Asia Pacific Journal of Developmental Differences

Volume 8 ♦ Number 2 ♦ July 2021

DYSLEXIA ASSOCIATION OF SINGAPORE

Published by the Dyslexia Association of Singapore (DAS)

ISSN 2717 5200 (digital)

Contact:

The Managing Editor
Dyslexia Association of Singapore
1 Jurong West Central 2
#05-01, Jurong Point
Singapore 648886

Email: editor@das.org.sg

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Asia Pacific Journal of Developmental Differences

Asia Pacific Journal of Developmental Differences
Volume 8 | Number 2 | July 2021

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Vol. 8, No. 2, July 2021, pp. 186—188

Editorial Comment

Angela J. Fawcett, Editor-in-Chief

It is a very great pleasure to publish this issue of the Asian Pacific Journal of Developmental Differences, now in its 8th year of publication, which is published by the Dyslexia Association of Singapore. The response to the previous issues continues to be extremely gratifying, and we maintain these high standards in this issue and forthcoming issues. We are grateful for the support of the academics and professionals involved in resolving any issues arising, and ensuring our journal maintains high professional and ethical standards.

In this issue we highlight some of the issues arising from the COVID pandemic, which has impacted so severely world-wide, not just in terms of the mounting death toll, but also in terms of the many restrictions within our societies. This has meant that many children have been home schooled or have engaged in remote schooling. In the first article in this issue, a case study analysis of the impact of Home based learning on dyslexic children was undertaken, including children from primary and secondary schools in Singapore, by Tay Hui Yong and Siti Asjamiah bte Asmuri. The findings, on interviewing both children and their mothers, indicated that many dyslexic children struggled with the demands of typing for example, and with a system that necessarily had been set up at short notice without enough capacity to accommodate the needs of children with special needs. It is clear that key components here are the support of families in ensuring the ongoing emotional well-being of all children in these difficult circumstances. In the second article here, by Sui, with comprehensive analysis in a large -scale study examined the factors affecting parental efficacy, a key component of success for these children with a range of special needs. Although not addressed specifically to the pandemic, there are a number of clear lessons to be learnt. This article revealed that for this Hong Kong based study, the impact of ASD and ADHD was greater in terms of parental stress than other learning difficulties, with important factors including economic and environmental access to support. A need for more widespread social and community support was identified as a vital step forward to ensure more positive outcomes.

Turning to the academic issues associated with special needs of all types, the next set of articles addresses issues in reading, spelling, writing and maths. The first article here presents a longitudinal study by Sharyfah nur Fitriya of a large sample of 1343 children

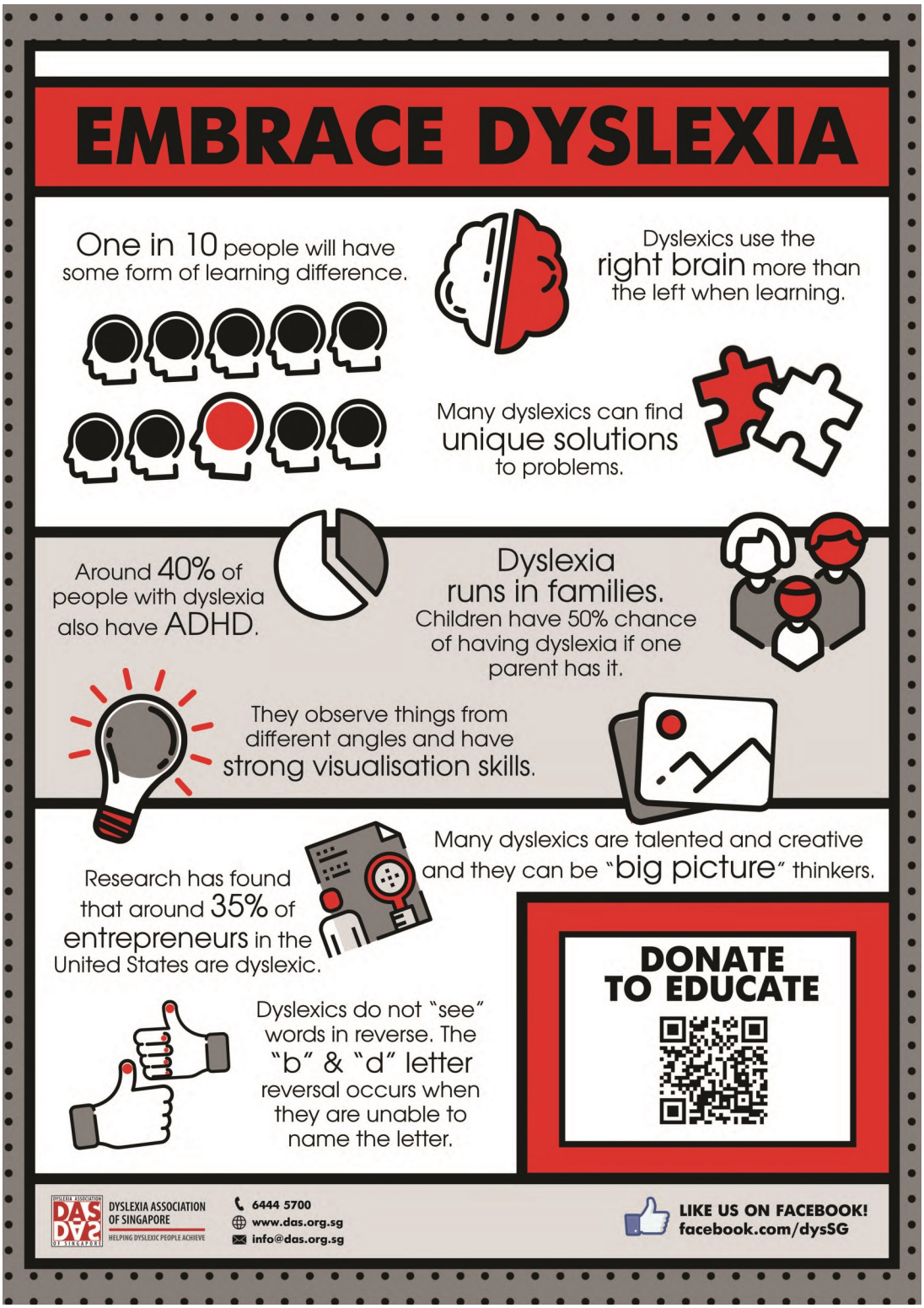
attending the Dyslexia Association of Singapore in their Main Literacy Programme over a 2-year period, in the age range 7-17. The topics assessed included word reading, spelling and writing using curriculum-based assessment tests. The results indicated that the support they had received had made a significant impact in their skills. This is the first of a series of articles that will break down the performance of this group further, in order to ensure that children continue to make meaningful progress.

The next article from Lockiewicz and colleagues, in a research project in which I was fortunate enough to participate, comparisons were made of progress of Polish adolescents learning to spell in their native language in comparison with English. Two samples of children were included, with a group of children studied in Sheffield, UK, in comparison with Polish adolescents, including groups both with and without dyslexia. Comparing progress in phonology and orthography, English children made more phonological errors and Polish children more orthographic errors, suggesting the use of a sub-lexical strategy in Polish that led to more bizarre attempts. The Polish dyslexic children showed the greatest difficulty overall, with implications for children learning in more than one language outlined.

Interestingly, the next study by Mariko Maeda and colleagues, highlights issues identified for a group of Japanese children with Downs Syndrome, in reading and writing, expanding the areas of learning needs usually addressed by this journal. The Down Syndrome children's progress was compared with younger typically developing children matched for mental age from 4-6 years old. Differences in cognitive processing related to environmental issues were considered, with children completing a number of phonological tasks as well as visual spatial tasks. The results indicated that the Down Syndrome children were able to achieve more than the typically developing children of equivalent mental age, with implications for future practice in teaching this subgroup. The final article in this section, drawn from Rameeza and Mazarrat Khan from India, examines the usefulness of the Concrete-Representational-Abstract approach and multisensory strategies in an inclusive approach to teaching Maths. Examining the Piagetian basis of learning, as well as evidence from a wide range of studies of the efficacy of this approach, the authors highlight the importance of skilled teaching in linking teachers the three components effectively.

The final article in this issue builds on an article published in the previous issue from Lynn Holmes and colleagues, in her case study of a dyslexic pilot who struggled to read but had built up his own strategies to ensure he could achieve his ambition of learning to fly. Here, the model of processing highlighting the interactions between learning, strategies and the emotional impact of dyslexic difficulties on the overall outcomes are examined in full.

It is a pleasure to note the rich and varied material which is now submitted to the APJDD for our review, and we hope our readers will find this issue interesting. We look forward to the UNITE SpLD 2021 conference, and the opportunity to participate once again in this world-class international conference, which as well as emphasising the importance of an academic approach to dyslexia, once again highlights the importance of the whole child in building the strengths, as well as supporting the weaknesses, associated with dyslexia.



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Vol. 8, No. 2, July 2021, pp. 190—217
DOI 10.3850/S2345734121000080

Dyslexic Children's Experience of Home-Based Learning During School Closures: 4 Case Studies

Tay Hui Yong[1*] and Siti Asjamiah bte Asmuri[2]

1. *National Institute of Education, Nanyang Technological University, Singapore*
2. *Dyslexia Association of Singapore*

Abstract

During the coronavirus pandemic, schools across the world shut down and education was transferred online, with the education of half a million students in Singapore continued through "Home-based Learning" (HBL), delivered through online platforms, including the Student Learning Space (SLS), accessible to all schools. A system was developed to ensure that economically deprived families who lacked equipment could borrow this from school, and those with no internet connection at home could return to school to engage in online learning. By contrast, specialized support for children with special needs was not necessarily designed to address these needs. The impact of this on the potential 20,000 dyslexic learners in Singapore forms an important research area for further investigation.
The current study gathered empirical evidence through one-to-one interviews of 4 students (2 from primary schools and 2 from secondary schools). Taking an ecological approach, the study also analysed the context of school, family and beyond. Hence, the study examined the participants' lessons and assignments as well as interviewed their mothers in order to form a complementary picture to answer the research question on their experiences of learning during HBL. The interview data was transcribed verbatim and analysed together with the artefacts for emergent themes across the cases. Data analysis surfaced 3 themes: dyslexic-(un)friendly use of technology, feedback- focused pedagogy and social-emotional support. These findings will help guide professional development for teachers in mainstream classes who design e-learning experiences for inclusive classes with dyslexic students.

Keywords: Dyslexia, distance learning, online learning, school closure, inclusive classrooms.

***** *Correspondence to:*
Dr Tay Hui Yong, Learning Sciences and Assessment, National Institute of Education.
Email: huiyong.tay@nie.edu.sg

INTRODUCTION

The advent of the coronavirus (Covid-19) pandemic has brought about unprecedented disruption. Education was not spared. Schools were hastily closed to stem community spread and remain closed in many countries. It was estimated that 90% of the world's student population (UNESCO, 2020) was affected by these school closures.

In Singapore, the education of half a million students continued through "Home-based Learning" (HBL) (MOE, 2020, April 3). HBL is best characterised as distance e-learning, defined as the use of e-learning to support distance learners (de Freitas & Roberts, 2003).

Much of this HBL is delivered through a number of online platforms including the Student Learning Space (SLS), accessible to all schools (Ministry of Education, 2020). Teachers typically required students to type text or upload word documents to SLS which does not offer text-to-speech features. Families who lacked equipment could borrow devices from the school. In addition, students who had no internet connection at home could return to school to engage in online learning.

In contrast to such support for economically disadvantaged families, support for those with special educational needs (SEN) was less forthcoming. It was not clear if these distance e-learning methods bore in mind the SEN children's learning needs. Given that the duration of this HBL approach was at least a month long, it is thus important to investigate how HBL was experienced by SEN children such as dyslexic learners, who are the focus in this study.

Dyslexia is defined as a specific learning difficulty of language learning and cognition that primarily affects accurate and fluent word reading and spelling skills. There are also associated difficulties in phonological awareness, verbal memory and processing speed (British Dyslexia Association, 2010; The International Dyslexia Association, 2020). The Dyslexia Association of Singapore (DAS, 2020) estimates that there are currently about 20,000 dyslexic students in mainstream classes at primary and secondary schools. In Singapore, children aged seven to twelve attend primary schools before they sit for a national examination to qualify for secondary school (for thirteen to sixteen-year-old students).

This paper presents an investigation of how dyslexic learners experienced HBL seen through an ecological lens. Hence, data was gathered through one-to-one interviews with the student participants and their mothers. It also examined their online school experience, including interaction with teachers and peers, as well as the larger context beyond family and school.

LITERATURE REVIEW

This section begins with defining dyslexia and the challenges that dyslexic learners face. This is followed by a review of literature on the use of technology and distance e-learning, and how they may help or hinder such learners.

Difficulties Faced by Dyslexic Learners in School

DAS (2019) defines dyslexia as:

> *a type of specific learning difficulty identifiable as a developmental difficulty of language learning and cognition. It is a learning difficulty that primarily affects the skills involved in accurate and fluent word reading and spelling.*

Once conceived as a phonological dysfunction, dyslexia is now understood as encompassing a whole host of issues: from slow visual processing and auditory processing in combination with attention, sequencing, and timing difficulties, left–right confusions, to poor short-term memory (Bosse, Tainturier, & Valdois, 2007; Varvara, Varuzza, Padovano, Sorrentino, Vicari & Menghini, 2014). It is now thought to be a result of temporal processing impairment, characterized by the brain being unable to process brief stimuli in rapid temporal succession (Habib, 2000). Baddeley and Logie's model of working memory (1999) identifies the phonological loop as a key component of working memory responsible for storing phonological and verbal content received through auditory stimuli. This explains the plausible relationship between dyslexia and other difficulties associated with cognitive processes requiring the utilisation of working memory. Examples of such difficulties are planning, organising, sequencing and selecting tasks, sustaining focus and self-monitoring. It suggests reasons why these learners have challenges regulating their attentional resources to enable greater automaticity in retrieving information and switching tasks. Other challenges include manipulating, integrating and adapting information in response to dynamic situations and environments (Herbert, Kearns, Hayes, Bazis & Cooper, 2018).

Their challenges in learning can also be further attributed to procedural learning difficulties explained by the neural-systems approach of the cerebellar functions involved in language-related skills (Fawcett and Nicolson, 2007). Since procedural learning is the picking up of skills and habits with little conscious effort, impaired functions in the language-based procedural learning system result in children with dyslexia having difficulties performing tasks requiring automatisation such as listening to the teacher and taking notes at the same time. This is further supported by the automatization deficit hypothesis (Nicolson & Fawcett, 1990), where the learning of skills by students with dyslexia is neither automatic nor fluent.

A likely outcome of these difficulties is often demonstrated in their low academic school performance. This in turn can lead to serious effects on their social and emotional development such as low confidence levels, a lack of motivation, feelings of helplessness and inadequacy and disruptive or attention-seeking behaviour (Thomson, 2010).

Although some learners may develop compensatory strategies along the way, others may continue to struggle in managing curricular demands or keeping pace with their peers.

Use of Technology to Mediate and Remediate Learning for Dyslexic Students

With these struggles, it behoves us to examine if dyslexic learners will benefit from the use of e-learning tools, especially when they involve reading and spelling tasks. Fortunately, there has been research on the use of technology as effective learning and teaching aids for students with dyslexia in areas such as reading, writing, memory and even mathematical learning. For example, computer games with interactive and fun features incorporating audio-visual phoneme discrimination tasks are said to have contributed to improvements in visual-processing and short-term memory (Chai & Chen, 2017).

Technological advancements, coupled with greater emphasis on inclusive education, also facilitated the development of assistive technologies. These new developments aimed to offer students with learning challenges opportunities to overcome the obstacles they usually encounter in traditional environments (Chai et al., 2017). Assistive technology, as defined by Lewis (1998), is one that allows individuals to compensate for their impairments, focus on what they are capable of and experience success by improving performance. It enables learners with dyslexia to complete their tasks independently and efficiently, thereby improving their chances for higher academic achievement. Some applications such as Text-to-Speech (TTS) and voice recognition or Speech-to-Text (STT) are also readily accessible on tablets and smartphones. Spellchecker allows users to check for spelling errors, and Grammarly ensures the text is free of grammatical errors.

These tools are used by many, not just individuals with dyslexia. They help remove stigma and enable them to participate in activities on more equal terms with their peers. They are also better engaged when they are less dependent on teachers for help (Paramanantham, 2018; Svensson, et al., 2019).

The Advantages and Disadvantages of Distance e-Learning

Earlier, HBL has been described as distance e-learning. Though the two terms "distance learning" and "e-learning" are sometimes used synonymously, there are differences. The former connotes that the learner and teacher are separated by space and maybe even

by time; while e-learning involves "the use of electronic media for a variety of learning purposes that range from add-on functions in conventional classrooms to full substitution for the face-to-face meetings by online encounters" (Guri-Rosenblit, 2005, p. 469).

In Singapore, e-learning has increasingly become part of the local educational experience (Koh & Lee, 2008). Defined as "learning and teaching online through network technologies", e-learning has indeed been acknowledged by many as a powerful, alternative platform to the traditional classroom with the potential to engage learners effectively and accelerate learning (Hratinski, 2008). While students can use it to facilitate learning at home, teachers can also keep track of students' progress (Paramanantham, 2018). Up till the Covid-19 pandemic, most local e-learning initiatives have been carried out in an asynchronous mode to complement in-person learning in school.

Asynchronous e-learning allows students to perform learning tasks without the need to be in a certain place at a certain time. Although educators may set a time duration for learners to complete certain tasks, asynchronous learning offers learners the flexibility to access and complete learning materials at their own time and pace, as long as they have access to the Internet. Some examples of asynchronous e-learning tools are online portals, emails, blogs, pre-recorded video lessons or webinars, as well as online forums and discussion boards.

The platform adopted by all schools in Singapore for such asynchronous e-learning initiative is the Student Learning Space (SLS). All primary, secondary and post- secondary students in Singapore have access to the online portal set up to encourage learners to be self-directed and customise learning according to their needs and interests. School leaders and educators provide students with an array of quality curriculum resources to supplement and enrich students' learning experiences beyond the classroom (MOE, 2020).

A more recent development with the advent of higher broadband speeds is synchronous communication technologies such as video-conferencing tools. Termed synchronous online learning, such a mode enables students to interact with classmates and teachers through text-, audio-, and/or video-based communication of two-way media (Martin, Ahlgrim-Delzell & Budhrani, 2017). Proponents have lauded its use in instruction because it offers a real-time environment similar to that in face-to-face communication (Blake, 2000). It motivates learners to participate in the interaction while benefiting from immediate ongoing feedback (Chen, Ko, Kinshuk, & Lin, 2005). A study involving 105 participants at a college that exclusively serves students with LD, ADHD and Autism found that they preferred synchronous to asynchronous online discussions (Dahlstrom-Hakki, Alstad, & Banerjee, 2020). The participants reported greater engagement and motivation.

However, opinion is divided whether distance e-learning will benefit dyslexics. One study of dyslexic students enrolled in distance learning with the Open University in the United Kingdom found that they were just as likely to complete as their course mates, though less likely to pass or get good grades (Richardson, 2015). Perhaps, these learners could have benefited further from the use of computers. Crivelli, Thomson and Andersson (2004) argue that computers can help dyslexic learners by creating "a patient, non-judgmental environment" (p. 304) with functionalities that can support dyslexics in reading (e.g. text-to-speech features) and writing (e.g., assistance in planning and editing). As such, the use of information technology can bolster their self-esteem. It can even make learning fun with the inclusion of multimedia and games.

