever & Cornell, 2003). However, it is important to note that while the data suggests a higher risk for SEN children, further investigation is needed to confirm this observation, particularly from the parents' perspectives.

One possible explanation for this is that children with SEN may be perceived as different or less capable by their peers, making them more vulnerable to bullying (Rose et al., 2012). Additionally, it is worth noting that some parents included in the study had children who were not identified as having special educational needs. While this suggests the presence of non-SEN students in the sample, additional information is required to confirm this and explore potential dynamics between non-SEN students and their peers with SEN in relation to bullying experiences.

The study also found that bullying incidents were often prolonged, with a quarter of children experiencing it for multiple years. This is concerning, as prolonged bullying can have long-term negative effects on a child's mental health and well-being (Arseneault et al., 2010). It is important for schools to take a proactive approach to addressing bullying and to provide ongoing support for victims.

As per the findings parents of children aged 7-11 were particularly uncertain about whether their child had experienced bullying. This suggests that younger children may be less likely to report bullying incidents or may not fully understand what constitutes

bullying. It is important for parents and teachers to educate children about what bullying is and how to report it.

The data also suggests that boys were more likely to be victims of bullying than girls. This is consistent with previous research, which has consistently found that boys are more likely to be both victims and perpetrators of bullying than girls (Smith et al., 2002). It is important for schools to address this gender disparity and to provide support and resources for male victims of bullying.
Moreover, parents reported various reasons why their child may be bullied, including difficulties with social cues and low self-confidence. This suggests that strategies that help children develop stronger social skills and build self-confidence may be effective in preventing bullying. For example, social skills training programs have been found to be effective in reducing bullying and improving social skills among children with SEN (Woods & Wolke, 2004).

Additionally, the study highlights the importance of reporting bullying incidents to school staff. While a majority of parents reported the bullying incidents to school staff, a significant proportion of incidents may go unreported. It is important for schools to create a safe and supportive environment where children feel comfortable reporting bullying incidents and for staff to take appropriate action to address them.

The evidence presented corroborates a need to improve awareness and support for victims of bullying. A significant proportion of bullying incidents may go unreported, highlighting the need for increased awareness and support for victims. This finding is consistent with previous research that indicates that many incidents of bullying go unreported, particularly among students with disabilities (Hymel et al., 2013). The study affirms that parents reported various reasons why their child might be bullied, including difficulties with social cues and low self-confidence. Therefore, strategies that help children develop stronger social skills and build self-confidence may be effective in preventing bullying.

The results of the research also highlight the need for increased awareness about special needs and bullying in schools. Many parents expressed concerns over the lack of awareness about SEN in schools and the need for education on the topics of special needs and bullying. Therefore, it is essential to provide training to teachers and staff members to increase their understanding of SEN and how to support students who are victims of bullying. Additionally, there is a need for more targeted educational interventions for students, which can increase their understanding of disabilities and promote positive attitudes towards students with special needs.

The findings from both Figure 3 and Figure 4 underscore the importance of continued efforts to address and prevent bullying in schools and other settings. Parents and educators should be aware of the prevalence of bullying and its potential impacts on

children's mental health, academic achievement, and overall well-being. In addition, efforts to promote positive social relationships, empathy, and conflict resolution skills among children may help to prevent and reduce bullying behaviours.

The goal of the research was to examine the vulnerability of special educational needs (SEN) students to bullying and the support mechanisms available to them in schools. The evidence presented here supports the hypothesis that SEN students are particularly vulnerable to bullying due to their learning differences, with a majority of respondents reporting that their child had been bullied. This is consistent with previous research that has identified SEN students as a high-risk group for bullying (Rose et al., 2012).

The study further supports the hypothesis that there is a lack of support for SEN students in schools. Participants shared their experiences of schools not taking appropriate addressing or failing to provide the necessary support to SEN students. This finding is consistent with previous research that has identified a lack of support for SEN students in schools (Ttofi et al., 2011).

Moreover, the results support the hypothesis that there is a lack of awareness about SEN and bullying in schools. Parents expressed concerns about the lack of awareness and education on these topics among teachers, students, and parents. This finding aligns with previous research that has highlighted the need for increased awareness and education about SEN and bullying in schools (Ttofi et al., 2011; Rose et al., 2012).

The results add weight to the hypothesis that educating parents, teachers, and students about SEN and bullying is essential. Participants highlighted the need for increased education and awareness about SEN and bullying to prevent and address bullying incidents. This finding is consistent with previous research emphasizing the importance of education and awareness in preventing and addressing bullying incidents (Ttofi et al., 2011).

In conclusion, the results of the present study provide strong support for the hypothesis that SEN students are vulnerable to bullying and are likely to be bullied due to their learning differences. The study also highlights the need for increased support mechanisms, awareness about SEN and bullying in schools, and education for parents, teachers, and students. Future research could further explore the effectiveness of strategies to prevent bullying and support SEN students in schools.

LIMITATIONS

Despite the valuable insights gained from this study, some limitations should be acknowledged. Firstly, the study's sample size was relatively small and may not represent the broader population of SEN students and their families. Additionally, the sample was limited to parents of dyslexic students from the Dyslexia Association of

Singapore. It may have included only those more likely to report bullying incidents, potentially overestimating the true prevalence of bullying.

Furthermore, the study relied on self-report data from parents, which may not accurately reflect their children's experiences. Children with SEN may have difficulty communicating their experiences, or parents may not be aware of all bullying incidents their child may have experienced. It would be valuable for future research to include data directly from SEN students, potentially through interviews or focus groups.
Another limitation of the study is that it was conducted in a single geographical location and may not be generalizable to other regions or cultures. It would be valuable for future studies to include a more diverse sample to understand better the cultural and contextual factors that may impact bullying experiences for SEN students.

Finally, the study focused solely on the experiences of SEN students and did not include a comparison group of non-SEN students. A comparison group would allow for a better understanding of whether bullying experiences for SEN students differ from those of their non-SEN peers.

Overall, while this study provides important insights into the experiences of SEN students and their families, some limitations should be considered in future research to better understand the issue of bullying in this population.

CONCLUSION

In conclusion, the present study sheds light on the prevalence and nature of bullying experienced by students with special educational needs (SEN). The findings of this study provide strong evidence that SEN students are particularly vulnerable to bullying due to their learning differences, with a majority of respondents reporting that their child had been bullied. Verbal, indirect, and peer bullying were the most common forms, with cyberbullying being less prevalent. The study also found that bullying incidents were often prolonged, with a quarter of children experiencing it for multiple years.

The research also underscores the need for increased awareness and practical strategies to prevent and address bullying among school-aged children. Parents, educators, and policymakers should collaborate to create safe and inclusive learning environments for all students.

The study highlights the need for increased awareness about special needs and bullying in schools and improved support mechanisms for victims of bullying. Strategies that help children develop stronger social skills and build self-confidence may effectively prevent bullying. However, it is essential to recognise the study's limitations, including its reliance on parent-reported data, which may not accurately capture the full extent of bullying experienced by children with SEN. Further research is needed to explore the perspectives

of children with SEN on their experiences of bullying and investigate the effectiveness of specific interventions and support mechanisms in preventing and addressing the bullying of SEN students.

Overall, the findings of this study have important implications for educators, policymakers, and parents. Schools must develop comprehensive policies and practices to prevent bullying and support students with special educational needs at heightened risk of bullying. Additionally, there is a need for increased awareness and education about special needs and bullying among all stakeholders, including parents, teachers, and students. By working together, we can create safer and more inclusive learning environments for all students, regardless of their learning differences or abilities.

FUTURE RECOMMENDATIONS

Based on the results and discussion above, several future recommendations can be made to address the issue of bullying among SEN students. Firstly, schools and teachers should receive comprehensive training on identifying, preventing, and addressing bullying incidents, particularly those involving SEN students. This training should include strategies for promoting a positive and inclusive classroom environment, developing social skills among students, and building self-confidence and resilience.

Secondly, there is a need for increased awareness and education among parents, teachers, and students about special needs and bullying. This could be achieved through regular workshops, training sessions, and awareness campaigns that address SEN students' unique challenges and provide strategies for supporting and protecting them from bullying.

Thirdly, schools and educators should take a more proactive approach to addressing bullying incidents, particularly those involving SEN students. This may involve implementing clear reporting procedures, providing additional support and resources for victims of bullying, and working closely with parents and caregivers to ensure that students receive the necessary support and interventions.

Finally, future research should focus on developing evidence-based interventions and programs to address bullying among SEN students. These interventions should be rigorously evaluated to determine their effectiveness in reducing bullying incidents and improving SEN students' well-being and academic outcomes.

Overall, addressing the issue of bullying among SEN students requires a comprehensive and coordinated approach that involves schools, educators, parents, and students. By working together and implementing evidence-based interventions and strategies, we can create a safer and more inclusive learning environment for all students, regardless of their abilities or learning differences.

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APPENDIX 1—DAS Bullying Questionnaire

ARE YOU CONCERNED THAT YOUR CHILD IS BEING BULLIED?

DAS BULLYING QUESTIONNAIRE

Dear DAS Parent,

DAS is committed to providing support for you and your child in areas influencing their learning. You may have read in National media about Bullying and how it affects those who are discriminated upon by various acts. The issue of bullying is particularly critical for children with Special Educational Needs as it affects learning and emotional health.

This survey has been designed to obtain information of the prevalence, nature of and support for acts of bullying encountered by children with dyslexia. Your contributions will prompt further action, including the development of Behaviour Management to support students and parents.

Please be assured that all information shared in this survey will be kept private and confidential. When sharing the final report, all information will be anonymised. This survey will take between 10-20 minutes to complete. Thank you for taking the time to complete this survey.

Madinah Begum
Educational Advisor, Dyslexia Association of Singapore (madinah@das.org.sg)

SECTION 1:BACKGROUND DATA

Name of parent: _____ (OPTIONAL)

No. of Children attending DAS: 1| 2 | 3 | 4 (please select one)

	Child 1	Child 2	Child 3	Child 4
Name of child at DAS				
Age				
School level				
Gender				
DAS Learning Centre				

Number of Family Members: □ 1–2 □ 3–5 □ 6–10 □ more than 10

Email Address of parents: _____

(OPTIONAL – Please provide us with this information if you consent to us contacting you to further clarify your responses.)

SECTION 2: PREVALENCE OF BULLYING

Please indicate your level of agreement or disagreement with each of these statements regarding Bullying.

Questions on the Prevalence of Bullying	Always	Often	Some-times	Rarely	Never
1. Was your child physically bullied at school?					
2. Was your child verbally bullied at school?					
3. Was your child indirectly bullied at school? (e.g, peers talking behind their back, being excluded from peer circles)					
4. Was your child ever cyberbullied?					
5. Was your child bullied by his peers?					
6. Was your child bullied by his teachers?					
7. Was your child bullied outside of school (e.g, siblings, cousins, uncle, aunt, etc)					

If you answered Sometimes, Often and/or Always to any of the above questions, please proceed to Section 3. ^

If you answered Rarely and/or Never to all the questions, please proceed to Section 4. *

^ *(Internal comment - Those who have children who have been bullied respond to sections 1,2 & 3. Total number of Qns:21)*

* *(Internal comment - Those who have children who have not been bullied respond to sections 1,2 & 4. Total number of Qns:15)*

SECTION 3:

PERSPECTIVES OF PARENTS WHOSE SEN CHILDREN HAVE ENCOUNTERED BULLYING

Please complete this if you answered "Sometimes", "Often" and/or "Always" to any of the questions in Section 2. We appreciate your honest and open responses to the following questions.

Q9: How often was your child bullied and how long did the bullying last? Elaborate more on the bullying incident/s.

_____

Q10: Why do you think your child was bullied?

_____

Q11: Did you or your child approach the school staff to report the bullying? If yes, please elaborate on the response from the school?

_____

Q12: Did your child avoid school by playing truant or pretending to be sick because they were bullied? If yes, please elaborate.

_____

Q13: Did your child think about hurting him/herself or taking his/her life? If yes, please elaborate.

_____

Q14: Is your child coping well with the bullying? If yes, what has helped your child cope with the bullying?

_____

Q15: Does your child feel distressed in situations which remind them of the bullying event/s? If yes, please elaborate.

_____

Q16: Did the bullying event/s cause long-term effects to your child? If yes, please describe below.

_____

Q17: What do you think adults/schools/parents do to eliminate bullying in school?

_____

END

Your views are very important to us.

Thank you for taking the time to participate in this study. If you would like to find out more about the study or what can be done to support your child with the bullying encountered in school, please contact me at: madinah@das.org.sg

SECTION 4:

PERSPECTIVES OF PARENTS WHOSE SEN CHILDREN HAVE NOT ENCOUNTERED BULLYING

Please complete this if you answered "Rarely" and/or "Never" to the questions in Section 2.

We appreciate your honest and open responses to the following questions.

Q18: "Students with SEN are at greater risk of being bullied than a child without learning disabilities." Do you agree with that statement? Please elaborate.

_____

Q19: Why do you think your child has not been bullied? Please elaborate.

_____

Q20: What suggestions do you have for parents of children who are being bullied?

_____

Q21: Do you think that enough is done to minimise bullying? If no, please elaborate on what else you feel can be done to improve this for SEN learners.

_____

END

Your views are very important to us.

Thank you for taking the time to participate in this study. If you would like to find out more about the study or what can be done to support your child with the bullying encountered in school, please contact me at: madinah@das.org.sg

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Effectiveness of incorporating a structured e-books programme to improve the outcomes for early struggling readers

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Abstract

Using a mixed study design of both qualitative and quantitative data analysis, this paper examined the implementation of Raz-Kids interactive electronic-books (e-books) levelled readers for shared reading in four preschool early literacy intervention classrooms (PELP) located at three different learning centres. The study looked at educational therapists' implementation of shared e-book sessions, projecting e-books onto a screen to extend the shared reading experience, and the impact this had on struggling readers' early literacy skills and comprehension. Participants included a diverse sample of 20 children and 5 Educational Therapists (EdTs). Following a brief training session to ensure consistency of approach across the sample, teachers conducted 10 e-book shared reading sessions, over a 10-week period. A pre and post informal curriculum-based measure was used and compared with a control group to assess learning. Results suggest that the use of Raz-Kids e-books had helped in improving pupils' comprehension skills and complement teaching, learning and reading engagement. It concludes that there is similar effect from shared reading using print books to shared reading using e-books, and that both support children's learning of discrete literacy skills, but may not be enough in helping them to become independent readers

Keywords: Struggling Learners, Preschool, Raz-Kids, Reading, e-books

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INTRODUCTION

While most children follow a typical trajectory in their development of early language and literacy skills, some show signs of struggle or gaps in their learning very early on, with initial difficulties being observed in children as young as 3 years of age (Government of Ireland, 2001; Shaywitz, 2004). Young children may fail to pick up reading skills due to a number of reasons. These reasons include, but are not limited to, a lack of exposure, developmental delay, and dyslexic-type difficulties. The prevalence of dyslexia from international studies amongst the school-going population is estimated to be between 4-10% (BDA, n.d.).

Most recent research emphasizes the importance of early intervention over a "wait-and-see" approach, suggesting that it is imperative to identify problems in early literacy delay, regardless of causation, and provide timely intervention (Torgesen, 2001; Greenwood et al., 2015; Bick and Nelson, 2016). This is necessary because the plasticity of the brain is at its maximum between the ages of 0 to 6 (Richards et al., 2000; Simos et al., 2002; Bick and Nelson, 2016). Support provided for children struggling in nursery can be effective from the age of 4, and sustainable over the next 18 months (Fawcett et al., 2014). The early years provide a golden window of opportunity for learning and therefore seeking effective ways to identify and improve children's language and literacy skills and ultimately, their school readiness during this time is important (Greenwood et al., 2015).

Supporting the varied learning needs and learning styles of kindergarteners with literacy learning difficulties requires the use of a variety of specialised resources for teaching and learning. One such initiative by the DAS is the incorporation of Electronic Books (e-books), which provides a platform to enhance children's language and literacy skills through technology (Larson, 2010). Computer-assisted reading support can be a particularly effective tool to support struggling readers (Ivey, 2000; Nicolson, Fawcett; Nicolson, 2000; Thompson, 2014). It has also been postulated by some that even the most reluctant readers enjoy reading using technology (Picton and Clark, 2015).

Dyslexia Association of Singapore (DAS) utilises smart technology to enhance children's learning experiences (Shamdasani, 2018). The local curriculum / framework for preschool curriculum Nurturing Early Learners (NEL) allows for the incorporation of information Communication Technology (ICT) into its curriculum, subject to three guiding principles: that it complements learning, that it is facilitated, and that its benefits and drawbacks are carefully considered by teachers (MOE, 2012). It is hoped that such technological platforms may provide pupils who have learning difficulties with an additional avenue to access learning, support in narrowing gaps and may help instil the motivation in such children to want to explore books, listen to stories, read willingly, and read for enjoyment. A fundamental principle of Vygotsky's Social Constructivist Theory is that of the Zone of Proximal Development (ZPD), which supports the notion that difficult

tasks can be mastered with guidance from more-skilled peers or adults (Shabani, Khatib and Ebadi, 2010). Children with learning difficulties often do better with extra support and in many cases these children need quite extensive guidance from a more skilled adult or peer.

By listening to stories being read aloud, children can improve vastly as this process builds vocabulary, helps develop children's recognition of commonly used words, exposes them to the structure and grammar of the language and enhances their alphabet knowledge, all of which are important in learning to read (MOE, 2013). As emphasised by Sticht (2017), no matter how well children can read, it is their listening and speaking vocabulary which will support making sense and understanding. Shared reading, along with quality questioning techniques, builds pupils' comprehension, vocabulary, oracy, knowledge and higher-order thinking skills (Ng at el., 2019). During the Preschool Early Literacy Programme (PELP) intervention, shared reading is carried out for 30 minute sessions. Educational Therapists (EdTs) complement quality interactions through oracy and use various questioning techniques during shared reading. The books that EdTs use are alternated between conventional and e-books. The DAS PELP utilises e-books from Raz-Kids, also known as the Kids A-Z or Raz-Plus reading program.

Raz-Kids is multi-faceted and can be employed in different ways and on multiple devices (Thompson, 2014; Marchand, 2015). Raz-Kids Interactive e-books can read themselves to children (ear reading) as they follow along. Some books include animation as the story unfolds, and all have a voice-recording function that allows children to record and listen to their own voice as they attempt to read the text. Within Raz-Kids there are different genres of e-books available. The digital features of interactive e-books were employed during shared reading to further supplement teaching, learning of early reading skills, reading comprehension and foster reading engagement. It is not employed as a substitute to print books, more so as a complementary addition to the collection of books which may be designated.

Studies on the Raz-Kids program found it to be motivating children to read, and this included those who were reluctant to read print books (Widmyer, 2011; Thompson 2014; Marchand, 2015; Picton and Clark, 2015; Klein, n.d.). Korat and Shamir (2012) identified several educational tools in high level e-books design features for kindergarteners such as (a) oral reading with text highlights; (b) a dictionary option; (c) multiple choice questions strategically placed in the story line and; (d) a game mode separate from text mode.

Schneps et al. (2013), compared reading on paper and on a small handheld e-reader device for 103 high-school students with dyslexia and found that the e-reader significantly improved reading fluency and comprehension. It is possible that for some e-books offer accessibility options, that are impossible in print.

One of the first and largest researches into the impact of e-books on school reading attitudes was for the National Literacy Trust, spearheaded by Picton and Clark (2015). They measured pupils' attainment in 40 United Kingdom (UK) schools for a period of 10 months. The study concluded that using e-books can significantly raise literacy levels, improve engagement and change attitudes to reading for reluctant readers. Their study revealed more improvement for boys as compared with girls who also improved and findings correlated with positive changes in reading attitudes (Picton and Clark, 2015). Significant findings point to lifelong lasting ingrained positive attitudes towards reading enjoyment (Picton and Clark, 2015).

Several studies have shown that adults can facilitate children's understanding of stories by engaging them in discussions and by explaining events or making connections between books, events and the children's own lives, thus activating their prior knowledge (Bus and van IJzendoorn, 1995; Neuman, 1996; Lonigan, Shanahan, and Cunningham, 2008). Studies by Bus and van IJzendoorn (1995) and Neuman (1996), shows that comprehension can be facilitated through engaging children in discussions, explaining events, asking questions, and supporting children in making connections with their own world and experiences. Ministry of Education (2013), describes different levels of comprehension as literal, inferential, critical, application and appreciation that children should develop in order to make deeper and fuller sense of a text. Research has found that such reading experiences are highly beneficial for children and the benefits include fostering listening skills, building a strong foundation in literacy and language skills, delivering enriched language exposure, building vocabulary, and supporting reading comprehension (Bus and van IJzendoorn, 1995; Grimshaw et al., 2007; Lonigan, Shanahan, and Cunningham, 2008; Neuman, 1996; Sticht, 2017).

In an independent research summary on questioning in teaching conducted by The Singapore Kindergarten Impact Project (SKIP), it was revealed that kindergarteners should be asked questions at both the literal and inferential level, and that children's comprehension skills acquisition is not linear (Ng et al., 2019). It was concluded by Ng and colleagues (2019) that inferential questions engage children in critical thinking, and that teachers should be encouraged to ask a variety of questions that boost vocabulary building, higher order thinking and oracy. NEL's curriculum framework highlights the importance of using a dialogic, shared book approach, and asking levelled questions which to some extent challenge and complement a child's level of thinking and expression.

EdTs plan different levels of questions ranging from literal, to inferential to critical, which they ask throughout the shared reading experience. Children can choose to answer multiple-choice quiz questions projected on the screen, later given on a printed worksheet. With prompting and support from EdTs, pupils try to tackle specific comprehension skills such as main idea, recall of text details, retelling, character analysis, classification of information, cause and effect, comparing and contrasting, fact

or opinion, identifying problems and solutions, sequencing events, identifying reality or fantasy, making inferences and drawing conclusions, identifying story elements, and vocabulary (Marchand, 2015).

Research aims

The purpose of this study was to determine whether the interactive electronic books (e-books) that are part of the computer program, Raz-Kids, might assist in supporting early core literacy skills and comprehension for 5-6-year old children attending DAS PELP.

Research Questions

The study was designed to answer the following questions:

1. Does incorporating a structured, interactive e-books program as part of early intervention for early struggling readers improve their reading skills and levels of engagement?
2. What are the benefits and drawbacks of the e-books reading program within PELP as perceived by the teachers?

Professional Role and relationship to participants

The researcher's professional role in this research was as an educational therapist working with kindergarteners with weak literacy skills and as a key member of the PELP. The researcher guided and supported preschool therapists initially on using the Raz-Kids e-books reading programme within their classrooms. The therapists then began carrying out the e-books reading programme in their classroom.

Research Design

Stratified sampling was used for the purpose of this study to group the pupils based on the variables being measured. Pupils with any formal diagnosis were excluded from this study. The researcher then carried out a simple random sample from this group to obtain a stratum.

Participants

The quantitative study sample consisted of 20 children in kindergarten 2 aged between 5 years to 6 years old. They were split equally into the experimental group and the control group. The children had varied levels of literacy but all of them exhibited dyslexia-type tendencies. The experimental group consisted of 5 boys and 5 girls. They read 2.3 (SD= 2.1) books on average with their parents for 180 (SD=138.6) minutes weekly. The control

group consisted of 7 boys and 3 girls and read 3 (SD=2.36) books on average with their parents for 160 (SD=119.2) minutes weekly.

The qualitative study sample consisted of the above-mentioned children as well as 14 female preschool educational therapists who had worked an average of 4.5 years (SD=3.2) in the DAS. They filled out a survey, revealing their experiences with the use of Raz-Kids e-books during shared-reading within early intervention.

Procedure

Experimental group

DAS, PELP Educational Therapists (EdTs) applied the shared-book approach (SBA) to reading instruction by utilizing Raz-Kids e-books. During SBA for the experimental group, books were projected onto a big screen in the classroom whereas the control group received the traditional SBA with print books. The sessions were carried out for 30 minutes once a week for a duration of 10 weeks. The experimental group involved pupils listening (ear reading) to the online e-book, followed by a second round of eye reading-aloud along with the therapist. They were not allowed to access the play features during these sessions. In addition, pupils received instruction in small groups for guided reading and focused on improving oracy, reading fluency and comprehension skills. Fiction and non-fiction levelled stories were selected to teach specific skills such as:

a) asking and answering questions about key details in text,
b) retelling a story,
c) making reasonable predictions and change predictions according to story's unfolding plot,
d) using illustrations and details in a story to describe its characters, settings, and events and
e) sequencing details in the story.

Pupils answered questions which facilitated comprehension, reading fluency, vocabulary, expressive, and receptive language skills.

Control group

For the control group consisting of 10 pupils, intervention did not incorporate assistive technology. Instead the children enjoyed conventional shared-reading experience with printed levelled books as selected by the EdT.

Experimental group

The experimental group, consisted of 10 pupils who enjoyed Raz-Kids e-books programme along with various downloadable activities for their pupils to work within the intervention classroom.

Data Collection Methodology

The research drew on several data collection methods in order to gather multiple perspectives satisfy the principle of triangulation and increase the likelihood of the data being both reliable and valid. A mix of quantitative and qualitative data collection methods were used. This combination method was used because it provides a better understanding on the use of e-books factually and insightfully.

Quantitative data was gathered through a curriculum-based assessment using the pre and post-test method. It took a total of 12 weeks to complete data collection and intervention. This began with pre-test at week 1, followed by 10 weeks of intervention, and after a week the post-test was carried-out. During the intervention, pupils were instructed using the Raz-Kids reading program described above for 30 minutes, once a week for 10 weeks. The post-test was administered after 10 weeks of intervention to record pupils' performance scores and comprehension quiz scores. For all the pupils the pre-and-post-test was administered by the EdTs on their respective pupils.

To gather further qualitative information, survey questions completed by the EdTs at the end of the study period were analysed. Further to this, the open-ended data received from EdTs open-ended feedback forms were thematically analysed, and coded. These data were subsequently analysed and evaluated at the end of the study period.

Assessment Tools for Quantitative Data Collection

The DAS Pre-and-Post Assessment Tested for six components:

1. **Letter Recognition – Letter Naming Fluency (LNF)** was included as an indicator of risk. Teaching letter names does lead directly to improvements in pupils reading outcomes (Allington, 2011).
2. **Letter-Sound Correspondence (LSC),** this measure is a standardised, administrated test of the alphabetic principle including letter-sound correspondence in which letters represent their most common sounds.
3. **Nonsense Word Fluency (NWF)-** the NWF measure is a standardized, administrated test in which letters represent their most common sounds and the ability to blend letters into words.
4. **Sight Word** – Most of the words used were from Dolch Primer List (examples: do, good, have).

5. **Comprehension Quiz from Raz-Kids Level A**, book read for pre-test was "The Big Cat" and for post-test was "Maria goes to school". The control group did the printed copy of the book during testing and the experimental group did the e-book version. Both intervention groups were read out the questions from the quiz, pupils circled the correct answers on printed paper.

6. **The Yopp-Singer Test of Phoneme Segmentation** (Yopp, 1995) tests children's phonemic awareness, and is designed specifically for children in kindergarten, although it can also be used with older children. The test has twenty-two items that ask children to isolate and pronounce the individual phonemes in words. The Yopp-Singer Test (YST) has been extensively used in phoneme awareness research and its measurement of phoneme awareness is highly correlated (Torgesen, 2001).