On the other hand, Beacham and Alty (2006) argue that the use of mixed media in e- learning (text, diagrams, sounds) can pose even greater difficulties because the switching of media stresses the dyslexic's short-term memory. Other online experiences that tax the short-term memory include new routines such as password to log in (Blankfield, Davey, & Sackville, 2002), the need to keep track of discussions or even navigating hypertext structure because it involves reverse sequencing (Rainger, 2003).

Other problems posed by e-content include visual readability (e.g. choice of font and contrast of text) that can potentially exacerbate difficulties in visual processing (McCarthy & Swierenga, 2010; Rainger, 2003). However, this can be overcome with the flexibility for dyslexics to manipulate the text to larger fonts and more generous character spacing that can help them read faster (Rello & Baeza-Yates, 2017). Allowing them to submit type-written work on computers will both take away the stigma of poor handwriting and offer help with bad spelling via the spell-check function (Mullen, 2016). Distance e-learning may also be a boon to dyslexics who are typically reflective learners who work most effectively in isolation or in a one-to-one setting (Alsobhi, Khan & Rahanu, 2015, 116).

In the same light, synchronous activities such as web conferencing can also disadvantage dyslexics. Their difficulties in reading quickly and responding accurately in typing mode could mean that they cannot keep up with text-based or collaborative synchronous activities (Habib, Berget, Sandnes, & Sanderson, 2012; Ingram, Hathorn, & Evans, 2000). Dyslexic university students involved in a study investigating text-based synchronous e- learning reported difficulties learning in that modality (Woodfine, Nunes & Wright, 2008). This finding is consistent with another study involving 48 secondary students (half with dyslexia and other half without). In particular, the dyslexic participants struggled with unorganized synchronous discussion (Pang & Jen, 2018). Even asynchronous discussion in a forum was a challenge when posts were in long and complex sentences. In both studies, dyslexic participants reported lowered self-esteem when they were unable to keep up and participate as actively as others.

The Gap in Literature

As shown in earlier section, the extant literature does not present an unambiguous picture of whether distance e-learning is beneficial to dyslexic learners. This lack of clarity is compounded by the lack of empirical studies in this area. A search on two databases (Academic Research Complete and ERIC) using keywords "dyslexia or dyslexic", "online or e-learning" and "synchronous" uncovered only six peer-reviewed studies, of which only one involved school going children. The majority of the studies in this area seems to involve older students in institutes of higher learning (Pang, Chen, Teh & Anding, 2015). Also, semi-structured interviews or questionnaires were generally used to gather data. None of them took the ecological approach of analysing the context of school, family and beyond.

Such an ecological paradigm is necessary to gain "an all-round understanding of the child within their life-context" (Poole, 2003, p. 177) by taking into consideration the various sources of influence from the home and school, (microsystem) to political and cultural context (macrosystem). Examples of such an approach, though not in a distance e- learning context, include investigations into children and parents' perspectives on living with dyslexia (Leitão et al., 2017), parental abuse (Hurford, 2015), teachers' experiences on teaching and supporting students with dyslexia (Olivier, 2017).

Significance of Current Study

This study aims to fill the gap to better inform teachers and policy makers of the effects of distance e-learning on some individuals from a vulnerable segment of learners. The case study approach adopted can provide in-depth investigations of their experience during extended periods of school closure. The discussion can help advance the larger conversation on how teaching and learning can be redesigned not just for dyslexics but for all.

METHOD

Research Question

The present study sought to answer the research question: What are the experiences of dyslexic children, of learning during Home-Based Learning (HBL)? The latter is a term used in the Singapore education system when physical schools were closed and lessons migrated to distance learning mode largely driven by online platforms.

Research Design

The study took an ecological perspective that viewed the dyslexic child within the familial and larger context, taking into account the other factors influencing the child's

development. However, for the purposes of this study, the factors were limited to considering the microsystems at home (support from family) and in school (pedagogy and support from teachers) as well as the macrosystem (e.g. educational policy) The research was designed as an instrumental case-study with each participant investigated in-depth to understand the child's unique experience while looking for commonalities with other cases (Stake, 2006).

Ethics Protocol

The study complied with the ethical protocols set by Nanyang Technological University and DAS where the study was sited. Once the participants and respective parents were identified, they were briefed over a phone call on the nature of the study and their involvement. This was followed by an email with a soft copy of the Study Information Sheet attached, to seek written consent. In the latter, details on research objectives and procedures were clearly mentioned and matters pertaining to consent, anonymity, confidentiality and the right to withdraw were explicitly addressed.

Participants

They were shortlisted from among students who attended DAS support class in English Language. For maximal variation in participant sample, they were drawn against a matrix of gender, age and reading levels (See Table 1). At DAS, students undergo a bi-annual curriculum-based assessments (CBA) in areas such as Oracy, Phonology, Listening Comprehension, Reading Fluency, Spelling, Writing and Reading Comprehension. Based on their CBA performance scores in Reading and Spelling, the participants chosen for the study were drawn from two categories: Beginning / Intermediate and Advanced.

Table 1 Summary of Participants' Key Characteristics

Case**	Level (Age)	Gender	Reading levels	Other support / comments
Lee	Pri (11)	Female	Beginning to Intermediate	Mum helps in Mathematics; Attends Science group tuition.
Arun	Pri (12)	Male	Advanced	Has own room at home; Attends Mathematics individual private tuition.
Ian	Sec (13)	Male	Beginning to Intermediate	Attends group tuition in English Language; Attends individual private tuition in Mathematics and Science (separately; since Primary 3)
Tia	Sec (16)	Female	Advanced	Dad helps in Mathematics. Has own laptop in own room while brothers share device in the living room.

***pseudonyms Note. Pri = Primary; Sec = Secondary*

The semi-structured interview schedule was in two main parts: first, the child's overall experience of school in general and of HBL; second, the child's perspective of effective HBL (See Appendix A). Their mothers who were the main care-givers at home during HBL were also interviewed separately to form a complementary picture of the child's experience (See Appendix B for interview schedule). The semi-structured interview approach allowed flexibility in pursuing relevant points such as awareness of assistive technology. Because of the social-distancing regulations during the time of the study, the 45-60 minute interviews were conducted online by the researcher after permission was sought and consent forms signed.

The interview data was transcribed verbatim. The data analysis was guided by the adapted ecological perspective, focusing on home and school contexts that might mediate the child's experience. This approach guided in developing the a priori codes which were used in the initial coding (See Table 2).

Table 2 Initial Coding Template

Categories	**Codes**	**Notes (and examples)**
Technology	**T**	Platforms / affordances mentioned (video conference platforms)
- help	**T+**	Specific mention of help (replaying video if unsure)
- hindrance	**T-**	Specific mention of hindrance (Wifi problems)
Pedagogy	**P**	Approaches adopted by teachers to facilitate learning (clear instructions)
- help	**P+**	Specific mention of help (additional support through unofficial channels)
- hindrance	**P-**	Specific mention of hindrance (lack of detailed feedback)
Child	**C**	Characteristics of child (with regard to dyslexia)
-help	**C+**	Characteristics of child that helped enhance HBL (self- directed, organised)
- hindrance	**C-**	Characteristics of child that hindered HBL (keyboarding skills)
Family	**F**	Immediate family members (father, mother, siblings)
- help	**F+**	Specific mention of help (resolving problems with tech or homework)
- hindrance	**F-**	Specific mention of hindrance (close supervision)
Larger Context	**LC**	School / national educational policy, after-school commitments (e.g., private tuition)
- help	**LC+**	Specific mention of help (exemption from some subjects)
- hindrance	**LC-**	Specific mention of hindrance (national exams end-of-year)

These codes were suggested by the review of literature. The two researchers coded and analysed the data separately before discussions regarding the coding template. New codes that arose from the data were subsequently added (e.g. pace). These codes were subsequently collated into potential themes which were also constantly revised before being finalised.

FINDINGS

This section will begin with an overview of each individual case, highlighting one particularly memorable incident (to student or mother) and other relevant factors that will contextualise their HBL experience. This is followed by the findings that cut across the cases, organised around the factors that were suggested by the ecological perspective adopted: school (specifically use of technology and pedagogy), home and larger contexts.

The section will end with a summary highlighting the themes that surfaced through analyzing the interaction among these various factors.

CASES

Lee is an 11-year-old girl who was sent for diagnosis when she was 6 years old because her mother was concerned that though she was very vocal, she could not read nor write. The intervention at DAS helped her to improve her confidence. However, according to her mother, though Lee can understand, she has difficulty remembering what the teacher said in class, including instructions. Hence, she needs constant reminding and repetition. Also, she has difficulty in presenting her understanding in written form. The mother highlighted an incident that happened years ago when a Mathematics teacher wrote "It's a fluke" against Lee's correct answer because Lee had not shown the required working. It helped explain why Lee kept reiterating during the interview that teachers must allow for different ways of answering questions. Perhaps, her concern arose also because the Mathematics teacher who taught her during HBL was not her usual class teacher.

Arun is a 12-year-old boy who is a middle child. According to his mother, he is very much left to his own devices and has thus grown to be quite independent, especially after achieving vast improvement in reading through DAS intervention. The mother shared that recently, she had more complaints from his teachers about him being distracted in class and not handing in work. In contrast, he has been very enthusiastic in HBL. In fact, he remarked that HBL has "made (him) smarter- suddenly, I know all the answers to everything". The boy had also taken the initiative to arrange additional one-to-one pro-bono tuition sessions in Math. While he appears to be fully engaged in one-to-one Math tuition and small group online DAS classes, his mother remarks that he is often distracted in his school online classes, often observed to be folding paper at the side, out of view.

Ian is a 13-year-old boy who was away from school for two months before the onset of HBL because of surgery on one of his fingers. As such, he was quite lost initially during HBL, especially in being acquainted with logging in and other instructions that would have been conveyed in class lessons before HBL. He was particularly upset at the technological hiccups that caused one teacher to broadcast to the class that he had not handed in work when he already did. However, being away from school for a long period gave him time to learn other things like card tricks and even experiment with coding. Still, he said he would rather go back to school, because in HBL, you "cannot ask questions- cannot see the teacher- like a lot of difference- if you have a question- you cannot tell him immediately- you have to wait".

Tia is a 16-year-old with a positive outlook, probably because her mother told her from young that "You're not stupid, you're just different" especially after hearing unkind remarks by her peers or cousins when she could not read simple words. Her mum finds that Tia is an independent and disciplined learner who can be entrusted with her own laptop in her room. Hence, her mother generally left her alone so that she could attend to her 12- year-old son who is also dyslexic and sitting for national examinations in the same year. Tia's main frustration is that she is "super slow" in writing because when she writes, she finds her thoughts "very scattery" as she struggles to put pen to paper, conscious that writing is not as easily editable as in typing. She recounted one incident when everyone else had finished their work and left the room, she was still struggling to finish.

FINDINGS ACROSS CASES

Technology

Online platforms were key during HBL. Before the physical schools closed, students were issued with a timetable (See example in Figure. 1). During the time indicated, students generally met their teachers online via video conferencing tools such as Zoom.

Sometimes, they would be directed to engage in online activities on the SLS platform. The platform would also help remind the child of work assigned and his or her progress in the required activities (e.g., "In progress" and "Completed").

These activities generally involved watching a video recorded by the teachers themselves or from another source such as YouTube. Students are often required to complete a set of Multiple-Choice Questions (MCQ) to check on their understanding (See Fig. 3). The younger participants mentioned more engaging activities such as Kahoot and simulations.

	0730 to 0800	0800 to 0830	0830 to 0900	0900 to 0930	0930 to 1000		1030 to 1100	1100 to 1130	1130 to 1200	1200 to 1230	1230 to 1300	1300 to 1330
Mon	Assembly	Class Meeting	Art		English (EL)	R E C E S S	Maths		PA	EL	Mother Tongue Language (MTL)	
Tue	Maths		MTL				Science		EL		Physical Education	
Wed	Performing Arts (PA)		PE	Music	EL		MTL		PE		Maths	EL
Thu	Catholicism (PC)	EL		Science			MTL		Maths			Character Education
Fri	EL		Character Education		MTL		Science		EL		Maths	

Figure 1. Lee's timetable during HBL

Science (SLS)	1. Get ready with your SLS details. Log in to SLS 2. Click on "'P5 All Sci HBL (29 Apr)' and complete the activities. 3. Click on Activity 1 'Quiz on Water and its changes of states' and complete the quiz. 4. Click on Activity 2 'Review answers of Science workbook (systems) Activity 4.2, 'Parts of a cell' page 29 and complete corrections. 5. Click on Activity 3 'Vitamindz Cells' and complete 'Knowledge check- in and MCQ section only'	1hr

Figure 2. Example of SLS activities.

It was observed that much of the instruction communicated was written. Ian's mother noted:

> *"I think he struggles on HBL sometimes there is no clarity as teachers don't really tell them what to do. Everything's on screen so he has to read up and understand, and decipher what they want. So it takes a lot of time. Whereas if you are in school, your teacher will explain to you what you are supposed to do before they give you the work. Now he has to read it himself, understand himself, cos there's no teacher zooming in, coming in and telling you what to do. So I guess that is the downside to having HBL at home."*

Apart from the official channels where the HBL was taking place, there was also a very active informal feedback channel via Whatsapp. Every child/parent pair mentioned how Whatsapp was used: teacher sending questions to students who in turn took photos of their answers to send back (Lee), students trying to alert teacher that they needed more time to complete their offline work (Tia), student trying to clarify something on group chat (Ian), teachers giving feedback to parent on child (Arun).

As expected, participants reported some teething problems in the use of online lessons as expressed by Tia:

> *"Sometimes SLS could be really buggy. A bunch of times, our teacher sent a bunch of things but it never went through. So we all sat down for an hour waiting for our assignment, but they never showed up. We started texting our teacher, and asking what happened. For some reason there was some lag, the whole country is trying to get into one single thing, and it's making a mess. Everybody is just waiting."*

Other interferences could come from the home environment, for example, "trucks moving outside" (Lee).

In addition, typing also proved to be an additional hurdle to two participants, Ian and Lee. Based on the last CBA assessment conducted at the DAS, their Reading and Spelling scores placed them at the Beginning-to-Intermediate stage of literacy achievement. Lee reported, *"I am bad at typing because when I do typing I keep on getting typos also so I don't like..."* Ian's mum explained it as such: *"It takes a lot of preparation time to write out things (which Ian prefers to do) and put it inside the keyboard. So it's double work for him. So it becomes very tiring, and time consuming".*

There was also no evidence suggesting the use of dyslexia-friendly applications such as Speech-to-Text or Text-to Speech. When asked if she was aware that she could use it to help her with spelling and typing, Lee said, *'No you can't do that, you have to type it out yourself'* and that she had never used it before.

In contrast, Tia who is placed at the Intermediate-to-Advanced stage of literacy achievement based on her Reading and Spelling scores attained on the last DAS CBA assessment, said:

> *"so when I type I know what I am writing so I don't have to cancel out things, I can just type, and then like delete. So it's always there if you need to change. But when I am writing, I need to be very sure of what I am writing, because when I am writing, I feel so scattery, and I feel so distracted, I am so easily distracted I can't write properly."*

Participants recognized other advantages in using technology. Arun, who has problems with transposing, found that with the iPad, it is *"easily copy and paste important information, to see, to make the questions easier to understand".* Tia found recorded videos helpful because she *"could just go back and rewatch the videos if (she) didn't understand".*

PEDAGOGY

As mentioned, teaching during HBL generally consisted of recorded videos or video conference sessions. The latter often involved teachers giving the correct answers to homework that was assigned to be completed offline. Students were then asked to mark their own work. If needed, homework was submitted through an online platform like Google Classroom where the teacher could track who had submitted and who had not. Occasionally, teachers gave feedback through the same channel. This combined approach of offline and online engagement could be partly attributed to a commitment by the ministry to limit the amount of screen time especially for the younger students.

Pre-recorded lessons met with mixed reviews. Tia liked her chemistry teacher's flipped classroom approach, where students watched videos on the new content before attending the online class when they could raise questions directly with the teacher. In contrast, Lee did not find such pre-recorded videos nor online teaching helpful because she felt that they "did not go in-depth". She felt that she could not "actually go up directly" and "can't really ask questions" when in doubt. Similarly, while the multiple-choice questions or the fill-in-the-blanks assignments which she had to attempt on SLS could give her immediate feedback on whether her answers were correct, they "don't actually explain" why she was right or wrong.

What was conspicuously missing was class discussion where learners could collaboratively construct their understanding. Instead, the student participants mentioned how the teachers would mute everyone during their lesson. While this meant they could "hear more clearly", the approach resulted in passive listening. This led the interviewees to tune out at best; at worst, they were frustrated at the lack of opportunity to clarify. There were tools for the students to signal their questions but as Ian said, his hand had been "virtually" raised for two weeks and yet the teacher had not responded. When Tia's class tried to ask for more time to complete class work, it was too late by the time the teacher saw the Whatsapp message. Tia highlighted that this would not have happened in school where the teacher would have seen for himself that the class was generally struggling.

It thus appears that one commonality in the participants' experience centred around feedback: both in the giving and receiving of feedback. In contrast to the immediacy of response afforded in a typical lesson in school, the student-teacher interaction was hampered by the online environment during HBL. As one mother remarked, "You can't

see their expression as much and what they are doing behind your back". Teachers could have used the technological tools to enable better interaction or feedback. But there was little evidence of the technology used in such a way to support pedagogy.

One last point worth noting is that it was unanimous that even if the teachers knew of the students' conditions, teachers did not differentiate their pedagogy and feedback approach to accommodate the needs of the dyslexic students. Lee mentioned that "..school is in general for most students so we don't really understand sometimes ... usually they will just say it once and then they will go with the majority if they need to go through it over again." What this suggests is the propensity of teachers to adopt a whole-class approach in the teaching of content and if such is the case, the same would probably have been undertaken for product and assessment of learning. Perhaps, the differentiation then might have come through the feedback to the individual child based on their knowledge of the child's needs. Even so, Arun remarked that the approach to feedback was "the same" in school and HBL. In Lee's case, the teacher who taught her Math during HBL was not even her regular subject teacher. The students were allocated to different groupings on the basis of their performance in the subject. Lee reported that she could not understand "the different explanation" of this unfamiliar teacher. As a result, the learning process for her became rather fragmented, which could then exacerbate confusion. It could be that the drastic transition to HBL might have left teachers with little time to plan for differentiation. Much effort would have been focused on exploring the different applications and tools to enable effective delivery and converting content to the digital format.

Parents

Since HBL took place when the parents were also working at home, the interviewees had their parents' help when they encountered difficulties. These difficulties were often technical in nature: how to log in, photograph their assignments to be submitted online (or "pdf it" as the interviewees said turning the noun into a verb). At other times, the mother had to monitor if work assigned was done or checked, especially when they considered the children to be disorganized (e.g., Lee and Tia's younger brother). In some cases, the parents played the role of the teacher to explain content (Tia's engineer father explaining mathematics) or assisting with the homework (Ian's mother reading out the question for him, Lee's mother breaking down the problem in steps for her). In many ways, the parents played a significant role in mediating the child's HBL experience. Previously, they had always availed themselves if their children asked for help but during HBL, they took greater steps and time to support them.

A theme that came across all the different cases was how the parents were a source of affirmation for the participants. Since young, the parents used positive talk to help their dyslexic children when the latter struggled with learning. One example is by Tia's mother that there was nothing wrong with her but that her pathway was different: "If people go

route A to study, you have another route to study." Lee's mother's constant message to her child was to accept she had dyslexia and to always try her best. In fact, the mother emphasized to Lee that she should not use her condition "to her advantage", an excuse for not trying.

Larger Context

Apart from the parents, this group of participants benefited from a larger network of support: the DAS and sometimes, additional tuition outside of school. As such, what the students missed out in the individual attention from school, they could access through these other teachers. They also benefited from the policy that exempted them from learning another language. In Singapore, apart from English Language, all students must learn a second language. The latter, termed their Mother Tongue Language (MTL), is determined largely by the child's ethnicity. For example, children of Chinese race are likely to study Chinese Language as their Mother Tongue. This study found that three of the four participants were exempted from learning MTL because their parents had requested it on account of their child's dyslexia. Because of this, the participants had one fewer subject to study.

Consequently, they enjoyed less homework than their classmates and at least one free hour which was the allocated slot on their timetable for MTL. On a normal school day, the participants would still be physically present in class and so their hours in school were just as long. However, because they were at home, the participants could sometimes get on with other assigned work and so finish earlier. In all, the parents reflected that HBL was a bonus for the children because the hours were shorter and the pace was less punishing. Even for Tia who said that this was "needlessly stressful" year because of the looming national exams, her mother noted:

> *I see her smiling, taking time, going outside socialising with her brothers, even playing Monopoly. Yesterday I saw her sitting down playing Monopoly, I was like Tia, you're joining them? Usually she'll be cooped up in her room, she'll be doing her stuff, because you know rush. But yesterday she had time to be out. I said so good. She spending more time with the boys, which is very good for me. For me, there's always the pros and cons. For me, the pros is that I can see the kids relaxed, not as stressed out, have more time to breathe.*

Arun's mother concurred that her child was often "wiped out" after a long day at school. In contrast, the pace was more comfortable during HBL. He seemed to be able to cope better, resulting in him feeling that he "suddenly know the answers to everything". His mum reported that even his teachers were pleased with his progress.

One contributing factor to such long hours was the other commitments after school, notably extra classes at DAS or tuition centres in one or more school subjects. Lee and

Tia's weekends also included enrichment or religious classes. So ironically, the participants' experience of HBL was enhanced by the suspension of these other activities due to social distancing measures.

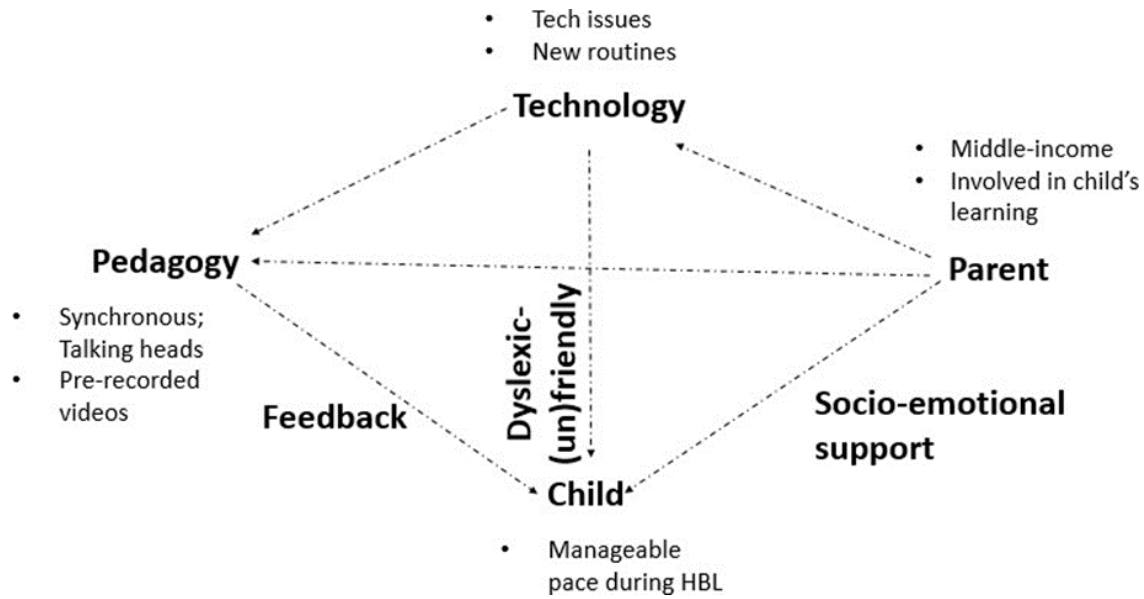

Figure 3. Summary of Findings

SUMMARY

The findings suggest that generally the participants in this study found HBL to be a positive experience. However, it was not due to how learning was enhanced by technology or the pedagogy used during HBL. In fact, all four participants preferred to be back in school because they missed the interaction with the teacher to clarify when in doubt. Instead, it appeared that they enjoyed HBL because of their supportive home background and the larger context of a less demanding workload. These factors and themes are summarised in Figure 3.

However, one hastens to note that these findings are in the context of participants who enjoy a middle-income background with extra classes outside of school. Their parents hold professional jobs (e.g., engineers) and their mothers are very much involved in their children's learning.

DISCUSSION

The study was set in an unprecedented month-long lock-down when schools were closed. Nevertheless, students continued to attend lessons in a distance e-learning mode, termed

locally as Home-Based Learning (HBL). This study aimed to investigate the experiences of dyslexic learners during HBL. The qualitative findings from interviewing both the learners and their mothers, as well as examining artefacts, revealed several key factors that will enhance the learning of such students: dyslexic-friendly use of technology, feedback-focused pedagogy and socio-emotional support. The following section will discuss each of these in detail, along with the attendant implications and recommendations.

Dyslexic-(un)friendly Use of Technology

Much has been said that our young are all digital natives who take easily to the use of technology (Prensky, 2001). This seems to be supported by the observations of the participants in this study. There were initial teething problems due to navigating the new routines involving the use of technology. However, they were more inconveniences than hurdles.

What proved to be more inhibiting was the typing required. The keyboarding skills expected added another hurdle on top of the difficulties dyslexics experience when expressing their thoughts in writing. It appears that one key intervention for dyslexic learners is to learn key-boarding skills (Beers, Berninger, Mickail, & Abbott, 2018). Herbert et al., (2018) also emphasised that using word processors would only be effective for dyslexic students if they had experience in keyboarding, otherwise it would greatly underestimate their writing skills. Alternatively, other technological affordances such as text-to-speech or audio submissions instead of text should be made more prevalent.

In the meantime, teachers should be more aware of the extra cognitive load placed on dyslexics with the current practices. There may be intangible barriers limiting rich communication, participation and optimum engagement (Lee, Song & Hong, 2019). Activities and tasks conducted in both synchronous and asynchronous modes of learning are mostly reading, writing and typing and rely quite heavily on memory, self-organisation and automatisation skills. Thus, it would seem likely that some learners with dyslexia will have particular difficulties and will be disadvantaged to some extent. Unlike traditional classroom settings, synchronous environments may require students to toggle between browsers, windows and applications while focusing on texts presented, listening to explanation and instructions and typing responses almost simultaneously. These activities tend to exert additional cognitive load on learners with dyslexia who are already struggling with phonological processing difficulties, short term memory and retrieval skills. This can result in their integration processes being less efficient, often demonstrated in their much slower or delayed response, difficulties keeping pace with the rest of their classmates and understanding content taught. Having to process information coming from the various modalities and competing structures may impose additional pressures on their short-term memory, sequencing and organisation, which explains why they often have to spend many more hours in their own time, going through

notes and asking their teachers questions repeatedly (Beacham & Alty, 2006; Snowling, 2000; Woodfine et al., 2006). Frustrations may be further compounded with few opportunities to ask questions, clarify and seek help.

Apart from the above, something as innocuous as text fonts or colour or line spacing could also exacerbate the dyslexic's difficulty with visual processing (Rainger, 2003). It has also been reported that presentations containing text and diagrams may result in little retention of visual-verbal and non-verbal information due to pre-existing phonological processing difficulties and the potential for experiencing a split-attention effect (Sweller, van Merrienboer, & Paas, 1998). Ayres and Cierniak (2012) recommended that instructional designs should attempt to present information from two different sources (e.g. text and diagram) in an integrated manner to maximise retention and learning. This can be done, for example, by embedding written instructions within a diagram instead of presenting them separately or inserting audio text in a targeted picture.

Other dyslexia-friendly accommodations that teachers can make to instructional presentation and lesson delivery to help learners navigate online materials with much less frustration, would be to use a consistent and predictable screen layout with an uncluttered appearance. There should not be too many pictures or diagrams on the same page. Instead, teachers can put items in bullet points, number them in order or place important items in boxes. Should continuous prose be presented, it is highly recommended that an estimation of a finger spacing in between words and lines be provided and clear headings in between paragraphs be provided. O'Hanlon (2005) reported that learners who read passages with titles and headings were able to recall approximately twice as many items and had higher levels of comprehension than a control group which was given the same text but without any titles and headings.

In short, teachers should be encouraged to intentionally design online experiences that will not put dyslexics at a disadvantage (e.g. synchronous interactions). At the very least, our practices should do no harm.

FEEDBACK-FOCUSSED PEDAGOGY

Technology has sometimes been portrayed as a game changer for education (OECD, n.d.). Fullan and Langworthy (2014) also argue that technology can result in "deep learning". However, the claim is with the caveat that the technology is used with sound pedagogy.

This study suggests that one area teachers could have used technology more efficaciously is in supporting the feedback dialogue. We now know how important feedback is to improve learning (Hattie & Timperley, 2007; William, 2018). This is even

more important in the context of distance e-learning with the spatial or even temporal gap separating the teacher and learner.

While dialogic feedback may be conducted on synchronous modes of instruction, the same cannot be said of the asynchronous mode. Asynchronous modes are heavily dependent on students' self-monitoring skills as they are frequently required to do self-checking of completed tasks. For some activities such as Multiple-Choice Questions (MCQ), students would submit their completed work and receive an automated response. However, no explanation would be given for incorrect answers. Students will need to seek clarification from their teachers separately via email or text messages if they want to understand more. Unless teachers check their emails or messages frequently, students do not usually get an immediate response. For students with dyslexia lacking self-monitoring and organisation skills who do not independently make it a habit to seek, clarify and follow up with their teachers or peers, the gaps in understanding will widen if left unresolved.

Feedback that is effective in supporting and enhancing students' learning takes place in the form of a dialogic engagement between teachers and students (Tan & Wong, 2018). Dialogic engagement entails both learner and teacher actively interacting and communicating to reconcile and clarify differences. Hattie and Timperley (2007) recommended embedding feedback in the teaching and learning process, such as the teaching of specific learning strategies, to facilitate transfer of knowledge from working memory to long-term memory, for more efficient retrieval in future. This could be made available in synchronous modes but would pose a challenge if instructional sessions on the synchronous mode are held for classes with more than ten students. Feedback may not be specific and targeted to close the individual student's learning gaps or resolve errors or misconceptions. Owing to their cognitive processing differences, one-size-fits- all instructional pedagogy commonly practiced in synchronous online lessons may result in them spending more time and effort struggling to learn and significantly less knowledge retention than they currently experience using conventional approaches (Zeglen & Rosendale, 2018; Beacham & Alty, 2006). Although there are generally two teachers assigned to a class (Home teachers), there are only about two or three SEN teachers (termed as Allied Educators) supporting such students in the whole school. Home class teachers may not be trained to cater to the specific learning needs of these students.

To be fair, the sudden transition from physical classroom to online learning as a result of the Covid-19 pandemic left very little room and time for teachers to plan, prepare and adjust content and materials to suit the online platform. This could probably explain why pedagogy seemed to have remained status quo with teachers downloading information as they would in a live classroom setting. Apart from quick dip-stick self-assess quizzes using multiple choice questions, it did not appear that feedback featured very highly in the lesson interaction. In the HBL context, dialogic feedback had to be necessarily mediated by technology. One possible alternative is for teachers to hold and facilitate

separate, small group meetings on the synchronous platform where students can be given ample, uninterrupted time, attention and opportunity to ask questions and clarify and for teachers to share specific correctional and monitoring strategies tailored to individual students' needs. As this did not happen then, it was therefore a missed opportunity to harness technology to give more focused feedback especially for struggling learners including the dyslexics. Both schools and policy makers should study how this can be addressed in future episodes of HBL.

SOCIO-EMOTIONAL SUPPORT

It was clear that the family support mediated the children's experience of HBL. Research investigating effective online instruction has identified collaborative learning and strong instructor presence as key factors (Dixson, 2010). In distance e-learning, the absence of teachers, instructors or schoolmates with whom students may want to communicate with or seek clarification from could possibly trigger feelings of vulnerability over gaps in understanding they may not be able to address immediately. Feelings of isolation may intensify that could possibly lead to reduced self-efficacy and motivation. In the physical absence of teachers, the participants in this study were fortunate to have had their parents as alternative sources of support, guidance, assurance and affirmation - from explaining less understood concepts to helping with teacher communication and submitting completed assignments. Perhaps teachers could further support these students and their families by providing guidance and recommending suitable tools and applications that can help them better utilise online platforms to their advantage.

LIMITATION AND FUTURE RESEARCH

As indicated in the earlier section, the participants of this study came from generally comfortable family backgrounds. They were able to afford classes at DAS, even without financial support in two cases. The parents were supportive and encouraging. Hence, it is harder to extrapolate the findings to other contexts, particularly with children who are less well-off. It is tempting to infer that the latter would have a less positive experience of HBL. However, whether this is a valid inference remains unclear without another study focusing on this other student group. Such a study will uncover the impact of HBL and perhaps other contributing factors that hinder their learning. It will be an important input for policy-makers who may be contemplating more extensive use of distance e-learning. Singapore, for example, has already decided that HBL will become a regular part of student life (Ang, 2020).

In particular, they should be sensitive to the different levels of parent or caregiver efficacy in how they are managing the family's financial situation, nucleus, work arrangements and involvement patterns concerning academic support for their children (e.g., extra lessons at DAS). These factors would potentially impact students' access to learning, motivation and engagement differently. For example, students whose parents

have financial constraints may not be able to afford the technological access. The same goes with large families having more than three or four school-going children requiring separate devices and Internet connectivity to access HBL should they have to do so at the same time. Unlike non-working parents, those who are working from home are also juggling multiple responsibilities and roles to manage their day-to-day affairs, including that of their children's educational needs. Outcomes would conceivably differ for parents with little efficacy to provide the necessary technological, literacy and academic support for their children with dyslexia and possibly other specific learning needs. Such situations would certainly necessitate a collaborative and co-ordinated system of support involving both school and social agencies.

CONCLUSION

In our efforts to provide greater accessibility and promote inclusivity for all in both conventional and online education, there is a need to look into whether students who face challenges in traditional classes (including those with dyslexia) will struggle even more in the online learning environment, and if so, what reasonable adjustments can possibly be made?

The present study highlights two possibilities: dyslexic-friendly use of technology and feedback-focused pedagogy. In addition, socio-emotional support is also important; if not provided for by the family, then by the school context. It is worth noting that these accommodations do not disadvantage non-dyslexics either. Indeed, these supports offer benefits to others as well, with "access for everyone" (O' Hanlon, 2005; McCarthy et al., p. 151), thus providing all students the best opportunities to succeed in this new normal of distance e-learning.

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APPENDIX A

Semi-structured Interview Schedule (Students)

Research Question:

"In what ways does distance e-learning help or hinder the dyslexic student".

I. Introduction

- The focus of this interview is your experience of Home-Based Learning. The purpose is to help me understand what usually happens in HBL. Then I will write a report so that others can understand how to design better HBL.
- It is not part of your assessment and what you say will be kept confidential and not be communicated to your classmates or teacher. When I write up about this study, nobody will be identified by his/her real name.
- You can stop the interview anytime.

II. Your school / HBL experience

a. Tell me a little about lessons in school. What do you like most / least.
b. Tell me about HBL. Do you enjoy them? Why / why not?

III. Your ideas on good HBL experience

a. Let us now discuss one HBL which you liked. What did you like about it?
b. How does HBL at DAS compare with the HBL from schools? Which do you prefer and why?
c. How same / different is HBL lessons across different subjects?
d. Do you prefer the use of e-learning? Or hardcopies (e.g. textbooks, printed worksheets)? Or classes at school? Explain your choice.
e. What can teachers do in HBL that will really help you?

IV. Any other information

Please feel free to tell us anything else important about HBL that we have missed out on.

Thank you for your time.

APPENDIX B

Semi-structured Interview Schedule (Parents)

Research Question:

"In what ways does distance e-learning help or hinder your child with dyslexia?"

I. Introduction

a. This interview should last approximately 45-60 minutes.
b. The focus of this interview is the home-based learning (HBL) experienced by your child. The purpose is to help me understand what has helped or hindered learning.
c. Any information you give will be kept anonymous and you will be assigned a pseudonym. The recording we are making will be used for transcription purposes and it will not be heard or played back for anyone not directly involved in the research.

II. Background

a. Tell me a little about your child (name of child with dyslexia).
b. How is your child's experience of school in general?

III. Child's HBL experience

a. What have you noticed of your child during the HBL period? More stress? Happier? Why?
b. Which were the HBL lessons / approaches that were more effective for your child? Why?
c. (We will also discuss some points raised by your child during his/her interview for your input).

IV. Closing

Any information that you feel that we should know about HBL but was not raised earlier?

Thank you for your time.

Asia Pacific Journal of Developmental Differences
Vol. 8, No. 2, July 2021, pp. 218—236
DOI: 10.3850/S234573412100009X

Factors influencing well-being and parenting self-efficacy of parents of children with special needs and the developmental outcomes of their children

Angela F. Y. Siu[1*] & Anna N. N. Hui[2]

1. *Chinese University of Hong Kong*
2. *City University of Hong Kong*

Abstract

Child characteristics and family demographics are important factors influencing the degree of parental well-being and parenting self-efficacy. Parents of children with special needs have reported more parental stress, depression, health problems, and poor parenting self-efficacy compared with parents of typically developing children. However, limited research has provided an overview of the effects of family demographics and child characteristics on parents' well-being and parenting self-efficacy in Asian countries. This quantitative study examined the effects of children's disabilities types and family demographics with well-being and parenting self-efficacy of parents (N = 420) of children with special needs aged ranged from 2.83 to 7.17. Family income, parental education level, work status, and parental age were found to be effective demographic variables predicting the well-being and parenting self-efficacy of parents of children with disabilities. Limitations and future research directions are presented.

Keywords: children with special needs, parents, well-being, parenting self-efficacy

* *Correspondence to:*
Angela Siu, Associate Professor, Department of Educational Psychology, The Chinese University of Hong Kong,
Email: afysiu@cuhk.edu.hk.

INTRODUCTION

Raising children with special needs can be challenging for parents. Past research has revealed that parents of children with special needs experience greater stress than parents of typically developing children (Ritzema & Sladeczek, 2011; Weiss, 2002; Yoong & Koritsas, 2012), due to the higher demands on both the physical and emotional capacities of the caregiver, as well as the material resources of the family (Cavanagh & Ashman, 1985; Doig et al., 2009;). As the parents must adapt to their extended caregiving role to maintain their children's health and the functioning of the family, they often experience higher levels of stress and parenting burden (Brown et al., 2020; Negash et al., 2015; Seltzer et al., 2004;). Since parents have been shown to play a vital role in influencing the developmental outcomes of children with special needs (Van Hooste & Maes, 2003), investigating the factors contributing to developmental differences among children with disabilities can help families and childcare practitioners better understand how they can optimize the developmental potential of children with special needs.

LITERATURE REVIEW

Abidin (1995) discussed two sources of parenting stress (or two categories of stressors): child-related stress and parent-related stress. "Child-related stress" involves child behaviors and characteristics that make parenting difficult and contribute to parenting stress, while "parent-related stress" is related to the characteristics and experiences of the parents that contribute to parenting stress but do not directly involve the child, such as parental competence or the spousal relationship.