Table 1: Educational Therapist feedback Questionnaire

EDUCATIONAL THERAPIST FEEDBACK (LIKERT SCALE)	
Q1	This is an acceptable programme to address reading concerns.
Q2	This programme is effective in improving my pupils' reading skills.
Q3	I would be willing to use this during the intervention regularly.
Q4	I would suggest the e-book readers to other teachers and parents.
Q5	This programme would not result in any negative effects for my pupils.
Q6	This intervention is a reasonable way to improve my pupils' reading skills.
Q7	I found the worksheets available in this structured e books reading programme useful.
Q8	I like the procedures used in this structured e-books reading programme
Q9	I found the e-books programme complementary to planning my literacy lessons.
Q10	Overall, this programme appears beneficial for my pupil.
EDUCATIONAL THERAPIST FEEDBACK (OPEN ENDED)	
Q11	Please describe the strengths of and/or what you liked about this intervention:
Q12	Please describe the limitations of and/or difficulties with implementing this intervention:
Q13	Was it reasonable to implement the intervention weekly? YES/NO Why or why not?
Q14	The interactive features of assistive technology complemented DAS Preschool Literacy Intervention? YES/NO. How or How not?
Q15	Are there any additional points you would like to add?

Assessment Tools for Qualitative Data Collection

Educational Therapist Feedback

In order to answer the second question on the benefits and drawbacks of the e-books reading program within PELP as perceived by the teachers, likert scale feedback forms were given to 14 DAS Educational Therapists to get constructive feedback on use of the Raz-Kids e-books. The Likert scale feedback form for the EdTs showed a scale of 1-5, 1 indicated Strongly Disagree (SD) and five indicated Strongly Agree (SA). There are a total of 10 Likert scale questions, followed by a open-ended questions section for the teachers to give additional comments, as sometimes this generates the most useful feedback, covering areas not touched on by the presented scale.

RESULTS

To investigate the differences between the experimental and control group in the six literacy areas listed above, an independent samples t-test of the differences between pre and post-tests was conducted.

To further investigate the improvements each group made a paired samples t-test comparing the pre and post-tests was carried-out individually for the experimental and control groups.

Qualitative data collection was followed a systematic analysis and organisation of data, including the EdTs feedback forms and open-ended questions. The organised data was gathered and grouped together on similar themes. It was analysed from various perspectives, and subsequently interpreted. From this, some conclusions were drawn. This analysis is now presented in the following section.

Data Analysis

Quantitative Data Analysis

An independent samples t-test was performed comparing the mean differences between comprehension scores between the experimental and control group over 10 weeks as seen in table 2. The experimental group (M = 1.60, SD = 0.97, N = 10) showed significantly more gains than the control group (M = 0.80, SD = 0.42, N = 10), $t(12.31) = 2.40$, $p = 0.03$, two-tailed. This indicated a large effect size (d = 1.07) and shows a greater impact on comprehension scores for the experimental group.

An independent samples t-test was performed comparing the mean differences in the reading scores on nonsense word fluency between the experimental and control group over 10 weeks as seen in table 2. The control group (M = 3.20, SD = 2.48, N = 10)

Table 2 – Independent samples t-test

Measure	Group	N	Mean	SD	t	df	sig
Letter Naming	Exp	10	8.4	11.63	0.24	16.75	0.81
	Cont	10	7.3	8.78			
Letter Sound Correspondence	Exp	10	10.5	5.64	-0.84	16.67	0.41
	Cont	10	13	7.54			
Sight words	Exp	10	7.2	4.69	-0.64	16.44	0.53
	Cont	10	8.8	6.4			
Nonsense Word Fluency	Exp	10	1.1	1.3	-2.37	13.5	*0.03
	Cont	10	3.2	2.5			
Yopp-Singer Test	Exp	10	1.1	1.5	-2.22	18	*0.04
	Cont	10	4.8	5.1			
Comprehension	Exp	10	1.6	0.97	2.4	12.31	*0.03
	Cont	10	0.8	0.42			

** indicates statistical significance at the p<0.05 level*

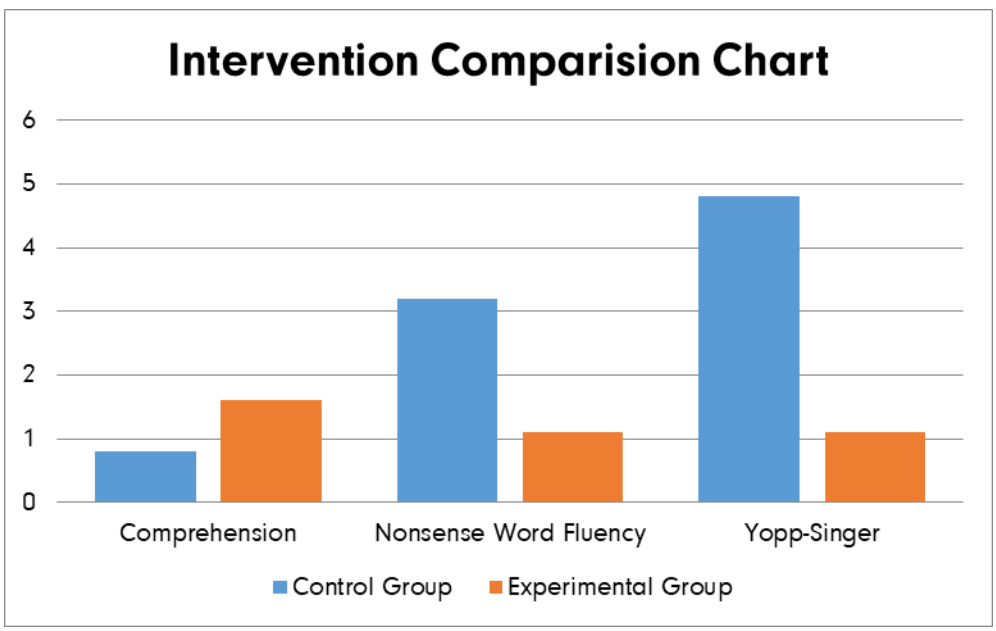

Figure 1. Comparison between groups

showed significantly more gains than the experimental group (M = 1.10, SD = 1.29, N = 10), $t(13.5) = -2.35$, $p = 0.03$, two-tailed. This indicated a large effect size (d = 1.06) and shows that the intervention had a great impact on nonsense word reading scores for the control group.

An independent samples t-test was performed comparing the mean differences in the Yopp-Singer test (YST) of Phoneme Segmentation scores between the experimental and control group over 10 weeks as seen in table 2. The control group (M = 4.80, SD = 5.05, N = 10) showed significantly more gains than the experimental group (M = 1.10, SD = 1.52, N = 10), $t(10.63) = -2.22$, $p = 0.05$, two-tailed. This indicated a large effect size (d=0.99) and shows that the intervention had a great impact on YST for the control group.

Quantitative Data Experimental Group

A paired samples t-test was conducted to assess differences between pre and post-test in the experimental group. The results indicated that the experimental group made significant improvements in Letter Sounds Correspondence, sight words, nonsense word fluency and the Yopp-Singer Test of Phoneme Segmentation as seen in Table 3.

Control Group

A paired samples t-test was conducted to assess differences between pre and post-test in the control group. The results indicated that the control group made significant improvements in Letter Naming Fluency, Letter Sounds Correspondence, Sight words and Nonsense Word Fluency as seen in Table 3.

The implications of these results are discussed in the next section.

Qualitative Data Educational Therapist Feedback

The EdTs feedback form as seen in table 1 was on a 5 point Likert scale where 1 indicated strongly disagree, 5 indicated strongly agree. Fourteen EdTs provided feedback to ten questions on the use of Raz-Kids e-books. The feedback as shown in the chart below (refer to figure 2).

For question 4, all of the EdTs either 'strongly agreed' or 'agreed' that they would recommend shared reading with e-books to other teachers and parents. In question 2 and 6, there were sizeable neutral answers indicating these EdTs may have felt that in addition to e-books, print books are also reasonable ways to improve their pupils' reading skills. In question 7, which had the least 'strongly agree', it may be possible that the worksheets available within Raz-Kids e books reading programme were sometimes very useful and at other times not. It is also significant to note that none of the EdTs answered with a 'disagree' or a 'strongly disagree' to all 10 questions. In addition to the

Table 3. Paired samples t-test

Measure	Pre/ Post	N	Mean	SD	t	df	sig
EXPERIMENTAL GROUP							
Letter Naming	Pre	10	28.4	15.42	-2.12	9	0.063
	Post	10	36.4	7.88			
Letter Sound Correspondence	Pre	10	6.3	7.01	-5.89	9	*0
	Post	10	16.8	8.7			
Sight Words	Pre	10	5.3	11.41	-4.86	9	*0.001
	Post	10	12.5	13.7			
Nonsense Words Fluency	Pre	10	1.1	3.48	-2.7	9	*0.024
	Post	10	2.2	4.57			
Yopp-Singer Test	Pre	10	1.3	4.11	-2.28	9	*0.048
	Post	10	2.4	5.25			
Comprehension	Pre	10	2.9	1.29	-1.94	9	0.085
	Post	10	3.9	0.99			
CONTROL GROUP							
Letter Naming	Pre	10	31	11.27		9	*0.027
	Post	10	38.3	6.17			
Letter Sound Correspondence	Pre	10	11.2	7.6	-5.45	9	*0
	Post	10	24.2	2.94			
Sight Words	Pre	10	8.9	11.53	-4.32	9	*0.002
	Post	10	17.7	12.89			
Nonsense Words Fluency	Pre	10	1.7	1.64	-2.98	9	*0.016
	Post	10	4.5	3.95			
Yopp-Singer Test	Pre	10	6	7.12	-1.25	9	0.245
	Post	10	8.6	9.06			
Comprehension	Pre	10	3.4	0.7	-1.5	9	0.168
	Post	10	3.8	0.92			

** indicates statistical significance at the p<0.05 level*

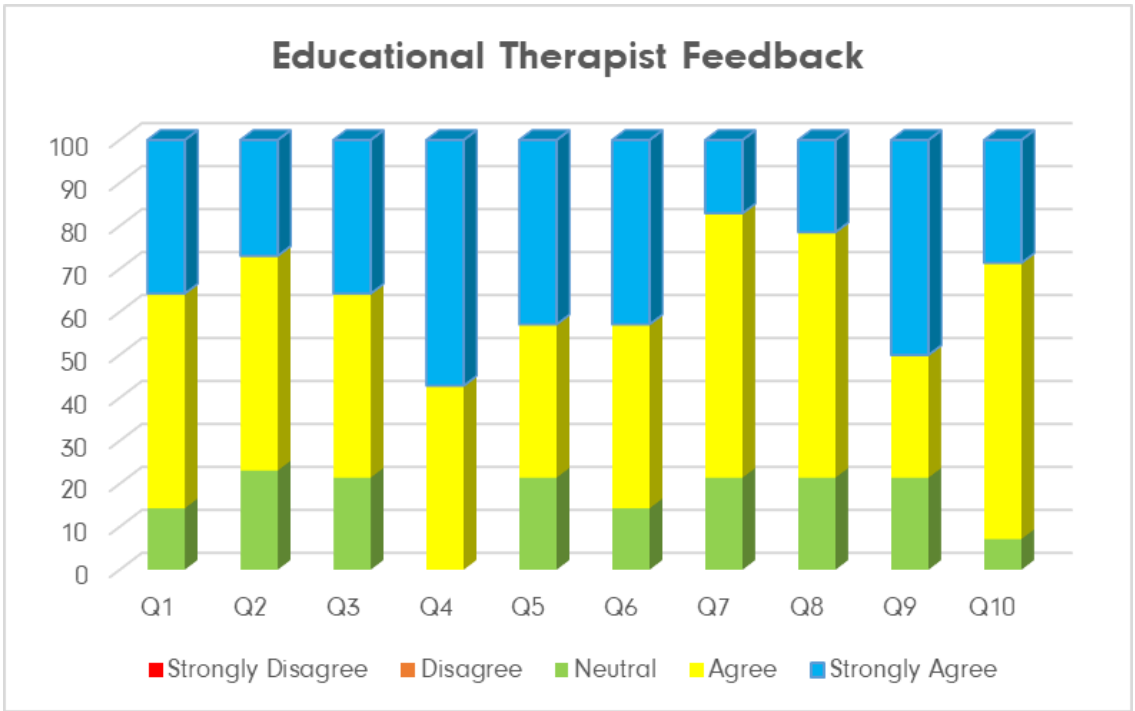

Figure 2 Educational Therapist Feedback

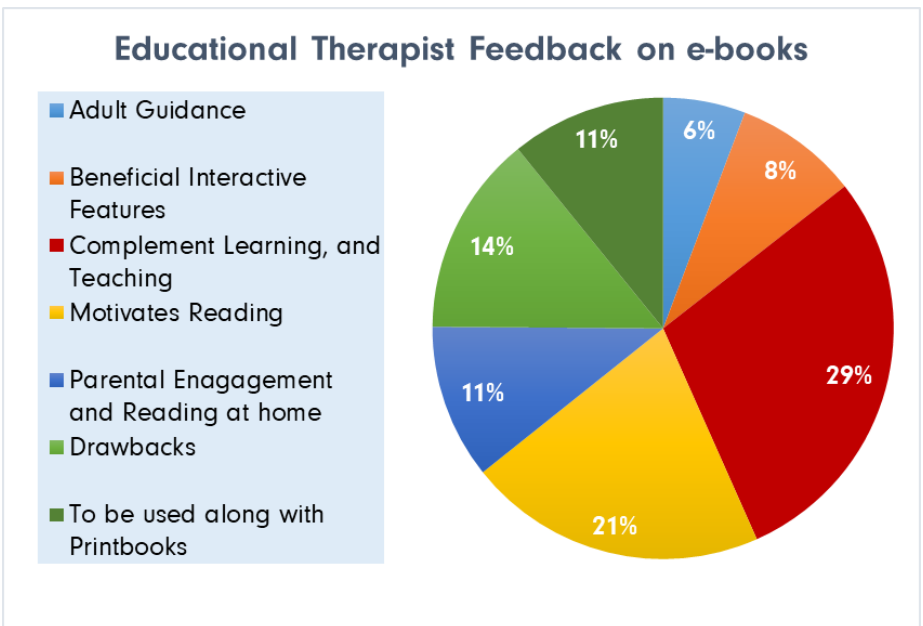

Figure 3 Educational Therapist Feedback thematic analysis

likert scale questions, the EdTs filled in the blanks and gave substantial answers to five open-ended questions . The researcher described, interpreted and classified the data from the EdTs answers through a six step thematic data analysis.

Braun and Clarke's (2006), guided the thematic analysis through their 6-step framework approach which are:

1. becoming familiar with the data, 2
2. generate initial codes,
3. search for themes,
4. review themes,
5. define themes and
6. write-up.

During initial coding, the first stage, line-by-line coding was carried out, in the second stage 102 'free codes' were organised into related areas, which constructed 139 more 'descriptive themes' and at the third stage 10 'analytical themes' were developed and reviewed. Lastly, 7 themes emerged and they are :

1. Adult Guidance,
2. Beneficial Interactive Features,
3. Complement Learning and Teaching,
4. Motivates Reading,
5. Parental Involvement and Reading at home,
6. Drawbacks
7. To be used with print books.

These themes as presented below in according to the percentage of responses that they represent (See Figure 3). These themes are a refinement of feedback, and in essence reveal the EdTs thoughts and first-hand experience using Raz-Kids e-books.

Out of seven, five main themes emerge about Raz-Kids e-books as pointed-out by the EdTs and they are:

1. complements teaching and learning (29% of codes),
2. motivates children to read (21% of codes),
3. gives children an opportunity to read at home and is an opportunity for parental engagement (11% of codes), and
4. some draw-backs were raised (14% of codes), 5) e-books to be used as a resource along with print books (11% of codes).

DISCUSSION

Förster, Kawohl and Souvignier (2018) stated that studies on reading achievement on any age group indicate large inter-individual differences. This is a somewhat comparable situation within PELP, despite best placement efforts, the pupils' pace of learning and developmental stages follow an idiosyncratic trajectory. As a consequence, EdTs are faced with varying levels of challenge for differentiation, with more or less levels of heterogeneity within each classroom. Explicit steps were initiated with the intent of making intervention consistent in this study. However, within this structure, flexibility was allowed for the EdT to pace the lessons and use variations that provided scaffolding to meet an individual child's learning needs. Even though there were standardisation across teaching during the shared-reading instructions, variations between EdTs during teaching has been acknowledged.

The first research question was to determine if incorporating Raz-Kids e-books within PELP improved reading skills and reading engagement. The experimental group made significantly more gains than the control group on the test for comprehension quiz scores, with a large effect size. Similar to studies by Ciampa (2012), results in this study indicate that e-books with embedded comprehension quizzes increased comprehension for pupils. Comprehension is an important skill necessary for skilled reading (Roberts and Scott, 2006). Therefore, to answer the first question, the results support that the use of Raz-Kids e-books had helped in improving pupils' comprehension skills. Since skilled reading is an interdependent process between both word recognition (decoding) and language comprehension (Roberts and Scott, 2006), children from the experimental group will continue to require intervention for independent reading to take place.

Results also indicated that the control group did better for word reading (nonsense words) and phonemic awareness. The control group were brand new pupils just starting in the programme whereas the experimental group were pupils who started with DAS end of the year, they may have had exposure outside of the DAS. A ceiling effect may have occurred since a number of participants, in this case those in the experimental group, may have been at the top end of the scale for most of the measures hence making discriminations between measures impossible (Garin, 2014). Therefore, the ceiling effect may have impacted the experimental group's reading skills measures and progress in measures such as comprehension were more apparent. PELP (Sathiasilan and Wong, 2018) and the OG instructional approach demonstrate educationally significant outcomes for struggling readers (Hwee and Houghton, 2011; Lim and Oei, 2015). It is also possible that the outcomes measured in this study are from the combination of phonological based instructions and shared-book reading (Roberts and Scott, 2006).

One of the findings, from the current study is the evidence for associations between measures of phonological-based instructions and shared-book reading. Progress

analysis within groups, which is the difference between pre-and-post test scores within the experimental group and within the control group helps to interpret this data from a different angle. Results indicate that each group markedly made significant progress. Similarly, both groups made progress in sight word knowledge, nonsense word fluency and letter sound correspondence. On the contrary, the experimental group made significant improvements in the Yopp-Singer Test of Phoneme Segmentation. Whereas, the control group instead made significant progress in letter naming. This indicates progress in different areas, and that inter-individual differences are apparent.

Salaschek, Zeuch and Souvignier (2014), point out that the inter-individual differences include, among others, level of achievement and different growth trajectories. Förster, Kawohl and Souvignier (2018), also revealed that it is expected for pupils with lower reading skills to obtain higher growth in basic reading skills. This is obvious as the progress analysis shows control group significantly improved in letter naming skills (a basic pre-reading skills) and experimental group significantly improved in Yopp Singer Test of Phonemic Awareness (initial reading skills). This may also be because, even though the intervention hours were similar, the control group was assessed in the beginning of the year and the experimental group was assessed at the end of the year, therefore pupils in the experimental group may have had more time to grow.

Pupils from the control group begun in the beginning of the year and may have begun with lower reading skills. This may explain why the control group made progress in letter naming (lower reading skills) and the experimental group made progress in Phoneme Segmentation (higher reading skills) (Förster, Kawohl and Souvignier, 2018). Progress analysis within groups indicates that all pupils benefited in accordance to their distinct profile.

The comparison of data, across control-group and experimental group shows that shared-reading with e-books autonomously is not enough in helping children to become skilled readers. However, the progress analysis of data within each group shows that shared-reading with e-books alongside structured evidence based synthetic phonics programme complemented pupils in acquiring reading skills according to a child's level. Therefore, the partial answer for question one is that this study found that incorporating Raz-Kids e-books within PELP improved comprehension for early struggling readers and that there is similar effect from shared reading using print books to shared reading using e-books, and that both support children's learning of discrete literacy skills, but may not be relied on autonomously in helping pupils to become independent readers (Rose, 2009).

Educational Therapist's experience and perceptions in incorporating e-books is critical into helping to figure out how to effectively use Raz-Kids e-books to support pre-schoolers in bridging their early literacy learning gaps. From qualitative data, the theme 'Motivates Reading' received codes that directed to reading engagement and these codes were 1)

children were interested during lessons, 2) it encouraged pupils to read, 3) children started to read independently, 4) children read more books at home and 5) it made reading fun. Overall, EdTs revealed that the interactive features were beneficial (8%) and motivated reading (21%) thereby fostering reading engagement (29%). Data from the EdTs, answers the second part of research question one, that Raz-Kids e-books foster reading engagement.

The second research question is on the benefits and drawbacks of the Raz-Kids e-books reading program within PELP as perceived by the teachers. EdTs found various benefits and some drawbacks while using the Raz-Kids program. The benefits were mainly directed to complementary teaching and learning, children who were motivated and engaged to read, and the intervention that was extended to the home environment and was an avenue for parent engagement. For parent engagement, there were also ample feedback that it was challenging to get a number of parents to follow-up by using Raz-Kids at home. Research has shown that having as few as 25-50 books at home (both electronic and print) improves reading test scores and directly impacts children's academic achievement (Evans et al., 2014). Hence, EdTs naturally felt strongly about extending reading to the home environment.

Similar to results from Allington (2011) and Picton and Clark (2015), it was revealed within the theme 'motivated reading', that some of their reluctant readers enjoyed reading using technology and a few pupils appeared to be more engaged during e-books read aloud sessions compared to conventional methods. The theme 'adult guidance' (8%) referred to adult facilitation, and adult supervision. It was revealed that adult supervision was necessary for pupils reading e-books independently as the in-built reward features distracted them from truly listening, reading and completing the online comprehension quiz. These findings are consistent with other studies that found certain features of e-books to be distracting to some children (de Jong, and Bus 2002; Zucker, Amelia and McKenna, 2009), and suggested for the need for adult supervision to complement e-book reading (Marchand, 2015).

EdTs also pointed out other drawbacks such as that e-books 1) depends on wifi to work, 2) glitches with technical issues do arise, 3) storyline being less captivating. The storyline of the Raz-Kids e-books compared to the print books may not be as interesting. This was also suggestive by some pupils during their feedback. This can be managed when an assortment of different format books is being used purposefully (Kamil, Intrator and Kim, 2000; Kucirkova, Littleton and Cremin, 2016). Using print books along with e-books was also a theme which emerged from EdTs feedback and the literature review in this study also backs this up. It is possible that for some, e-books offer accessibility options, that are impossible in print (Schneps et. al., 2013). It is necessary to provide children with an assortment of book formats, as well as cater to the different learning needs of children.

Overall, similar to the study by Marchand (2015), it is found that Raz-Kids program when used during shared-reading by a skilled EdT, would be beneficial as a supplement to reading instruction and small group guided reading instructions for early struggling readers. This study also received mixed reviews about e-books distractive features, and it concludes that e-books interactive features such as the incentives feature can be both distracting and a motivating factor, as such this should not be a barrier to utilising e-books, especially since these distractions can be tackled with adult facilitation and deactivation (Roskos and Burstein, 2012).

There were several limitations in this study. First and foremost, the results of this study cannot be generalised due to the small sample size, and the pupils in this study form a varied profile since they've been identified with early literacy learning difficulties. The small sample size of 20 limited the amount of data that could be collected to determine if the Raz-Kids program was successful as a reading intervention for kindergarteners with literacy learning difficulties. Secondly, the intervention group and control group pupils were evaluated during different times of the year. This was due to unforeseen circumstances which resulted in change of control group pupils part way through the intervention. Therefore, the experimental group was evaluated end of the year and the control group was evaluated at the beginning of the year.

Thirdly, the study took place over a short period of ten weeks. There were also some inconsistencies between the pupils and the amount of time spent on the program. Some pupils were absent from class and were not able to complete all of the sessions. Interruptions in the school calendar and staff deployment were also factors, for example, public holidays, and change of class educational therapist due to redeployment, and maternity leave.

In a replication of this study, the variables may be better controlled and results can then be compared. Such as, the sample size in this study is relatively small, therefore it would seem essential to extend this study to a larger population and to discern and analyse trends across various child profiles. It would also seem necessary for standardisation across intervention for both control and experimental groups, such as using identical e-books/books during the intervention, comparable timelines, along with controlling consistency in teaching by using just one experienced EdTs to teach both the control and the experimental group. Employing just one assessor with the least bias, who the children are familiar with across all the pupils will increase assessment reliability and validity.

It is also recommended to utilise universally recognised measurement tools to look at children's reading skills, especially comprehension e.g. The Developmental Reading Assessment (DRA) could be considered.

Future research might also look at parent engagement, and home intervention, which is not examined in this study, as all PELP pupils have access to Raz-Kids and have been encouraged to access it with adults at home. A multi-tiered support approach is key in helping struggling readers (Greenwood et al., 2014) to incorporate guided parent tutoring alongside school-based efforts to extend and improve the quality of learning (Kupzyk et al., 2011). When parents take an active role in their child's reading growth, reading attitudes and reading performance improves (Fredericks and Rasinski, 1990; Kupzyk et al., 2011). Parents' general feedback on the Raz-Kids programme may be presented for future research.

CONCLUSION

This study has contributed to existing literature that Raz-Kids e-books with adult facilitation compliments comprehension, teaching and learning, fosters reading engagement, and supports early readers with an additional avenue to access books. The main findings in this paper after thorough evaluation of all the data gathered, suggest that children from both the control group and experimental group profited from the structured early reading intervention and that both print and e-book readers were a beneficial part of early reading intervention for struggling readers. This study concludes that explicit types of e-books such as the Raz-Kids reading programme may, when used wisely, complement both teaching and learning for young learners, especially those who are struggling to access reading.

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Drama Approaches to Enhance Communication Skills in Children with Special Educational Needs (SEN)

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Abstract

Communication is an important aspect in life. Every day we use varied forms of communication to communicate meaning to one another. Whether we are acquiring information or disbursing information, communication plays a vital key in education. Many children with special needs may find it extremely difficult to cope in schools for various reasons and one of them is the inability to communicate effectively among their peers and people around them. This paper examines the literature on drama approaches in relation to children with special educational needs (SEN), particularly children diagnosed with dyslexia and Speech and Language Impairment. Through this literature review, we hope teachers and educators alike would find drama as the bridge to foster and enhance communications skills among children with SEN.

Keywords: drama, dyslexia, speech and language impairment, communication

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INTRODUCTION

Students with speech and language impairment tend to have difficulties in social interactions and communication skills (Ashely, 2007). Speech and Language Impairment is defined as an individual having significant difficulties in using language to express themselves, hence having a compelling deficit in the field of language in the absence of any primary cause (Jarvis & Watts, 2012). Children diagnosed with speech language impairment often have communication problems, which may then affect their social behaviour (Law et al., 2013). According to Turkington and Harris (2006), "People with speech and language disorders have trouble producing speech sounds, using spoken language to communicate, or understanding what other people say" (p. 74). Hence, this can create boundaries in forming new relationships and in turn, it may then affect their social behaviour.

Speech language impairments (SLI) do share common traits with dyslexia, therefore sharing a common link. Studies have found significant co-morbidities between SLI and dyslexia (Newbury et al., 2011). It was found that approximately 43% of children diagnosed with SLI, are also diagnosed with dyslexia (Snowling et al., 2000). Whereas, 55% of children diagnosed with dyslexia met the diagnostic criteria for SLI (McArthur et al., 2000). This finding has led to the proposition that SLI and dyslexia may share some aetiological factors or, that they may constitute distinct manifestations of the same underlying cognitive deficit (Pennington & Bishop, 2009).