Parenting Stress in Parents of Children With Special Needs

Empirical studies have examined the potential causal factors of parenting stress among parents of children with special needs. The behavioral problems of these children can be an important factor leading to increased parenting stress. Parents experience unique challenges in managing the characteristics of their children with autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD). Children with ASD usually share common features of having impaired social skills and ritualistic behaviors (Di Renzo et al., 2017; Szumski et al., 2019). Parents must manage their children's problematic behaviors in public situations to avoid misunderstandings and misinterpretations among the general public (Estes et al., 2009; Valicenti-McDermott et al., 2015). In addition, parents of children with ADHD have reported high levels of stress when dealing with their children's symptoms of inattention, hyperactivity, and impulsivity (Theule et al., 2013), especially those closely attached to or perceiving themselves as the primary caregiver of their children (Baker, 1994). As children with special needs are often unable to properly adjust and adapt to environmental changes, parents are in the very stressful position of caring for and protecting them (DeLambo et al., 2011).

Although the characteristics of children with special needs contribute to increased parenting stress, such stress is also affected by the perceived parental functioning of their parents. With a child with special needs, the parents need to take care of the child's special needs, in addition to their daily needs (Dabrowska & Pisula, 2010). Parents must work hard to learn how to manage their child's unique conditions, make appropriate medical decisions, and advocate for their needs in the healthcare system and at school (Churchill et al., 2010). In addition, they bear the financial burden of their children's medical care and the time required for appointments with the healthcare services (Theule et al., 2013). This intensified caregiving role increases the parenting stress among parents of children with special needs.

From a broader perspective, society exerts stress on people with special needs and their family members. Milton and Sims (2016) found that those with special needs have been categorized as societal othering and excluded by their schoolmates, colleagues and even relatives. In contemporary Hong Kong, as revealed in Holroyd's ethnographic study (2003), children with special needs have been seen as disordered, and both the children and their parents were marginalized and isolated. Mothers of these children were also stigmatized and blamed, attributing their children's disability to the misfortune of women and their families (Holroyd, 2003; Kwok et al., 2014).This is a possible source of stress from society on bringing up a child with special needs for parents. Thus, these parents are more likely to experience both child-related and parent-related stress, compared to parents with typically developing children (Abidin, 1995).

Well-Being and Parenting Self-Efficacy Among Parents of Children With Special Needs

As mentioned previously, the increased parenting stress experienced by parents of children with special needs is due to their adjustment to the extra obligation in taking care of their children. Previous studies have revealed an increased risk of psychological distress and depression among parents of children with special needs. These parents, especially mothers, often have to give up their jobs and their personal interests to become the primary caregiver of their children's special needs (Olsson & Hwang, 2001). Parents have also reported facing severe financial constraints to meet the needs of their children's medical care, negatively affecting their psychological health (Seltzer et al., 2001). Furthermore, Ryan and Runswick-Cole (2008) described that parents of children with special needs were in a liminal position in which they experienced a sense of disability even they were not disabled. These parents have shared experiences of discriminatory practices and being stigmatized with their children in their child rearing, such as schooling, parenting and daily living.

Many studies have examined the psychological well-being of parents of children with special needs (Baker et al., 2003; Hauser-Cram et al., 2001; Olsson & Hwang, 2001), but little is known about their physical health. Longitudinal studies have been conducted to investigate the differences in psychological and physical health between parents of

children with special needs and parents of typically developing children (Eisenhower et al., 2009; Eisenhower et al., 2013). Parents of children with special needs have shown significantly poorer psychological and physical health over time compared with parents of typical developing children. According to the neurobiological model, chronic stress and a depressed mood can suppress the neuroendocrine stress response system, which regulates the functioning of the human immune system (Herbert & Cohen, 1993; McEwen, 2000). The prolonged psychological stress of parents of children with special needs has been linked to various health problems, including poor sleep quality and increased mortality (Gallagher et al., 2010; Martin et al., 1995; Murphy et al., 2007).

In addition to poor psychological and physical health, parents of children with special needs have been found to have a lower level of parenting self-efficacy (Hoza et al., 2000; Rogers et al., 2009). Parenting self-efficacy is defined as parents' subjective belief in their ability to perform their parenting role (Coleman & Karraker, 2003; Hess et al., 2004). Parents of children with special needs face unique challenges in managing their children's special symptoms and behavioral problems. For example, it has been revealed that parents of children with ADHD often attribute their children's inattentive and impulsive behaviors to internal causes, leading the parents to perceive themselves as less able to deal with their children's problems (Johnston & Freeman, 1997). Importantly, low parenting self-efficacy can have negative effects on the long-term development of their children. The level of parenting self-efficacy has been found to affect parents' effective participation in the medical treatment of their children (Hoza et al., 2000). Parents with lower self-efficacy also tend to feel less competent in helping their children adapt to the school environment and pursue academic achievement (Rogers et al., 2009).

Effects of Family Demographics on Well-Being among Parents of Children With Special Needs

Although many studies have examined the effects of children's special needs (children with and without developmental problems) on parental psychological and physical well-being, more evidence is needed regarding other possible risk and protective factors influencing the well-being of parents with children with special needs. For instance, the effects of family demographics (including family income, parental education level, parental age, and employment status) on parents' psychological and physical well-being remain inconclusive.

Regarding the relationship of family income and availability of support services with the health of parents of children with special needs, Dyson (1991) reported that the financial advantages of families did not reduce their parenting stress. However, other studies have shown that parents from low-income families have lower levels of well-being because of their concerns about lacking money and resources to support effective intervention for their children with special needs (Churchill et al., 2010; Smith et al., 2001;). With lower levels of education, parents of children with special needs have reported higher time

demands and caregiving burden, leading to poor psychological well-being (Haveman et al., 1997). Nevertheless, parents' education level has not been shown to affect the psychological health of parents of children with special needs (Churchill et al., 2010). Older parents of children with special needs (aged 40 or older) have been shown to have worse psychological health because of intense anxiety about their ability to provide appropriate care for their children with special needs later in life (Collins-Moore, 1984), but they have reported lower parenting stress because of their higher social status, enabling them to utilize community resources to help their children (DeLambo et al., 2011). In terms of parental employment status, increased depressive symptoms have been observed among unemployed parents of children with special needs due to the lack of sufficient financial resources for their children's prolonged medical treatment. However, no significant difference in the psychological health of parents with children with special needs has been found in relation to parental occupational status (Smith et al., 2001). Therefore, the effects of demographic variables on the general well-being of parents with children with special needs remain unclear.

Effects of Family Factors on the Development of Children With Special Needs

Family factors, including parenting styles, parental attitudes and expectations about child performance, and marital relationships, have been suggested to affect the development of children with special needs (Van Hooste & Maes, 2003). Parents who have sensitive, directive, and elaborative responses to their children with special needs can effectively create a conducive and stimulating environment for positive development of their children, whereas parents who exhibit inconsistent and hostile behaviors toward their children can increase the frequency of problematic behaviors in their children (Aunos et al., 2008). In addition, parents with children with special needs tend to have low expectations for academic achievement and social attainment, while children's inability to have good academic performance further lowers parents' expectations (Boersma & Chapman, 1982).

According to the studies related to family conflict (e.g., Amato & Keith, 1991; Cummings et al., 2003; Negrino, 2020), marital stress and conflict can also negatively affect children's development. Children are expected to experience unhappiness, distress, and insecurity when facing parental hostility. Poor marital relationships create an undesirable home environment for the development of children and adversely affect their psychological adjustment. In addition to affecting children's developmental outcomes, parents suffer from increased stress when arguing with their spouse, which reduces their effectiveness in managing parenting tasks. A high level of marital conflict has also been associated with more behavioral problems among children with disabilities (Vrijmoeth et al., 2012). Under marital stress and conflict, parents are often less able to take care of their children's developmental needs and manage their behavioral problems. Furthermore, from the lens of a strength-based approach, parents are capable of promoting children's development and well-being with their own strength and resources, while the cooperation and

collaboration of both parents are necessary for cultivating a supportive family environment for children (Ma & Lai, 2014). Children with special needs, specifically need more help and care from their parents or caregivers than typically developing children, because of their developmental problems (Brandon, 2007; Ryan & Runswick-Cole, 2008). Therefore, family factors can contribute to the developmental outcomes of children with special needs in a range of ways.

OBJECTIVES OF THIS STUDY

Few empirical studies of the effects of children's special needs and family demographics on the well-being and parenting self-efficacy of parents of special needs children have been conducted in Asian countries (DeLambo et al., 2011; Eisenhower et al., 2013; Valicenti-McDermott et al., 2015). This study aimed to examine how different types of disability in children affect the general well-being and parenting self-efficacy of their parents. The inconsistent relationship between family demographic variables and the well-being and parenting self-efficacy of parents of children with special needs also prompted an examination of its possible effects.

The current study investigated the well-being and parenting self-efficacy of parents with children with special needs based on the effects of family demographics (age of parents, family income, parental education level, and employment status) and different types of special needs among children. Ethical approval from the University was received by the researchers prior to data collection.

METHOD

Participants

Four hundred and twenty parents or primary caregivers of children with special needs from a larger study of the early childhood intervention program supported by the Hong Kong government were recruited by convenience sampling. With the support of service providers of the intervention programme, they were invited to complete a self-report questionnaire on a voluntary basis. The age of the participants ranged from 21 to 65, and the majority were the parents of the children (81.5% were mothers and 17.1% were fathers), and the rest were caregivers, such as grandparents. Most of them were a homeworker without a full-time job (45.5%) and married (91.5%). Their monthly family incomes were between HK$10,001 and HK$20,000 (28.7%), between HK$20,001 to 30,000 (20.3%), and between HK$30,001 to 50,000 (22.1%). According to statistics by the Hong Kong government, the average monthly family income was HK26,500 in the year that the questionnaires were administered (Census and Statistics Department, 2018).

The age of children of the parents recruited ranged between 2.83 and 7.17, and the mean age was 5.14 years old. A breakdown of children's disability types in percentage was listed in Table 1.

Table 1. Types of Disabilities of the Children of the Recruited Parents

TYPES OF DISABILITIES	PERCENTAGES
Mental Handicap	2.8
Physical Impairment	0.3
Cerebral Palsy	0.3
Visual Impairment	0.3
Hearing Impairment	0.3
Autistic Spectrum Disorder	34.0
Speech Impairment	55.0
Global Developmental Delay	13.3
Attention Deficit Hyperactivity Disorder	4.3
Fine Motor Delay	5.0
Gross Motor Delay	3.5

There are parents missing a number of questions in certain subscales, thus turning into missing data. The missing data was cleaned during the data analysis process.

Instruments

Parenting Self-Efficacy Questionnaire

Maternal Self-efficacy Questionnaire (MEQ; Teti & Gelfand, 1991), a 10-item self-report scale, was adopted to assess parents' ability to take care of their children, such as the ability to cope with their children's emotions and their performance in daily routine tasks. The MEQ has been also used for assessing both fathers' and mothers' self-efficacy in other study with a good reliability (Leekes & Burne, 2007). Questions such as *"When my child gets mad or cries, I can comfort him/her"* and *"I can do well in childcare duties (e.g. feeding, bathing, etc.)"* were used in the study and were scored on a 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). Adding the item scores generated a maternal self-efficacy score, ranging from 10 to 50. Higher MEQ scores indicated a higher level of parenting self-efficacy. The Cronbach's alpha (α) value for the MEQ was .80.

Early Intervention Parenting Self-efficacy Scale (EIPSES)

The 16-item EIPSES (Guimond et al., 2008) was used to (a) assess the degree to which caregivers perceive themselves as personally effective and capable of parenting their children, with questions such as "When my child shows improvement, it is because I am able to make a difference in my child's development;" and (b) measure the extent to which they believe that their children's outcomes are influenced by environmental factors or constraints (family background and availability of early intervention or community support), with questions such as "Children will make the most progress if their early interventionists work with them rather than if the parents work with the children." Items were scored on a 7-point Likert scale, ranging from 1 (Strongly disagree) to 7 (Strongly agree). The total scores ranging from 16 to 112 were computed by summing all items of the scale. Higher scores reflected greater perceived self-efficacy. The Cronbach's alpha (α) value for the EIPSES was .80.

Parental Stress Scale (PSS)

The PSS (Berry & Jones, 1995; Cheung, 2000) comprises 18 items to assess parents' perceived stress level by asking them to evaluate their feelings and thoughts based on different life situations when taking care of their children. Questions such as *"Caring for my child sometimes takes more time and energy than I have to give"* and *"I enjoy spending time with my child"* were used in the study. Items were scored on a 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). A composite score was obtained by summing all items, yielding a possible score range of 18 to 90. Higher PSS scores indicated higher levels of stress among the respondents. The Cronbach's alpha (α) value for the PSS was .89.

Aggravation in Parenting Scale (APS)

The APS (Abidin, 1995) is a 9-item self-report scale evaluating parenting effectiveness. It includes measuring the frequency in the past month that the parent felt that it was much more difficult to take care of the child than usual, the child did things that really bothered the parent, the parent was angry with the child, and the parent felt that he/she was giving up more of his/her life for the child's needs. Questions such as "I find myself giving up more of my life to meet my child's needs than I ever expected" and "I feel trapped by my responsibilities as a parent" were used in the study and were scored on a 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). Summing the items and dividing the score by the total number of items generated a total score ranging from 9 to 45. Higher scores indicated higher aggravation in parenting. The Cronbach's alpha (α) value for the APS was .69.

General Health Questionnaire (GHQ)

This 4-item self-report scale from the GHQ (Chan, 1993; Goldberg, 1978) measured individuals' current physical and psychological well-being by assessing their sleep patterns, level of distress, social dysfunction, among others. Questions such as "I am weaker and sicker compared with six months ago" and "My child changes my sleep patterns" were used in the study. Items were scored on a 5-point Likert scale, ranging from 1 (Strongly disagree) to 5 (Strongly agree). Summing the scores of the four items generated a general health score ranging from 4 to 20. Higher scores indicated higher individual distress and poor overall health. The Cronbach's alpha (α) value for the GHQ was .82.

Data analysis

To examine the effects of children's disability types and family demographics on the well-being and parenting self-efficacy of parents of children with special needs, independent samples t-tests were performed to compare different groups of parents based on each child's disability type (for example, group comparison between children with ASD and non-ASD children, children with ADHD and non-ADHD children, children with speech delay and children with normal speech development) and demographic variables (group comparison between family monthly income below HK$30,000 and above HK$30,001, parental education level below high school and above tertiary education, parent as a homemaker and as a working adult, and parents aged below 38 and above 38). The mode of the family monthly income of the participants was "HK$20001 to $30000", the upper line HKD$30000 was therefore selected as the marker.

RESULTS

The Effect of Child's Disability Type on the Well-Being and Parenting Self-Efficacy of Parents of Children With Special Needs

Based on the results of the independent samples t-test, parents of children with speech delay, visual impairment, hearing impairment, global developmental delay, and gross motor delay had no significant difference in terms of well-being and parenting self-efficacy in childcare compared with their counterparts without this type of disability.

However, the results of the independent samples t-test showed that parents of children with ASD, ADHD had statistically significant differences in their well-being and parenting self-efficacy compared with their counterparts (See Table 2).

Table 2 Independent Sample T-test Comparing the Well-being and Parenting Self-efficacy Between Parents of Children with ASD, ADHD, and Their Counterparts

	Groups							
Variables	*N*	*M*	*SD*	*N*	*M*	*SD*	*df*	*t*
	Parents with non-ASD children			Parents with ASD children				
PSE	299	38.70	4.60	102	37.70	5.56	150	1.65
EIPSE	262	74.75	8.83	81	75.22	9.83	341	-.41
PS	300	47.90	8.58	101	50.75	9.05	399	-2.85**
AP	300	2.85	.74	102	3.03	.70	400	-2.14*
GH	303	12.15	2.75	102	12.40	2.96	403	-.79
	Parents with non-ADHD children			Parents with ADHD children				
PSE	310	38.62	5.04	91	37.87	4.25	170	1.41
EIPSE	266	75.61	9.24	77	72.29	7.95	341	2.86**
PS	311	48.19	8.74	90	50.09	8.81	399	-1.81
AP	313	2.84	.72	89	3.08	.76	400	-2.82**
GH	314	12.01	2.78	91	12.92	2.76	403	-2.77**

Note. PSE = Parenting self-efficacy; EIPSE = Early intervention parenting self-efficacy; PS = Parental stress; AP = Aggravation in parenting; GH = General health
*p < .05, **p < .01, ***p < .001.

Parents of Children with ASD and Non-ASD Children

Parents of children with ASD reported significantly higher parental stress ($t(399) = -2.85$, $p < .01$) and aggravation in parenting ($t(400) = -2.14$, $p < .05$), compared with parents of non-ASD children. This indicated that parents of children with ASD had a higher level of psychological stress when taking care of their children and perceived themselves as being highly bothered by their children compared with parents of non-ASD children. However, no significant differences were found for their general health and maternal and early intervention parenting self-efficacy.

Parents of Children with ADHD and Non-ADHD Children

Parents of children with ADHD reported significantly poorer general health ($t(403) = -2.77$, $p < .01$), lower early intervention parenting self-efficacy ($t(341) = 2.86$, $p < .01$), and higher aggravation in parenting ($t(400) = -2.82$, $p < .01$) compared with parents of non-ADHD children. The results showed that parents of children with ADHD not only developed poor physical health and were easily angry with their children, but also tended to attribute the developmental outcomes of their children to the external factors (e.g., community support, early intervention, and family background) instead of their personal abilities in taking care of their children. However, there were no significant differences in their psychological stress and maternal self-efficacy.

The effects of family demographics on parents of children with special needs

Based on the results of the independent samples t-test, family income, parental education level, employment status, and parental age had significant effects on the well-being and parenting self-efficacy of parents with special needs children (see Table 3).

Family Monthly Income

Parents with monthly income below HK$30,000 reported significantly lower early intervention parenting self-efficacy ($t(350) = -2.95$, $p < .01$) and poor general health ($t(412) = 2.39$, $p < .05$), meaning that they felt unable to provide effective care and medication to their children and had poor physical health. However, there were no significant differences for their maternal self-efficacy and psychological health.

Parental Education Level

Parents with an education level below high school reported significantly lower early intervention parenting self-efficacy compared with parents with tertiary education or above ($t(173) = -2.11$, $p < .05$). This indicated that they felt unable to provide effective parenting and medical care to their children. However, no significant differences were found for their well-being and maternal self-efficacy.

Table 3. Independent Sample T-test of the Effects of Family Demographics on the Well-being and Parenting Self-efficacy Among Parents with Children who Have Special Needs

	Groups							
Variables	*N*	*M*	*SD*	*N*	*M*	*SD*	*df*	*t*
	Parents with monthly family income below HK$30,000			Parents with monthly family income above HK$30,001				
PSE	244	38.55	5.10	166	38.45	4.60	408	.21
EIPSE	212	73.73	8.42	140	76.61	9.67	350	-2.96**
PS	243	49.26	8.58	167	47.75	9.04	408	1.71
AP	242	2.94	.74	169	2.82	.74	409	1.65
GH	245	12.51	2.73	169	11.84	2.87	412	2.39*
	Parents with high school education or below			Parents with tertiary education or above				
PSE	273	38.68	4.94	137	38.17	4.82	408	.99
EIPSE	244	74.15	8.37	108	76.51	10.23	173	-2.11*
PS	271	48.58	8.63	139	48.78	9.11	408	-.22
AP	272	2.90	.71	139	2.88	.79	409	.24
GH	275	12.30	2.75	139	12.10	2.91	412	.69
	Parents as homeworkers			Parents as working adults				
PSE	174	37.78	5.16	236	39.05	4.64	408	-2.61**
EIPSE	153	74.93	8.78	199	74.82	9.25	360	.11
PS	174	50.34	9.11	236	47.39	8.34	408	3.40**
AP	176	3.03	.77	235	2.79	.74	409	3.38**
GH	176	12.74	2.84	238	11.86	2.72	412	3.18**
	Parents aged below 38			Parents aged above 38				
PSE	213	39.02	4.81	197	37.95	4.95	408	2.23*
EIPSE	184	75.62	8.49	168	74.05	9.55	350	1.63
PS	212	48.31	7.80	198	49.01	9.74	377	-.80
AP	215	2.86	.68	196	2.93	.80	409	-.88
GH	215	12.16	2.77	199	12.32	2.85	412	-.57

Note. PSE = Parenting self-efficacy; EIPSE = Early intervention parenting self-efficacy; PS = Parental stress; AP = Aggravation in parenting; GH = General health *$p < .05$, **$p < .01$, ***$p < .001$.

Parents' Employment Status

Parents who were homeworkers reported significantly higher parental stress ($t(408) = 3.40$, $p < .01$), higher aggravation in parenting ($t(409) = 3.38$, $p < .01$), lower maternal self-efficacy ($t(408) = -2.61$, $p < .01$), and poorer general health ($t(412) = 3.18$, $p < .01$). Homeworkers tend more to be irritated when parenting their children with special needs, perceive themselves as ineffective in performing daily tasks, and have poor physical and psychological health compared with working parents. However, no difference was found for their early intervention parenting self-efficacy.

Age of Parents

Parents younger than 38 reported significantly higher maternal self-efficacy compared with parents over 38 ($t(408) = 2.23$, $p < .05$). This indicated that parents under the age of 38 had more self-confidence in taking care of their children with special needs. However, no significant differences were found for their health and early intervention parenting self-efficacy.

DISCUSSION

Effects of Children's Disability Types

The quantitative results revealed that the well-being of parents of children with ASD and ADHD was generally poorer compared with parents of children with other types of special needs, and they appeared to be more stressed when parenting their children. Children with ADHD and ASD had problematic and maladaptive behaviors, with high impulsivity and low social skills to adapt to environmental changes, and usually required extensive care. Parents' management of their children's behaviors could lead to a high level of parenting stress or psychological distress (Estes et al., 2009; Valicenti-McDermott et al., 2015). However, such explicit behavioral problems of children have not been accepted and are regarded as the consequences of incapable or poor parents by the public, which is a kind of stigma from the community as perceived by the parents (Kwok et al., 2014). This experience probably leads a great level of stress in child rearing for them.

Effects of Family Demographics

Most parents, especially the mothers who were the primary caregivers of their children, were unable to work, even part-time. Raising children with special needs is more demanding than those without special needs. Although there are various rehabilitation services for children with special needs in Hong Kong, parents still have additional responsibilities related to their children's disabilities, such as medical checkups, visiting to school teachers and therapists. Brandon (2007) found that parents even need to sacrifice

their own time for personal care and leisure to take care of children with special needs. Thus, two parents in a family may not be available and cannot afford to enter the labour force concurrently, resulting in lowering their family income. In fact, the financial burden on the family increased parental stress because of their perceived inability to meet the needs of their children with special needs (Scherer et al., 2019). This is consistent with the quantitative findings that parents of children with special needs having lower monthly family income are at higher risk of poor health than those parents with higher monthly family income.

The quantitative results also identified another risk factor leading to poor physical and psychological health of parents with children with special needs. Homemakers tended to have higher parental stress and poor general health than working parents. Indeed, homemakers are expected to assume greater responsibility for child rearing and family management than their working spouses (Hastings, 2003). Especially for parents of children with ASD and ADHD who were homemakers, their prolonged care of their children's behavioral problems without sufficient support from their spouses had a negative effect on their general well-being. Moreover, devoting most of their time to take care of children and family also diminished parents' social network with friends and colleagues that would normally provide support for themselves (Brandon, 2007)

To improve the well-being and parenting self-efficacy of parents of children with special needs, special attention should be paid to spouses to alleviate the heavy childcare responsibility of parents and maintain the family functioning of children with disabilities. As the study identified some of the risk factors associated with the lower levels of well-being and parenting self-efficacy of parents of special needs children, more support should be provided to vulnerable parent groups with low family income, low educational level, and being unemployed. By providing social support and community resources, including the creation of district-based parent resource centers, child intervention and family services provided by individual social welfare agencies, child management skills and close interdisciplinary collaboration with schools, families should be able to improve parents' ability to perform childcare tasks, in turn support children's development.

LIMITATIONS

In the current study, the effects of demographic variables on the well-being and parenting self-efficacy of parents of children with different types of special needs were different from previous studies. Future research should focus on the effects of demographic variables on parents of children with special needs in Asian countries to obtain information from parents about other factors contributing to their good health and parenting self-efficacy. Moreover, this is only a quantitative-based study overviewing the factors influencing parents of children with special needs. In future research, interviewing the parents to acquire a more comprehensive understanding of their parenting practices and the challenges encountered in bringing up children with special needs can further

benefit the investigation of their well-being and parenting self-efficacy, providing a qualitative basis for the current findings.

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ACKNOWLEDGEMENT

The study was part of a governmental project in the early childhood intervention supported by Lotteries Fund (Social Welfare Department, HKSAR)

The authors would like to thank all the children, parents, teachers, professionals and researchers who participated in the study. Our gratitude also goes to the investigators: Elaine Au, Hui-fang Chen, Wu-ying Hsieh, Man-tak Leung, and Sam Ye.

Asia Pacific Journal of Developmental Differences
Vol. 8, No. 2, July 2021, pp. 238—249
DOI: 10.3850/S2345734121000103

Evaluating the longitudinal progress of a large sample of dyslexic children in reading, spelling and writing.

Sharyfah Nur Fitriya [1*]

1. *Dyslexia Association of Singapore*

ABSTRACT

The purpose of this research was to demonstrate whether the reading and writing skills of dyslexic students in the English Main Literacy intervention programme in Singapore could be improved in a statistically significant manner using improved curriculum teaching methods. A statistically significant result would validate the improvement in the transfer of knowledge to the students due to the educational intervention. This study evaluated the progress made from 1343 students aged 7-17 enrolled in the English Main Literacy intervention programme for six school terms from 2016 to 2018. All participants were assessed using a Curriculum-Based Assessment (CBA), which focuses on three test items: words to read, words to spell, and writing tests. The test items were analysed using the Central Limit Theorem (CLT) and hypothesis testing. Test scores were analysed comparing means across three years, with a Z-score calculated to determine the findings' statistical significance. The mean scores of the students increased from an average mean of 48.54 in 2016 to 62.43. The calculated Z score of 1.65 yielded a probability of $p<.05$, with a probability level of 95%. Therefore, the Z score did indicate a significant improvement. This supported the research hypothesis that the literacy program demonstrates a statistically significant improvement in reading and writing scores in a population of dyslexic students. The findings from this research show that the English Main Literacy intervention programme is an evidence-based practice, and the results increase the validity of the intervention.

Keywords: assessment, statistical significance, dyslexia, Central Limit Theorem (CLT), hypothesis testing

**Correspondence to:*
Sharyfah Nur Fitriya, Senior Educational Therapist | Dyslexia Association of Singapore Email: sharyfah@das.org.sg

INTRODUCTION

Dyslexia is identified when a person has trouble with recognising words accurately, comprehending, writing, and spelling and is a result of deficits in the phonological component of language; often related to other cognitive abilities that can cause behavioural or emotional problems (Rutter, Kim-Cohen & Maughan, 2006; Lyon et al., 2003). Characteristic features of dyslexia include difficulties with phonological awareness, verbal memory, and processing speed. With dyslexia, students may often experience co-occurring challenges in language, motor coordination, mental calculation, concentration, and personal organisation (Rose, 2009). The literacy difficulties associated with dyslexia can result in those students with dyslexia becoming less motivated (Gooch et al., 2016). This becomes more common when students begin the transition to secondary education, where literacy forms a huge component of many lessons, especially since it is assumed that these students have acquired the necessary reading skills.

At the Dyslexia Association of Singapore (DAS), students are taught the basic concepts of reading, spelling, and writing by adopting the Orton Gillingham (OG) principles of structured, sequential, multi-sensorial and phonics-based teaching (Ritchey & Goeke, 2006; Rose & Zirkel, 2007). The DAS have their integrated curriculum that is undertaken in-house to cater to students of all abilities. This study evaluates the progress made by 1343 students aged 7-17 enrolled in the English Main Literacy programme for six school terms from 2016 to 2018. All participants were assessed using a Curriculum-Based Assessment (CBA), which focuses on three test items: words to read, words to spell, and writing tests.

LITERATURE REVIEW

The study highlights that reading and writing difficulties have a significant relationship with children diagnosed with dyslexia. In the DAS English Main literacy intervention programme, assessment of transcription issues and follow-up discussions can help understand the plan's effectiveness.

Dyslexia and its impact on reading and spelling

Dyslexic students often find it hard to read, write and spell words during their education journey (Catts et al, 2012). A collaborative approach between parents and teachers helps identify the dyslexic problems in students and provides a platform for successfully implementing the English main literacy intervention programme. (Daniels & Share, 2018). Dyslexia, therefore, is a difficulty evident in children and causes challenges in reading and writing, that may be exacerbated during exposure to a noisy classroom environment (Calcus et al, 2016, 2018). Scholars further indicate that students with dyslexia are low on their reading or writing exercises, making dyslexia a deficit in phonological skills (Sümer Dodur & Altindağ Kumaş, 2020). Amongst other challenges, dyslexia hinders the reader's ability to link intense sounds and symbols together. In this case, the student with dyslexia

will struggle with phonemic stages. Reading instruction in schools primarily focuses on robust phonemic based reading methods, whereby the student must decode words (Galuschka et al., 2020). Readers, therefore, take the initiative to translate instructions systematically, going letter by letter. Decoding is the aspect that consumes much of the dyslexic student's comprehension ability, because their difficulty in processing each word impacts on their understanding. These are cognitive comprehension abilities. Spelling and reading involve different reciprocal parts of one task, which are essential since they connect letters and reading sounds.

Dyslexic students will exhibit common types of spelling difficulties which are persistent until adolescence. The dyslexic problem is evident when students are engaging in phonological processing. (Hagan-Burke et al., 2011). Therefore, when it comes to spelling unknown words, encoding, students require practice and need to apply different strategies taught by the teacher. Students also have difficulties remembering long sentences, as students with dyslexia tend to have weak working memory (Alloway et al., 2017). It is through these reasons that the student's spelling abilities end up predicting their reading abilities.

With difficulty in reading and spelling, it is not a surprise that students with dyslexia will manifest difficulties in writing as well. Students with dyslexia will have poor spelling, lack of vocabulary and poor organisation skills that is also due to their reading abilities and spelling abilities (Hebert et al., 2018). In DAS, we have the English Main literacy intervention programme that addresses all these challenges in students. This study aims to evaluate the progress made by these students.

Dyslexia and the Integrated curriculum

The old curriculum based on the Orton Gillingham approach adapted for Singapore, included reading, spelling and writing. However, the new concept for the day was not integrated throughout the lesson. In the DAS improved curriculum, we integrate the lesson's new concept into reading, spelling, comprehension, and writing. The aim of integrating the new concept in different components of the lesson plan is to create a more holistic literacy instruction. The in-house curriculum has applied strategies to address the students' reading, writing, and spelling difficulties through the English Main Literacy programme.

Dyslexia and the English Main Literacy intervention

The MLP intervention is supported by evidence-based research and instruction from the National Reading Panel (US), Professional Practice Guidelines (SG) and the Rose Report (UK). The programme provides individualised group lessons taught in accordance to the Orton-Gillingham principles (Ritchey & Goeke, 2006; Rose & Zirkel, 2007).

- Diagnostic and prescriptive - where learning needs and profiles of the learners are the backbone of our lessons.

- Emotionally sound - where lessons are also geared towards helping the learners experience successes while bridging any learning gaps they have.

- Cognitive - every lesson includes both basic and advanced literacy skills and strategies essential in reading, spelling, reading comprehension and writing.

- Structured, cumulative and sequential - the knowledge and skills taught are built upon from previous lessons to ensure that the learners are not only competent but also confident in applying what they've learnt and acquired (Ritchey & Goeke, 2006; Rose & Zirkel, 2007).

Apart from incorporating the OG principles, writing and reading comprehension skills, the following approach is adopted. The concepts are also taught and delivered to students according to PPP (Presentation, Practice, Production) stages: The Presentation stage facilitate the pre-activity discussions through modelling. The Practice stage scaffolds and guides students in a structured, cumulative and sequential manner to enhance learning and the Production stage provides opportunities for students to be independent in applying the concepts/skills learnt (Criado, 2013)

PURPOSE OF RESEARCH

The purpose of this research was to demonstrate whether the reading and writing skills of dyslexic students in the DAS English Main literacy programme could be improved in a statistically significant manner using improved curriculum teaching methods. A statistically significant result would validate the improvement in the transfer of knowledge to the students due to the educational intervention.

RESEARCH HYPOTHESIS

On average, students' performance in the Curriculum-Based – Assessment has improved in the last three years.

RESEARCH DESIGN AND PROCEDURES

A total of 1343 students aged between 7 -17 were sampled. All students had been formally assessed and diagnosed with dyslexia, either at the DAS or elsewhere in Singapore, based on full scale IQ and problems in literacy leading to lowered achievement in comparison with non-dyslexic students. These students were enrolled in the English Main literacy programme for six terms from 2016 to 2018, attending 2 hours

weekly in small groups of 3 to 4 students. A random sampling method was used in this study. (Ramus, Pidgeon & Frith, 2013). The evaluation was done using Curriculum-Based Assessment (CBA). The CBA focused on three main tests assessing the words to read, words to spell, and writing tests (Ramus, Pidgeon & Frith, 2013).

The Curriculum Based Assessment(CBA)

All students in the DAS were assessed using the Curriculum-Based Assessment (CBA) to track their transfer of knowledge and progression in the English Main Literacy programme. The CBA focused on three main tests assessing the words to read, words to spell, and writing tests. Some examples of the CBA words to read and words to spell test are shown below:

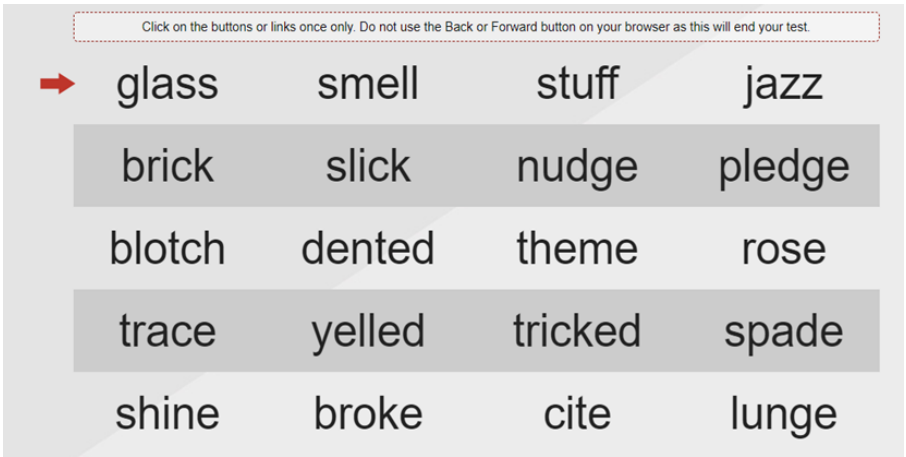

Figure 1. An example of Words to read

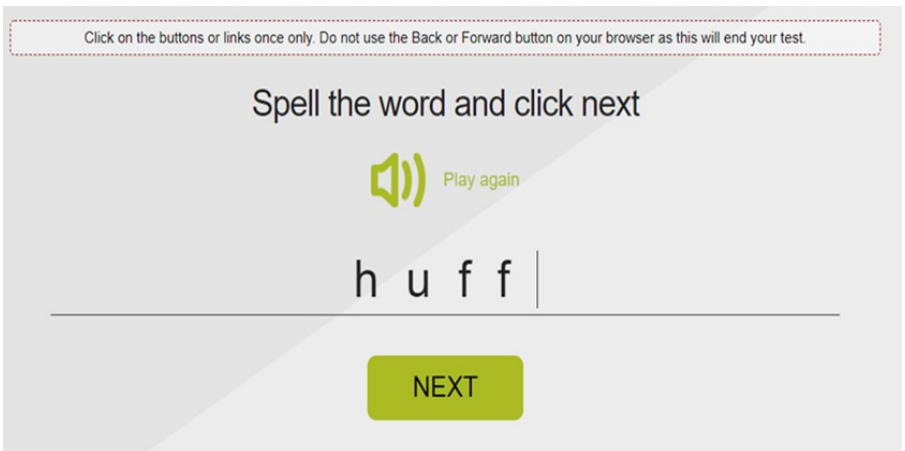

Figure 2. An example of Words to Spell

For the CBA words to read, students will be given five minutes to read as many words as possible, and the words progress from easy to challenging.

Students can press the play again button to hear the spelling words for the CBA words to spell. Students then will type the words in the given space. These are a few examples of CBA assessments.

RESULTS

The percentage scores

An evaluation of progress was undertaken in term 2 and term 4 annually over 6 points from 2016 to 2018, with a period of 6 months interval between the two test dates. Measures of performance in reading single words, spelling single words, and writing sentences were undertaken and the overall score for each student included in the data set as a percentage of the total score possible.

DATA ANALYSIS

The research data was analysed using Central Limit Theorem (CLT), and hypothesis testing. The reason for using hypothesis testing is because this method helps to evaluate two mutually exclusive statements about a population to determine which statement is best supported by the sample data.

In this study our hypothesis is:

'On average, the performance of students in the Curriculum- Based – Assessment has improved in the last 3 years'

We know that students in 2018 will improve from 2016 but there are also students in 2018 who had scored below the mean in 2016.

The Hypothesis testing method helps to find out the statistical significance of the research undertaken, this is to prove that the data did not happen by chance alone.

By statistically significant we precisely mean that if we select multiple independent random samples, of 100 students each , who appeared in the CBA test in 2018, then what is the probability that most of those random samples will have an average mean higher than 2016 $(\mu 18 > \mu 16)$

The Hypothesis testing method is used to find out whether or not the research has been successful. The Null hypothesis would be that there is no statistically significant increase in the average marks scored by the students in 2016 and 2018.

Null hypothesis $H_0 : \frac{\mu 18 - \mu 16}{S / \sqrt{n}} = 0$

Research hypothesis $H_1 : \frac{\mu 18 - \mu 16}{S / \sqrt{n}} > 0$

Figure 3. The formula for hypothesis testing

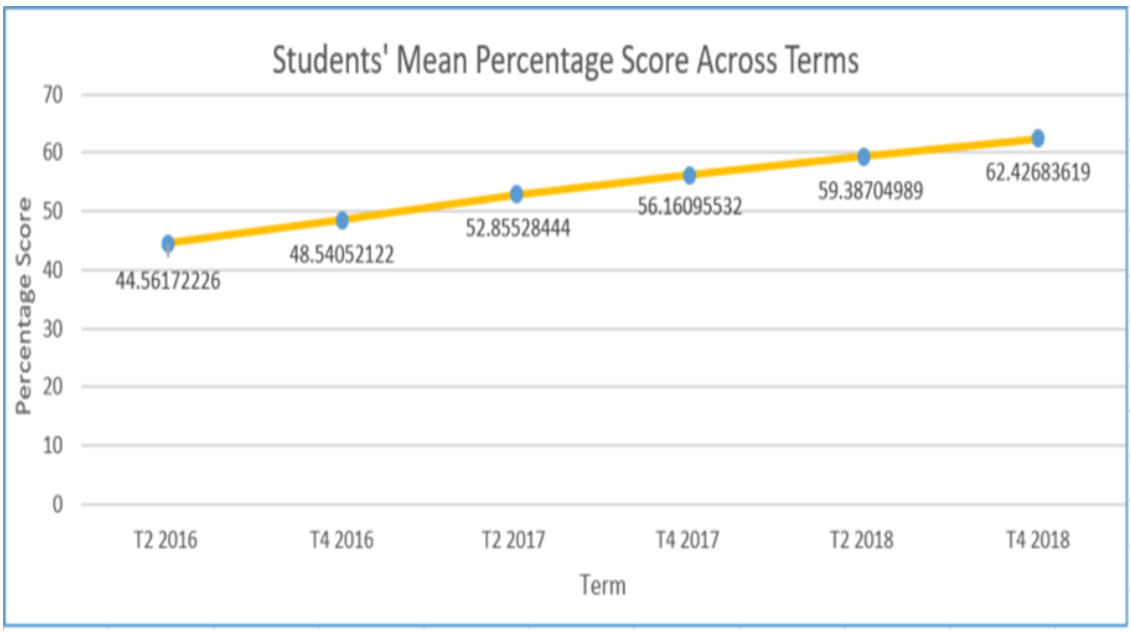

Figure 3a Progression of mean % scores over time

Figure 3a above shows the progression of students' mean percentage scores across terms in the three test items: words to read, words to spell, and writing tests. The students' mean scores increased from an average mean of 48.54 in 2016 to 62.43 in 2018.