The term "Dyslexia" originated back in the late 1800s, where a range of neurological issues accounted for spelling and reading difficulties in individuals (Spafford & Grosser, 1996). There are many theories and arguments to the definition of dyslexia. Hinshelwood (1917) reported two cases of congenital word blindness (today known as dyslexia) and noted that there were often several cases in one family and that the symptoms were closely related to those that appeared in adults who had lost the ability to read due to brain injuries. Orton (1937) preferred to use the term developmental rather than congenital, because the former could include both the hereditary tendency and environmental factors for word blindness. Over the years, many researchers have shown interest in SEN and the term 'word blindness' has evolved into dyslexia. Rose (2009) defines dyslexia as "a learning difficulty that primarily affects the skills involved in accurate and fluent word reading and spelling" (p. 30). A further definition of dyslexia is given by Reid (2016), which defined it as deficiencies in the literacy aspect, affecting the individual in areas such as reading, writing and spelling as well as having a negative impact on cognitive processes.

Dyslexia is a complicated syndrome, as it is not just based on one symptom, for example, it is not only poor spelling and reading (Mather & Wendling, 2011). Some characteristics of dyslexia includes difficulties in oral language and communication skills. Individuals with dyslexia may have problems with pronouncing words or communicating

what is on their mind (Thomson & Gilchrist, 1997). Another set of difficulties that may arise are in cases such as having a weakness in working memory, executive function, and attention (Hultquist, 2006).

Therefore, the purpose for this literature review is to examine the literature on the drama approaches in relation to children with special educational needs (SEN), particularly children diagnosed with dyslexia and SLI. A child with SEN may require alternative approaches to education that not only accommodate their conditions but also toward creating ways for them to further develop their own capacity to learn. For instance, when a child with SEN has difficulties in communicating, their education may require expertise in addressing such issues and finding methods to connect with them. Through this literature review of exploring drama activities as a tool to enhance communication skills with children with special learning needs, it is intended that educators, curriculum developers and parents would be more receptive of including drama activities as a part of their children's learning journey.

LITERATURE REVIEW: DIFFICULTIES FACED BY STUDENTS WITH SEN

Low Self-esteem

Self-esteem can be associated more with emotional security. It is the impression of one's self and how that individual assumes how others view him (Reid, 2011). According to Gross and MacIlveen (1998), "Self-esteem has been defined as the extent to which we like or approve of ourselves or how worthwhile we think we are" (p. 402).

Students with learning difficulties, such as dyslexia, tend to have a high rate of depression and low self-esteem as compared to students without any learning difficulties (Banks & Woolfson, 2008). In a study by Senerath (2019), levels of self-esteem were studied in a sample of children diagnosed with dyslexia and compared to the group without dyslexia. The study consisted of 30 students, aged between 10 to 11 years old. The children were given three types of questionnaires. The findings showed that children with dyslexia had significantly lower self-esteem as compared to children without dyslexia.

In a study by Lindsay et al. (2002), a group of children comprising of 52 boys and 17 girls diagnosed with SLI between the ages of 6-11 years old were sampled. The procedure included children completing a measure of self-esteem. In this study, it showed that children diagnosed with SLI between the ages of 10 years to 11 years old, not only possessed academic difficulties but also curtailed estimations of their educational abilities and their competency in social interactions (Lindsay et al., 2002).

In summary, Senerath (2019) and Lindsay et al. (2002) have shown consistent outcomes that children diagnosed with dyslexia and SLI have lower self-esteem.

A generalisation of the disability may also cause one to neglect important aspects of identified issues for the individual. In a study by MacMaster (2002), other people's expectation, attitude, and behaviour often changes upon realising that the child has been classified under a diagnosis. Hence, using such labels causes feelings of inferiority amongst students, as they would feel they are not part of the group, hence leading to lower self-esteem (MacMaster, 2002). When a child is not accepted by his peers and often experiences rejection, it can lead to the occurrence of emotional problems (Georgiadi et al., 2012).

It has also been noted that in dyslexia, one of the most hidden aspects is the emotional side (Sako, 2016). Parents and educators may be efficient in noting down areas of weaknesses in academic work and reading, however, they may miss noticing elements such as low self-esteem feelings and motivation, which develops over time (Sako, 2016).

Anxiety

Beesdo, et al. (2009) refers anxiety to the brain response to danger, an event that an organism will actively try to avoid. Children with anxiety may exhibit avoidance and have difficulties in communicating cognition and emotions (McCathie & Spence, 1991).

According to Schultz and Heimberg (2011), anxiety may increase when in a situation in which one feels powerless and has no control, for example being asked to read in front of others, being unable to bounce the ball in sports or not being able to answer a question in class.

Students with speech language impairment (SLI) are more likely to experience general anxiety as compared to their peers without SLI (Conti-Ramsden et al., 2010). In a study by Beitchman et al. (2001), a cohort of children with SLI from 5 to 19 years of age were assessed for psychiatric comorbidity. It was found that participants with SLI had higher rates of anxiety disorders (Beitchman et al., 2001). Conti-Ramsden and Botting (2008) also found increased general anxiety symptoms amongst adolescents with SLI regardless of the severity of their language and communication difficulties.

Children with dyslexia do tend to experience low self-esteem, anxiety, and emotional instability due to the long-term experience of learning frustration, which further affects their learning motivation and emotional state (Huang et al., 2020). Huang et al.(2020) also mentioned that many individuals diagnosed with dyslexia have experienced failure, despite spending many hours in special classes and putting in their best effort in the assigned task. Their progress may not be acceptable or on par with their peers, hence causing them to feel frustrated and demotivated.

In research by Orton (2010), most pre-schoolers were excited and well-adjusted with aspects of school. Their emotional problems only start to develop when they realised that their reading instruction does not match their learning needs (Orton, 2010). This may then cause them to be fearful of school causing them to feel anxious when faced with a reading task. Individuals with dyslexia do feel anxious when they are placed in a situation where they feel incompetent, such as school activities like reading aloud, having discussions or having to complete a writing task (Alexander-Passe, 2015).

In another study, Tsovili (2004) studied how anxiety played a part in the lives of adolescents with dyslexia and it was found that adolescents with dyslexia had higher reading anxiety in comparison to those not diagnosed with dyslexia. This suggests that adolescents with dyslexia viewed reading as an extremely stressful task, thus causing anxiety. An increased risk of anxiety and lower motivation is manifested when there is a decrease in self-esteem (Battle, 2004). Dyslexia has been linked to negative attributes such as low self-esteem, anxiety and generally behavioural issues (Boyes, et al., 2020).

In a study by Zuppardo et al. (2021), a sample size of 47 children and adolescents, aged between 8-18 years old, were studied to explore self-esteem, anxiety and behavioural problems as clinical manifestations that could be associated with dyslexia. The findings showed that students with dyslexia showed higher levels of anxiety and lower levels of self-esteem as compared to classmates without dyslexia. The higher levels of anxiety in dyslexia were found in social anxiety. The findings aligned with previous research (Nelson & Harwood, 2011) that suggested that children and adolescents with dyslexia also displayed social-emotional issues, beyond the typically noted academic difficulties with reading and writing associated with dyslexia.

Difficulties in Social Interaction

Social interactions encompass a combination of verbal cues and non-verbal cues like gestures or body movements and help to form friendships and build rapports with one another. When a child is diagnosed with SLI, he or she may have difficulties in the area of social interaction; this is because the child might tend to have difficulties in verbalising his or her thoughts due to his or her impairment, hence lacking in communication skills (Daulay, 2022).

A child diagnosed with SLI would not feel so confident talking to their peers who are at the same age as them, because of their difficulties, hence, children with SLI would rather communicate with children who are younger than they are or even older than them, like adults (Marton, 2008).

According to Redmond and Rice (1998) theoretical framework, children diagnosed with SLI who have deficiencies in language and communication are obstructed in their involvement in social settings; hence, these children are more likely to be rejected by

their peers than typically developing children. In addition, studies are progressively demonstrating that children diagnosed with SLI have more obstacles in their communication in a social setting than can be described by their language deficit alone (Adams et al., 2009).

Dyslexia often affects oral language functioning as well. A child with dyslexia may have difficulties finding the right words to say, may stammer, or may even require more processing time to answer a question (Kong, 2012). Children with dyslexia do face communication problems, which in turn leads to social interaction difficulties, as they are unable to comprehend social cues such as interpreting what others are thinking and feeling (Kalsoom et al., 2020). Hence, this puts the children at a disadvantage when they enter school as the use of language becomes more central to their relationships with peers.

Anger

According to Plummer (2008), there are countless children who are able to deal with their diagnosis of SLI with such great perseverance, on the other hand, there are those who are deeply agitated by deeply rooted anger reactions, because of their struggles in communicating effectively.

In a recent study by Yasir et al. (2023), a study on the role of self-esteem and aggression was conducted. It was carried out on a sample size of 56 primary and secondary school students, among which 28 students were diagnosed with dyslexia and 28 were non-dyslexic. The findings revealed that anger traits were higher among students with dyslexia than non-dyslexic students. It was also found that students without dyslexia were better able to control their anger as compared to students with dyslexia, as the findings showed that students with dyslexia tend to express their anger more than controlling it. The levels of self-esteem were also found to be lower in students with dyslexia than students without dyslexia.

Children with SLI and dyslexia often are unable to express themselves or describe complicated emotions due to their lack of vocabulary, hence having limited management over their emotions (Bishop & Snowling, 2004). Many of the emotional problems caused by dyslexia and SLI occur out of frustration with school or social situations (St Clair et al., 2011).

The Approach – Drama Activities

Drama

Children with dyslexia often suffer from anger, frustration, and low self-esteem (Kaiser, 2020). Therefore, it is crucial to identify and take appropriate actions to not only help

children overcome their difficulties, but to cater as well to their social-emotional learning needs (Kaiser, 2020).

Drama can be a suitable intervention that can be used with children diagnosed with SLI or dyslexia, because activities included can be both verbal and non-verbal. Children with SLI and dyslexia are overwhelmed with communication issues and difficulties in expressing themselves (Rice, 2020). Hence, with drama, it does not solely rely on cognitive and verbal skills, but instead it comprises other skills such as mime, improvisation, role-play and tableaux.

With drama, children need to take on the role of others, where they learn to relate to the problems of others, as well as learning to work together harmoniously in a team and learning to communicate effectively (Azlina et al., 2021).

Improvisation

According to Holden (1981), drama involves activities such as improvisation in which individuals use his or her imagination to transport themselves into another situation. Improvisation provides an opportunity for a child to express himself with body movements and words, by using his imagination (Ho, 2020). Improvisation is unscripted and requires the actors to narrate lines or act in spontaneity. It is a performance that is not practised but instead invented by the performers themselves on the spot. According to Dougill (1987), the adoption of drama aids in the cultivation of the developmental of the individual in a socially, intellectually and linguistically useful way.

With improvisation activities, it can increase self-esteem, create a heightened scope for compassion and help to decrease feelings of rejection (Stern, 1980). Hence, children with SEN would be given opportunities to develop their communication skills through improvisation. According to Crimmens (2006), "Drama is ideal for teaching and practising social skills for children with communication and cognitive impairments" (p. 12). In order to have good social skills, one has to have good interaction skills and cognition. Due to their impairments, children with special educational needs may be excluded in peer interaction, hence making it harder to acquire social skills (Schwab et al., 2021).

Role-play

With drama, children can also learn appropriate social behaviour and interaction skills through varied role-play activities in a group setting (McCabe, 2020). Role- play provides students the opportunities to be part of the story by taking up roles of the characters and relating to the problems of the characters (Hamzah, 2019).

However, role-play can be coined as an ideal way of life, making it an unrealistic activity. According to Amato (2010), role-play situations can be unrealistic and irrelevant to the real situations occurring in the life of a child. In addition, since role-play activities includes language use and interaction, children with SLI may struggle with role-play, as they may not have the ability to communicate (Stitch, 2010).

On the other hand, role-play provides stimulation in learning conversational interactions. Wagner (1999) views role-play as a language-based activity where learners are given the freedom to express themselves freely with the use of language while incorporating imaginativeness. It also serves as a very good form of practising conversational skills as it focuses on language and expressions.

Storytelling

Language plays an important part in the delivery of information in the classroom; it requires communicative activities and the use of oral communication strategies to facilitate learning (Jaca & Javines, 2020).

Storytelling activities comprising of group work are particularly successful in stimulating the creation of ideas, which in turn can lead to developing social interaction and thus improving communication skills (Hampshire, 1996). This author also indicated that group activities involving storytelling are particularly successful in stimulating the generation of ideas, which in turn can lead to development of social interaction.

It was found that drama could aid children with language difficulties to bridge the gap between their lack of exposure to interactions, thereby exposing them to socialisation opportunities that previously would have been denied due to their limited linguistic abilities (Peter, 2003). It was also found that different contexts within drama would offer a range of different communication possibilities, enabling participants to develop greater self-awareness (She, 2017).

Examining How Drama Helps with Self-esteem

According to Sam (1990), drama aids by re-establishing the situation, by shifting the whole process of learning by starting with the meaning and henceforth approaching the form of language. It inculcates a purposeful form of learning, gearing them up for real life situations. Many studies have proven that there is a strong link between an individual's motivation and self-esteem in respect to learning. In Stern's (1983) research, quantitative and qualitative observational research were used to study the reasons by what means and how drama works.

Stern (1983) clearly indicated that self-esteem, kinaesthetic and emotional components are imparted in communicative language teaching. In this study, it was revealed that

there was a huge increase in motivation, self-esteem, spontaneity and even a decrease in the feelings of rejection.

In another study by Oterino (2022), 18 students, 9 boys and 9 girls, aged between 12 and 13, were assessed in varied components in the drama course. The teachers used an evaluation rubric, a reflective teaching diary of longitudinal nature and audio-visual recordings of the class sessions. The assessments of the pupils were carried out by comparing the results obtained by the pupils when they performed the play at the beginning of the course with the results obtained in the play performed at the end of the course. In terms of self-esteem and confidence in speaking, students showed lack of confidence in interaction and speaking at the beginning of the drama course. With the use of drama activities, students learned to express themselves in front of an audience thus resulting in improvements in the level of confidence in speaking. The results showed that all students obtained the highest score in the self-esteem and confidence component in speaking at the end of the drama course.

Examining How Drama Helps with Anger

In drama there are two distinct concepts; the connection between perspective and expression and containment (Emunah & Johnson, 2009). Drama generates experiencing from someone else's viewpoint, viewing himself in an aspect and developing one's viewpoint (Emunah & Johnson, 2009). Hence, experiencing from a different viewpoint helps to cultivate awareness and compassion within one's self, whereas witnessing one's self in a distinct aspect, involves creating some gap that can initiate change and control (Emunah & Johnson, 2009). Although changing one's viewpoint might be impossible in reality, however in a dramatic realm, it can be facilitated in a calm and permissive manner. According to Emunah and Johnson (2009), viewing from varied perspectives empowers an individual to reflect on the past and move forward in the present terms, being aware of one's traits and understanding how actions can have a ripple effect in their surroundings. Hence, a combined effort of perspective and containment can play a significant part in anger management.

The effects of drama on the development of anger management of 15 students, aged between 14-15 years old were analysed by Çapacioglu and Demirtaș (2020). In the study, both pre-test and post-test were used and the data was collected using the Anger Expression Scale. Drama lessons were conducted once a week for 90 minutes, in a 12-week period. The results showed that the drama activities had an extensively positive effect on the students' anger levels.

Examining How Drama Helps with Language Difficulties

The use of drama can be an inventive method in teaching English as a second language (ESL), especially to children diagnosed with SLI and dyslexia who are from ESL

backgrounds, however drama should not be used in isolation but instead in a unified form of teaching English. With the use of drama activities, it can help individuals develop their language skills and to acquire the language more deeply and naturally (Angelianawati, 2019). Learning the English language with the use of drama can provide the child an engaging way to improve his communication skills in a safe environment (Bsharat & Barahmeh, 2020).

In a study by Hamzah (2019) conducted with students at the Dyslexia Association of Singapore, the Southampton Emotional Literacy Scales (SELS) for students, and interviews with parents were conducted to explore the efficacy of a speech and drama programme in developing the social-emotional literacy of children. Out of 6 students aged between 7-11 years old, 5 students gave an improved score in the SELS Pupil Checklist after attending the speech and drama programme for a year. Also, in the parents' interviews, parents noted that they saw improvements in their child's confidence level as well as their social skills. Therefore, similar to the findings by Bsharat & Beheak (2021), drama is a powerful tool for developing communication and thinking skills, it helps students to improve and strengthen their abilities for both oral and written communication.

According to Sam (1990), drama aids by re-establishing the situation, by shifting the whole process of learning, by starting with the meaning and henceforth approaching the form of language. It inculcates a purposeful form of learning, gearing them up for real life situations.

In a study in Malaysia by Gaudart (1990) of over 300 teachers, where drama was used in teaching language in varying class abilities and capacities with diverse types of teachers, the study showed an increase in motivation in students.

With hindsight while student's motivation might increase in learning the English language, it is important to take consideration of the teacher's abilities too. When integrating drama into teaching language, teacher's fears must be addressed. Some teachers may have concerns of being incompetent in teaching drama and looking silly (Royka, 2002). Therefore, teacher's motivation needs to be taken seriously if drama is to be used as an intervention.

CONCLUSION

There is limited study in the use of drama for children with SEN (Jindal-Snape & Vettraino, 2007). As a result, this can be demanding for SEN teachers who wants to develop their practice by using drama. On the other hand, with limited studies, this can provide the teachers with the flexibility of using drama in many ways. With drama, it can lead to the formation of a teaching situation where students rarely experience failure, in turn this creates a safe environment where students are given the chance to practice important social skills (Attwood, 2006).

Active engagement in a dramatic activity can yield positive social outcomes such as a sense of belonging to a group. Although this sense of belonging can be felt by all and can be beneficial to all, it may have more of a particular importance for children with SEN (Gallagher, 2007). This may be because of the numerous times where these children may have been excluded from social situations due to their communication skills. Therefore, with drama activities, a sense of belonging can be fostered, thus helping them to enhance their communication skills.

Vygotsky (1987) states that disability is only seen as a flaw when put into a social context. Vygotsky (1987) mentions the main problem of disability is not the physical or cognitive impairment itself but its implications in the social context. The disability can affect the child's interaction with the world and the educator must not focus on the neurological factors but instead on the child's social consequences (Vygotsky, 1987). In Vygotsky's (1987) words, "A child whose development is impeded by a disability is not simply a child less developed than his peers; rather, he has developed differently" (p. 96).

Interventions that promote positive emotions may be the basis for a child's development in different aspects of life, including personal, academic, social and emotional (Mazher, 2020).

Children with dyslexia tend to have low self-esteem due to poor perceptions of themselves (Eadon, 2012). Therefore, drama can be a useful tool that allows children to express themselves emotionally, verbally, physically and socially, which in turn can build the self-esteem and emotional aspects of a child (Azlina et al., 2021).

RECOMMENDATIONS

The literature review revealed that drama approaches do play an important role in enhancing communication skills in children with special educational needs. For example, drama approaches can be used to help children with anger issues, low self-esteem, social interactions and language difficulties. However, this literature review also revealed that there is limited research in using drama for children with special educational needs. On this basis, it is recommended that future research should examine the benefits of using drama approaches for children with special educational needs, aged 9-12 years old.

It is also recommended that children with special educational needs be given an opportunity to attend drama lessons so that they can learn new skills and further improve their communication skills.

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Dyslexia in the Malay Language in Singapore

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Abstract

This study investigated the difficulties faced by English-Malay bilingual learners with dyslexia. The purpose of the study was to have a better understanding of the difficulties faced by bilingual learners with dyslexia in acquiring the Malay language, particularly in the aspect of reading and reading comprehension. Secondly, the study aimed to gain a deeper understanding of Malay as a second language in learners with similar profiles.

Inductive analysis revealed that word reading difficulties were affected by unfamiliarity of words, increasing word length and complexity of syllables and affixed words. Challenges in reading comprehension were due to poor word vocabulary and long comprehension passages. Additionally, the perceived usefulness of the Malay language as an alternative language for communicating with members of the community, as well as feeling supported in the classroom were the underlying motivating factors to learn the language.

These findings suggest that in teaching learners of this unique profile, phonological knowledge and morpheme instruction can facilitate reading in the Malay language. The length and lexical level of a given passage is also a factor to take into account when assigning tasks in the classroom. Finally, the esteem and anxiety levels must be considered for these English-Malay bilingual learners with dyslexia to maintain interest and motivation to learn Malay as a second language in Singapore.

Keywords: dyslexia, English, Malay, Singapore, bilingual

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1. INTRODUCTION

1.1 Singapore's Multilingual Society

Singapore's linguistic scene creates a rather complex path in language learning among students in the country. The multilingual society has four official languages: English, Mandarin, Malay, and Tamil, with English as the lingua franca and the language of the curriculum in schools. The English language was promoted as the language essential for international business, diplomacy and technology (Dixon, 2003; Bolton & Ng, 2014; Sim, 2020). It was also to promote cohesion between the different ethnic groups, allowing them to communicate with one another in a common language. On top of learning English, students are required to learn their home or ethnic language, Mother Tongue language (MTL), according to the Bilingual Policy, where one's MTL is dependent on one's ethnic group: Mandarin for the Chinese community, Malay for the Malay community, and Tamil for the Indian community. Learning one's MTL served as a gateway to learning one's heritage, safeguarding Asian identities, and preserving the respective ethnic cultures. The policy also seeks to provide students a competitive edge when pursuing global and regional prospects in the future (Ministry of Education, 2020). With MTL learnt as an additional subject in schools, students in Singapore are thus bilingual and bi-literate (Bolton and Ng, 2014; Zhang, Chin and Li, 2017). On top of being a compulsory subject to learn, proficiency in MTL is also assessed; this applies to primary schools through to pre-university institutions. At the primary level, MTL is one of the 4 subjects assessed in the Primary School Leaving Examination (PSLE), the national examination taken by all students in Singapore primary schools in the final year of their primary education. Thus, how well a student performs in the MTL subject will directly contribute to their overall PSLE score.

1.2 Dyslexia in Singapore

Learners with dyslexia, making up 3% to 10% of the student population (Ministry of Education, 2021a), are amongst those who face the brunt of the linguistic demands brought forth by these requirements and policies. Dyslexia is a learning difficulty of neurobiological origin that affects one's reading and spelling ability (International Dyslexia Association, 2022), where learners exhibit challenges in aspects of literacy, including word decoding, reading accuracy, reading fluency and reading comprehension (Ziegler et al., 2003; Ziegler and Goswami, 2005; Snowling, 2013). English language has been found to be complex in nature, owing to its orthography and phonological structure (Seymour et al., 2003; Ziegler et al., 2003). As such, the fact that English is the medium of instruction in Singapore schools already presents itself as a challenge for learners with dyslexia.

Current psychological assessments to diagnose dyslexia involve standardised tests in the English language, with remediation support primarily in the English language. With the

spotlight being on English-learning support for dyslexia, the other national languages have received little attention. In fact, in learners with dyslexia, second language acquisition as a means of maintaining competence in bilingualism and bi-literacy may compound language learning difficulties even further (Crombie, 2000; Andreou and Segklia, 2017).

1.3 Malay Language in Singapore

Furthermore, Singapore has been experiencing an overall language shift to English over the years (Singapore Department of Statistics, 2020). The recent statistics from Singapore's General Household Survey showed that by 2020, English was the predominant language spoken at home for 48.3 percent of the resident population aged 5 and above (Singapore Department of Statistics, 2020). According to the recent census, even the community that showed the most resilience against the language shift, has begun to succumb. Specifically, the Malay community that makes up approximately 13.5 percent of Singapore's ethnic composition (Singapore Department of Statistics, 2020, p. x.), has shown a 22 percent rise in the population shifting from speaking mainly Malay at home to predominantly English. This is the steepest rise observed compared to the other languages (Singapore Department of Statistics, 2020).

For the population aged between 5 and 14 years, only 3 percent indicated Malay as the only language spoken at home, as the majority were English-Malay bilinguals, notably 57 percent spoke predominantly English and 34 percent spoke predominantly Malay (Singapore Department of Statistics, 2020, p. 158). One may expect this trend to continue in the upcoming years. In a bid to counter the language shift and uphold the effectiveness of the Bilingual Language policy, in 2015 the Ministry of Education (MOE) announced that $25million was budgeted for the 3 Mother-Tongue Language committees to continue to promote and enhance the learning of MTL (Ministry of Education, 2015). Malay Language was no exception. Efforts included implementation of Bulan Bahasa (Malay Language Month) celebrated annually, to celebrate with the community while instilling a sense of appreciation for the Malay language (Majlis Bahasa Melayu Singapura, 2022).

1.4 Dyslexia in Malay in Singapore

The Malay language is of sharp contrast to English, in that it's orthographic and phonological nature is relatively easier to acquire (Winskel and Widjaja, 2007; Lee, Low and Mohamed, 2013; Zhang, Chin and Li, 2017). Despite this, Malay language support was recently offered under the Mother Tongue Support Programme, an early intervention programme recently rolled out in 2021 across all schools for Primary 3 and Primary 4 students who needed more support in their respective MTL (Ministry of Education, 2021b). Little has been said about the details of MTSP since its launch in 2021. However, what is known is that class sizes are smaller than the main classroom, and foundational skills in

oracy and literacy is the main focus of the programme (MOE, 2021b). This suggests that there are indeed learners who face challenges in Malay, even midway through their elementary years. The Malay Language curriculum taught in primary schools focuses on 'listening, speaking, reading, writing and interaction skills' and are offered at 2 proficiency levels: Foundation Malay and Standard Malay (MOE, 2020b). Students who are struggling to cope with the standard curriculum could opt for Foundation Malay instead, although the marks are being scaled down prior to adding to the overall score (Wong, 2019). For the newly implemented scoring system introduced in 2021, subjects are scored based on 8 bands called Achievement Levels (AL), with AL 1 being the highest score and AL 8 being the lowest. Scores for Foundation subjects will be mapped to the lowest 3 levels of the scoring system, which is AL 6 to AL 8. This means that while a student may score full marks for the Foundation Malay paper, the highest attainable level would be an AL 6 (MOE, 2021c). A student may also be exempted from taking a Mother Tongue Language if a child has had specific learning difficulties that impeded their learning. In this case, the child would be assigned an MTL score between AL6 and AL8.

Ms Indranee Rajah, then Second Minister of Education, mentioned at a Parliamentary meeting in 2019, that 70% of students with special educational needs in mainstream schools take MTL at PSLE, and that an average of 4.5% of students were exempted from taking MTL (Ang, 2020). However, the proportion of students exempted from Malay was not specified, and neither were the details on the specific learning difficulty. Based on this, it is presumable that learners with dyslexia may be amongst those taking MTL at foundation level in primary school or considering MTL exemptions. They may also stand to benefit from the additional support of MTSP.

1.5 Research Aims and Questions

Despite Malay being offered at different proficiency levels to accommodate to students' varying abilities and learning needs, the emphasis on bilingualism and the linguistic expectation puts learners with dyslexia at a disadvantage. Furthermore, implications on learning Malay considering the unique profile of having dyslexia and being English-Malay bilingual in the context of Singapore has not been widely studied. This gives impetus for research in the difficulties faced in acquiring the Malay language amongst this group of learners.

The research study had two aims:

- to understand how dyslexia is manifested in the Malay language among bilingual learners in the aspect of reading and reading comprehension
- to deepen the understanding of second language acquisition amongst learners with similar profiles

The following three questions guided this study:

1. What are the reading difficulties faced amongst bilingual learners with dyslexia?

2. What are the challenges faced when comprehending texts?

3. What are perceptions and motivations towards learning Malay?

Findings from this research may act as a catalyst to modify the existing pedagogical approach that is currently being practised in schools, whether it is for a future MTSP programme that supports beyond Primary 4, or for Malay language teachers in the main classroom.

2. LITERATURE REVIEW

2.1 Theories of Dyslexia

Stages of Reading Acquisition

The development of reading acquisition involves metalinguistic awareness, the ability to manipulate the linguistic units of a particular language (Nagy and Anderson, 1995). Essentially, early stages of reading start with understanding print to speech mapping and how sounds are being represented as symbols in a particular language (Nagy and Anderson, 1995; Zhang, Chin and Li, 2017). This is referred to as the logographic stage of reading (Stuart and Coltheart, 1988; Frith, 1985; Seymour, 1984). Phonological awareness is one type of metalinguistic awareness that has been found to play an important role in early stages of reading (Nagy and Anderson, 1995), which involves associating graphemes and phonemes to one another. This is the second stage of reading acquisition according to Seymour's theory, the alphabetic stage (Stuart and Coltheart, 1988). The orthography and phonography of a particular language determines whether small grain-size units (phonemes) or large grain-size units (syllables) are decoded for word reading (Ziegler and Goswami, 2005; Zhang, Chin and Li, 2017).

The final stage of reading according to Seymour is the orthographic stage, which involves orthographic and lexical functions to read words (Stuart and Coltheart, 1988). At this stage, morphological awareness, another type of metalinguistic awareness, also contributes to word reading. This refers to being able to manipulate the smallest unit of meanings (morphemes) and the morphological constituents in a word (Carlisle, 2003). Furthermore, according to Gough & Tunmer's Simple View of Reading (Florit and Cain, 2011; Snowling, 2020; Gough & Tunmer, 1986), reading comprehension is dependent on both decoding and linguistic comprehension. In other words, being able to comprehend texts is attributed to one's ability to decode the words and process aurally presented

information in a particular language, and difficulty in any of the two areas will lead to reading comprehension difficulties (Florit and Cain, 2011).

Dyslexia is a learning difficulty in which the phonological deficit hypothesis has been predominantly used to understand the underlying cause (Snowling, 2013). The hypothesis suggests that the difficulties faced by learners with dyslexia is attributed to phonological deficits, which affects the ability to map letters to their corresponding sounds, thus impeding their ability to perform tasks that require phonological processing (Liberman et al., 1974; Ehri et al., 2001). Phonological awareness, that is one's ability to manipulate the sounds of speech at different levels (e.g. phonemes, syllables, rimes) has been extensively researched in the past and has shown to play a causal role in acquiring reading skills in an alphabetic orthography (Liberman et al., 1974; Wagner and Torgesen, 1987; Ehri et al., 2001; Winskel and Widjaja, 2007). Thus, problems in this aspect are indicators of reading difficulties, in which the ability to decode pseudo-words (i.e. grapheme-phoneme mapping rules without context) has been highly regarded as the main indicator.

Furthermore, in English older children, morphological awareness has also shown to play a role in reading and spelling acquisition (Carlisle, 2003; Winskel and Widjaja, 2007). In learners with dyslexia, Frith concluded that there is discontinuity between the stages of reading, and challenges in mastering one stage will result in difficulties advancing to the next stage (Frith, 1986). Thus two subtypes of dyslexia can occur, according to Frith: classic dyslexia and classic dysgraphia, where the former refers to poor mastery in the alphabetic stage, and the latter refers to poor mastery at the orthographic stage (Frith, 1986). Learners with dyslexia have shown that in tasks where phonological or lexical skills are not the focus (such as digit strings), they exhibit deficits in processing letter strings (Boros et al., 2016; Ziegler et al., 2010).

Temple and colleagues (2001) found impairments in the brain of learners with dyslexia in the aspect of orthographic processing too, particularly single letter processing. This had also been explained as deficits in visual attentional processing, where they show poor performance in visual search tasks, whether it involved letters, digits, or symbols. (Boros et al., 2016). Other bodies of research have raised concerns regarding phonological instruction only improving reading accuracy, but having little effect on reading fluency and reading comprehension (Wolf and Bowers, 1999; Landerl and Wimmer, 2000; Snellings et al., 2009). Wolf and Bowers (1999) found that processing speed was impaired in learners with dyslexia, specifically in the aspect of rapidly naming symbols involving language stimuli (e.g. letters, numbers objects). They coined this a double-deficit, in which naming speed was a second deficit in learners with dyslexia, and together with a phonological deficit, a learner with dyslexia would face significant challenges in reading (Wolf and Bowers, 1999).

2.2 Impact of dyslexia on reading acquisition in different language structures

Past studies have confirmed how both orthography and phonology of a language determine the incidences of reading difficulties and the degree of the severity (Ziegler and Goswami, 2005). Seymour and colleagues' (2003) hypothetical classification of European languages was built on the dimensions of orthographic depth and syllabic complexity. Orthographic depth resembled the consistency of letter-phoneme mapping in a language. A shallow orthography had letters mapped to phonemes consistently, while a deep orthography contained inconsistent letter-phoneme mapping and complexities that included morphological effects and multi-letter graphemes (Seymour et al., 2003). Syllabic complexity in a language referred to the predominance of open or closed syllables in a language, and the positions in which consonant clusters appeared (Seymour et al., 2003). The authors hypothesised that reading acquisition was achieved more rapidly in languages of simple syllabic structure and shallow orthographic depth, while development was slower in languages with complex syllabic structure and deep orthographies (Seymour et al., 2003).

In reading shallow orthographies, there has been little emphasis on the effect of phonological deficits in reading acquisition, as reading accuracy scores have been shown to be high or comprising minimal errors (Ziegler et al., 2003; Ziegler and Goswami, 2005; Marinus and de Jong, 2010; Dandache, Wouters and Ghesquière, 2014). One example is a study by Milankov and colleagues (2021) on the consistent Serbian language. They found that reading difficulties in their participants were manifested as slow phonological decoding, which resulted in reading speed deficits, as opposed to reading errors (Milankov et al., 2021). On the contrary, other studies have found that both phonological deficits are evident, on top of reading speed deficits, amongst learners with dyslexia, regardless the orthographic depth of the language. This was seen in Boets and colleagues' (2010) longitudinal study on Dutch-speaking children with dyslexia. The authors attributed the disparity with past studies to the measures they had used in their study – that they were sensitive measures, and were thus able to reveal deficits in both phonological and, in turn, reading deficits. This was in spite of Dutch having medium orthographic depth (Seymour et al., 2003). This was in line with another study comparing reading difficulties in German and English (Ziegler et al., 2003), even though Seymour (2003) classified German being of shallow orthography.

Reading errors were seen across both languages, although they were relatively higher in the English language, due to its inconsistent orthography. Relevant to note, however, is that in both languages, phonological deficits surfaced when reading non-words in either language and that the significant size of the non-word reading deficit across the two were similar (Ziegler et al., 2003). Eklund and colleagues (2015) did a study on the transparent Finnish orthography in students in Grade 2, 3 and 8. Their findings on word reading accuracy revealed high scores and minimal errors, consistent with earlier findings (Ziegler et al., 2003; Ziegler and Goswami, 2005; Marinus and de Jong, 2010;

Dandache, Wouters and Ghesquière, 2014). However, similar to Ziegler (2003), non-word reading accuracy resulted in low scores. It is worth pointing out that this was not only seen in the participants in Grades 2 and 3; the students in Grade 8 exhibited this too. These studies give insight to the persistent difficulties in phonological decoding that are subject to the demands of a task when tasks are perceived to be more challenging (Eklund et al., 2015). The fact that difficulties were faced in the older learners is notable, as past studies have found that the reliance on grapheme-phoneme mapping may no longer be the decoding strategy as one's reading skills develops (Borleffs et. al, 2019; Landerl & Wimmer, 2008; López-Escribano & Katzir, 2008, Tressoldi et. al., 2001).

In reading acquisition, the role of syllables in word recognition is another aspect of reading that may affect one's ability to acquire a language, as the complexity of a syllable varies between languages. A study by Seymour and colleagues (2003) revealed that one's ability to decode non-words was subject to the syllabic complexity, while real word and pseudo-word reading depended on the depth of the language. They concluded that these two aspects – syllabic complexity and orthographic depth – determined the rate at which language was acquired. They hypothesized that the difficulties acquiring a language will increase as syllabic structures got complex, and as orthographies got deeper. Verhoeven and Keuning's findings (2018) on children with dyslexia in the intermediate grades learning the Dutch language found that significant errors in word decoding accuracy were observed, particularly as the word length increased. However, in decoding pseudo-words, the participants were inefficient in decoding both long and short pseudo-words (Verhoeven and Keuning, 2018), and this was especially so when they encountered digraphs (Marinus and de Jong, 2010). Several researchers have attributed the complexity of a syllable to the consonant clusters in words, of which the problems varied depending on the position of the clusters in a word. Ziegler's study (2003) found that even after initial complex onsets (like consonant clusters) were excluded from tested words, both English and German learners with dyslexia displayed length effects, where reading longer words (both real and non-words) was found to significantly affect their reading speed, due to considerable effort and time spent on decoding each letter as words increased in length (Ziegler et al., 2003).

Research has shown that the morphological structure of the language is a contributing factor in the reading process, where developing readers will rely on their knowledge of morphemes when processing pseudo words or words with morphologically complex structure (Borleffs et. al. 2019). Some researchers have argued that it is morphological awareness, and not phonological awareness, that is required for reading new and longer words (Quémart, Casalis and Colé, 2011), and continues to develop as one progresses across upper primary school years and beyond (Berninger et al., 2010). This is more so in learners with reading difficulties where their reading would otherwise be slow (Suárez-Coalla and Cuetos, 2013). There have been few studies conducted in the aspect of dyslexic learners. One case was done on a deeper orthography that is French, by Quémart, Casalis and Colé (2011). They found that learners with dyslexia relied on

their morphological awareness to facilitate visual word recognition. However, compared to the typical readers, they were found to be impaired in tasks that required the use of morphological knowledge, notably in the absence of context cues. Traficante and colleagues (2011) found that Italian learners with dyslexia were able to identify morphemic units to aid the reading of pseudo-words. However, in orthographic sequences without morphological structures, the learners with dyslexia achieved a low level of reading accuracy. In comparing these findings, worth noting is that French has a deep orthography (Seymour et al., 2003), thus the difficulties in morphological processing could be attributed to the opacity of the language. As for Italian, it is of rather shallow orthography and not agglutinative in nature, which means a word may not comprise of several morphemes or may not be morphologically complex, resulting in easier decoding.

With word recognition being subject to the syllabic and morphological structure of the words, on top of an underlying phonological deficit in learners with dyslexia, it is logical to expect difficulties in reading comprehension. Studies have highlighted the role of morphological awareness in reading comprehension (Carlisle, 2000, 2003; Singson, Mahony and Mann, 2000). Being able to process the morphemes in a word can allow learners to easily draw its meaning and the syntax when found in a sentence (Carlisle, 2003), thus contributing to reading comprehension, more so as words get more complex beyond lower elementary grades (Kuo and Anderson, 2006). Furthermore, morphological knowledge helps learners develop vocabulary (Anglin, 1993; McKeown and Curtis, 2014).

The concern on whether or not students were able to recognise morphemes in a morphologically complex words and derive meaning from it was discussed in Carlisle's commentary (2003). She cited Tyler and Nagy's findings (1990) where weak readers were found to make more syntactic errors than better readers (Carlisle, 2003). Nagy and Anderson (1984) suggested that learners who are sensitive to the morphemes in a word may be able to employ their morphological processing skills when building vocabulary. This implies that learners acquiring a morphologically-rich language may be advantaged due to their earlier years of developing morphological awareness, possibly facilitating vocabulary acquisition and reading comprehension in learners with dyslexia, as seen in Bertram, Laine, and Verkalla's study (2000).

In the case of more transparent orthographies, Zarić and Nagler (2021) found that in their study on weak readers in the German language, reading comprehension at sentence level was not only dependent on phonological processing and naming speed, but also orthographic knowledge. However, the authors noted that the participants displayed a primary reliance on using word-specific knowledge here, whereas application of general orthographic knowledge was only employed when they encountered uncommon words (Zarić and Nagler, 2021). However, this was not the case for reading comprehension at text level (Zarić and Nagler, 2021) where the phrases and sentences integrate information and ideas (Castles, Rastle and Nation, 2018). In this

aspect, the participants were found to mainly rely on phonological knowledge (Zarić and Nagler, 2021).

This was consistent with findings from Constantinidou and Stainthorp's study (2009) in Greek-speaking children, where poor decoding skills and, in turn, poor fluency were revealed to compromise the text-level reading comprehension among weak readers. In agglutinative languages like Finnish, Torppa and colleagues (2012) associated poor reading fluency to weak reading comprehension. In a study comparing dyslexic and typical readers in French, Casalis and colleagues (2004) found that the children with dyslexia made more errors in the reading comprehension task that required application of syntactical and semantic skills.

The results also revealed that the learners with dyslexia struggled in tasks that required them to use context cues to complete sentences with derived words; this was observed to be more challenging than identifying affixes and base words, although the latter was an aspect they performed poorly in as well. The authors attributed the difficulty of producing derived words to the focus placed on the semantic and syntactic elements of the suffixes. This supported earlier findings that have highlighted how meaning can be lost in a passage when the analysis of the word structural properties take precedence (Craik and Lockhart, 1972; Perfetti and Hogaboam, 1975).

2.3 Dyslexia and Bilingualism

Research has shown that when acquiring a second language, it is likely that those with reading or learning difficulties will face problems. According to Ganschow, Sparks and Javorsky (1998), the ability to learn a foreign language is dependent on an individual's linguistic ability, and that the skills one possesses in their first language is crucial in learning a second language. This was echoed by Marogna (2013), who concluded that one's ability to acquire a second language is affected by how competent they are in their native language, as linguistic factors are major causal determinants for proficiency in an additional language (Marogna, 2013).

Previous studies have compared the reading abilities between bilinguals of varying orthographies, and have revealed cross-linguistic transfers of phonological skills, where phonological knowledge in reading proficiency in L1 would influence the L2: Spanish-English bilinguals (Durgunoğlu, Nagy and Hancin-Bhatt, 1993), Italian-English bilinguals (D'Angiulli et. al., 2001), Portuguese-English (Da Fontoura and Siegel, 1995), Dutch-English bilinguals (van Setten et al., 2017). Cross-linguistic transfers of morphological skills had also been observed in English-French bilinguals (Deacon, Wade-Woolley and Kirby, 2007).

A study comparing Spanish-English bilinguals to Chinese-English bilinguals (Bialystok, Majumder and Martin, 2003) revealed that the latter scored lower due to Chinese and

English having contrasting phonetic and orthographic structure. The Spanish-English bilinguals, however, appeared to be at an advantage due to the shallow orthography of Spanish granting easy access to phonological awareness, and the fact that the alphabetic orthographic system, as well as their phonological structure of both Spanish and English are relatively similar. This was consistent with Fontoura and Siegel's study (1995) on Portuguese-Canadian children with dyslexia, where their findings revealed when compared to the English monolinguals with dyslexia, the bilingual children scored significantly higher, implying that there was a transfer of consistent grapheme-phoneme conversion knowledge learnt through Portuguese that were employed to facilitate reading in the more opaque English language. However, it was observed that in both languages, phonological processing deficits were found to be the underlying cause of their reading difficulties. In the study on Dutch-English bilinguals with dyslexia (van Setten et al., 2017), reading difficulties were observed in both languages, however reading and spelling deficits were more evident in English (L2), which implies that phonological deficits, or reading impairment would be found in L1 and L2 .

These findings support Sparks and Ganchow's (1993) Linguistic Coding Deficit Hypothesis (LCDH) which posits that difficulties in one's first language will impede the ability to acquire the acquisition of a second language. The hypothesis also attributes the underlying cause to phonological deficits. However, it is important to note that the degree of difficulties faced will vary across languages, due to the varying orthographies and unique characteristics that each language possesses (Dulude, 2012). If both L1 and L2 are similar in orthography and phonological structure, the learning could be made easier, as skills that had been developed in acquiring the first language may facilitate learning of the second language.

At the same time, the varying orthographic depth of the two languages have to be considered as well. In the case of Fontoura and Siegel's study (1995), Portuguese (L1) is considered of relatively transparent orthography compared to English (L2), similarly in van Setten and colleagues' study (2017) comparing Dutch (L1) and English (L2). Interesting to note is how the weak readers amongst the Portuguese-English bilinguals only displayed significant difficulties in in the English word reading task than the Portuguese reading task, but generally showed equal difficulties across the two languages, including the pseudo-word reading task, despite the varying orthographic depth. This was observed in the Dutch-English bilinguals as well (van Setten et al., 2017) and is consistent with findings from a study on Swedish (L1) and English (L2) bilinguals by Miller-Guron and Lundberg (2000). On the contrary, a study done by Andreo and Segklia (2017) on cross-linguistic skills transfer in learners with dyslexia in Greek (L1) and English (L2), revealed that weak decoding skills was more significant in English than Greek.

The importance of decoding skills in second language (L2) reading gives rise to a logical expectation that deficits in this area will affect L2 reading comprehension (Melby-Lervåg and Lervåg, 2011). This was seen in Mikulek's study (2015) comparing reading in English

(L1) and Spanish (L2) through miscue analysis. The findings revealed that they were largely reliant on word-level decoding when reading in Spanish (L2). This was observed through significantly higher incidences of sounding out the words and reading the words repeatedly before proceeding to the next word, suggesting that their focus was placed on accurate decoding than reading for meaning. This was further supported through the miscues that did not semantically make sense (Mikulec, 2015). As such, their sentence level meaning was affected, in that they used prediction strategies to derive meaning, and relied on their background knowledge to compensate for their lack of understanding. In adopting this, they were only able to grasp a holistic view of the text, however the depth, details and nuances of the story were lost (Mikulec, 2015). The case study provides a different perspective on L1 and L2 reading, as the participants were typically developing adult readers proficient in both languages. Although Spanish was learnt as a foreign language, they were proficient enough to be teachers in the subject, and had been learning the language for 7 years. This gives us insight on the difficulties learners bilingual learners with dyslexia may face in the aspect of reading comprehension, and the negative effects of low proficiency in a second language on comprehending texts.

In learning another language, how one regards the usefulness and practicality of the language has to be taken into account (Crombie, 2000), as the acquisition of another language is influenced by one's motivation, self-esteem as well as anxiety levels (Marogna, 2013; Crombie, 2000; Ganschow et. al., 1998; Krashen, 1982). Past research has confirmed the low-levels of self-esteem in learners with dyslexia (Humphrey, 2002; Glazzard, 2010; Novita, 2016) as well as high level of anxiety (Novita, 2016) that can influence acquisition of a second language (Sparks and Ganschow, 1991). Furthermore, aspects of classroom accommodations, teaching approaches, and their overall learning experience in schools have shown to affect their levels of esteem (Humphrey, 2002; Glazzard, 2010). These factors, in turn, play a major role in determining a learner's motivation to learn (Harter, 1996).

Kormos and Csizér (2010) also raised the issue of self-concept affecting the motivation levels in learners with dyslexia, in that they held negative views of themselves as language learners, due to the nature of their difficulties. The authors also noted the concern of anxiety in acquiring German, of which they speculated traditional approaches exclusive to the language that were difficult for learners with dyslexia (Kormos and Csizér, 2010). In the case of Hungary learners with dyslexia acquiring either German or English as their second language (L2), the students generally did not display high levels of interest towards the L2 language (Kormos and Csizér, 2010). The authors concluded that the L2 languages were not widely used outside of school, and was thus perceived as yet another school subject. However, worth noting is that the learners studying English (L2) displayed more favourable attitudes towards learning the language, compared to those taking German (L2) (Kormos and Csizér, 2010). This is on account of English being used globally, which has led to higher levels of motivation to gain proficiency in the

language. What is interesting is that the practicality of the English language took precedence over the simpler and transparent orthography of German (Kormos and Csizér, 2010).

2.4 Dyslexia and Malay Language

The Malay language is an Austronesian language, of which is the national language for Singapore, Malaysia, Indonesia, and Brunei (Tadmor, 2009; Benjamin et. al., 2009; Yap et. al, 2010;), although the standard Malay of each country differs slightly from one another, with Singapore's being almost exactly identical to Malaysia's Bahasa Malaysia. While Malay makes up one of Singapore's four national languages, the other 3 countries have Malay as their official language.

The Malay orthography is of sharp contrast to English. Its orthographic depth is characterised as being shallow, syllable structures simple, and morphology transparent (Yap et al., 2010). The Malay writing system uses Latin alphabets (Lee, 2008; Yap et al., 2010; Lee, Low and Mohamed, 2013). The writing system uses the five simple vowels, and the remaining consonants, with the exception of "x", are used. It possesses five digraphs, "gh", "kh", "ny", "ng" and "sy", and three diphthongs, "au", "ai", "oi" (Yap et al., 2010; Lee, 2008; Awang, 2004). The Malay language has been characterised as having shallow orthographic depth due to its letter-phoneme mapping being highly consistent; each letter corresponds to a single sound (phoneme) (Yap et al., 2010; Lee, Low and Mohamed, 2013; Zhang, Chin and Li, 2017).

To demonstrate with the Malay word *makan* (eat): the five letters (i.e. 'm' + 'a '+ 'k' + 'a' + 'n') correspond with five phonemes (i.e. /m/ + /a/ + /k/ + /a/ + /n/). Unlike in English words like "rain", for example, where the four letters correspond with only three phonemes (i.e. /r/ + /eɪ/ + /n/). The vowel "e" is the only exception in the direct letter-phoneme correspondence, in which it takes on two forms, /e/ and /ə/ (Yap et al., 2010; Zhang, Chin and Li, 2017). Although the regular letter-phoneme mapping suggests that phoneme instruction would be the basis of teaching reading skills, this is not the case. Rather, Malay reading instruction involves working at the syllable level instead of phoneme level, which includes segmentation and blending of syllables (Ziegler and Goswami, 2005; Winskel and Widjaja, 2007; Lee, 2008).

To date, there have been very few studies done on the impact of dyslexia in the Malay language. One case was done on native Malay low-progress readers by Lee and Wheldall (2011). The authors emphasised phonological awareness as playing an important role in Malay word reading, particularly the ability to manipulate phonemes and adopt a grapheme-phoneme decoding strategy, instead of a whole-word recognition strategy considering the consistent orthography of the language (Lee and Wheldall, 2011). The word reading error analysis revealed a significant number of non-word errors over visual errors, suggesting that phonological processing impairments

affect the way in which words are decoded in Malay. This was also evident in Winskel and Widjaja's study (2007) amongst native early readers in Indonesia who speak *Bahasa Indonesia*, a slightly different form of the Standard Malay language used in Singapore and Malaysia. Interestingly, Zhang, Chin, and Li's (2017) study on English-Malay Singapore bilinguals found that the participants of his study, exhibited use of phonemic awareness in word reading too. Worth noting is that the participants were in Grade 3 and Grade 4, older than the readers in Lee and Wheldall's study (2011). Furthermore, they were typically developing readers. It is interesting that despite Malay reading instruction in Singapore focusing on syllable level, phonemic awareness was found to be a significant contributor to word reading (Zhang, Chin and Li, 2017).

Lee and Wheldall (2011) observed the role of syllabic structures in Malay reading, and found that the presence of digraphs and the position it appeared determined the complexity of the syllable, especially since the majority of Malay words are multisyllabic, even at beginner levels of reading (Zhang, Chin and Li, 2017; Lee et al., 2012). Furthermore, despite Malay having only few consonant clusters (Winskel and Widjaja, 2007; Yap et al., 2010), the language has digraphs that are frequently occurring. The presence of diphthongs and the letter e (since it has two phonemic forms) also contributes to the increasing difficulty of words (Lee and Wheldall, 2011; Zhang, Chin and Li, 2017). The complexity in the syllables or words of the language is expressed by both syllable and phonic structure (Lee and Wheldall, 2011).

Malay words have simple syllable structures, and a review by Lee (2008) identified the four basic ones being V, VC, CV, and CVC. Multi-syllabic words dominate the Malay language, in comparison to mono-syllabic words, with most Malay words constituting various combinations of the basic syllables. For example, CV and CVC can combine to form a simple two-syllable word like *rumah* (house), but *masyarakat* (society) made of CV + **C**V + CV + CVC has four syllables combined including a digraph (represented as **C**), thus increasing the complexity of the word (Lee, Low and Mohamed, 2013). The weak readers in Lee and Wheldall's study (2011) were observed to struggle with recognising and segmenting the different syllable structures. Specifically, as syllabic complexity increased, word reading performance decreased (Lee and Wheldall, 2011; Winskel and Lee, 2013). Thus the authors concluded that syllables, on top of phonemes, play a significant role in word reading. The participants here were Grade 1 students, and so this finding is expected, since they are still developing reading acquisition.

Zhang, Chin and Li's study (2017) on typically developing readers revealed that morphological processes, on top of phonological processing, underpinned reading acquisition in English-Malay bilinguals. The participants were found to use morphological knowledge as a supplementary skill to phonological decoding, where morphemes and derived affixes were involved (Zhang, Chin and Li, 2017), as well as spelling multisyllabic affixed words (Winskel and Widjaja, 2007). Past research (see Section 2.2) has shown how morphological awareness may serve as a compensatory strategy when reading

(Casalis, Colé and Sopo, 2004). However, the complexity of the morphological structure that will vary across languages could affect decoding competency in a particular language in learners with dyslexia. In the case of Malay, words are largely formed through affixation, of which there are 25 derivational affixes in Malay (Lee and Wheldall, 2011; Zhang, Chin and Li, 2017; Prentice, 1987). These include prefixes (e.g. ***me-*** *+ makan* [eat] ⇨ ***me****makan* [eating]), suffixes (e.g. *ajar* [to teach] + ***-an*** ⇨ *ajar****an*** [teachings]), and circumfixes (e.g. ***ke-*** *+ kuat* [strong] + ***-an*** ⇨ ***ke****kuat****an*** [strength]). Generally, derived forms of words do not lead to any phonological or orthographic shifts. However there are exceptions for prefixes *pe-* and *me-* (Yap et al., 2010; Zhang, Chin and Li, 2017) where the prefix will change depending on the first letter of the base word. For example, when prefix *me-* is added to the base word *sebut* (to say), the prefix *me-* changes to *me****ny-,*** while the "s" in the base word is dropped to form the new word *menyebut* (saying). Other examples include *pe-* changing to *pe****ng-*** when added to the word *karang* (to compose), forming the new word *pe****ng****arang* (author), where the initial letter of the base word, "k", was dropped. Reduplication is another means of word formation (Lee and Wheldall, 2011; Zhang, Chin and Li, 2017). With the word *murid* (student), it becomes a plural form upon reduplication, *murid-murid* (students).