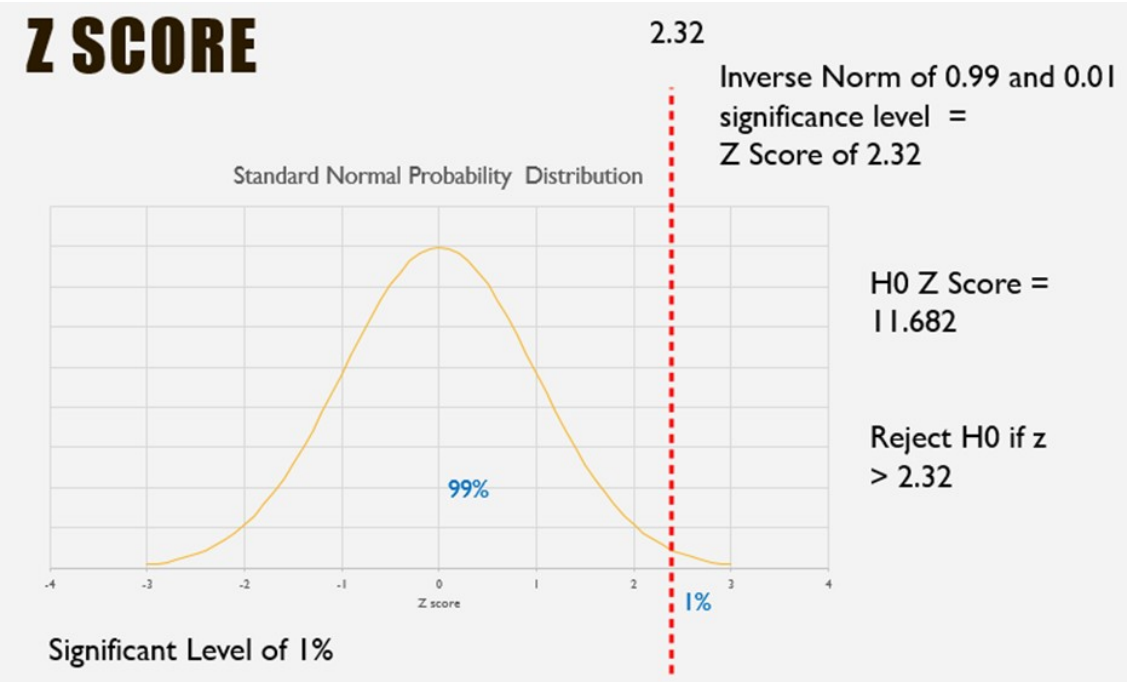

Figure 3b. Z scores across 3 years

Figure 3b test scores were analysed by comparing mean scores that cut across three years using the Z score. The analysis shows that the students' mean scores increased from 48.54 in 2016 to 62.43. The calculated Z score of 1.65 yielded a probability of $p<.05$, with a probability level of 95%. Therefore, the Z score did indicate a significant improvement and we reject the Null Hypothesis. This supported the research hypothesis that the literacy program demonstrates a statistically significant improvement in reading and writing scores in a population of dyslexic students. A descriptive research design was applied to help answer the hypothesis and research questions

DISCUSSION

This research shows that the DAS English Main literacy programme is an evidence-based practice, and the results increase the intervention's validity. The in-house curriculum has applied strategies to address the students' reading, writing, and spelling difficulties through the English Main Literacy programmes.

The research findings and analysis indicate that teachers should continue to use the in-house curriculum and use teaching methods suitable for individual learning. Implementing an English Main Literacy programme is not enough without proper teaching tools in place. These techniques can help address children with reading and

writing difficulties in the English Main Literacy programme (Martínez-García et al., 2020). However, teachers from schools may have limited ability to understand dyslexia and handle students with dyslexia, and therefore it is important to increase awareness of the needs of dyslexic children in education. The education institutions need to strive to ensure teachers can understand a student with a disability (Moats, 2019). Face to face and specialised instructional materials need to be applied by the instructors to help the students improve on their reading, spelling, and writing challenges.

Teachers should understand the importance of the issue of phonological awareness. Phonological awareness training needs to be incorporated when children have dyslexia. In such strategies, students will learn how to comprehend a text, reading and extracting vital messages from the text to bring about healthy development and cognitive skills (O'Brien, 2020). Teachers should also be trained on phonological awareness to understand how they can use the strategy and generate positive outcomes in students with dyslexia.

CONCLUSION

The research study overall shows that students' performance in the Curriculum-based assessment has improved in the last three years. The DAS English Main literacy programme is credited towards helping the student's performance increase. Through the intervention programmes, students and teachers interact, which allows the teachers to understand the reading challenges faced by dyslexic students.. The DAS English Main literacy programme also allows for close monitoring and evaluation of the students to ensure they focus on the academic goals. Any setback encountered can be discussed and addressed by the teachers, which allows for successful implementation of the English Main Literacy programme.

Dyslexic students have difficulties in reading, writing and spelling. These challenges make students lag in their educational pathway. It is the role of parents, instructors, and institutions to develop programmes to help identify students with dyslexia and help them in their academic pathway. The DAS English Main Literacy programme is a vital tool towards helping instructors in addressing challenges for students with dyslexia.

The improved English Main Literacy programme increases the validity of the intervention. Therefore, institutions should develop appropriate English intervention programs and understand the plan for their practical application. Proper implementation of these intervention programmes can result in success within these institutions.

Research studies of this type prove that instructors and the ministry of education have an opportunity to implement educational support in institutions of learning. These platforms allow the development of an ambient environment that they can use to improve dyslexic students reading, spelling or writing capabilities.

Future research aims to explore different aspects for students' improvement, following curriculum, this research seek to understand the number of programmes the students joins in the DAS and explore the number of years the educators have been in the special needs field.

LIMITATIONS

The first limitation of this study is the difference in the dates that the test was administered, a potential limitation of all longitudinal research. The test administrations were undertaken over a three-year period. It is a limitation because there are also possible confounding factors of history and maturation. The second limitation is the scores. It is stated that the scores are a "total" score which is extracted from having the addition of all the three items incorporated in the test, and they are from each student. The differences in progress on the different skills measured may dilute the actual differences in scores on each of the skills. If Student A made a great deal of reading progress while Student B made only a little, the overall change in a total reading + spelling score might be significant. However, the improvement in each skill may not be significant, so to counter this, the next evaluation will set out to measure students skill in test components and see which test components students struggle with the most when progressing to the next level. The third limitation is that the set of words administered to a student in 2016 may not be the same as words administered in 2018. This is a possible confound that could underlie the significant difference in terms of difficulty, although words are matched each year for level of difficulty.

FUTURE DIRECTIONS

For future research, we aim to explore different aspects of students' improvement, following curriculum and intervention. This research seek to understand the number of programmes the students joins in the DAS and explore the number of years the educators have been in the special needs field in order to establish the most effective approach to remediation.

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Asia Pacific Journal of Developmental Differences
Vol. 8, No. 2, July 2021, pp. 250—268
DOI: 10.3850/S2345734121000117

Single Word Spelling in English as a Native and a Foreign Language in Students with and without Dyslexia

Marta Łockiewicz[1*], Martyna Jaskulska[1] & Angela Fawcett [2]

1. *University of Gdansk , Poland*
2. *Swansea University, Dept of Psychology , United Kingdom*

Abstract

The goal of our study was to examine the potential link between dyslexia and spelling difficulties in EFL (English as a Foreign Language), to identify and characterize a model of relations between Polish as a Native Language phonological awareness, rapid automatised naming, and verbal short-term memory, and spelling in EFL, and to compare these relationships with analogical ones for English as a Native Language. Our participants included junior high school students: thirteen with dyslexia, 15 without dyslexia from England, and 16 with dyslexia and 16 without dyslexia from Poland.

We found that in an English single word spelling task Polish students with and without dyslexia made more phonological errors than English students with and without dyslexia, and more orthographic errors than English students without dyslexia. Polish students with dyslexia made more orthographic errors than English students with dyslexia, but Polish students without dyslexia performed on a level with English students with dyslexia. The behavioural symptoms of phonological deficits in students with dyslexia were more conspicuous in English than in Polish.

In our study, orthographic errors were more frequent than phonological errors in the English group; opposite proportion occurred in the Polish group. This suggests that Polish students employed an earlier spelling strategy, more based on sublexical than lexical knowledge and skills, and more frequently misspelt the words practically beyond recognition.

Keywords: spelling; Polish; phonological processing, orthographic errors, phonological errors

***** *Correspondence to:*
Dr. Marta Łockiewicz, Institute of Psychology, Social Sciences Faculty, University of Gdańsk, Bażyńskiego, 480-952 Gdańsk, Poland. Email: marta.lockiewicz@ug.edu.pl

INTRODUCTION

Although dyslexia is fundamentally a reading disability, spelling difficulties often accompany reading problems (Lyon et al., 2003), as phonological, morphological, and orthographical knowledge constitutes a prerequisite for spelling (Joshi et al., 2008;2009). Thus, learners with dyslexia typically commit errors within word structure: orthographic errors, when they spell a word the way it sounds (e.g. **inteligent* instead of *intelligent, *sed* for *said*) and/or phonological errors, when they spell a word not the way it sounds (e.g. **saying* for *staying*, **efry* for *every*) (Mather & Wendling, 2012). Inaccurate spelling has also been documented as characteristic of dyslexia in learning English as a Foreign Language (EFL) in native speakers of the following languages , e.g. Italian (Bonifacci et al., 2017), Swedish and Finnish (Lindgren & Laine, 2011), and Polish (Łockiewicz & Jaskulska, 2016). In this latter study, 17-year-old high school Polish students with dyslexia, as compared with their peers without dyslexia, made more phonological and orthographic errors in a single English word spelling task.

In fact, phonological and orthographic skills transfer from NL to FL (a foreign language) (Sparks, et al., 2006), as language and literacy competence in NL form a basis for such competence in FL (Cummins, 1979). For example, Palladino and Ferrari (2008) found that FL learning problems result from NL phonological processing deficits. Among these, phonological awareness, rapid automatized naming (RAN), and verbal short-term memory are crucial for the development of literacy, and impaired in dyslexia (Hoien, et al., 1995; Wolf et al., 2000). EFL word spelling was predicted by phonological awareness in Norwegian as NL (Helland & Morken, 2016) and correlated with phonological awareness and verbal short-term memory, but not with RAN, in Dutch as NL (van Sette et al., 2017).

The rules of spelling are diverse between alphabetic languages. Polish, as compared with English, has a much more consistent, transparent, and regular orthography for spelling (Awramiuk, 2006). Most words can be spelt phonetically, as each phoneme maps onto 1 grapheme (Gajda, 1999), with few exceptions, e.g. phonemes that have 2 corresponding graphemes (consonantal pairs: *ż* and *rz*, pronounced as */ʒ/*, *ch* and *h* - */x/, ó* and *u* - */u/*) (Łockiewicz et al., 2019). In English, phonemes map onto different grapheme and/or graphemes; this mapping changes between words (Nijakowska, 2010).

FL learning occurs in an environment in which NL of the FL learners is the language of instruction at school. Thus, learners' FL exposure is limited almost exclusively to FL classes at school, or hobbies, e.g. foreign films or video games. Such learning is formalized and artificial, as compared with NL acquisition, and usually lacking social, emotional, or personal importance. In Poland, FL instruction used to start comparatively early, around 7 years of age, at school entry. Children took 2 (elementary school) and later 3 (elementary and junior high school) FL hours per week, following the state-wide core

curriculum (Ministry of Sport and National Education, 2002). FL instruction does not involve spelling strategies, the assumption being that they are taught during NL class.

Our main aim was to examine if phonological processing disability relates to spelling skills depending on the consistency of orthography and varied NL (Polish and English, respectively) spelling instruction. Specifically, we wanted to analyse the relationship between dyslexia, NL (Polish) phonological processing skills, and spelling difficulties in EFL (English as a Foreign Language). We also aimed to compare these relationships with analogical ones for English as NL. For this purpose, we used a single English word spelling task. Particularly, we aimed to compare the spelling accuracy of Polish and English students with and without dyslexia. English students who participated in our study had acquired English in a natural, both familial and academic environment (cf. Carroll, 2008). Our Polish participants had only studied English through formal schooling, and mostly for educational purposes. Moreover, interlingual interference due to using NL rules to spell in EFL could have resulted in transfer errors in the Polish group (Zybert, 1999). Therefore, we assumed that English students would commit fewer orthographic and phonological errors than Polish students. Moreover, a typical symptom of dyslexia is faulty spelling (Lyon et al., 2003), and literature reported poorer spelling in EFL of native speakers of different languages with dyslexia, as compared with their peers without dyslexia (e.g. Helland & Kaasa, 2005; Nijakowska, 2010). Thus, we expected that students without dyslexia would commit fewer orthographic and phonological errors than students with dyslexia.

English has more complicated grapheme-phoneme correspondence rules as compared to Polish; thus, phonological problems might be more conspicuous, and phonological errors more frequent. However, English students, being native speakers, are more experienced in the intricacies of English phonology than Polish students are; thus, orthographic errors might be more frequent, showing a better understanding of a certain type of orthography. Moreover, Romonath et al. (2005) reported that FL learners tend to make phonological, not orthographic, errors when they spell, and learners at first rely on phonology, and then on orthography (Zhao et al., 2016). Hence, though we expected a possible difference in the proportion of orthographic and phonological errors committed by English and Polish students in English, we did not assume the exact direction of this proportion. Instead, we decided to treat this question as an explanatory one.

Yeon, Bae, and Yoshi (2017) found that NL (Korean) metalinguistic awareness predicted EFL spelling. We also tried to validate a model of relations between NL (Polish) phonological abilities: phonological awareness, RAN, and verbal short-term memory, and spelling accuracy in EFL, and, additionally, to compare it to a model of relations between NL (English) phonological abilities and spelling accuracy in English as NL, following the analyses we conducted for reading accuracy and fluency (cf. Łockiewicz et al., 2020). The original aspect of this research constitutes a comparative analysis of both Polish and English students' spelling of identical words. To conclude, we intended to

provide new data about the relationship between phonological processing and FL spelling.

MATERIALS AND METHODS

Participants

Thirteen (21.67% of the total number of participants) English students with dyslexia, 15 (25%) without dyslexia, 16 (26.67%) Polish students with dyslexia, and 16 (26.67%) without dyslexia participated in the research ($\chi^2(1) = 0.08$, $p = .782$)[1]. All participants in the study were junior high school male students. All participants were native speakers of either English or Polish, respectively. The groups were matched for education and age ($M =$ 14 years, 2 months, $SD =$ 13 months for English students with dyslexia, $M =$ 14 years, 3 months, $SD =$ 11 months for English students without dyslexia, $M =$ 14 years, 6 months, $SD =$ 7 months for Polish students with dyslexia, $M =$ 14 years, 5 months, $SD =$ 8 months for Polish students without dyslexia, $F(1,56) = 0.09$, $p = .765$), and intelligence (as measured with *The Standard Progressive Matrices*: Raven, 1991, 2006). All participants with dyslexia had a report issued by professionals working in certified counselling centres confirming their dyslexia prior to the research. Both parents and students provided their written consents to the participation in the study, revealing information about a dyslexia report and diagnosis. A SENCO (Special Educational Needs Coordinator) and a school psychologist, responsible for co-ordination of the recruitment for the study in the UK and Poland respectively, gathered the necessary data. Reading tests in corresponding NLs confirmed the initial group assignment as dyslexic or non-dyslexic (for details please see Łockiewicz et al., 2020. A summary of the findings from this paper is given below, as they confirm dyslexic difficulties manifested by our participants). Specifically, English students with dyslexia scored lower in sight word and phonemic decoding efficiency than English students without dyslexia (as measured with TOWRE-2: Torgesen et al., 2012; this test includes two tasks: 1. reading single English words, and 2. reading single English nonwords, each one within 45 seconds). Polish students with dyslexia read single words with less accuracy and more slowly than Polish students without dyslexia (as measured with *Real words reading task*: Jaworowska et al., 2010; this test requires reading 89 single Polish words; there is no time limit). Moreover, Polish students with dyslexia read single nonwords with less accuracy and more slowly than Polish students without dyslexia (as measured with *Nonwords reading task*: Jaworowska et al., 2010; this task requires reading 71 single Polish nonwords, within 60 seconds). Furthermore, all Polish students commenced their EFL mandatory course in Year 1 of the elementary school. There was no difference between Polish students with and without dyslexia in the length of EFL schooling ($M =$ 7.18, $SD =$ 1.17 years for Polish students with dyslexia, $M =$ 7.30, $SD =$ 0.48 years for Polish students without dyslexia, $t(19) = 0.30$, $p = .770$); the students had attended on average 3 classes weekly. Additional private tutoring classes in English differentiated the groups ($\chi^2(1) = 4.57$, $p =$ 0.033) – more Polish students with dyslexia (5 boys (18.75%)) than Polish students without

dyslexia (1 boy (3%)) participated in them for 2.5 years on average. No Polish boy participating in the study spent more than 6 months (a defined period) abroad.

Procedure

We developed a short survey with open questions for Polish students, which provided demographic information about EFL education and practice. This survey was completed as a first element of the group assessment, in a written form. All students participated in 2 parts of the assessment (both conducted by the 1st and 2nd author): 1. a group assessment (about 45 min. long, including e. g. the Raven Test Matrices, single word spelling in English), and 2. an individual assessment (about 30 min. long, including e.g. tasks measuring spoonerisms, phonemic segmentation, verbal short-term memory, and RAN). All assessments were carried out in school classrooms. The procedure of the study was approved by the Ethics Board for Research Projects at the Institute of Psychology, University of Gdańsk, Poland.

Methods

Spelling

English words in context:

It assesses spelling skills, as measured with the number of errors committed when spelling 30 single English words missing within given, printed sentences. When selecting the target words, we used an elementary EFL coursebook (Evans & Dooley, 1999), which was 1 level below the mandatory one in the junior high school that we cooperated with. We chose every tenth word from the reading comprehension sections, with the exclusion of proper names, specialist vocabulary, articles and repeated items. Thus, we left only nouns, verbs, adjectives and adverbs. Next, we used the list to choose 30 words and put them in the context of sentences. We selected the words specifically to ensure that they included grapheme-phoneme correspondence combinations especially difficult for learners with dyslexia. The students had to fill in the gaps with the missing words, one missing word per sentence, e.g. *Water in the _____ is cold*. They listened to a recording voiced by a native speaker of English, in which they heard each target word to be completed three times (before, in, and after the sentence): *River. Water in the river is cold. Write: river*. The examples of words were: *said, whale, disgusting*. We classified the errors as phonological and orthographic ones. These are errors within the word structure. The number of phonological errors was a measure of phonological accuracy. The number of orthographic errors was a measure of orthographic accuracy. An orthographic error occurs when the spelling used is wrong; however, the word is written as it sounds, e.g. *wale instead of whale, *polution instead of pollution. A phonological error occurs when the word is written not as it sounds, e.g. *jewler instead of jewel, *discusting instead of disgusting. A Cronbach's alpha was 0.94. The 1st and 2nd authors prepared

this measure, as there had been no available measures standardized for Polish spellers (see Łockiewicz & Jaskulska, 2016, where the original description of this task is included). This task was completed by both Polish and English students.