Compounding is another way in which words are formed in the Malay language. For example, compounding the two words *kolam* (pond) and *renang* (swim) results in the formation of a new word, *kolam renang* (swimming pool). Complex forms as a result of reduplication and affixation can also emerge, like in the word *hormat* (respect) becoming *hormat-menghormati* (respect each other), where *menghormati* involves prefix *me-* changing to *meng-.* Lyytinen and Lyytinen (2004) conducted a study on Finnish, a transparent and agglutinative language, and hypothesised that participants who had displayed difficulties with morphological awareness during their earlier years of reading acquisition was at risk of being diagnosed with dyslexia in the future. In the Malay language, the complexity of derivation and the frequency of its occurrence may impede reading acquisition among learners (Zhang, Chin and Li, 2017) . This was seen in Lee and Wheldall's (2011) study in Malay native-speakers. Longer multisyllabic words that had derivational affixes attached to them compounded the difficulties of the low-progress readers in their study (Lee and Wheldall, 2011). Worth noting is that the authors attributed this difficulty to the increasing word length that extended beyond three syllables as a result of affixation, and not the complexity of the affixes specifically.

To date, very few studies have discussed reading comprehension in the Malay language, more so in learners with difficulties or bilinguals. Thus, comparisons can be drawn from studies in other similar languages. Bertram, Laine and Virkkala (2000) studied the effects of morphological knowledge in vocabulary acquisition in the Finnish language. The findings showed that its morphologically-rich nature required learners to utilize morphology when comprehending texts, particularly those that comprise of words infrequently used or seen. Since Finnish is similar in nature to Malay orthography, their findings raise the possibility of learners with dyslexia learning Malay being at an

advantage when trying to get through reading comprehension tasks that could otherwise be overwhelming. However, relying on morphology alone is not sufficient; other skills required to support learners in reading comprehension tasks include contextual cues, syntactic skills and semantic skills (Adams, 1977; Boets et al., 2010; van Bergen et al., 2012).

Carlisle's commentary (2003) stated how syntactic errors are seen amongst weak readers, which suggests that learners with dyslexia reading Malay passages, despite being able to use morphological knowledge to facilitate their reading, may have difficulties accessing syntactic information in affixed words, and thus may not be able to derive meanings from words this way. In the context of Malay, although the earlier examples on affixation show close relations between the base word and the affixed forms, deriving meaning from the newly formed words may not be so clear-cut. For example the base word *satu* (one) can become *ber + satu* (be united) and *per + satu + an* (an association). Key words in a text that comprise of derived affixation in a similar manner may thus give rise to syntactic errors in turn affecting one's reading comprehension. In the context of learners with dyslexia in Singapore, although they would have developed morphological awareness at a young age in learning Malay, the elements of syntax, semantics, and vocabulary also come into play, on top of their phonological deficits. Furthermore, the bilingual aspect has to be considered too. The research aims to add further insight into the difficulties in reading comprehension amongst learners with this unique profile.

Drawing parallels from past research on dyslexia and bilingualism with English-Malay bi-literacy in Singapore in the aspect of motivation to learn the language, if a learner with dyslexia does not predominantly use Malay for communicating or views it as having little practical use, there may be little motivation to be proficient in the language, even if Malay's shallow orthography makes it an easy language to acquire. Cavallaro and Serwe's study (2010) revealed that younger age groups tend to demonstrate higher use of the language than the older participants. The authors attributed this to the social networks comprising mainly of their family members and ethnic peers. Interestingly, across all age groups, other than when speaking with relatives, the use of the Malay language was found to be mainly used when communicating with religious teachers and Malay shopkeepers. The findings also revealed the language shift from Malay to English takes place as one gets older (Cavallaro and Serwe, 2010).

The language predominantly used at home is largely influenced by parents' perspectives as well. A study by Abu Bakar (2015) revealed a large percentage of Malay parents in Singapore who used English or predominantly used English than Malay in their homes. The inclination to use English at home, despite most of them conversing with their spouses in Malay, was attributed to supporting their child's proficiency of English in school due to it being the language of the curriculum. However, the findings also revealed that these parents did not want the Malay language to be lost on their

children, and hence would prefer to send their children to Malay-speaking religious classes as a means of maintaining the language, despite knowing that their child learnt better in English (Abu Bakar, 2015).

However, published studies exploring this aspect of learners with this unique profile is close to none. The concern with motivation is one that warrants investigation, particularly due to the bilingual landscape of Singapore, and the learning challenges of dyslexia. Norhaida (2009), in her study on the linguistic practices of bilingual Singapore Malay students, cited Holmes (2008) on how institutional support is crucial to ensure an ethnic language is preserved, amongst which education was considered an important domain of support.

Although use and appreciation of the language can develop from reading more Malay books and coming up with more engaging reading materials, more importantly is the creation and planning of lessons, instruction, and teaching resources that will need to take into account the varying needs of learners and their different levels of proficiency and ability (Norhaida, 2009; MOE, 2005). Specifically, with the increased exposure to English due to the education system in schools, the perceived relevance of learning Malay comes into question. These factors determine how much exposure a learner with dyslexia will have to the Malay language, and will influence how they perceive the relevance of learning the language and the practical aspects of using it. This may be especially important for English-Malay bilingual learners with dyslexia, as their language deficits may already affect their performance in the English language (L1) in comparison to their peers.

2.5 Research Gap

The literature review suggests that acquiring the Malay language may not be as easy the shallow orthography sets it out to be, and that there are several factors that could impede learners with dyslexia from achieving proficiency in the language. Winskel and Widjaja (2007) conducted their study on Indonesian Malay (*Bahasa Indonesia*), while the study by Lee and Wheldall (2011) was on Malaysian Malay (*Bahasa Melayu*). They are different in that *Bahasa Indonesia* has its letter names directly corresponding to the sounds the letter makes, whereas *Bahasa Melayu*, which is the standard form of Malay, does not have letter names that correspond to the letter sounds (Winskel and Lee, 2013). The Malay language used and taught in Singapore uses the standard form of Malay, like Malaysia.

Although insights can be gained from both studies mentioned, as discussed in the review of the literature, their findings have to be exercised with caution when making generalisations in local context. This is largely due to Indonesia and Malaysia having Malay as their national language, a stark contrast to Singapore, where English is the main language, and a student of Malay ethnicity only receives official Malay language

instruction as a subject in school. While past studies have provided us some insight on the difficulties that have affected word reading in Malay, further research needs to be done to give us a better understanding of the challenges unique to bilingual learners with dyslexia. Additionally, these studies have been either in typically developing readers, or weak, beginner readers, but little has been said for those who have already passed the early stages of reading acquisition.

Furthermore, the focus of past research in Malay has been in relation to word recognition, rather than reading comprehension. However, with reading comprehension being the function of word reading, the limited published studies investigating this important aspect warrants the need to understand how dyslexia affects Malay comprehension too, particularly in bilingual learners.

Finally, in view of the previous studies in the literature review that found self-esteem to affect second language acquisition amongst learners with dyslexia, considerations need to be made in promoting learning of the Malay language in classroom amongst learners with dyslexia; ensure they are supported to maintain healthy levels of esteem (Glazzard, 2010), employ effective teaching approaches that considers their learning difficulties (Kormos and Csizér, 2010) and provide them with opportunities for success (Crombie, 2000; Kormos and Csizér, 2010). As such, when analysing how bilingual learners with dyslexia learn the Malay language in Singapore, it is important to consider their perception and attitudes they have towards the language, along with their learning experiences in the classroom.

Moreover, while Singapore's bilingual policy places emphasis on Mother Tongue competence, the progressive language shift to English as a result of English being the *lingua franca* and language of the curriculum, shows how the Malay language has been eclipsed by the prevalence of English. Thus, the element of being bilingual may compound the learning challenges in dyslexics acquiring Malay, more so in current Singapore where the use of Malay continues along a downward trend.

2.6 The Present Study

Given that the past studies on dyslexia and Malay have found phonological awareness to be a predictor of reading in the language, the present study adopted the phonological deficit theory of dyslexia. The present study was conducted on Singaporean English-Malay bilinguals with dyslexia that investigated their word reading abilities (influenced by morphological and syllabic complexity in words) vocabulary, comprehension skills, and attitudes towards learning Malay.

There were three main questions that guided this study:

1. What are the reading difficulties faced amongst bilingual learners with dyslexia?
2. What are the challenges faced when comprehending texts?
3. What are the perceptions and motivations towards learning Malay?

3. METHODOLOGY

3.1 Research Design and Rationale

Due to the unique profile of the learners – English-Malay bilinguals in Singapore with dyslexia – having yet to be studied, a qualitative research method was used. Moreover, although prior studies had revealed the possible factors affecting reading and comprehension, the complexity of the problem given the profile of the learners had yet to be captured, therefore necessitating further exploration of the factors contributing to their difficulties. Using a qualitative method was also important in understanding the thoughts and behaviours of the participants when discussing their difficulties, particularly their perceptions on learning Malay.

Since the present study intended to investigate learning challenges in Malay, as well as gain insights on the learners' behaviour and attitudes, a multi-case study research appeared to be the most appropriate way of capturing the data required to answer the research questions.

3.2 Participants

The participants were eight students whose school levels ranged from Primary 5 to Secondary 1, aged 11 to 13. All of them had a diagnosis of dyslexia and were studying at local, mainstream schools. At the time of the study, they were current students of the Dyslexia Association of Singapore (DAS), receiving intervention for the English language. They were all of Malay ethnicity, and were taking Malay as their Mother Tongue language.

3.3 Sampling and Recruitment

The study was approved by the Ethics Committee of the University of South Wales and the DAS Research Committee. Upon approval, a nation-wide recruitment process across the 14 DAS Learning Centres took place. Ethical considerations were described and explicitly stated in both parents and student information sheets.

In order to ensure participants met the inclusion criteria, a parent survey form was disseminated to interested parents.

The inclusion criteria for potential participants comprised of the following:

a. currently in Primary 5 to Secondary 1 levels
b. from a predominantly Malay speaking at home
c. not exempted from Mother Tongue (MT)
d. not receiving external support (e.g. private tuition)
e. no known comorbidities
f. failing MT or scoring borderline pass for the past two years

The rationale behind the first criteria was a means of ensuring the participants would be able to express themselves well, and provide reliable data to the researcher. Studying at the stated levels was also a means of ensuring the participant had received adequate years of exposure to the Malay language, and would have already been taught the foundations of the language. For the learners to be pre-dominantly Malay speaking indicated that they were familiar with the Malay language. It was important that the learners were not exempted from Malay, so that they would be able to share recent accounts and experiences. The fourth criteria ensured that their difficulties were not a result of confusion between different teaching approaches or support from places other than their schools. It was also important that the students did not have comorbidities, as any findings observed may be a result of other underlying learning difficulties rather than dyslexia. The final inclusion criteria ensured that these learners showed persistent difficulties in the Malay language. Exclusion criteria included criteria that fell outside the boundaries of the inclusion criteria.

Recruitment was assisted by a member of the Research Committee and other Educational Therapists in the organisation to recommend students who would potentially meet the criteria. Two of the participants only met five of the six criteria, in which the participant was scoring well in Malay. However, these participants were still considered a potential participant, as their participation would allow the researcher to explore for any differences or commonalties during the cross-case analysis, thus contributing to the richness of the data gathered. Through these recruitment techniques used, a total of 8 participants consented to their taking part in the research.

3.4 Development of Assessment Tools

For this qualitative study, multiple sources of data were gathered, namely through semi-structured interviews, three reading-related tests (pseudo-word reading, single word reading, vocabulary and sentence comprehension) and a review of documents (exam papers). The multiple forms of data collection ensured the participants' accounts were substantiated, and ultimately represented correctly.

Three sets of tests were developed that were designed in line with the research questions: pseudo-word syllable reading, single word reading, sentence comprehension.

Since there is currently no Malay standardised tests, the tests had to be developed and checked for validity and reliability. Details of how each tool was designed and developed are elaborated below. Several factors were taken into consideration in designing these research instruments, due to the unique profile of the participants. As such, considerations included the structure of the interview, questioning techniques used, clarity of instructions given, duration of each test, fonts and spacing in the test (McGrath, Palmgren and Liljedahl, 2019). In addition to that, it was important that the administration of each task was not prolonged, as it may lead to a loss of attention.

3.4.1 Interview Questions

The primary source of gathering data was through semi-structured interviews to provide a deeper understanding of the participants' experiences and views. The interview questions developed were aligned with the research questions, covering the aspects of reading difficulties faced, understanding Malay words and passages, perceptions of learning Malay, and understanding their attitudes towards learning the language. The questions consisted of an interplay of direct questions, probing questions, specifying questions, and indirect questions (Brinkmann and Kvale, 2018) . Their age group and their learning difficulties might make it difficult for them to elaborate or extensively convey their accounts. Thus, the flexibility in the questioning techniques was to ensure that the important themes were being covered, while allowing the researcher to probe further in the event that the participants raised potential themes beyond their initial responses. The leading questions were imperative in verifying the interpretations of the participants' responses, particularly to test the reliability of their answers where information was lacking or unclear.

3.4.2 Syllable Word Reading

A list of non-words was developed to measure decoding skills, based on the theory that a phonological deficit is the underlying cause of dyslexia (Snowling, 2013). However, since Malay reading instruction in Singapore schools involves working at syllable level, conducting a task on mono-syllabic non-words seemed appropriate. The test was developed based on the quality criteria outlined by Colenbrander, Nickels and Kohnen (2011). Firstly, the list included words of varied difficulty levels that served as a sensitive measure that would be able to detect any difficulties. It had 37 words, a practical consideration to ensure the test could be administered in a short amount of time, since the purpose was to understand problems with grapheme-phoneme mapping (Colenbrander, Nickels and Kohnen, 2011). Furthermore, a stopping rule was not considered appropriate since it was imperative to capture as much information about the participants' decoding abilities. The non-words selected were also consistent, in that the words would never be pronounced differently, regardless the position of the letters. Syllables with the letter "e" were the only exception, where participants would be tested to retrieve both sounds of "e". The test also comprised of words where the grapheme-

phoneme correspondences differed in complexity, in which digraphs and diphthongs were included. The digraphs and diphthongs comprised of letter combinations that occurred in the Malay language, as Colenbrander, Nickels and Kohnen (2011) highlighted that non-words should be orthographically legal. The list was arranged in order of increasing word difficulty, with digraph and diphthongs syllables only appearing towards the end of the list (Colenbrander, Nickels and Kohnen, 2011).

3.4.3 Single-word Reading

The reading list aimed to assess reading ability in words of varying structures. Reference was made to Lee and Wheldall's study (2011) in choosing appropriate words to include. There were 7 levels in the test, corresponding to the school levels from Primary 1 to Secondary 1. Each level had 12 words, of which the words were derived from the respective Malay textbooks.

The words were carefully selected based on (a) the frequency of occurrence in a given level, and (b) phonological structure (syllable and phonic structure), as recommended by Lee and Wheldall (2011). They were sequenced in order of difficulty level. The level of difficulty of each word was determined by the complexity in syllabic and phonic structures, and was sequenced according to Lee and Wheldall's (2011) recommendation. The participants had to read a total of 84 words.

3.4.4 Vocabulary and Sentence Comprehension

A list of sentences was developed to test for comprehension and vocabulary. Based on past evidence that found morphological awareness to affect comprehension (Carlisle, 2003; Zhang, 2016), the test was designed as an affix choice task similar to Zhang, Chin & Li's study (2017). Furthermore, affixation is one of the main ways in which Malay words are formed (Lee and Wheldall, 2011; Zhang, Chin and Li, 2017). Comprehension was measured through sentences rather than passages, to avoid possible feelings of frustration or intimidation in the participants.

The test was divided into 7 parts, where each part comprised of 4 questions that aligned with the content covered at the respective school levels between Primary 1 to Secondary 1. They were arranged in order of increasing difficulty. The affix choices only included those that had been learnt at each level, based on the syllabus by the Ministry of Education (MOE). The affix choices given to fill in the blanks were real derived words, as this task also served to test for the vocabulary of the participants. Comprehension questions were based on Bloom's taxonomy. Since sentences were used here, question types primarily involved literal skills, focusing on recalling and understanding the text.

3.4.5. Validity of Reading-related Tests

To ensure the validity of the developed tests, content validation was measured using subject matter experts. Two Malay Language (ML) teachers were consulted for this process, of whom were teaching in different schools. Their role was to evaluate the testing tool and agree on whether the items tested were relevant as an appropriate measure for this study (Wynd, Schmidt and Schaefer, 2003).

The single-word reading test was evaluated using a rating scale, while the other two tests were evaluated for relevance qualitatively. Inter-rater agreement was measured using Scale-level Context Validity Index. 80 of the 84 items achieved a high relevance rating amongst the two raters. The S-CVI/UA was 0.95.

3.5 Data Collection Process

3.5.1 Interview

The sessions with the participants were conducted at their preferred DAS learning centre, to allow them to feel comfortable during the process, as McGrath, Palmgren and Liljedahl (2019) stated how interviews may be perceived by some as difficult. Ethical considerations were made throughout the interview process (Creswell, 2013), more so since the participants were a vulnerable population. Despite the participants having already signed the consent form earlier during the recruitment process, details of the study were being shared verbally at the start of the session (Creswell, 2013). Participants were also informed that their identities remained anonymous. The purpose of the interview was explicitly shared, and how their experiences will contribute to the study (Brinkmann and Kvale, 2018).

Following the interviews, three tasks were administered in the following sequence: pseudo-word syllable reading, single-word reading, and sentence comprehension. At the end of each test, participants were asked to share their opinions regarding the test, any items they found particularly difficult and the reason for their difficulties. The duration of the interview session and test administration combined was between 60 to 75 minutes for each participant. Each session was audio recorded with their, and their parents' consent. One of the participants opted to have the session conducted online via video conference, due to the pandemic – the call was recorded, without any video.

3.5.2. Pseudo-word Syllable Reading

Participants were shown a list of syllables and were tasked to read them aloud from left to right. They were informed that they were non-words, but could be read as though they were real words. The syllables were printed on an A4-sized paper.

3.5.3 Single-word Reading

Participants were asked to read a list of 84 real words. They were informed that they were to read the words at their own pace, and since the words got increasingly difficult they had the option to stop at any point in time. Participants were also aware that they could skip words they found too challenging. To ensure clarity of the printed words, the test was presented on an A3-sized paper.

3.5.4 Vocabulary and Sentence Comprehension

Participants were asked to read aloud 28 sentences, while filling in the blanks with a suitable affixed word from three given options. All affixed words were real words. In testing for comprehension, literal questions were asked regarding the sentence they had just read. Where errors were displayed in a question, whether in the aspect of word recognition or selection of affix, participants would then be asked to define selected words in the given sentence. In instances where confusion was exhibited in choosing an appropriate affix, participants were asked to explain their choices. This test required them to answer verbally. Test questions were presented on an A4-sized paper.

3.5.5 Exam Papers

Participants were required to submit a latest copy of their school examination or tests. This provided an alternative angle to understanding their difficulties. Bowen (2009) stated that reviewing documents had various functions, some of which included providing supplementary data and verifying findings. The exam paper components on reading comprehension and affixed vocabulary were analysed to corroborate their experiences shared during the interview. During the interview session, the exam papers were also used as a reference point for the participants. Specifically, when relaying their experience in learning Malay, exam papers allowed the participants to make references to the specific components learnt, which then lead to participants sharing more detailed and rich accounts. However, not all participants provided exam papers, and thus its purpose in this study was primarily for verification of findings from the other sources of data stated above.

3.6 Data Analysis

Once the data collection process had been completed, data analysis and interpretation followed to identify the difficulties in reading and comprehension, as well as the perceptions and motivations towards learning the Malay language.

Thematic analysis was conducted to identify and analyse patterns within the data. Specifically, a general inductive approach was used to allow themes to emerge from the raw data (Thomas, 2006; Creswell, 2013). A qualitative analysis software, Quirkos, was

used throughout the coding process. Through the inductive analysis coding process, four major themes and five sub-themes were identified that established the framework for the findings directly relevant to the research questions.

4. RESULTS AND FINDINGS

Participants' Profiles

There were 8 participants for this study, in which the inclusion criteria was ensured through the Parents' Survey from submitted upon expression of interest to participate. Although Participant 1 showed high performance in Malay, he was still included in the study as his Malay reading ability was indicated as *somewhat difficult*. Details of the participants are tabulated below in Table 1.

Table 1. Participants Profiles

Participant	School Level	Duration of study in DAS Main-Literacy Programme	Performance in Malay Language (% range)
1	Primary 6	9 months	65% - 69%
2	Primary 5	6 years	50% - 59%
3	Primary 5	5 years	<30%
4	Primary 6	8 months	30% - 39%
5	Primary 6	8 months	50% - 64%
6	Primary 5	1 month	50% - 59%
7	Primary 6	10 months	40% - 49%
8	Secondary 1	7 months	50% - 59%

Presentation of Themes

A qualitative multi-case study approach was used for the study, with findings gathered primarily from semi-structured interviews. Observations were also made on three activities conducted with the participants: a monosyllabic word reading task, single-word reading task, and a sentence comprehension activity. Inductive thematic analysis was employed for this research. 4 major themes emerged that answered the research questions: (a) word reading difficulties, (b) reading comprehension difficulties, (c) perceived usefulness, and (d) supportive learning environment.

4.2. Word Reading Difficulties

The first of the interview questions was in relation to the difficulties faced, if any, when reading Malay words. Due to the young age group, and the unique profile of the students, the initial question that was being asked was a close-ended question. The intended purpose of this was to act as a starting point, which was to allow the researcher to probe further with open-ended questions depending on their initial response. For example, if the researcher had started with "What are some of the difficulties you face when reading?" would be to assume that every participant faced difficulties in their reading, which may not be the case, as they may be struggling in other aspects of the Malay language instead.

The open-ended question may also be too broad for this age group, and hence may easily result in "I don't know". In response to this question, four of the participants confidently expressed that they were able to read Malay words, 2 of them said they were only able to do so sometimes, while 1 of them said he was unable to read Malay words entirely. Difficulties in word reading shared from the interviews and observed through the reading-related tests emerged as the following categories:

(a) difficulties reading unfamiliar words,
(b) difficulties reading long words,
(c) difficulties reading words with complex syllabic structures and affixes.

4.2.1 Difficulties Reading Unfamiliar Words

Seven of the participants shared that reading difficulties they faced was a result of mispronouncing the words, particularly for words that were unfamiliar, as remarked by Participant 4:

> *"...if I've never seen it before then that's the part when I... when I always uh do something wrong."*

Drawing comparisons to Participant 5 who demonstrates a better understanding of the language compared to the others based on the school performance scores provided, her sentiment was no different, as explained:

> *"...some words that is like n-not common to me, I will have... mm... hard to pronounce it."*

Due to the term "familiar" being subject to one's experiences and background, the findings from the single-word reading activity were analysed to observe whether any patterns emerged to corroborate their claims.

Table 2. Number of errors made at each reading level.

SCHOOL LEVEL	PARTICI-PANT	Pri 1 words #1 - #12	Pri 2 words #13 - #24	Pri 3 words #25 - #36	Pri 4 words #37 - #48	Pri 5 words #49 - #60	Pri 6 words #61 - #72	Sec 1 words #73 - #84
Pri 5	**2**	0	0	0	0	1	1	**2**
	3	0	2	1	2	4	3	**7**
	6	0	0	0	2	0	1	**5**
Pri 6	**1**	1	0	0	0	2	1	**3**
	4	0	0	0	0	2	0	**6**
	5	0	0	0	0	2	0	**4**
	7	0	1	2	1	3	2	**5**
Sec 1	**8**	0	0	1	0	0	0	**4**

Pri = Primary, Sec = Secondary

Table 2 details the number of reading errors made at each level by the participants. Each participant showed minimal errors when reading the words that were below their grade level. To demonstrate, Participant 2 who is in Primary 5, made no errors when reading words from the Primary 1 to Primary 4 levels. This would be due to having seen them over the years of learning the language. However, difficulties surfaced upon reading words in her grade level and beyond, with the highest number of errors made when reading common Secondary 1 words. Generally, all the participants found the words in Secondary 1 the most challenging, as these words would be considered the least familiar to them.

The findings from the activity support the claims made by the participants suggests that having exposure to a wide range of words plays an important role in achieving reading accuracy.

4.2.2. Difficulties Reading Long Words

There were mixed responses with regard to whether the length of the word affected their ability to decode, and hence read. Upon reflecting on this, Participant 7 highlighted how the length of the word contributed to her reading difficulties:

> *"3 syllables can. But then when it's more than 3 syllables I cannot."*

On the contrary, Participant 4 expressed how the length of the word was secondary compared to familiarity with the word:

> *"...if I see it before, then it'll be easy."*

The other participants displayed some struggles with trying to elaborate on the details of their reading difficulties, with most of them explaining their difficulties as "difficult for me to pronounce it". Results from the single-word reading task of commonly seen words at each level provided more insight.

Table 3. Observations in reading affixed words from Single-Word Reading task

PARTICI-PANT	NO. OF ERRORS	ERRORS WITH AFFIXED WORDS	ERROR OBSERVATIONS
1	7	0	None
2	5	1	Affix -i
3	20	5	Syllable boundary confusion with digraph *ny* (*menyambut* ⇨ *men-yam-but*) Phonetic confusion—(*mengetahui* ⇨ *men-je-tahui*)
4	8	2	Affixed words with 4 syllables Phonetic confusion—(*mengetahui* ⇨ *meng-ge-tahui*)
5	6	2	Affix -i
6	8	0	None
7	14	6	Phonetic confusion—(*mengetahui* ⇨ *meng-ge-tahui*) Visual confusion—(*menghargai* ⇨ *menghargia*) Visual confusion—(*kegemaran* ⇨ *keng-gemaran*)
8	5	1	Phonetic confusion—(*mengetahui* ⇨ *meng-ge-tahui*)

Based on the findings in Table 3, although affixes are considered long words, the errors made by the participants were not particularly skewed towards affixed words. In fact, errors with affixed words only made up a small proportion of the total number of errors made.

Since the reading list also comprised of non-affixed long words and words with varied syllable structures, the other errors were examined for any commonalities or patterns.

4.2.3. Difficulties Reading Words with Complex Syllabic Structures and Affixes

Analysis of the errors revealed that their challenges were attributed to the complex syllable structure of the word and retrieving the corresponding sounds.

While errors with affixed words were observed, Table 2 shows that this was not particularly difficult for the majority of the participants. In fact, the participants were observed to have slowed down their reading pace when reading the words with affixes, as the morphemes allowed easier segmentation of the word into syllables. It is interesting to note that Participant 3 was the only one who raised that being able to read words accurately was dependent on the time given to decode a word:

> *"...if I take some time to read it then it won't be difficult..."*

While his struggles with affixed words were evident during the activity, further observations on his error types in the syllable reading task revealed that his errors were attributed to words with ng and ny digraphs, rather than the affixes. Participant 7 struggled with the affixed words too, however this was particularly with words that had two vowels. She shared her confusion on VV syllable words that she had skipped during the task, as explained:

> *"because it's like confusing... the first one (syllable) is usually like 'ter' 'se' 'na' 'men'... ya like that I can but then this type right is like 'f-a-e...'"*

Through these findings it is thus understood why some participants would have difficulties decoding longer words. Another observation worth noting was challenges in reading words that had more complex syllable structures. A breakdown of the error types from the reading task are shown in Table 3.

Most of the participants had difficulties reading *teladan* (a model example of), due to the complex syllable structure, CVCVCVC. The majority read it as *"telandan"*, while Participant 1 read it as *"taladan"*, and Participant 3 and 6 as *"telanda"*. Although there were other words with the same syllable structure that were read correctly, perhaps the unfamiliarity of the word, as explained earlier, lead to the visual error.

Table 4: Error types from Single-word Reading Task

ERROR TYPES	PARTICIPANTS							
	1	2	3	4	5	6	7	8
Inconsistent 'e'	✓	✓	✓	✓	✓	✓	✓	✓
vowel substitution	teladan ⇨ taladan							
letter substitution							✓	
vowel/letter substitution			✓		mudah ⇨ mudar	✓	✓	
digraph	kh tarikh ⇨ tarik	kh	ng, ny, sy,	kh	✓		kh	
addition		✓	✓	✓		✓	✓	
deletion	siapa ⇨ siap		pandai ⇨ pada	pantas ⇨ panas		✓		
combination				✓				
reversal	asal ⇨ asla							telah ⇨ letah
English 'g',	✓	✓	✓		✓	✓		
English 'u'							✓	
CV + CV + CVC,	✓	✓	✓	✓				
CV + CVC +CV				✓	✓			
VV			✓				skipped ✓	

It appears that reading challenges were more apparent with unfamiliar or more complex words, as it required them to use their decoding skills. Phonetic errors, that is errors associated with phonological deficits were seen across all participants, whether it was errors of substitution, deletion, addition and reversal of letters and syllables, or a combination of them.

All participants also exhibited at least one error related to vowel "e", as it carries two sounds. To illustrate, the word *tema* (theme) was pronounced with the /e/ sound instead of /ə/, and this confusion became more evident in words that were more unfamiliar like *lagenda* (legend).

Five of the participants made errors that displayed confusion with the English language, notably with the letter "g". For the word *lagenda* (legend) for example, the five participants pronounced it with a /j/ sound. Participant 4 and 7, showed confusion with the English language in other aspects. During the syllable reading task, Participant 4 shared that "ing" and "ung" was confusing for him as he "thought it was English". As for Participant 7, she did not explicitly share that she had any confusion, however it was observed in both the syllable reading task and the single-word reading task that she would recognise words with the "u" as /ŭ/, like in "up" instead of /oo/. These observations are perhaps unsurprising, since the participants would have been used to decoding in English with it being the main medium of instruction in Singapore. This will be further discussed in the discussion section.

Taking into account these observations and findings made, it appears that affixed words may not necessarily be a challenge simply because of their length. Instead, the ability to accurately decode words in general was dependent on the base word: familiarity with the word, length, and complexity of the syllable structure.

4.3. Challenges in Reading Comprehension

When asked about the challenging aspects of learning the Malay language, most of the participants (n=7) expressed reading comprehension as one of their main difficulties. Factors that contributed to this varied between the participants, in which 2 themes emerged: (a) weak vocabulary, (b) difficulties with long passages.

4.3.1. Weak Vocabulary

A common theme that emerged was associated with the understanding of the text rather than decoding of the words. All the participants highlighted how the ability to understand a story was dependent on how familiar they were with the words that appeared in the passage. If the vocabulary in the text was not perceived as common, regardless their ability to decode the word attempting to understand the passage would present as a challenge, as Participant 8 explained:

"...Sometimes like the article got the new words that I don't even understand and I don't know how to pronounce it. I sometimes just skip that word then I just continue reading... I don't understand the meaning ah, but then pronouncing I try ah."

This difficulty was echoed by Participant 4:

"I finish reading, but I don't know what I read."

These remarks raised two areas that affected their comprehension: firstly, the ability to recognise words correctly, as discussed in Section 4.2.1, and secondly, being able to recall the right meaning attached to the word.

This was further supported by the observations made during the Sentence Comprehension activity. Tabulated below is an overview of the types of errors observed during the task.

Table 5. Observations from Sentence Comprehension Task

Participants	ERRORS AFFECTING COMPREHENSION			
	Inferring without defining	**Weak morphological awareness**	**Wrong context**	**Wrong definition**
1	**5**	2	3	4
2	3	1	1	**6**
3	3	2	1	**11**
4	2	3	not observed	**6**
5	**4**	2	not observed	1
6	**5**	2	2	**6**
7	not observed	not observed	not observed	**4**
8	**8**	1	1	5
TOTAL ERRORS	**30**	**13**	**8**	**43**

Seven of them had difficulties providing the definitions for words or phrases in the sentence. It is relevant to note that these words may have been read correctly but the participants were not able to define them At times this was a result of substituting the words for another real word. To demonstrate with one of the questions:

> *Salmah _____ (ajakan, mengajak, diajak) saya ke majlis hari jadinya.*
> *[Salmah invited me to her birthday party. ; Answer: mengajak]*

Participant 2 was able to provide the correct answer and fluently read the sentence. However when asked what Salmah was doing, she responded with "... teach me". It appears that she processed the word as *mengajar* (verb: teaching), where the base word *ajar* is the Malay word for "teach". While she was able to recognise the word correctly, she was unable to recall the right meaning attached to the word, instead providing the definition of the substituted word.

Participants 3, 4 and 6, on the other hand, misread *majlis* (event, or party in this context) as "*majilis", "majalis"* and "*majid"* respectively. When asked to define the word, all of them responded 'mosque'. The Malay word for "mosque" is *masjid*. In this case, the three participants were unable to identify the word correctly, and thus were not able to retrieve the correct meaning.

At times the incorrect definitions were instead inferred based on the semantics of the word. To give an instance with one of the questions:

> *Saya hendak _____ (pendapat, terdapat, mendapat) keputusan yang cemerlang.*
> *[I want to achieve / get excellent results. ; Answer: mendapat]*

Participant 6 and 8 were both able to provide the correct answer here. However, when asked to define *cemerlang* (excellent), Participant 6 said "like...he (is) smart", while Participant 8 defined it as "proud". *Cemerlang* is often associated with school, success, and good grades which explains their answer. As a result, this alters the meaning of the sentence and thus their comprehension.

When asked about the details of the sentences, the participants were also observed to understand the main idea without diving into the details, leaving out words they found challenging. Take the response of Participant 8, for example, for the following question:

> *Pertubuhan itu _____ (penghuluran, menghulurkan, huluran) bantuan kepada mereka yang terjejas oleh keadaan COVID-19.*
> *[The organisation extended help to those affected by the COVID-19 situation. ; Answer: menghulurkan]*

Participant 8 explained:

> *"Pertubuhan is like, like… organisation… So they give help... I think this is like a vaccine?"*

However, when asked what his answer, "*menghulurkan",* meant, he defined it as "stretch...like, long". He concluded that the sentence was regarding a vaccine, although this detail was not found in the sentence. While he did not understand the term *menghulurkan* when asked explicitly, he had in fact mentioned "give help" in his response.

Participant 1 also inferred the meaning of this sentence, and elaborated:

> *"The COVID-19 is… more…more, uh, more cases because (so) they need more people to help."*

There was no mention of rising cases, and interestingly he did not translate *pertubuhan* (the organisation), implying that he did not know its definition.

Having the same challenge was Participant 5, who despite not knowing some words, had a clearer understanding of the sentence:

> *"The body part…pertubuhan..... Uh I don't really get the sentence… was having a...people helping? Helping people who was involved with the COVID-19."*

All of them were able to provide the correct answer. However, in communicating the meaning of the sentence, their understanding of the sentence varied slightly based on the inferences made. Participant 5, like Participant 1, was unable to define *menghulurkan* but was familiar with the common phrase *menghulurkan bantuan* (giving or extending help) and hence was able to infer the main idea of the sentence.

It is important to highlight that these were errors made at sentence level, and the participants only had to infer words within the sentence to grasp the main idea. Typically, passages in school extend beyond sentence level; the texts comprise of several paragraphs. With the exception of Participant 5, all the participants expressed challenges in answering the reading comprehension component in their school exams, as explained by Participant 3:

> *"As sometimes the word are not like… you just have to copy some words from inside there, but sometimes you cannot find it inside the paragraph."*

This comment suggests that there may be an over-reliance on answering strategies taught in schools, in order to compensate for the lack of understanding. However, this

may not be adequate, especially when conclusions and inferences are required to be drawn based on the information in the passage. Participant 8, whom although showed during the activity that he was generally able to infer the main idea, highlighted how questions regarding details of the passage was particularly challenging. He elaborated on his difficulties:

> *"Sometimes like when they say like 'why' or 'what' will happen all that right, and right… mostly got like based on a story. Sometimes it's hard for me to find what...what is- like… why did the boy do that, or like, where is it."*

These findings suggest key information, details, and nuances may be misinterpreted, hence compounding their difficulties when attempting to comprehend the passages in school. The concern regarding the length of passages was further explored in the next section.

4.3.2. Difficulties with Long Passages

The ability to comprehend texts being dependent on the length of the passage was another opinion that was shared across all the participants, where longer passages were found to be more difficult. Participant 6 shared his perspective:

> *"I don't understand the...uh the words…Because when I see the words, then I feel like blur… I need to wear spectacles then like ya."*

He clarified that wearing spectacles did not aid his reading, but it was something that he experienced only when it came to tackling difficult components. It is important to note that participant 6 exhibited difficulties with word retrieval during the interview session, thus his choice of words were not always appropriate. However, his response implied how overwhelming passages generally were to him and how longer passages could exacerbate his difficulties. Participant 4 also lamented the length of the passage:

> *"When you see the passage, then it's like my...my head will be very crammed then I'll be lazy to read… Because, tsk, too many words."*

For Participant 5, although she did not consider the reading comprehension aspect of the language one of her main difficulties, she addressed how longer stories would make it difficult for her to comprehend, despite her strong reading ability. Reflecting on her difficulties, she detailed:

> *"Like when it gets longer, there is more problems into it."*

Participant 2 shared her concerns on longer passages, raising the issue of remembering details:

"Because sometimes I can't remember when I read all."

These responses draw attention to the barriers that act as a hindrance in attempting to comprehend passages, making it evident as to why reading comprehension is perceived as challenging.

4.3. Perceived Usefulness and Motivations

Throughout the interview session with the participants, the researcher noted that some participants had unfavourable opinions with regard to learning the Malay language, while others viewed it in a more positive light. Thus, the researcher sought to investigate the underlying motivations and interests to examine whether this aspect had any implications on their learning of the language.

The two categories emerged here:

a) Malay as an alternate language of communication,

b) supportive learning environment

4.3.1 Malay as an Alternate Language of Communication

Six of the participants perceived the Malay language to be useful, of which five of them cited how it was useful for socializing and communicating with friends or parents. An interesting perspective was offered by Participant 7, who explained the ease of communicating with her Malay friends, where the Malay language allowed her to compensate for English words she had difficulties retrieving:

"Because when you- like… [when you're] with your Malay friend, and you don't know how to say the Malay thing in English, you can just say them to them- say the thing to them in Malay."

Although Participant 4 felt that the language was "just too difficult", he expressed the importance of being able to understand Malay in order to communicate with others. He shared his plight of having a weak command of the language, saying:

"If they expect me to answer back, then I will just stand there… [I] feel embarrassed, because I need to talk in English."

Three of the other participants also perceived Malay as a useful form of communication outside of their household and social circles. Participant 3 shared his perspective:

> *"Like im-imagine you [are] going to a stall, but the stall owner says [it] in Malay, then you don't know how to speak in Malay. Then you in the end speak English, then the shop owner didn't know [what you meant] then you have to buy another in the [other] shop."*

It is important to highlight how none of the participants perceived Malay as an essential means of communication in Singapore, rather it was seen as a supplementary language to help them go about their daily lives. Participant 5 shared how the language allows her to communicate with family members who were not well-versed in the English language. She commented on the usefulness of the language in Singapore's context:

> *"Not really important… mostly people are talking English and Malay."*

Interestingly, both she and Participant 8 articulated how knowing the language was useful mainly for when they traveled to countries where Malay was the main spoken language.

These findings suggest that while understanding the language was beneficial, in the context of multilingual Singapore it was not central in communicating, in that not knowing the language simply meant having to rely on English to communicate, the main language used in the country – a language barrier was of minimal concern.

When asked about the importance of being able to read Malay, matters pertaining to meeting examination standards were raised by half of the participants (n=4). Participant 4, sharing how his bad grades would result in a scolding from his mum, weighed in on his views:

> *"…if I know how to read, I will know how to understand a passage and the question, then I can get the answer correct."*

His sentiments suggest that despite his challenges, he acknowledged the importance of performing in the subject and there was an expectation for him to do so. The need to do well enough to progress applied to secondary school students as well, as highlighted by Participant 8:

> *"For secondary [level], I know it's very important, and then we can like, can graduate. Then mostly like… because I want to go Sec 2, so…I pay attention in my Mother Tongue lessons... to pass my Mother Tongue."*

The general feelings from these participants reflect the emphasis placed on students to fulfill the progression criteria to the next school level.

4.3.2. Supportive Learning Environment

With the exception of one participant, all the participants maintained a generally positive attitude towards learning the Malay language. Some of the participants attributed this to their teachers, while others cited the engaging activities that were carried out in class.

Participants who mentioned their teachers felt that they were often rendered support in areas they found challenging even for a seemingly easy task, as shared by Participant 1:

> *"She help me how to explain... how to give clue... how to do the passage."*

This sentiment was echoed by Participant 8, who found his teacher to be understanding of his learning difficulties:

> *"...maybe because like... trying to help. Like for kids like me.... to pronounce...like help ah."*

Participant 4 viewed his overall learning in the classroom through a negative lens, despite sharing that his teacher trained him well in learning the Malay affixes. He highlighted aspects he found more important that were lacking in support:

> *"If the teacher can help to translate some of the words... And the... if the teacher help to show how to spell the words."*

Based on these responses, it appears that the participants had a more positive learning experience in the classroom when they felt that extra help was provided to accommodate their specific learning needs.

Another aspect relevant to note is the esteem-levels of the students that affect their motivation to learn and do well in the language. It appeared that participants felt very discouraged when tasks got too challenging. They associated challenging tasks to be the most uninteresting aspect of learning Malay in school, as shared by Participant 7:

> *"... Like a story, after that you have to fill in the blanks. They ask you the question after that you... that one I hate that part."*

Participant 3 shared the same sentiments:

> *"The fact that uh...that sometimes teacher... my teacher give us hard question. And I couldn't solve it. Some of my classmate didn't solve it even because it was too hard."*

This was echoed by Participant 4, who felt very strongly about this aspect:

> *"Like when I go to school, then it's always Mother Tongue, I feel like I want to go [to the] toilet and then just sleep in the toilet."*

He later highlighted this sentiment once again, citing reading comprehension activities as the main reason. Interestingly, most of the responses were in relation to comprehension-type activities as well as writing.

On the contrary, some of the participants (n=2) who held positive views about learning Malay attributed it to the feeling of achieving good grades. Participant 3 reflected on this:

> *"…It's something I like now, but then… 'cause uh...after the high marks I got, I feel like I want to try learning more Malay words. In the past I feel like I do not… I didn't want to learn Malay… 'cause I got low marks, then I feel like I [was] not that good at saying Malay..."*

This comment suggests that the interest in learning the subject was influenced by one's ability to perform well, or achieve a passing mark. Participant 5 who shared that it was one of the few subjects she would study for, provided her perspective on this:

> *"I like to score the… I like to score [in] the Malay [subject] because I don't… like, I don't score all the subjects full."*

These comments provide insight to the notion that achieving a sense of accomplishment spurs learners with dyslexia to learn the Malay language. However, when they are faced with persistent difficulties during their learning, when left unsupported, it eventually creates a barrier that prevents them from feeling a sense of achievement. Thus, their motivation is affected and, in turn, their interest in acquiring Malay.

Summary

The participants were English-Malay bilingual learners with dyslexia who revealed aspects of the Malay language they faced challenges in. Where they displayed challenges answering the interview questions, or detailing their difficulties, observations from the reading-related tests were analysed.

In the area of word reading, participants displayed difficulties with:

(a) unfamiliar words,
(b) long words and
(c) affixed words and complex syllable structures.

This shows us that exposure to reading Malay is imperative, particularly since English is extensively used in schools and homes. The increasing length of words did not directly affect word reading, rather if a long word was unfamiliar or had complex syllable structures (e.g. digraphs and diphthongs or both), only then did it exacerbate their reading difficulties. Similarly, affixation was found to be challenging when there were digraphs or diphthongs. Observations from the reading related tasks also revealed several error types, including visual, phonetic, and errors from cross-linguistic transfers.

In the area of reading comprehension, the participants mentioned :

(a) weak vocabulary and
(b) long passages as factors that affected their reading comprehension.

Weak vocabulary here was defined as words they could not read or did not know the meaning of. The sentence comprehension task delved deeper into their difficulties and revealed their sentence comprehension to be compromised by making predictions based on the main idea of the text, along with syntactic errors that were sometimes a result of visual errors. Furthermore, most of the participants found lengthy passages to increase the difficulty level of reading comprehension tasks.

Despite these difficulties, all the participants viewed Malay as an alternative language to communicate in, and most of them showed motivation to learn the language when they felt that their needs were supported and accommodated to in the classroom.

5. DISCUSSION

5.1 Discussion

The first research question addressed the reading difficulties faced among English-Malay bilingual learners with dyslexia. There were three aspects of reading difficulties observed pertaining to difficulties with unfamiliar words, long words and words with affixes and complex syllabic structures. The single-word reading task revealed that reading words that were less familiar resulted in more errors than reading frequently seen words, where errors were largely underpinned by phonological deficits. Although non-words were not being used in this study, reading less frequently seen words beyond their level revealed non-word errors and phonetic errors. This is consistent with past studies that have investigated dyslexia in shallow orthographies (Ziegler et al., 2003; Eklund et al., 2015) and corresponds to error analysis previously done in the Malay language (Lee and Wheldall, 2011).

The non-word error suggests that the learners used a grapheme-phoneme strategy to decode the words, but were unable to string them efficiently. Interesting to note is how participants found unfamiliar words to be harder to read than longer words, suggesting that syllable-level and morpheme-level instruction in schools supports their decoding at

larger grain-sizes (Winskel and Widjaja, 2007; Zhang, Chin and Li, 2017), but not in fine-grain sizes (Lee and Wheldall, 2011). Another interesting finding to highlight is how reading accuracy was affected in more complex syllabic structures, and when affixed words included digraphs or diphthongs. This is in line with Lee and Wheldall's findings that highlighted the complexity in the word length, rather than the affixes (Lee and Wheldall, 2011). Evidence of cross-linguistic transfer was also observed, in that participants use grapheme-phoneme mappings from English (L1) to facilitate decoding in Malay (L2).

The second research question investigated the challenges faced when comprehending texts. In the simpler sentences, participants read with ease and made few syntactic errors. However, as the difficulty level of the sentence increased, and sentences included vocabulary that were not frequently seen and or complex, errors in answering the comprehension questions were largely either semantic or syntactic. Furthermore, as the comprehension sentences increased in length, participants were observed to make more reading errors, which compromised their ability to either select the correct answer (using syntactic skills), or comprehend the text (using semantics).

Although Malay comprehension difficulties in learners with dyslexia has not been widely explored, the present study findings correspond to studies done in the French language (Casalis et al., 2004), Finnish (Torppa et al., 2012) and Greek (Constantinidou and Stainthorp, 2009) and second language learners in Spanish (Mikulek, 2015). This was observed through some of the participants struggling to apply syntactical skills in selecting a suitable affixed word, as well as the poor word decoding that affected their fluency and processing of the sentences. While the morphologically-rich nature of Malay may have facilitated their reading of the words (Carlisle, 2000, 2003; Nagy and Anderson, 2984), the syntactic errors that arose from the morphological structure of Malay words also proved to affect the accessing of semantic information of the word. This supports earlier findings that pointed out that relying on morphology alone for comprehension will not suffice (Adams, 1977; Boets et al., 2010; van Bergen et al., 2012) Poor comprehension skills was also observed through the prediction strategies used that omitted details, when asked to recall the sentence that they had just read, similar to the adult Spanish (L2) learners in Mikulek's study (2015). It is thus logical to expect that the learners found that long reading comprehension passages were more difficult to comprehend, considering the cognitive demands required to understand passages (Castles, Rastle and Nation, 2018).

The third research question addressed the perceptions and motivations of learning the Malay language as an English-Malay bilingual learner with dyslexia. Most of the participants viewed learning Malay through a positive lens, citing the importance of passing exams. Moreover, contrasting the study in Hungary among German (L2) and English (L2) learners, the interest towards learning Malay was influenced by the practicality of being able to communicate with other members in the Malay community

(Kormos and Csizér, 2010). Even the participants who were scoring borderline pass in Malay were motivated to learn the language, which they attributed to the positive overall learning experience in the classroom. For participants who had little interest, they appeared to have felt discouraged as a result of a less supportive learning environment in the classroom. This corresponds to previous studies that investigated motivation, self-esteem and levels of anxiety in second language acquisition amongst learners with dyslexia. (Marogna, 2013; Crombie, 2000; Ganschow et. al., 1998; Krashen, 1982).

5.2 Recommendations for Future research

Building on the findings of this study, there are three recommendations to be considered for future research:

1. Conducting a quantitative study that investigates the significance of the difficulties found in the present study in relation to reading and reading comprehension

2. Adapting the present study to include a homogenous profile of bilingual learners with Dyslexia.

3. Conducting a study that focuses on the role of morphology in Malay reading comprehension in order to enhance access of syntactic and semantic skills among learners with the same profile.

4. Investigating how English-Malay bilingual learners with dyslexia perform in spelling and writing tasks.

5.3 Limitations and Implications of present study

To begin with, the ability of the participants varied, and as such, caution must be made when making generalisations from this study. The qualitative nature of the study is a limitation in itself, in that eliciting responses from the participants required a lot of probing. Some participants were more elaborate in explaining their difficulties, while others needed more prompts. As such, not every participant was able to provide a holistic view of their difficulties in the language. Although the reading-related tasks were found to provide an alternate perspective on their difficulties, there were aspects that were only observed through the tasks but not explained by the participants themselves. Another limitation of the study pertains to the profile of the participants. They were not entirely homogenous, as some participants had been in the programme longer than others, and their test performances varied in range. Finally, another limitation is in relation to the focus on reading skill and the qualitative approach in analysing their difficulties only.

6. CONCLUSION

The qualitative multi-case study investigated the difficulties faced by English-Malay bilingual learners with dyslexia in the context of multilingual Singapore. The study sought to investigate difficulties in the aspect of reading and reading comprehension. The study also sought to investigate the perceptions these learners had towards learning Malay, considering their unique profile. Inductive analysis of findings found difficulties in word recognition to be influenced by the lack of familiarity of words, the length of words, and the morphological and phonological elements of the words. More specifically, phonological deficits were observed to underpin their reading difficulties, along with the complexity of the syllabic structures that arose with the presence of digraphs and diphthongs, which corresponds to previous research on younger native-speaking learners (Lee and Wheldall, 2011). While morphological knowledge facilitated reading of sentences, it was found to be lacking in contributing to the semantic and syntactic skills required in higher-levels of comprehension. Lastly, the practicality of using Malay as another form of communication, along with feeling that their learning needs were accommodated to and supported in the classroom were found to be an important motivating factor to learn the language.

Despite the limitations, the present study provided some important implications. Firstly, syllable-level instruction may not be sufficient in supporting bilingual learners with dyslexia due to the underlying phonological processing deficit. Although the participants did not exhibit significant errors in the reading tasks, accessing phonological knowledge to decode unfamiliar words can facilitate their reading. More so since the bilingual landscape in Singapore and the ongoing language shift may result in less consumption of Malay print and media, as well as application of the language. Secondly, in teaching reading comprehension to learners with this unique profile, explicit morpheme instruction needs to be taught to learners, particularly as a means of accessing semantic and syntactical skills, on top of facilitating reading. Furthermore, the cognitive demands of comprehension passages prove to be overwhelming for English-Malay bilingual learners with dyslexia. As such, in selecting comprehension passages for teaching comprehension skills, the length of the passage and the lexical level needs to be taken into consideration. Finally, the concern of anxiety and low self-esteem among learners with dyslexia have to be taken into account when teaching Malay, especially since the learning of a second language can exacerbate their anxiety levels. Thus, providing learners with opportunities for success and creating a positive learning experience is key in maintaining enthusiasm and interest in learning Malay.

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Experience of activity and participation in individuals with Developmental Coordination Disorder/Dyspraxia and their surrounding people: a qualitative systematic review

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Abstract

Developmental Coordination Disorder (DCD)/Dyspraxia features a significant delay in lifespan motor development, which limits daily activities and restricts participation. This study aimed to systematically review and comprehensively synthesize the subjective experiences of activity and participation in individuals with DCD/Dyspraxia and their families and service providers to inform decisions and strategy development at practice and policy levels. To locate both published and unpublished studies, the following seven main databases were searched in April 2022: CINAHL, PsycINFO, MEDLINE, Embase, ERIC, ProQuest Dissertations and Theses, SPORTDiscus. A total of 48 studies met the inclusion criteria. Of the 48 studies, 20 studies were appraised as being of high quality and were subsequently used in the meta-aggregation. From the 20 studies, a total of 304 findings were extracted, classified into six categories, and used to generate three synthesized statements on activity and participation at the home and family level, school and peer level, and community level. Our findings indicated that individuals with DCD/Dyspraxia experience the deep and pervasive impacts on activity and participation in individually unique and nuanced contexts. Individualized evaluation of context, increased clinical resources, education and training would facilitate activity and participation.

Keywords: activity, developmental coordination disorder, dyspraxia, participation, qualitative research

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INTRODUCTION

Developmental Coordination Disorder (DCD) and Dyspraxia are common developmental conditions with an estimated prevalence of 6% in the motor domain among children aged 5-11 years. Some claim DCD and Dyspraxia are interchangeable (Gibbs, Appleton, & Appleton, 2007; Kirby, Sugden, & Edwards, 2010), while others point out the overlaps between the two (Dewey, 1995; Miyahara & Möbs, 1995). Due to the absence of a commonly accepted definition, assessment, and diagnostic criteria for Dyspraxia (Miyahara, Leeder, Francis, & Inghelbrecht, 2008), the interpretation depends on the role of people surrounding individuals with the condition (Miyahara & Register, 2000; Peters, Barnett, & Henderson, 2001). On one hand, the "neuropsychological definition of Dyspraxia refers to a disorder of motor sequencing and selection" (Miyahara & Baxter, 2011, p. 440), assessed by gesture imitation (Miyahara et al., 2008; Miyahara & Möbs, 1995). On the other hand, some therapists and parents use the term broadly for a wide variety of sensory and motor disorders (Miyahara & Baxter, 2011), to medicalise and legitimise the condition (Correia, 2017). By contrast, a relatively stable definition and diagnostic criteria of DCD exists, featuring two core components (American Psychiatric Association, 2013):

- "**Criterion A.** The acquisition and execution of coordinated motor skills is substantially below that expected given the individual's chronological age and opportunity for skill learning and use. Difficulties are manifested as clumsiness (e.g., dropping or bumping into objects) as well as slowness and inaccuracy of performance of motor skills (e.g., catching an object, using scissors or cutlery, handwriting, riding a bike, or participating in sports).

- **Criterion B.** The motor skills deficit in Criterion A significantly and persistently interfere with activities of daily living appropriate to chronological age (e.g., self-care and self-maintenance) and impacts academic/school productivity, prevocational and vocational activities, leisure, and play."
  (American Psychiatric Association, 2013, p. 74).