Phonological processing measures in NL: Polish and English:

We administered the same or corresponding measures to Polish and English students.

The same measures

For the Polish group, the tasks were administered in Polish, for the English group, the tasks were administered in English.

- **Backwards Digit Span:** Participants repeat a series of digits of increasing length said by the experimenter, in a reverse order. It assesses verbal short-term memory (Max. = 14 points). A test-retest reliability coefficient was .82. (Fawcett & Nicolson, 2005).

- **Rapid Naming (RAN):** It measures rapid automatized naming. Participants name 40 simple pictures (two identical sets of 20 different pictures) as fast as they can. Time (in seconds) of naming is recorded. A test-retest reliability coefficient was .85 (Fawcett & Nicolson, 2005).

Corresponding measures

Spoonerisms

1. The English group: (Fawcett & Nicolson, 2005), measuring the ability to create spoonerisms (*Max.* = 14 points). A test-retest reliability coefficient was .78. This task was administered in English.
2. The Polish group: (Bogdanowicz et al., 2012), measuring the ability to create and recognise spoonerisms (*Max.* = 12 points). This task was administered in Polish.

Phonemic segmentation

The English group: (Fawcett & Nicolson, 2005), measuring the ability to split words into sounds (*Max.* = 12 points). Participants repeat the words said by the experimenter, without certain syllables or sounds, i.e. *pan* for *panda*. A test-retest reliability coefficient was .88. This task was administered in English.

The Polish group: (Bogdanowicz et al., 2012), measuring the ability to split nonwords into sounds (*Max.* = 8 points). Participants repeat the nonwords said by the experimenter, but

they pronounce each sound separately, i.e. *b – o – t* for *bot.* This task was administered in Polish.

In order to calculate the results, a composite score was used to tap phonological awareness. Raw scores for phonemic segmentation and spoonerisms tasks were added (*Max.* = 26 points for the English group and *Max.* = 20 points for the Polish group). A Cronbach's alpha for accuracy was 0.659 (calculated for all tasks assessing auditory-linguistic functions).

RESULTS

Accuracy of Single English Word Spelling

All students spelt correctly: 11 (37%) words in the English students with dyslexia group, 18 (60%) in the English students without dyslexia group (*improve, explained, alive, buy, beard, statue, training, said, lives, become* in English students with and without dyslexia groups, and *there* in the English students with dyslexia group, and *know, ate, chemicals, whale, complete, including, enough* in the English students without dyslexia group), and 0 in the Polish students group. The easiest words (more than half the students spelt the word correctly) for Polish students were: *buy* (88% of correct answers for Polish students with dyslexia and 88% for Polish students without dyslexia), *alive* (69% for Polish students with dyslexia and 69% for Polish students without dyslexia), *there* (69% and 81%), survive (69% and 69%), *improve* (63% and 69%), *training* (63% and 69%), *lives* (63% and 88%), and, additionally, for Polish students without dyslexia, *vegetable, complete, become* (75%), *streets* (69%). The majority of words that were spelt best in the Polish group were spelt perfectly in the English group.

Most Difficult Words to Spell and the Proportion of Orthographic and Phonological Errors

The most difficult words to spell in the *English word in context* task for the English group were: *vegetables* (50% of correct spellings), *pollution* (57%), *jewel* (61%). In all these words, orthographic errors were dominant (e.g.**vegtables, *vegatables, *vegatbles, *vedgetables* (12 out of 14 incorrect spellings); **polution, *pollusion, *pulution* (10 out of 12); **jewl, *jewle, *jeul* (9 out of 10)). The most difficult words to spell in the *English word in context* task for the Polish group were: *jewel* (6% of correct spellings), *pollution* (6%), *treating* (16%). In the word: *jewel* phonological errors were dominant (e.g.**juall, *child, *giol, *geol, *gillow, *gilos, *jewler, *july, *geogle, *javearly, *ganule, *youal* (14 out of 21 incorrect spellings)), in the word: *pollution* - orthographic ones (**polution, *pollusion, *pelucion, *polition,* (18 out of 24), and in the word*: treating* both categories were distributed equally (orthographic errors: **treeting,* phonological errors: **threeteen, *traitin, *triteen*). Interestingly, as our lector native speaker did not produce the final g in

the latter word, Polish students tended to omit it in their spellings, either ignoring or not recognising the *-ing* ending in Present Participle. The same recurring (committed by at least 2 students) errors in Polish and English groups were orthographic: **no* for *know* (41% of spellings in the Polish group and 7% in the English group), **streats* for *streets* (6% and 7%), **polution* for *pollution* (8% and 8%), **vegatables* for *vegetables* (6% and 14%), and **Europian* for *European* (12.5% and 7%), and phonological: **eat* for *ate* (50% and 11%, respectively), **discusting* for *disgusting* (9% and 14%).

Phonological Processing Skills of Students With and Without Dyslexia in Their Respective NLs

Mean comparison. When comparing reading (see Participants section) and phonological processing skills of students with and without dyslexia in their respective NLs, we calculated differences only within the two groups: English and Polish, to confirm dyslexic deficits in our criterion group. The main point of interest of the study was spelling; however, we also aimed to examine a potential relationship between other cognitive tasks; thus, a range of further data was also investigated. We found that Polish students with dyslexia did worse in the RAN task in comparison with Polish students without dyslexia. English students with dyslexia had poorer results in the verbal short-term memory task in comparison with English students without dyslexia. Between Polish students with and without dyslexia no further differences were observed in the NL phonological processing skills. Similarly, no differences between English students with and without dyslexia occurred, though in all administered measures the students with dyslexia were outperformed by their non-dyslexic peers. The exact numbers for these comparisons are given in Łockiewicz, Jaskulska, and Fawcett (2020, p. 26)[2].

Spelling Skills in EFL of Polish Students With and Without Dyslexia and in English as NL of English Students With and Without Dyslexia

Mean comparison. When comparing spelling skills in English of Polish and English students with and without dyslexia, we calculated differences between the two groups: a 2 x 2 (dyslexia and country) ANOVA test was used (Table 1).

In the *English word in context* task, the ANOVA test 2 x 2 (dyslexia x NL) and Tukey post hoc tests (Table 1) showed that dyslexic students made more orthographic errors as compared with their non-dyslexic peers (main effect for dyslexia). Moreover, Polish students made more orthographic errors than their English peers (main effect for NL). Specifically, Polish students with dyslexia (M = 6.69, SD = 2.33, Min = 2.00, Max = 10.00) made more orthographic errors than both English students without dyslexia (M = 1.53, SD = 1.25, Min = 0.00, Max = 3.00) and English students with dyslexia (M = 3.38, SD = 3.20, Min = 0.00, Max = 8.00), and Polish students without dyslexia (M = 4.63, SD = 2.87, Min = 1.00, Max = 12.00) made more errors than English students without dyslexia.

Table 1. English Spelling in the Compared Groups

		dyslexic		Non-dyslexic					ED/ END	ED /PD	ED/ PND	END/ PD	END/ PND	PD/ PND
Errors		*M*	*SD*	*M*	*SD*	*F*	*p*	ηp²	*p (Tukey post hoc test)*					
ortho-graphic	English	3.38	3.32	1.53	1.25	9.12[a]	.004**	.14	.218	.005**	.549	≤.001	.006	.103
	Polish	6.69	2.33	4.63	2.87	24.36[b]	.001**	.30						
						.03[c]	.871	.00						
phono-logical	English	1.54	1.05	0.47	0.74	1.66[a]	.202	.03	.857	≤.001	≤.001	≤.001	≤.001	.726
	Polish	9.56	4.62	8.25	4.97	73.18[b]	.001**	.57						
						0.02[c]	.897	.00						

Note: [a] - Main effect for dyslexia; [b] – Main effect for Native Language; [c] Effect for interaction of dyslexia and Native Language; ** – $p \leq .01$
ED = English students with dyslexia, END = English students without dyslexia, PD = Polish students with dyslexia, PND = Polish students without dyslexia

However, Polish students without dyslexia performed on a level with English students with dyslexia. No other significant differences were observed.

In the *English word in context* task, the ANOVA test 2 x 2 (dyslexia x NL) and Tukey post hoc (Table 1) tests showed that Polish students made more phonological errors as compared with their English peers (main effect for NL). No main effect for dyslexia was observed. Specifically, Polish students with dyslexia (M = 9.56, SD = 4.62, Min = 4.00, Max = 19.00) made more phonological errors than both English students without dyslexia (M = 0.47, SD = 0.74, Min = 0.00, Max = 2.00) and English students with dyslexia (M = 1.54, SD = 1.05, Min = 0.00, Max = 3.00). Moreover, Polish students without dyslexia (M = 8.25, SD = 4.97, Min = 1.00, Max = 15.00) made more phonological errors than both English students without dyslexia and English students with dyslexia. No other significant differences were observed. Moreover, the t-test with repeated measures showed that Polish students with dyslexia ($t(15) = 2.17$, p = .047, d = 0.62) and Polish students without dyslexia ($t(15) = 2.84$, p = .012, d = 0.73) made more phonological than orthographic errors. Conversely, English students with dyslexia ($t(12) = 2.36$, p = .036, d = 0.87) and English students without dyslexia ($t(14) = 4.00$, $p \leq .001$, d = 1.19) made more orthographic than phonological errors.

Relations Between Spelling in English, Dyslexia, and Phonological Processing Skills in NL (Polish and English, Respectively) of Polish and English Students With and Without Dyslexia

Correlational analysis:

To analyse the relations between the investigated variables (dyslexia, orthographic and phonological errors, and phonological processing skills), Pearson's product-moment and point-biserial coefficients were computed (Table 2 and Table 3).

A correlation study showed the expected links (Table 2 includes data for the Polish group, and Table 3 includes data for the English group).

Regression analyses:

The same comparative data was used in a series of regression analyses. Several hierarchical multiple regression analyses were calculated. Dyslexia was entered as independent variable in Step 1. Phonological processing skills in NL: either English or Polish (phonological awareness, verbal short-term memory, and RAN) were entered as independent variables in Step 2. English spelling skills (as measured with the number of committed orthographic and phonological errors) were entered as dependent variables (Table 4).

Table 2 Correlations Between the Study Variables – the Polish Group

variable	orthographic errors[b]	phonological errors[b]
dyslexia[ac]	-.377*	-.140
phonological awareness	.036	-.083
verbal short-term memory	-.224	-.272
RAN (in sec.)[b]	.330[d]	.205

Note: **$p \leq .01$; *$p \leq .05$; Pearson product-moment correlations, except:
[c] point-biserial correlation coefficients; [a] 1 = dyslexia, 2 = lack of dyslexia; [b] higher score signifies worse performance; [d] = statistical trend.
Correlation co-efficient between orthographic and phonological errors was .153.

Table 3. Correlations Between the Study Variables – the English Group

variable	orthographic errors[b]	phonological errors[b]
dyslexia[ac]	-.376*	-.526**
phonological awareness	.040	-.012
verbal short-term memory	-.431*	-.300
RAN (in sec.)[b]	.119	.196

Note: **$p \leq .01$; *$p \leq .05$; Pearson product-moment correlations, except:
[c] point-biserial correlation coefficients; [a]1 = dyslexia, 2 = lack of dyslexia; [b] higher score signifies worse performance
Correlation co-efficient between orthographic and phonological errors was .592**.

In the English group (see Table 4) the regression analysis for English as NL orthographic accuracy of single word spelling showed that the independent variable: dyslexia explained a total of 9% of the variance ($F(1,25) = 3.59$, $p = .070$, statistical trend). The only significant independent variable in Step 1 was dyslexia ($\beta = -.354$), showing that participants without dyslexia made fewer orthographic errors. The regression analysis for English as NL phonological accuracy of single word spelling showed that the independent variable: dyslexia explained a total of 23% of the variance ($F(1,25) = 8.77$, $p = .007$). The only significant independent variable in Step 1 was dyslexia ($\beta = -.510$), showing that participants without dyslexia made fewer phonological errors.

In the Polish group (see Table 4) the regression analysis for English as FL orthographic accuracy of single word spelling showed that the independent variable: dyslexia explained a total of 10% of the variance ($F(1,29) = 4.48$, p = .043). The only significant independent variable in Step 1 was dyslexia ($\beta = -.366$), showing that participants without dyslexia made fewer orthographic errors. No other significant models were observed.

Table 4 Results of Hierarchical Regression Analyses in Which Dyslexia and Native Language Phonological Processing Abilities in Either a Foreign (for the Polish Group) or a Native Language (for the English Group) Were Regressed upon Spelling in English

		ENGLISH GROUP		POLISH GROUP	
		errors[b]			
Step	predictor	orthographic	phonological	orthographic	phonological
1	dyslexia[a]	-.354 (1.90)[c]	-.510 (2.96)**	-.366 (2.12)*	-.157 (0.86)
	ΔR2	.126[c]	.260**	.134*	.025
Total R2 /Adj. R2		.126/.091[c]	.260/.230**	.134/.104*	.025/-.009
2	dyslexia[a]	-.156 (0.66)	-.487 (2.14)*	-.254 (1.26)	-.002 (0.01)
	PA	.038 (0.18)	-.104 (0.52)	.319 (1.62)	.084 (0.39)
	VM	-.353 (1.42)	.047 (0.20)	-.229 (1.20)	-.270 (1.30)
	RAN[b]	.004 (0.21)	.086 (0.46)	.273 (1.35)	.201 (0.91)
	ΔR2	.077	.014	.115	.085
Total R2 /Adj. R2		.202/.057	.274/.142	.249/.133	.110/-.027

Note: ** $p \leq .01$; * $p \leq .05$; [c] = statistical trend; β given (*t* in parenthesis); [a] 1 = dyslexia, 2 = lack of dyslexia; [b] higher score signifies worse performance; PA – phonological awareness, VM = verbal short-term memory

DISCUSSION

When comparing the phonological and orthographic accuracy of single word spelling in English as either NL or FL between English students with dyslexia, English students without dyslexia, Polish students with dyslexia, and Polish students without dyslexia we found main effects of NL in both measures, and a main effect of dyslexia for orthographic accuracy. The impact of NL on spelling performance demonstrated an expected native speaker advantage, that we observed also for word and nonword decoding and word recognition accuracy and fluency in the same group (cf. Łockiewicz et al., 2020). Our participants were of the same age, and expected to spell fluently in their respective NLs. However, when exposure to English as NL and FL was compared, English students learnt English in preferential circumstances: for a longer time, from birth, and in a both familial and academic environment (cf. Carroll, 2008), as opposed to a shorter, limited, and formalised education that Polish students received. These differences turned out to be crucial, even though in both cases the actual spelling instruction likely took place mainly through schooling. Interestingly, 2 out of 3 most difficult words for both Polish and English students were identical: pollution and jewel, showing that problems with silent letters in consonantal pairs (hence the error in pollution) and less frequent spellings (hence the error in jewel) are common, regardless of NL. The observed link between dyslexia and orthographic accuracy is in agreement with the deficits typical for dyslexia (Lyon et al., 2003). The lack of an analogical link between dyslexia and phonological accuracy could be due to the selected words (elementary level) being very easy for both English students with and without dyslexia, and very difficult for both Polish students with and without dyslexia. This assumption matches with another finding, that in our study, contrary to expectations and reports of EFL spelling deficits in dyslexia in other alphabetic languages (Bonifacci et al., 2017; Lindgren & Laine, 2011), Polish students with dyslexia did not differ from Polish students without dyslexia, and English students with dyslexia did not differ from English students without dyslexia. In addition, an earlier study of 3-year older, high school Polish students with dyslexia demonstrated that they committed more orthographic and phonological errors in the same single word spelling task as used in the present study, as compared with typical readers (Łockiewicz & Jaskulska, 2016). They had studied English, however, 2 years longer. Moreover, Polish EFL learners do not practise spelling to dictation during EFL classes, which puts them at another disadvantage when compared with English peers, as this task was unfamiliar to them.

We found that both Polish students with and without dyslexia made more phonological errors than both English students with and without dyslexia. Phonological, morphological, and orthographical competence constitute prerequisites for mastering spelling skills (Joshi et al., 2008/2009); these are different for English and Polish (cf. Awramiuk, 2006; Jaskulska & Łockiewicz, 2017). Likely, both Polish students with and without dyslexia struggled with the EFL phoneme-to-grapheme conversion, due to lack of knowledge and practice, and possible application of Polish rules. Figueredo (2006) claims that FL learners base their FL performance on NL, namely, that there is a transfer from NL to FL.

However, such transfer or influence from NL decreases when the knowledge of FL increases. As the competence in EFL in Polish students with and without dyslexia who participated in our study was still elementary or lower, we think that they relied heavily on their NL, which led to transfer errors. In addition, phonemes not existing in Polish (e.g. /θ/, /ð/, /æ/) might have caused confusion as to which word was read, despite the words having been given within a sentence, to facilitate comprehension and recognition. We observed that Polish students with dyslexia made more orthographic errors than both English students with and without dyslexia, and Polish students without dyslexia made more such errors than English students without dyslexia, which agrees with our previous findings. However, Polish students without dyslexia performed on a level with English students with dyslexia. They heard the word correctly, but failed to spell it right, possibly completing the gap with any word with the given pronunciation that they knew. This might be due to an underdeveloped mental lexicon: a faulty and/or non-existent link between semantic, phonological, and orthographic data. This could explain why Polish students with dyslexia did not manage to equal English students with dyslexia score; even if they selected an inappropriate, but otherwise existing, English word, they might have changed its spelling so severely that it altered the plausible pronunciation, resulting in a phonological error. However, sometimes they manifested similar spelling errors patterns, showing that they learnt the possible pronunciations of letter combinations unfamiliar to Polish, e.g.: ea for /iː/, no for /nəʊ/. For English students with dyslexia, their dyslexic disabilities were so deep that they nullified the advantage of native speakers' status, which we also observed for decoding skills (Łockiewicz et al., 2020).

Within the group of English native speakers, we observed that English students with and without dyslexia made more orthographic than phonological errors. These students were aware of the irregularities and low consistency of phoneme-to-grapheme mapping in their NL, thus their spelling mistakes rather did not change the pronunciation. Moreover, learners progress from using a phonological to an orthographical strategy for spelling (Zhao et al., 2016). As we observed a reversed proportion in Polish students with and without dyslexia, who made more phonological than orthographic errors, we assume that Polish students with and without dyslexia might have used an earlier spelling strategy than English students with and without dyslexia did. Moreover, the category of phonological errors includes also serious distortions of a word structure, resulting in it being practically unrecognisable, especially should the context not be provided. Possibly, some participants failed to recognise a word, yet tried to spell it anyway, as encouraged by the instruction to complete all the gaps. However, we did not question our participants which strategies they applied. Our findings confirm Romonath et al.'s (2005) report that FL learners usually make phonological errors in spelling. Yeon et al. (2017) suggested that when EFL learners spell unknown words, they apply phonological processing skills, if their NL is an alphabetic, in particular shallow, orthography. A metanalysis by Zhao et al. (2016) found that bilingual students, who attended English-medium schools (so they had more exposure to English than our participants did), spelt real words in English as a Second Language (ESL) better than monolingual students (the

difference decreased with students' age). Conversely, monolingual students spelt nonwords in English, which was their NL, better than bilingual students, for whom English was SL. The latter task (i. e. nonword spelling) taps phoneme-to-grapheme conversion more than the former one (i. e. real word spelling) (cf. Coltheart, 2007), which is probably less developed in bilingual learners (Zhao et al., 2016). We found a similar relationship for EFL learners, as our Polish students without dyslexia, as compared with English students with dyslexia, made equal number of orthographic, but more phonological errors, failing in a task more deeply rooted in phoneme-to-grapheme mapping.