To address the diagnostic Criterion A, formal assessment tools have been developed for screening and examining whether an individual assessment result meets the diagnostic threshold. Norm-referenced standardised assessment tools (e.g., Henderson, Sugden, & Barnett, 2007; Wilson et al., 2009) may be sufficient to appraise Criterion A, but not Criterion B; an individual position on the normative scale provides no direct evidence for the significance and persistence of interference, or impact in daily contexts at home, school, and in the community (Cairney, 2010). For the evaluation of Criterion B, qualitative data are required by conducting clinical interviews with children and parents, and obtaining observation reports from teachers and specialists. Such qualitative data are usually stored in private confidential folders, not available to the public unless

specifically elicited by research interviews and focus groups and published as qualitative studies.

This review aims to capture the voices and experiences of individuals with DCD or Dyspraxia and relevant stakeholders. To achieve this aim, the adoption of a broad definition of Dyspraxia, in conjunction with the diagnostic criteria of DCD, provides the foundation for understanding the experiences of individuals with DCD/Dyspraxia for this review.

In addition to Dyspraxia, there is another complication that involves frequently co-occurring developmental conditions with DCD, such as, autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), and specific learning disorder (SLD) (American Psychiatric Association, 2013). When an individual with DCD, who also has ASD, ADHD, or SLD experiences a challenge participating in a physical activity, it is difficult to determine which condition is causing the activity and participation limitations (Caçola, Miller, & Ossom Williamson, 2017; Miyahara, Piek, & Barrett, 2006; Miyahara et al., 1997). However, our interest in the present review lies not in detecting which condition leads to the limitations, but in understanding the subjective experiences of individuals who have DCD/Dyspraxia, regardless of their co-occurring developmental conditions. To address the concomitant issue, the experiences of individuals with DCD/Dyspraxia should be considered, whether they have a comorbid developmental condition or not, as far as an individual is referred to as exhibiting DCD/Dyspraxia.

To date, only one qualitative systematic review has been conducted. O'Dea et al. (2021) used meta-ethnography to synthesize qualitative studies on children and young people's experiences of living with DCD/Dyspraxia from the first person perspective (O'Dea, Stanley, Coote, & Robinson, 2021). Their meta-ethnography developed new conceptual understandings through the reviewers' own interpretive synthesis. By contrast, we employ meta-aggregation (Hannes, Petry, & Heyvaert, 2018; Lockwood et al., 2020) in this review to present common meanings consistent with the intentions of primary study authors. We included both the first-person perspective of individuals with DCD/Dyspraxia and the third -person perspective of people surrounding individuals with DCD/Dyspraxia. The multiple perspectives were considered useful to propose synthesized statements, which are an outcome of meta-aggregation, that are comprehensive, balanced, and realistic. Synthesized statements based on multiple perspectives may be useful in assisting practitioners to make decisions and develop strategies at practice and policy levels (Hannes et al., 2018).

To ultimately produce synthesized statements for practitioners and policy makers (Hannes et al., 2018), the concepts of 'activity limitations' and 'participation restrictions' from the International Classification of Function (ICF) (World Health Organization, 2001) were used to define the phenomena of interest for our review (Miyahara, Moebs, Pocock, & Farquhar, 2020). The ICF defines 'activity limitations' and 'participation restrictions' as

"difficulties an individual may have in executing activities" and "problems an individual may experience in involvement in life situations", respectively. The difficulties and problems can be recognised when teachers and clinicians lack understanding and fail to provide reasonable accommodation and treatment. Such perceived barriers and the perceived impact of the barriers can be considered as experiences of individuals with DCD/Dyspraxia and their surrounding people.

The ICF also extends the meanings of the terms to include the positive poles of 'activity' and 'participation' beyond their use as indicators of the negative poles of 'activity limitation' and 'participation restriction'. Accordingly, our phenomena of interest for this review also included the positive poles, facilitators of 'activity' and 'participation', enabling us to generate synthesized statements (Hannes et al., 2018). We therefore aimed to synthesize qualitative studies on the experiences of activity and participation in individuals with DCD/Dyspraxia from the first-person and third-person perspectives.
The question of this review is: what are the experiences of activity and participation in individuals with Developmental Coordination Disorder/Dyspraxia and their surrounding people?

METHOD

The meta-aggregation approach to qualitative systematic review was completed in compliance with the guidance provided in the JBI Manual for Evidence Synthesis (Lockwood et al., 2020). An a priori protocol has been published (Miyahara et al., 2020) and our review was registered, and most recently updated on 19 February, 2023, in the International Prospective Register of Systematic Reviews (PROSPERO) (CRD42019137616). As shown in Figure 1, the meta-aggregation approach to qualitative systematic review consists of four major steps:

1) the identification of studies,
2) aggregation of findings,
3) categorising findings, and
4) synthesizing categories to develop synthesised statements to inform the decisions of practitioners and policy makers.

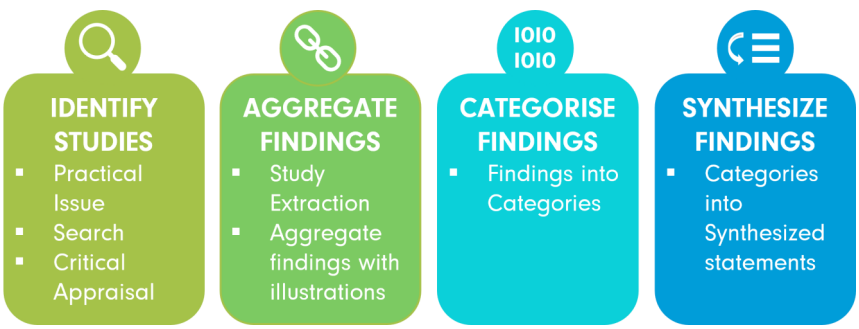

Figure 1. Overview of the meta-aggregation approach to qualitative systematic review

Step 1. Identification of studies

To generate inclusion and exclusion criteria based on our research question, we used a framework of participants, phenomena of interest, and context. Participants were individuals with DCD/Dyspraxia who were aged 5 years and above, their families, and service providers, such as educational (e.g., teachers, teacher aides) and medical professionals (e.g., medical doctors, occupational and physical therapists). Studies including children under 5 years of age were not eligible for inclusion because the diagnosis of DCD or Dyspraxia is not typically made earlier (American Psychiatric Association, 2013). The current review embraced all individuals described in primary qualitative studies as having either DCD, probable DCD, at risk of DCD, or Dyspraxia. Individuals with co-occurring developmental disorders, such as ADHD, Pervasive Developmental Disorders, ASD and SLD were included, as far as DCD/Dyspraxia was present and the primary study described the phenomena of interest in the context specified below.

The phenomena of interest for this review were the experiences of DCD/Dyspraxia on activity and participation defined in the International Classification of Functioning, Disability and Heath (ICF) (World Health Organization, 2001), including, but not limited to 'Activity and Participation' (e.g., carrying out daily routine), 'Body Function' (e.g., control of voluntary movement function) and 'Environmental Factors' (e.g., personal care providers and personal assistants). If the understanding and support for individuals with DCD/Dyspraxia could impact on their activity and participation, such phenomena were considered of interest to include in this review.

The context of this review included activities of daily living, educational, vocational, sports, leisure, and settings of clinical diagnosis, assessment, and treatment. Activity and participation could be experienced by variously gendered individuals in unique ethnic cultures, at different developmental stages in life, from childhood through adolescence and into adulthood, in which DCD/Dyspraxia could persist (American Psychiatric Association, 2013).

This review considered studies which focused on qualitative data, including primary academic studies published in peer-reviewed journals and gray literature (e.g., theses and dissertations). The qualitative studies could be based on the interpretive or critical paradigm, theoretically and methodologically underpinned by phenomenology, grounded theory, ethnography, qualitative description, action research, and mixed methods. Methods of qualitative data collection included, but were not limited to, interviews, focus groups, open-ended survey responses, and observation.

Our search strategy was devised to locate published as well as unpublished primary investigations. To ensure that no secondary qualitative review studies were in progress on the same topic, we searched Cochrane Database of Systematic Reviews, JBI Evidence

Synthesis and PROSPERO on 17 March, 2022. There was no ongoing review on the topic. Then we initiated a limited search for primary studies on the topic in CINAHL, PsycINFO, MEDLINE, Embase, and ERIC with search terms of 'developmental coordination disorder' and 'qualitative research'. Subsequently, we analysed the text words identified from the titles and abstracts of pertinent studies and the index terms that represented the studies. The formulation of full search strategies was based on identified key words, index terms, and our inclusion criteria. The full search strategies were adapted for each of the employed databases: CINAHL (EBSCOHost), MEDLINE (OVID platform), Embase (OVID platform), ERIC (ProQuest platform), PsycINFO (OVID platform), SPORTDiscus (EBSCOHost), and ProQuest Dissertations and Theses (ProQuest platform) as provided in Supplementary Material 1. These database searches were completed between 7 and 10 April, 2022.

To search gray literature, we planned to use OpenGrey in our protocol, but OpenGrey was discontinued in December 2020. Instead, we searched Google Scholar and PMC (Pub Med Central) with the terms "developmental coordination disorder" AND "qualitative, "developmental coordination disorder" AND "interview", "dyspraxia" AND "qualitative", and "dyspraxia" AND "interview". No additional studies of relevance were detected. The search platform of Project Muse did not allow a combination of fields, so the same search terms as Google Scholar and PMC were repeated for the abstract field. No additional studies were detected. SocINDEX was not available in the accessible libraries by the authors, and therefore not searched. A hand search of reference lists of included studies also detected no additional studies. We searched primary studies with identifiable English titles and abstracts in the above contemporary English databases without imposing any limits on publication period or language.

After the search, we collated all identified citations, uploaded into EndNote X9/2018 (Clarivate Analytics, PA, USA), and removed duplicates. Then two of the three independent reviewers (MM, IM, TP) screened all titles and abstracts by assessing against the inclusion criteria.

We retrieved full texts of potentially pertinent studies, and imported the citation details into the Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information (JBI SUMARI), (Joanna Briggs Institute, Adelaide, Australia), (Munn et al., 2019). The first author assessed the retrieved full-text studies against the inclusion criteria, which was later confirmed by the second or the third author. Among other studies with main text written in English, the main text of one study (Terčon, 2017) was written in Slovenian and the other in Portuguese (Galvão, Penido Bueno, Rezende, & Magalhaes, 2014). The Slovenian text was translated into English by Google Translate and the Portuguese text was translated into English by DeepL. The machine translations of critical points for us to determine the inclusion or exclusion of these studies were confirmed by a native Croatian and a native Portuguese speaker. When the first three authors had disagreement at each stage of the study selection process, we resolved

through discussion (Cf. Supplementary Material 2). The entire process of study selection is depicted in a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher, Liberati, Tetzlaff, & Altman, 2009) flow diagram (Figure 2).

After selecting studies, two independent reviewers (MM and IM or MM and TP) critically appraised methodological quality, using the standard 10-item JBI Critical Appraisal Checklist for Qualitative Research (Lockwood et al., 2020). Seven authors of the appraised studies were contacted to obtain missing or additional data, and five responded. When any disagreements arose between two reviewers, we resolved them through discussion, or through a mediation process with a third reviewer.
The exact questions used to determine methodological quality can be viewed at the bottom of Table 1. Briefly, questions covered "congruity between research methodology" and "philosophical perspective" (Q1), "research question/objectives" (Q2), "data collection methods" (Q3), "representation and analysis of data" (Q4), and "interpretation of results" (Q5). Questions also covered "cultural/theoretical positioning of researcher" (Q6), "influence of the researcher on the research" (Q7), "adequate representation of participant voices" (Q8), "ethical approval" (Q9), and "supported conclusions" (Q10).

For congruity between the research methodology and Q1: the "philosophical perspective", Q2: "research question", Q3: "data collection methods", Q4: the "representation and analysis of data", and Q5: the "interpretation of results", a study received a positive rating only if both methodology (e.g., phenomenology) and the other methodological aspects asked in Q1-Q5 were explicitly stated. A negative or unclear rating was received if one aspect was not specified or ambiguous (e.g., tenets of qualitative research). If a study failed to represent participants' voices adequately (Q8), the study was excluded.

To ultimately produce synthesized statements of high confidence (Porritt, Gomersall, & Lockwood, 2014), studies were only included in our meta-aggregation if they received a high grading for dependability (4 or 5 out of 5). Dependability scores for each study were developed from the aggregation of five items (Q2, Q3, Q4, Q6, Q7) in the JBI Critical Appraisal Checklist for Qualitative Research (Lockwood et al., 2020). Studies with a dependability score of less than four were excluded from our meta-aggregation.

Step 2: Aggregation of findings

Two independent reviewers (MM, TP) extracted study characteristics from studies included in the review, using the data extraction function of JBI SUMARI (Lockwood et al., 2020). The extracted data were tabulated under headings of methods, country, phenomena of interest relevant to the review objective (i.e., the experiences of activity and participation in individuals with DCD/Dyspraxia and their surrounding people),

setting or context, participant characteristics, and main findings. Methodology was added in the column of the methods.

The first author (MM) then extracted all findings and illustrations from studies meeting our inclusion criteria and dependability score threshold. The findings from individuals with DCD/Dyspraxia and their surrounding people were pooled together. Findings represented the verbatim analytic interpretations of authors, while illustrations represented the accompanying participant quotes. To enable assessment of confidence in the review findings at a subsequent stage (detailed below), three levels of credibility were assigned based on the fit between author interpretation (findings) and participant data (illustrations). Unequivocal (U) ratings were given when findings/interpretation were "directly reported/observed and not open to challenge"; credible (C) ratings were given when findings/interpretation "lacked a clear association with the participant data" (i.e., could only be logically inferred but not directly reported) and could be challenged; and not supported (NS) ratings were given when findings/interpretation were "not supported by data" (Munn, Porritt, Lockwood, Aromataris, & Pearson, 2014). Findings/illustrations rated as NS were not included in the meta-aggregation. Two other reviewers (IM, TP) independently checked that extracted findings/illustrations were relevant to the review question and that the credibility rating was accurate. Any disagreements that arose between the reviewers were resolved through discussion.

Step 3: Categorising findings

We pooled qualitative research findings in a web-based software named JBI SUMARI. Meta-aggregation, underpinned by pragmatism (Hannes et al., 2018), involved the aggregation of 'findings' to generate a set of 'categories' based on similarity in meaning.

Step 4: Synthesizing categories

The categories were synthesized to produce a set of 'synthesized statements' that could be used as a basis for evidence-based practice. Only unequivocal and credible findings were used in the synthesis. At least two reviewers undertook repeated readings of all extracted findings and accompanying illustrations. The extracted findings were first identified as relating to activity or participation, grouped on the basis of similarity in the level of experience (i.e., home, school, community, reflecting the approach of Hannes et al., 2018) and classified into draft categories of home, school, and community levels. The draft categories and accompanying findings/illustrations were subjected to iteration, re-examined by the first three authors, and the categories were refined and re-defined until final definitions of categories and synthesized statements were achieved by consensus. The synthesized statements addressed the research question by elaborating the Diagnostic Criterion B at the different levels.

The final synthesized statements were graded in accordance with the ConQual approach (Munn et al., 2014) for establishing confidence in the outcomes of qualitative synthesis. The ConQual score is made up of a combination of dependability and credibility ratings. Grading for dependability took into account how the majority of included studies within a synthesized statement scored in five (Q2, Q3, Q4, Q6, Q7) of the ten items of critical appraisal for dependability (Munn et al., 2014). The credibility for the synthesized statement was recorded as high, if "all research findings comprising the synthesized statement were unequivocal"; as moderate if the research findings were "a combination of unequivocal and credible"; and as low if the research findings were "credible only" (Munn et al., 2014).

RESULTS

Study inclusion

Figure 2 depicts the search results and the processes of screening and study selection, following the PRISMA method (Moher et al., 2009). In total, 2281 studies were identified from the database search. Of these studies, 1441 were eligible for inclusion after duplicates were removed. Following the title and abstract screening, 1366 were excluded. A total of 73 studies were retrieved in full and were assessed for inclusion through full text review; 25 studies were excluded. The remaining 48 studies were appraised for methodological quality (Lockwood et al., 2020).

Methodological quality

Of the 48 studies, the methodological quality of 20 were of high quality, 5 were of moderate quality, and 23 were of low quality, based on ConQual criteria (Lockwood et al., 2020) (Table 1 and Supplementary Material 3). The majority of the studies (> 80%) adequately represented participants and their voices (Q8), obtained ethical approval (Q9), and drew logical conclusions from the interpretation of the data (Q10). Half of the studies (50%) demonstrated congruity between research methodology and research question (Q2), data collection methods (Q3), the representation and analysis of data (Q4), and the interpretation of results (Q5). Half of the studies (50%) also stated the influence of the researcher on the research, and vice-versa (Q6). However, less than 40% of the studies mentioned specific philosophical perspectives (Q1) or the influence of the researcher on the research (Q7).

Only the 20 studies which rated high in the dependability rating (score of 4 or 5) were used in the meta-aggregation. This decision was made to ensure that the aggregated confidence levels (overall ConQual scores: high, moderate, low, and very low) would be as high as possible in our synthesized statements (Porritt et al., 2014). If the confidence level is low, our synthesized statements from this qualitative review would not be able to form a solid basis to make recommendations for practice or inform policy.

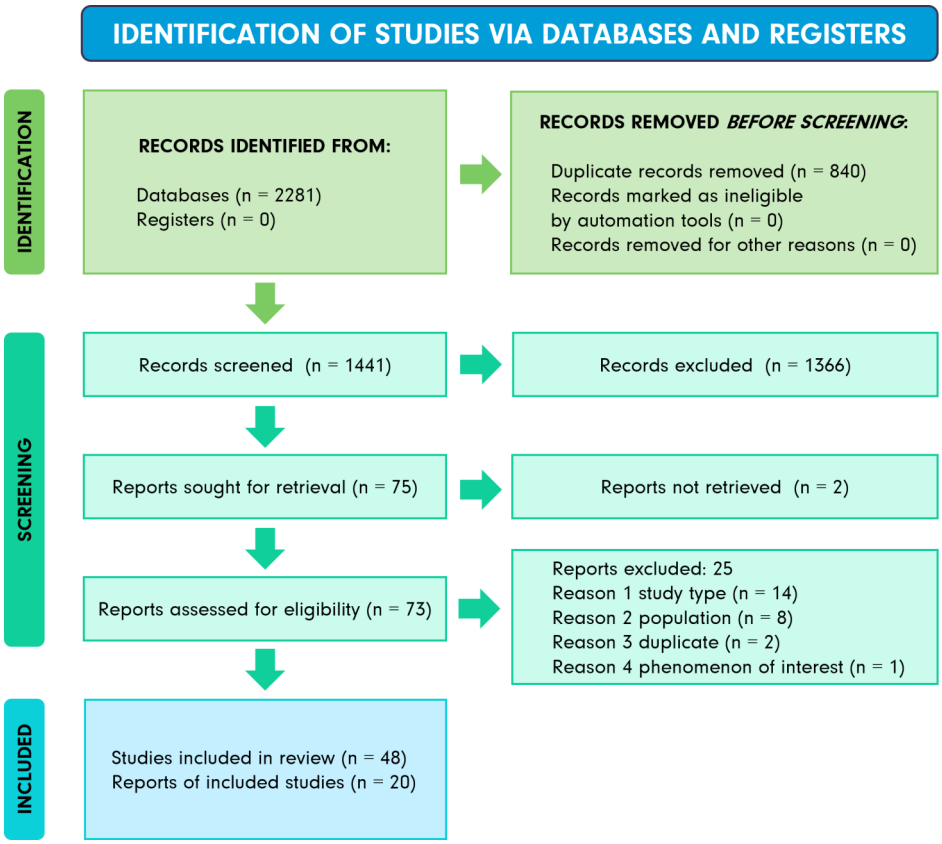

Figure 2. Search results and study selection and inclusion process (Page et al., 2021)

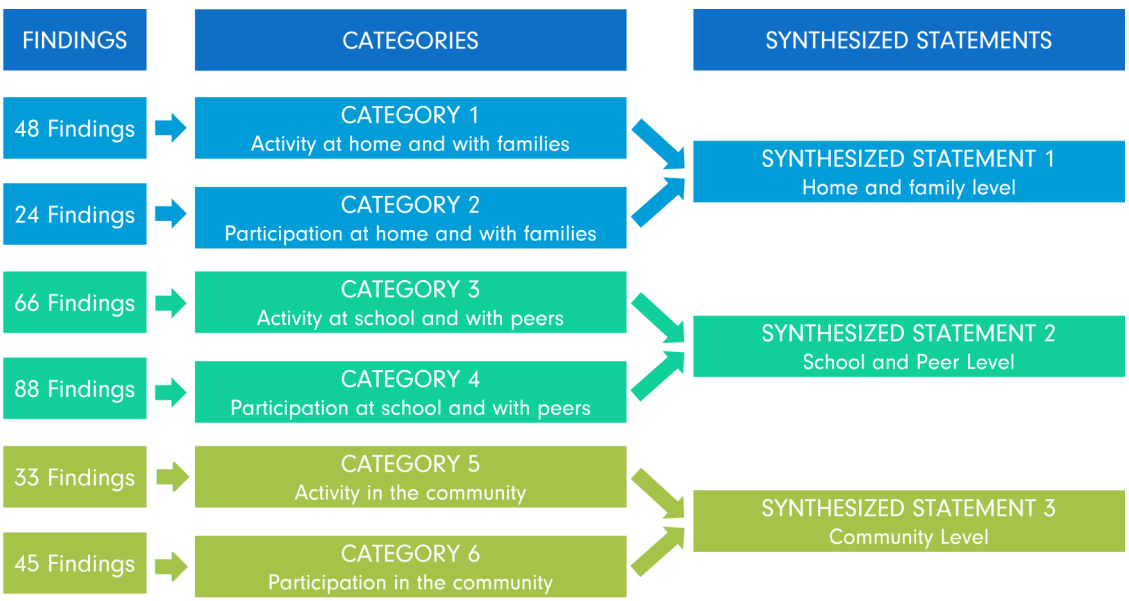

Figure 3. The structure of meta synthesis, comprised of a total of 304 findings, six categories, and three synthesized statements

Characteristics of included studies

The included 20 studies for meta-aggregation were conducted over two decades from 2001 to 2021. Nine of the 20, included studies that were written as PhD theses/ dissertations (Armstrong, 2016; Bolton, 2001; Kane-Hamer, 2018; Kirby, 2008; Lingam, 2012; Payne, 2015; Raleigh, 2013; Ungar, 2010; Winson & Fourie, 2018), and the remaining 11 studies were published in journal article format (Anderson, Wilson, & Carmichael, 2018; Hessell, Hocking, & Davies, 2010; Hitchcock, Hocking & Jones, 2020; Holmes, Fourie, Van Der Merwe, Burke, & Fritz, 2021; Martini et al., 2020; Missiuna, Moll, King, Stewart, & Macdonald, 2008; Missiuna, Moll, Law, King, & King, 2006; Rodger & Mandich, 2005; Scott-Roberts, 2018; Walker, Shaw, Reed, & Anderson, 2021; Zimmer, Dunn, & Holt, 2020).

Geographically, ten of the 20 studies were undertaken in the UK and the Republic of Ireland, (Armstrong, 2016; Bolton, 2001; Kane-Hamer, 2018; Kirby, 2008; Lingam, 2012; Payne, 2015; Raleigh, 2013; Scott-Roberts, 2018; Ungar, 2010; Walker et al., 2021); five in Canada (Martini et al., 2020; Missiuna et al., 2008; Missiuna et al., 2006; Rodger & Mandich, 2005; Zimmer et al., 2020); two in New Zealand (Hessell et al., 2010; Hitchcock et al., 2020); two in South Africa (Holmes et al., 2021; Winson & Fourie, 2018); and one in an unknown country (Anderson et al., 2018) by Australian and Canadian authors.

The studies employed a range of qualitative methodologies and methods, including phenomenology (Anderson et al., 2018; Kane-Hamer, 2018; Missiuna et al., 2008; Raleigh, 2013; Zimmer et al., 2020), ethnography (Bolton, 2001), descriptive approaches (Missiuna et al., 2006) to conducting interviews (Anderson et al., 2018; Armstrong, 2016; Bolton, 2001; Hitchcock et al., 2020; Holmes et al., 2021; Kane-Hamer, 2018; Kirby, 2008; Lingam, 2012; Martini et al., 2020; Missiuna et al., 2008; Missiuna et al., 2006; Payne, 2015; Raleigh, 2013; Rodger & Mandich, 2005; Scott-Roberts, 2018; Walker et al., 2021; Winson & Fourie, 2018; Zimmer et al., 2020), focus groups (Martini et al., 2020), case studies (Bolton, 2001; Holmes et al., 2021), and questionnaire surveys (Kirby, 2008).

Data were analysed by content (Kirby, 2008; Martini et al., 2020; Rodger & Mandich, 2005; Scott-Roberts, 2018), thematic (Anderson et al., 2018; Hitchcock et al., 2020; Holmes et al., 2021; Scott-Roberts, 2018; Walker et al., 2021; Winson & Fourie, 2018), or phenomenological analysis (Anderson et al., 2018; Kane-Hamer, 2018; Lingam, 2012; Raleigh, 2013; Zimmer et al., 2020). Sample sizes range from 1 to 76 (unknown sample size in one study) with the total aggregate sample size of 241 participants, including school aged children, university students, adults with DCD/Dyspraxia, and their parents, teachers, and clinicians. Supplementary Material 4 provides key characteristics of the 20 studies used for meta-aggregation.

Table 1. Critical appraisal results of eligible studies

STUDY	Q1	Q2†	Q3†	Q4†	Q5	Q6†	Q7†	Q8	Q9	Q10
Adams 2018	N	N	N	N	N	N	N	Y	Y	Y
Anderson 2018*	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Armitage 2017	N	Y	Y	Y	Y	N	N	Y	Y	Y
Armstrong 2016*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Barnett 2013	N	N	N	N	N	N	N	Y	Y	Y
Bolton 2001*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Coussens 2020	N	N	N	N	N	N	Y	N	Y	Y
Coussens 2021	N	N	N	N	N	N	N	Y	Y	Y
DeRoche 2015	N	N	N	N	N	Y	N	Y	N	Y
Edmonds 2012	N	N	N	N	N	Y	N	Y	Y	Y
Foulder-Hughes 2014	N	N	N	N	N	N	N	Y	Y	Y
Galvão 2014	N	N	N	N	N	Y	N	Y	N	Y
Hessell 2010*	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Hitchcock 2020*	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Holmes 2021*	Y	Y	Y	Y	Y	Y	N	Y	N	Y
Jackson 2019	Y	N	N	N	N	N	N	Y	Y	Y
Jackson 2021	Y	N	N	N	N	N	N	Y	Y	Y
Jasmin 2018	N	N	N	N	N	N	N	Y	Y	Y
Kane-Hamer 2018*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Kirby 2008*	N	Y	Y	Y	Y	Y	Y	Y	N	Y
Kirby 2011	N	N	N	N	N	N	N	Y	Y	Y
Lingam 2012*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Maciver 2011	N	N	N	N	N	N	N	Y	Y	Y
Mandich 2003	N	N	N	N	N	N	N	Y	N	Y
Martini 2020*	N	Y	Y	Y	Y	N	Y	Y	Y	Y
Medeiros 2019	N	N	N	N	N	Y	N	Y	Y	Y
Missiuna 2006*	N	Y	Y	Y	Y	Y	Y	Y	N	Y

Table 1. Critical appraisal results of eligible studies (Cont.)

STUDY	Q1	Q2†	Q3†	Q4†	Q5	Q6†	Q7†	Q8	Q9	Q10
Missiuna 2007	N	Y	Y	Y	Y	N	N	Y	Y	Y
Missiuna 2008*	N	Y	Y	Y	Y	Y	N	Y	Y	Y
Morris 2021	N	N	N	N	N	N	Y	Y	Y	Y
Novak 2012	N	N	N	N	N	N	N	Y	Y	Y
O'Dea 2021	N	Y	Y	Y	Y	N	N	Y	Y	Y
Payne 2015*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Payne 2020	N	Y	Y	Y	Y	N	N	Y	Y	Y
Pedro 2019a	N	N	N	N	N	N	N	Y	Y	Y
Pedro 2019b	N	N	N	N	N	N	N	Y	Y	Y
Pless 2001	N	N	N	N	N	N	N	Y	N	Y
Raleigh 2013*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rodger 2005*	N	Y	Y	Y	Y	Y	Y	Y	N	Y
Sangster 2010	Y	N	N	N	N	Y	Y	Y	N	Y
Scott-Roberts 2018*	N	Y	Y	Y	Y	Y	N	Y	Y	Y
Segal 2002	N	N	N	N	N	Y	N	Y	Y	Y
Summers 2008	N	N	N	N	N	N	N	Y	Y	Y
Ungar 2010*	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Walker 2021*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Williams 2015	N	N	N	N	N	N	N	Y	Y	Y
Winson 2018*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Zimmer 2020*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
TOTAL %	**33.3**	**50.0**	**50.0**	**50.0**	**50.0**	**50.0**	**37.5**	**97.9**	**81.3**	**100**

*Y = Yes, N = No, * = Used in meta-aggregation, † = Used to add the total dependability scores*
JBI critical appraisal checklist for qualitative research. Q1 = Is there congruity between the stated philosophical perspective and the research methodology? Q2 = Is there congruity between the research methodology and the research question or objectives? Q3 Is there congruity between the research methodology and the methods used to collect data? Q4 = Is there congruity between the research methodology and the representation and analysis of data? Q5 = Is there congruity between the research methodology and the interpretation of results? Q6 = Is there a statement locating the researcher culturally or theoretically? Q7 = Is the influence of the researcher on the research, and vice- versa, addressed? Q8 = Are participants, and their voices, adequately represented? Q9 = Is the research ethical according to current criteria or, for recent studies, is there evidence of ethical approval by an appropriate body? Q10 = Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?

REVIEW FINDINGS

From the 20 studies we extracted a total of 304 findings with supporting illustrations, classified them into six categories, (Supplementary Material 5) and generated three synthesized statements (Figure 3). In total, 215 findings were rated as unequivocal and 89 were rated as credible, based on ConQual criteria. Each synthesized statement consisted of two categories related to activity and participation at home and with family, in school and with peers, and in the community. Figure 2 shows the structure of meta-aggregation, with each synthesized statement consisting of the same contextual categories, and the numbers of findings in each category. The confidence in each of the following three synthesized statements is moderate with high dependability (dependability score of 4 or 5) and moderate credibility (downgraded one level from high credibility for a mix of unequivocal and credible findings). Table 2 shows an example of an illustration, supporting finding, and the credibility of the finding for each category.

Synthesized statement 1: Home and family level

DCD/Dyspraxia has a strong physical and emotional impact on family life at home, requiring families to assist with daily activities. Although difficulties often have a negative impact on the confidence of individuals with DCD/Dyspraxia, repeated practice could result in improvement and satisfaction within the family unit. Many families try their best to understand their child's difficulties and facilitate activity and participation at home.

Category 1: Activity at home and with family level

Forty-eight findings were grouped into this category. Parental support facilitated involvement of children with DCD/Dyspraxia in home activities to foster their independence. Repeated practice enabled children with DCD/Dyspraxia to improve their performance of activities of daily living and home-based tasks. Children and parents experienced satisfaction and joy from improvement and success when completing important individual, home, and family activities. While some parents were worried about their child's safety and felt uncertain about their child's ability, other parents developed confidence in their children's ability to succeed.

Category 2: Participation at home and with family level

Twenty-four findings were sorted into this category. Family members varied in their acceptance, understanding of, and support for individuals with DCD/Dyspraxia. Nonetheless, many families made an effort to support individuals with DCD/Dyspraxia, while noting that it takes time, effort, and practice to make positive change happen. Unfortunately, the nature of DCD/Dyspraxia negatively impacted the relationship between parent/s and individuals with DCD/Dyspraxia at times.

Table 2. An exemplary illustration, supporting finding, and the credibility of the finding for each category

EXEMPLARY ILLUSTRATION	FINDING (CREDIBILITY)	CATEGORY
"He's always been different... right from the get go... he never crawled, late with everything" (Hitchcock, 2020, p.26)	Aware from when their child with DCD was young that they had issues (Unequivocal)	Category 1: Activity at home and with families
"David: My Mum doesn't like me using it (the oven) because of my hands. She thinks I'll burn myself. Same with the kettle. See what I mean about the freedom?" (Payne, 2015, p.116)	Not allowed to do things independently because their parents perceived the risks to be too great (Credible)	Category 2: Participation at home and with families
"So dyspraxia does influence spatial relations or spatial perception. So that would definitely [influence] the writing field ... if they reverse letters, they will spell incorrectly and then if they spell incorrectly they will read incorrectly." (Winson, 2018, p.88)	Challenges with academic skills (Unequivocal)	Category 3: Activity at school and with peers
"[He misses out] everyday at school when all the kids have gone out to play and he takes five minutes longer to tie up his shoes." (Rodger 2005, p452)	Missed out on recess and opportunities for participation with peers (Unequivocal)	Category 4: Participation at school and with peers
"Because I consider myself a liability and wouldn't trust myself to be able to control the car say if there was a crash" (Kirby, 2008, p. 235)	Reasons given for not driving (Unequivocal)	Category 5: Activity in the community
"I look at friends skiing and ice skating and think that looks fun but could never think of joining in." "I tend to choose to do physical activities on my own as I know I can't compete in team activities." (Scott-Roberts, 2018, p.30)	Participation in more active leisure pursuits with others outside of the family was also carefully selected (Unequivocal)	Category 6: Participation in the community

Synthesized statement 2: School and peer level

The school environment represents a stage for public performance, peer comparison, and social inclusion and exclusion. The school environment also highlights the difficulties of students with DCD/Dyspraxia, particularly in handwriting and physical education/ sports, which may generate negative reactions from others and lead to anxiety and frustration. Nonetheless, students with DCD/Dyspraxia often find ways to navigate the school environment and seek assistance. Students with DCD/Dyspraxia require understanding, acceptance, and support from peers, teachers, and parents to cope with their physical and psychosocial challenges at school.

Category 3: Activity at school and peer level

Sixty-six findings formed this category. Individual differences at school evoked concerns for the student, parents, and teachers. The school environment (particularly, physical education, handwriting, and comparison with others) can create anxiety for students with DCD/Dyspraxia and an atmosphere of humiliation, frustration, and intimidation from peers and teachers. Many students, parents, and teachers were worried about students with DCD/Dyspraxia not being able to manage school/social life and how their performance differed compared to peers. Students with DCD/Dyspraxia may cope by isolating from peers, seeking additional support, using extra time to complete tasks, or by throwing emotional outbursts. However, students also found ways to compensate for their performance, such as re-writing work at home, learning in ways best suited to them, re-framing what 'success' in physical and/or other activities looked like, celebrating small victories, and seeking guidance to improve their performance. Experiences of achieving mastery and coping with activities that had once been difficult enhanced students' confidence, optimism, and hope.

Category 4: Participation at school and peer level

Eighty-eight findings were sorted into this category. Students with DCD/Dyspraxia may feel inadequate at school and in peer relationships, particularly situations which involve physical education, sports, practical activities, and navigation around the school. Students with DCD/Dyspraxia were frequently bullied, excluded, and isolated by actions of peers, and were often misunderstood and not supported by teachers or schools. The transition from primary school, through secondary school, and into higher education emphasised students' co-ordination difficulties, and created further challenges in terms of coping with new environments and increased workloads – at times, without additional support being provided. These students often developed negative perceptions of physical education or practical activities and devised various tactics to avoid these situations. Mentoring systems in school, parental support and advocacy, acquisition of skills, support services, positive experiences, and having supportive friends could improve participation patterns and peer relationships of students with DCD/Dyspraxia.

Synthesized statement 3: Community level

Community activities, transport, and work environments do not always accommodate the needs of individuals with DCD/Dyspraxia and can prevent individuals from participating and achieving competency. Participation is further affected by the availability and accessibility of individualised training and appropriate healthcare to support the needs of individuals with DCD/Dyspraxia and their families. An environment that is tailored for individual needs would facilitate participation in the community.

Category 5: Activity at community level

Thirty-three findings were combined to form this category. Situations within the wider community, ranging from childhood community activities, transport on foot and by car, and work environments, often emphasised individual differences in ability. Many individuals experienced bumps, falls, injuries, emotional scars, and reduced confidence during such community activities. However, these situations also helped individuals with DCD/Dyspraxia understand their own needs and limits, either directing effort to achieving competency or opting out of activities. Confidence improved if an individual with DCD/Dyspraxia acquired skills and developed an understanding of their own condition through diagnosis, training, and therapies. However, training and therapies were not always valued by individuals with DCD/Dyspraxia. Individuals with DCD/Dyspraxia highlight the importance of recognising achievements, accepting their own abilities and performance, and making the commitment to improve own skills.

Category 6: Participation at community level

Forty-five findings were classified into this category. Participation in the broader community environment, such as through leisure activities, transport, and work, was affected by a number of facilitators and barriers. The physical environment, requirements/demands of participating in leisure and work activities, and interactions with peers, employers, and the healthcare system uniquely affected the participation level of individuals with DCD/Dyspraxia. To transform barriers into facilitators, the community environment should be tailored to individual needs.

Individualized learning, sports, and recreational activities and programs facilitated participation in the community, especially when individual preferences and needs were met and other individuals with DCD/Dyspraxia were involved. Appropriate and timely support would ease the struggles that families and individuals with DCD/Dyspraxia experience. Proper recognition and support for DCD/Dyspraxia, including primary and secondary care, is needed, but not always available. Parents often need to fight for healthcare professionals' understanding and support for their children with DCD/Dyspraxia.

DISCUSSION

This qualitative systematic review, reported in accordance with the PRISMA 2020 guideline (Cf. Supplementary Material 6), aimed to evaluate the experiences of activity and participation in individuals with DCD/Dyspraxia and their surrounding people. The goal of this review was to provide practitioners with synthesized statements to assist them in decision-making and developing strategies at practice and policy levels. By synthesising findings of 20 high quality studies, we produced three synthesized statements around experiences of activity and participation at the levels of home and family, school and peer, and community. These synthesized statements could be used as a basis for evidence-based practice (Hannes et al., 2018). Recommendations based on our synthesized statements are provided at the end of the conclusion. Furthermore, our synthesis and evaluation of findings helps to elaborate the Diagnostic Criterion B, and could potentially contribute to the development of a tool for assessing this criterion in the future.

Our review is framed with the terms of activity and participation defined in the ICF (World Health Organization, 2001). It was possible for us to classify findings from included studies into relevant ICF codes, such as d540 Dressing and d820 School education. The components relevant to the present review were not limited to 'Activity and Participation' but extended to 'Body Function' and 'Environmental Factors'. However, it was problematic to classify findings from included primary studies into the pre-existing ICF codes for two reasons. Firstly, the illustrations of 'activity and participation' overarch the interrelated components of 'Body Function', 'Activity limitations', 'Participation restrictions' and 'Environmental Factors' in the ICF model, and not all findings could neatly fit into one of the components. Secondly, this review used the meta-aggregation approach to synthesize findings from primary studies to generate a set of categories from which synthesized statements were constructed. Due to the decontextualised nature of the ICF codes, mere categorisation of the findings from primary studies into the ICF codes would not lead to statements that could assist practitioners in decision-making and developing strategies at practice and policy levels.

The first challenge remained when we first classified findings into categories of either activity or participation. We evaluated the relative weight between the two categories based on the illustration associated with each finding. The second challenge was managed by adopting some of the synthesis levels of school, teacher, peer, and individual, (Hannes et al., 2018) based on practical usefulness, and modifying them to represent home and family, school and peer, and community levels. Thus, we have developed three synthesized statements that indicate contextualized synthesized statements for practitioners and policy makers with moderate confidence (as determined by ConQual criteria).

LIMITATIONS

This review has several limitations to note. Our inclusion criteria of qualitative studies, studies searchable by English-language databases, and primary peer reviewed evidence excluded a range of samples, phenomena, and contexts. First, most of the included qualitative studies employed interviews and focus groups, and the validity and appropriateness of these popular data collection, analysis, and interpretation methods have been recently questioned: do interviews and researcher interpretation accurately reflect the true experiences on individuals? (Jackson & Mazzei, 2011). Leaving this fundamental question aside, it is also important to consider the nature of participants who were interviewed by the researchers, clinicians, and postgraduate students who successfully published their interview-based studies in peer-reviewed journals, dissertations and theses, and gray literature. These participants were a particular group of people who were accessible to DCD/Dyspraxia researchers and self-identifying DCD/Dyspraxia discourse. We must further consider a different group of people who deny diagnosis and labels, such as DCD and Dyspraxia, would not engage in the DCD/Dyspraxia discourse (Novak, Lingam, Coad, & Emond, 2012), and would not participate in qualitative studies. Our review is limited to the former group of people who had opportunities and willingness to participate in qualitative research labelled with DCD/Dyspraxia.

Second, with regard to cultural geography where included primary studies were conducted, our search was limited to English-language databases. While we attempted translation of all non-English studies, two non-English study conducted in Slovenia and Brazil were located.

The majority of studies included in this review came from a Western perspective and Western research agenda of qualitative methodology. No included studies were conducted in Asia, the Middle East, Central America, or Africa except South Africa. We potentially missed other relevant studies in these areas which were inaccessible from our selection of databases. As a result, our synthesized statements may not be directly transferrable into other geographical or cultural contexts.

Third, in our critical appraisal of included studies, we checked if each study located the research culturally or theoretically (Q6) and addressed the influence of the researcher on the research, and vice versa (Q7) (Lockwood et al., 2020). The same questions should be directed to ourselves as reviewers, and our potential personal, theoretical, or cultural influence on the present review. In this regard, we used meta-aggregation underpinned by pragmatism (Hannes et al., 2018), which is our philosophical, theoretical, and methodological perspective adopted for this review. Culturally, the first three authors are based in Aotearoa New Zealand, a nation which embraces multiculturalism based on biculturalism of indigenous Māori and non-Māori. Admittedly, the nation is strongly influenced by English culture, which enables us to write this review in English language.

Personally, the first author MM, feels obliged to disclose that he has been motivated to conduct this review to compensate for the equivocal quantitative evidence that he and his collaborators revealed through the Cochrane review on the effect of task-oriented interventions for children with DCD (Miyahara, Hillier, Pridham, & Nakagawa, 2017); the Cochrane review indicates a moderate positive intervention effect supported by very low-quality evidence and no effect supported by low-quality evidence. With very little confidence in the effect estimates, the intervention effect has turned out to be inconclusive. This experience might have influenced his efforts to include only the studies with high dependency scores in the current review to maximise the confidence level in our conclusions (i.e., synthesized statements). Second author, TP has been educated in the field of physical activity and health. Her learnings and outlook have been influenced by the concept of inclusion and a belief that environments should be adapted, when needed, to facilitate the full and meaningful participation of all individuals. Working as a consultant psychiatrist for the past 13 years in New Zealand, IM the third author, has been using DSM and interested in developing an assessment tool for Criterion B which is often not investigated in a structured manner in making diagnoses. RK, the fourth author, is from a nursing background. She has worked on various systematic review projects largely in the area of dementia care. Not so familiar with the review topic of DCD/ Dyspraxia, she is, in a way, able to contribute to this review in an unbiased manner.

Finally, our synthesized statements were assessed as being of 'moderate level of confidence'. This level of confidence is achieved by aggregating findings of only the studies with high dependability scores (See Supplementary Material 7 for this and other deviation from protocol). There is a trade-off between including diverse lower-quality studies and compromising the confidence level; we might have failed to represent significant voice from participants in the excluded studies, albeit with a lower quality of methodological reporting (Soilemezi & Linceviciute, 2018). Given the goal of meta-aggregation is to generate synthesized statements to make recommendations for practice and inform policies, our priority of confidence over breadth would be justified for maximising potential utility of our synthesized statements.

CONCLUSIONS

The review has assembled the independently conducted qualitative studies in various contexts and painted a collective picture of experiences that reflect the deep and pervasive impact of DCD/Dyspraxia. Our three synthesized statements reflect activity and participation at home and with family, school and peer, and community levels. To conclude, we draw on findings of our review and synthesized statements to generate a series of recommendations for practice.

RECOMMENDATIONS FOR PRACTICE AND POLICY

Synthesized statements 1, 2, and 3 indicate that individuals with DCD/Dyspraxia experience difficulties in a wide breadth of activities and situations as a result of the status of motor skill development. Because exact activities and situations vary, a checklist type assessment, such as ICF codes, may overlook some activities and situations for participation that individuals with DCD/Dyspraxia or their surrounding people hold personal or social significance for. Therefore, to evaluate the DSM-5 Criterion B for DCD, specific activities and environmental situations surrounding participation in activities of importance should be reported by individuals with DCD/Dyspraxia or proxies by responding to open-ended questions.

Synthesized statements 2 and 3 suggest that teachers, health care professionals, educational and health policy makers should be the targets of campaigns to increase understanding around the significant physical and psychosocial impact of DCD/Dyspraxia on the life of the individual who has the condition. Guidelines and practical training are required for teachers to increase understanding of DCD/Dyspraxia and employ practical strategies for reasonable accommodation within educational environments. To alleviate stress, provision of psychological support is crucial either individually or in group settings within the existing systems, or if feasible, with additional systems.

Synthesized statement 3 indicates the need for increased resources for screening, diagnosis, and age-appropriate individual and social interventions for individuals with DCD/Dyspraxia. Such support systems should be available from an early age and remain present in educational and vocational settings within the existing systems, or if feasible, with additional systems.

RECOMMENDATIONS FOR RESEARCH

The directions for further research are threefold. First, a set of open-ended questions should be prepared, refined, and validated to assess the DSM-5 Criterion B for DCD. Our qualitative synthesis could inform the preparation for a prototype assessment tool, such as one drafted in Supplementary Material 8. Further development and standardization of the tool would contribute to a transparent evaluation process of and transparent reporting for Diagnostic Criterion B.

Secondly, more qualitative systematic reviews are needed to address the synthesis gaps that our qualitative systematic review and O'Dea et al.'s (2021) meta-ethnographic synthesis have not yet tapped into. The gaps include different approaches (e.g., thematic synthesis, realist synthesis, content analysis), different foci on condition (e.g., co-occurring dyslexia and DCD/Dyspraxia), phenomenon of interest (e.g., cognitive and emotional regulation) and context (e.g., self organisation at school). Further qualitative syntheses

with different goals, approaches, and analyses would shed new light on qualitative data and produce distinct understanding and insights from the two predecessor reviews.

Thirdly, future primary qualitative studies should avoid overlaps and seek untapped population (e.g., older adults, preschool teachers, pediatricians, psychiatrists, GPs, people in non-Western nations and cultures, people who refuse to engage in the DCD/ Dyspraxia discourse), phenomenon of interest (e.g., assessment experience, real-time account of activity and participation experience in situ) and context (e.g., different vocational settings).

Finally, but not least, authors of primary qualitative studies should transparently report their philosophical perspective, research methodology, cultural and theoretical orientation, and influence of the researcher on the research.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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SUPPLEMENTARY MATERIAL 1-8

Supplementary Materials are available for download at this weblink

https://das.org.sg/images/publications/apjdd/VOL10NO2/APJDD-10-2-Article-7-SupplementaryMaterials.pdf

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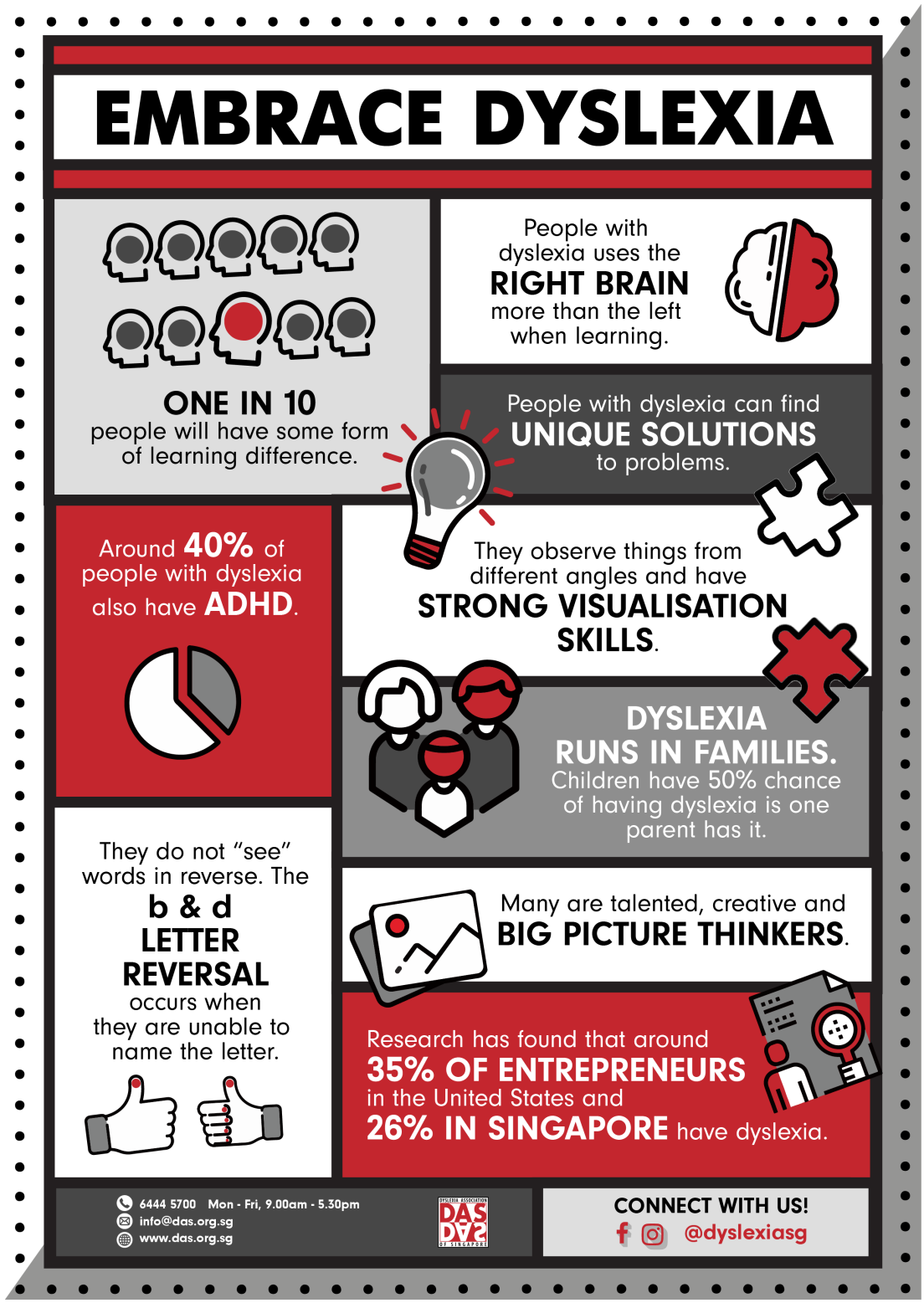

Asia Pacific Journal of Developmental Differences

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The Asia Pacific Journal of Developmental Differences (APJDD) will be unique in addressing a range of special educational needs including dyslexia, autism, dyspraxia, dyscalculia, ADHD in the Asian context. The journal will cover theory into practice and will provide a showcase for research in the Asian context as well as highlighting research areas which have implications for further research within Asia and beyond.

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The Journal will be published twice a year in January and July.

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Primary consideration for publications will be given to manuscripts that are focused on developmental differences within the Asia Pacific region. Manuscripts will be peer reviewed and included in the journal on the following criteria:

- They contribute to the further understanding of developmental differences as well as the applications and implications in the educational, social and cultural environments.
- They include sound research methods, interpretation and validity of results
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The APJDD takes the issue of retractions very seriously. In line with requirements of major academic journals the APJDD will continue to monitor publications for retractions. No future citation will be permitted for articles that have been retracted and a correction will be issued if any such article is published in error. In the case of citations prior to retraction no such correction will be issued, in line with the policy for other journals of this type. Please contact the editor in the first instance if there are any concerns. COPE guidelines have been accessed in preparing this guidance.

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Images, charts and diagrams should be sent separately where possible to ensure high quality reproductions.

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DYSLEXIA ASSOCIATION DAS OF SINGAPORE

Our Mission: Helping People with Dyslexia and Specific Learning Differences Achieve

Our Goal: To build a world class organisation dedicated to helping people with dyslexia and those with specific learning differences in Singapore.

Our Aims:

- To put quality first in delivering a comprehensive and effective professional service for dyslexic people and those with specific learning differences on a not-for profit basis.
- To provide an assessment service for individuals at risk of having dyslexia and/or specific learning differences.
- To provide educational programmes and other support services for individuals with dyslexia and/or specific learning differences.
- To raise public and professional awareness of the nature and incidence of dyslexia and specific learning differences.
- To enable others (teachers, parents and professionals) to help dyslexic individuals and those with specific learning differences.
- To assist and elicit financial and other support for people with dyslexia, those with specific learning differences and their families.
- To promote and carry out local research into dyslexia, specific learning differences and to disseminate results.
- To network with other organisations in Singapore and internationally to bring best practices to the DAS and Singapore.

DAS as a Social Enterprise

- We provide high-quality, professional, innovative and client-focused solutions to create and sustain services for the dyslexic community in Singapore and the region.

- We operate as a financially viable and cost-effective business which at the same time ensures that no dyslexic person is unable to access our services because they cannot afford it.

- We generate social returns on our investments through the development of a dynamic, motivated team of highly qualified and experienced professionals.

- We have a heightened sense of accountability to stakeholders through our professional management team.

Registered in 1991, the Dyslexia Association of Singapore (DAS) is today a vibrant voluntary welfare organisation with over 250 full-time staff who provide a wide array of services for dyslexics not only in Singapore but in the region. DAS Specialist Psychologists conduct assessment and diagnosis for preschool students to adults. DAS Educational Therapists, Speech and Language Therapists and Specialist Teachers provide support for over 3,500 preschool, primary and secondary school students in 14 venues all over Singapore. Increasingly, DAS provides support for dyslexics who also suffer from other Specific Learning Differences such as ADHD, Dyspraxia, Dyscalculia and Non-verbal Learning Differences.

The DAS Academy is a Private Education Institution (PEI) registered with the Council for Private Education (CPE). It is a wholly-owned subsidiary of the Dyslexia Association of Singapore (DAS).

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