In the English group, all the most difficult words were inaccurate orthographically. Both English students with and without dyslexia were familiar with the irregularities, non-consistency, and non-transparency of grapheme-phoneme relations in their NL, thus, their spelling errors rather did not change the pronunciation. Frequent error in the Polish group was the word pollution, spelt incorrectly as **polution* (letter deletion), demonstrating that silent letters in consonantal pairs are a mutual difficulty for English and Polish students. However, another orthographically difficult word for Polish learners, treating, was not among the most difficult for English learners. The most frequent faulty spelling that occurred in the Polish group, **triting*, manifested replacing the vowel digraph **ea* (which in Polish represents 2 phonemes, pronounced as /ea/) with a monograph i. This is due to a lack of distinction into long and short vowels and of no dependence of vowel pronunciation on whether a syllable is stressed or not in Polish. Thus, when students heard /tri:tiŋ/, they made a faulty approximation that English phoneme /i:/ is the same as Polish phoneme /i/, represented by grapheme i. Another common difficult word, jewel, resulted in orthographic errors in the English group, but in phonological errors in the Polish group. This noun includes two vowels non-existent in Polish: /uː/ and /ə/, and a silent consonant /w/, a concept also unfamiliar to Polish orthography. Though letter deletions, substitutions, and reversals also appeared, as in the English group, these frequently distorted the word beyond recognition, and thus impacted pronunciation. In addition, Polish learners often replaced j with g (unlike English learners), showing the knowledge of g - /ʤ/ grapheme-phoneme correspondence, typical of English, but not of Polish (g is realised phonetically as /g/ or, rarely, as /ɟ/). Generally, in the Polish group phonological errors dominated over orthographic ones in the most difficult words, which results from poor knowledge of the grapheme-phoneme relations in FL, not compatible with analogical rules in NL (cf. Łockiewicz & Warmbier, 2018; in this study, the most difficult English words for Polish junior and high school students to spell where these words, which were characterised with a low grapheme-phoneme correspondence). Faulty usage of NL (Polish) rules was observed in spelling igloo (/ˈɪgluː/ as **iglo* (a phonological error), which is a Polish spelling with the same meaning (though pronounced as /iglo/). However, transfer of Polish rules to English was sometimes helpful, as manifested in another difficult word: disgusting. Usually, the gerund ending was rendered correctly as -ing, with errors in the first two syllables; this could be attributed (though we did not measure that in our study) in Polish learners' tendency to pronounce such ending as: /ing/, retaining final g.

To conclude, even though some of the most difficult words for English and Polish students with and without dyslexia were the same, the most frequent errors not always were of the same type, but depended on the characteristic of the phonology and orthography of the language. Thus, we noticed both signs of a positive and a negative transfer (Figueredo, 2006) from NL (Polish) to FL (English).

In both groups, we observed that dyslexia predicted NL (English, in a group of English students) and FL (English, in a group of Polish students) orthographic accuracy of single word spelling. In the English group, but not in the Polish group, phonological accuracy of single word spelling was also predicted by dyslexia; participants with dyslexia made more phonological errors. These findings confirm earlier reports of phonological impairments in dyslexia (Hoien et al., 1995), and of spelling difficulties in EFL learners with dyslexia (Bonifacci et al., 2017; Lindgren and Laine, 2011). Also in an earlier study with different participants (junior high and high school students) we found that dyslexia, along with other educational and cognitive factors, predicted the accuracy of EFL single word spelling (Jaskulska & Łockiewicz, 2018). Although in the current study we did not find a predictive function of phonological awareness, RAN, and verbal short-term memory on FL spelling, they are all related to dyslexia (Hoien et al., 1995; Wolf et al., 2000), as spelling is, which our study showed. For example, FL spelling correlated with phonological awareness and verbal short-term memory, but not with RAN, in Dutch as NL (van Sette et al., 2017). Korean as NL metalinguistic awareness (a construct underlying phonological, orthographic, and morphological awareness) predicted EFL spelling. When analysed separately, however, orthographic awareness in NL did not contribute to EFL spelling (Yeon et al., 2017).

The biggest limitation of our research is a comparatively small number of participants. Moreover, since our Polish participants did not know all English phonemes, they could have attempted to spell similar Polish phonemes. In future studies, we would like to ask the participants to read the spelt words, and to transcribe their pronunciations. Moreover, we would like to include an older Polish group, with reading age level matched with English students with dyslexia.

CONCLUSIONS

We found that both Polish students with and without dyslexia, who struggled with the EFL phoneme-to-grapheme conversion, made more phonological errors than both English students with and without dyslexia, and more orthographic errors than English students without dyslexia. Similarly, Polish students with dyslexia made more orthographic errors than English students with dyslexia; however, Polish students without dyslexia performed on a level with English students with dyslexia. Likely, both Polish students with and without dyslexia had underdeveloped EFL mental lexicons, as compared with their English peers' NL lexicons, but Polish students with dyslexia additionally misspelt the words so substantially that it resulted in phonological errors. Moreover, English students

with dyslexia deficits were so deep, that they failed to outperform Polish students without dyslexia despite being native speakers, with much more language exposure and practice. Moreover, in our study dyslexia predicted orthographic accuracy of single word spelling in both Polish and English students, but phonological accuracy only in the English learners. This suggests that the symptoms of the phonological deficits at the behavioural level in students with dyslexia are more conspicuous in the English language rather than Polish. Moreover, despite differences in the consistency, regularity, and transparency of compared orthographies, similar words turned out to be most difficult for both native speakers and EFL learners.

We also found that orthographic errors were more frequent than phonological errors in the English group, while phonological errors were more frequent than orthographic errors in the Polish group. This suggests that despite being the same age, Polish students employed an earlier spelling strategy, more based on sublexical than lexical knowledge and skills, as compared with their English peers, and more frequently misspelt the words practically beyond recognition. We believe that teaching spelling rules should be introduced in EFL instruction, to facilitate the development of writing skills. In the future, we would like to conduct longitudinal studies, in which we would investigate the stages of EFL acquisition of Polish children, both in preschool and elementary school, and compare their reading and spelling ages and the trajectories of common errors with English learners.

Footnotes

1. The same group participated in a study by Łockiewicz, Jaskulska, and Fawcett (2019) and Łockiewicz, Jaskulska, and Fawcett (2020). Therefore, the numbers given in the Participants section are identical in these three papers, as these are necessary to report characteristics of the same students.

2. The results concerning phonological processing skills presented in this paragraph are also reported in Łockiewicz, Jaskulska, and Fawcett, 2020, a paper presenting the relationship between these skills and reading (cf. Introduction).

Acknowledgements

This work was supported by the National Science Centre, Poland under Grant no. 2014/14/M/HS6/00922.

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Asia Pacific Journal of Developmental Differences
Vol. 8, No.2, July 2021, pp. 270—284
DOI: 10.3850/S2345734121000124

Cognitive Information Processing and Environmental Factors in Hiragana Reading/Writing of Down syndrome Children- Compared to typically developing Children

Mariko Maeda[1*], Manami Koizumi[1], Kaori Hosokawa[2] and Michio Kojima[3]

1. Graduate School of Comprehensive Human Sciences, University of Tsukuba
2. Faculty of Education, Chiba University
3. Faculty of Human Sciences, University of Tsukuba

Abstract

Introduction: Factors related to reading/writing skills of children with DS were investigated by focusing on their cognitive information processing abilities and environmental factors.

Methods: Participants were children with DS (N=30), typically developing (TD) children N=59. Hiragana reading/writing tasks and cognitive processing ability tasks were performed. Moreover, a questionnaire was administered to their parents to investigate the children's profiles and environmental factors.

Results: Reading/writing scores of children with DS with a mental age (MA) of 4, 5, and 6 years and TD children with a chronological age of 4, 5, and 6 years were compared to identify the types of characteristics in which children with DS score higher than TD children. We showed the difference in environmental factors related to cognitive information processing ability and reading/writing ability of DS and TD children.

Conclusion Factors related to reading/writing of children with DS were also shown.

Keywords: Down syndrome, Hiragana, Reading and Writing skill

* *Correspondence to:*

Mariko Maeda, Graduate School of Comprehensive Human Sciences, University of Tsukuba1, Email: maai.tks@gmail.com

BACKGROUND

The Japanese writing system includes Hiragana, Katakana, and Kanji （Chinese characters), and sentences are composed of these characters. In elementary school, children usually first learn Hiragana, which is the basic Japanese writing system, and then learn Katakana. Children also start to learn Kanji in elementary school after learning Hiragana and Katakana. Hiragana includes various character types, such as voiceless sounds, voiced/semi-voiced sounds, and special syllables. Voiceless sounds consist of 46 characters, including combinations of five vowels (a, i, u, e, o) and nine consonants, and the syllabic nasal "n" (Fig.1). When pronouncing some of the voiceless sounds by adding a sonant mark or a p-sound mark, they become voiced or semi-voiced sounds. There are 20 voiced sound and 5 semi-voiced sound characters. When writing specific voiceless sounds short, and pronouncing them, or, pronouncing them long, they become special syllables.

There are four types of special syllables; geminate stop consonants, contracted sounds, long vowels, and contracted long vowels. Katakana characters were developed by simplifying specific Shakuji (Kanji used for sound equivalence). Kanji, which originated in China, is the most difficult of the Japanese writing systems. The Kanji teaching procedures are described in the Gakunenbetsu Kanji Haitōhyō (list of Kanji by school year) developed by the Japanese Ministry of Education as a part of educational guidelines. This list indicates which Kanji and the number of Kanji that students should learn in each grade. As the grade-level increases, the number and the difficulty of Kanji that students must learn increases. Specific researchers have reported that Hiragana reading and writing skills are acquired before school age.

Many studies related to reading and writing skills have been conducted in recent years in Japan. These studies have indicated that typically developing (TD) children can acquire Hiragana reading and writing skills around the age of 4, and cognitive processing abilities such as phonological awareness, visual cognition, and automatization, among others, are related to the acquisition of these skills (Shimamura, Mikami, 1994; Awaya, Uno, 2003; Uno, 2007; Inomata, Haruhara, 2013).

Hiragana has a regular grapheme-phoneme correspondence, such that one character corresponds to one mora. Therefore, phonological information processing ability, which is related to mora awareness, is involved in Hiragana acquisition (Amano, 1970). Moreover, one mora is represented by two characters in special Hiragana syllables, resulting in acquisition difficulties (Dairoku, 2000). Mitsuzuka (1994) demonstrated that young TD children's writing ability is correlated with figure-copying and spatial cognition task results, suggesting a relationship between writing ability and visual cognitive ability related to form and space perception. Moreover, previous studies on the correlation between reading and writing skills and the home environment have indicated that teaching to write at home affects children's writing skills. Furthermore, the frequency of

reading activities and the frequency of teaching letters affects the reading skills of 3-4-year-old children, but not the reading skills of 5-6-year-old children (Inomata, Uno, Sakai, Haruhara, 2016).

It has been reported in Japan, that cognitive processing abilities including phonological awareness, visual cognition, and manipulation of fingers are required for children with Down syndrome (DS) having intellectual disabilities to acquire Hiragana reading and writing skills, which are also necessary for TD children. Moreover, children with DS need to at least reach the developmental age of four in all these cognitive processing abilities (Kono,2014). Most of the past studies have been case studies that have attempted to verify the effects of teaching reading and writing skills on children with DS based on the child's conditions. These include, for example, a study that conducted teaching Hiragana reading using a top-down method of starting from word-learning, and gradually shifting to one-character learning; a study that used keywords as the intermediary for reading characters; and a study that taught writing by focusing on visual cognition (Kuboyama et al.,2008; Nagayama et al.,2010; Yamaguchi, 2006). However, no continuous studies have been conducted on factors related to reading and writing skills of children with Down syndrome in Japan.

The possibility that IQ and reading and writing skills are unrelated has been suggested (Kono, 2015). However, this possibility has been insufficiently investigated to date. Some of these studies have investigated children with intellectual disabilities and those with developmental disorders without distinguishing between the two. Other studies have reported findings on children other than those with DS. Furthermore, it is known that factors other than the level of intellectual development, such as the home environment might affect children's reading and writing skills. As described above, factors related to reading and writing skills of children with DS have not been sufficiently examined to date.

On the other hand, programs for teaching reading and writing skills for children and adolescents with DS have been developed overseas, administered, and their effects have been reported (Moni et al., 2000,Paola,2016). One such study examined correlations between reading and writing skills and phonological awareness by comparing TD children and children with DS between the ages of 5 and 18 years (Cossu et al.,1993,Laws et al.,2016, Loveall et al.,2016).

Overseas studies on reading and writing skills of children with DS have been conducted with a wide range of children, from early childhood to school age, and teaching programs have been developed for children in childhood to adolescence. The results of these studies suggest that reading and writing skills of individuals with DS might improve from early childhood to school age and adolescence.

As mentioned above, only a few studies have been conducted in Japan on the eading

and writing skills of children with DS and their characteristics have been insufficiently investigated to date. It is useful to understand the characteristics of children with DS when teaching them reading and writing skills. Therefore, in the present study, children's Hiragana reading and writing skills and their correlations with cognitive processing abilities as well as environmental abilities were examined in young children to high school students with DS by comparisons with TD children. Moreover, correlations with intellectual abilities were examined through comparisons between children with DS with a mental age of 4~6 and TD children.

METHODS

Participants

Participants were children with DS (N=30; 14 boys and 16 girls) and TD children (N=59; 27 boys and 32 girls) that were recruited from parents' associations, special education schools, and nursery schools, among others, in local communities. Requirements for children with DS included those that were interested in Hiragana, could read more than one character, and obtaining the parents' consent.

They comprised of 8 elementary school children, 14 junior high school students, and 8 senior high school students. They were affiliated to special needs classes (N=8) and special education schools (N=22). TD children comprised of 24 four-year-old children, 23 five-year-old children, and 12 six-year-old children. Table 1 shows the mean chronological age (CA) and the mean mental age(MA) of the participants.

Survey content

By referring to previous studies, Hiragana reading and writing tasks and cognitive processing ability tasks were conducted with young children with DS and TD young children. Moreover, a questionnaire was administered to their parents to investigate the children's profiles and environmental factors.

Tasks of reading and writing Hiragana

The tasks of reading and writing 46 voiceless sounds/ syllabic nasals, 20 voiced sounds, and 5 semi-voiced sounds, as well as tasks of reading 23 special syllables including a double consonant, contracted sounds, long vowels, and contracted long vowels were conducted, by referring to the Hiragana reading and writing test (The National Language Research Institute, 1972) used by Shimamura et al. (1994) and Ota et al. (2018). Recently, this test is administered to TD children for examining their Hiragana reading and writing skills development.

Table 1 Participant characteristics by DS and TD children

		Age group						All	
		4 years		5 years		6 years			
		DS	TD	DS	TD	DS	TD	DS	TD
		N=8	N=24	N=12	N=23	N=10	N=12	N=30	N=59
CA	**Range** years: months	8:04 to 16:02	4:00 to 4:11	8:06 to 15:08	5:00- to 5:11	11:02 to 16:11	6:00 to 6:07	8:04 to 16:11	4:00 to 6:07
	Mean years: months	11:07	4:04	12:08	5:04	14:09	6:01	13:01	5:01
	SD months	37.82	3.55	23.09	3.82	21.90	2.10	29.99	8.79
MA	**Range** years: months	4:00 to 4:11	4:00 to 4:11	5:01 to 5:10	5:00 to 5:11	6:00 to 6:08	6:00 to 6:07	4:00 to 6:08	4:00 to 6:07
	Mean years: months	4:05	4:04	5:05	5:04	6:04	6:01	5:05	5:01
	SD months	3.90	3.55	3.20	3.82	2.68	2.10	9.36	8.79

Tasks related to cognitive processing abilities

Phonological awareness tasks consisted of mora segmentation of normal syllables, long vowels, and geminate stop consonants, as well as non-word repetition tasks of 4-5 mora words. Visual cognition tasks included line-drawing tasks, spatial cognition tasks, and figure copying tasks.

In the case of phonological tasks, practice exercises of 2-3-mora words were conducted twice before the main task in the following order based on Kakihana et al. (2009): normal syllables, long vowels, and geminate stop consonants. Moreover, for non-word repetition tasks, a practice exercise of three-mora words was conducted before the main

task in the following order: four-mora words and five-mora words also by referring to Kakihana et al. (2009). The above tasks were selected because they were used in a previous study to examine 3-4-year-old children's reading skills.

Line-drawing tasks of drawing straight lines with different thickness, C-curves, inverted C-curves, and wavy lines were conducted as visual cognition tasks by referring to Gunji et al. (2015). Correlations between these tasks in the Frostig Developmental Test of Visual Perception for assessing visual perception skills, and writing skills, have been reported.

Moreover, the participants were requested to conduct a spatial cognition task of reproducing two types of sample patterns by connecting nine dots consisting of 3 rows X 3 rows by drawing lines. Furthermore, the participants conducted a figure copying task of copying a triangle.

Questionnaire on basic attributes of children and life environment related to reading and writing skills:

The question items in the questionnaire on the living environment were developed based on the children's basic attributes (age, affiliation, the presence of complications, among others) by referring to Hamano et al. (2012). The parents of the participants responded to the questions. The content of the question items included the following: past and present conditions of teaching reading/writing and the frequency of reading/writing activities in kindergartens, nursery schools, and schools, opportunities of contact with the characters and the frequency of reading and writing activities at home, children's interest in the characters, and the frequency of reading and writing activities in the current living environment.

Intellectual ability tests

The Tanaka-Binet Intelligence Scale V (Tanaka Institute for Educational Research, 2005) was administered to children with DS. This is a standardized intelligence test with established reliability and validity for Japanese respondents, which is frequently used to assess the mental age and IQ of children with intellectual disabilities.

Procedures

All the tasks were conducted individually by the first author.

Scoring

Table 2 shows the number of tasks and scoring criteria of Hiragana reading and writing tasks and cognitive information processing ability tasks. Environmental factors were scored based on the responses to the questionnaire by calculating the number of years of being taught reading and writing and conducting reading and writing activities to

Table 2 The number of tasks, the criteria, and the range of the scores

		TASKS	THE NUMBER OF TASKS THE SCORING CRITERIA	SCORE RANGE
Reading & Writing in Hiragana	Reading Task	voiceless sounds	46 characters ♦***1 point*** *per character*	1～46
		voiced/ semi-voiced sounds	voiced sounds 20 characters & semi-voiced sounds 25 characters ♦***1 point*** *per character*	0～25
		special syllables	3 characters and 20 words ♦***1 point*** *per character and word*	0～23
	Writing Task	voiceless sounds	46 characters ♦***1 point*** *per character*	0～46
		voiced/ semi-voiced sounds	voiced sounds 20 characters & semi-voiced sounds 25 characters ♦***1 point*** *per character*	0～25
Tasks Related to Cognitive Processing Abilities	Phonological Awareness Tasks	mora segmentation	9 questions ♦***1 point*** *per question*	0～9
		non-word repetition tasks of 4 mora words	10 questions ♦***1 point*** *per question*	0～10
		non-word repetition tasks of 5 mora words	10 questions ♦***1 point*** *per question*	0～10
	Visual Cognition Tasks	line-drawing tasks	8 questions ♦***2 points:*** *A continuous line is drawn between two parallel lines.* ♦***1 point:*** *The drawn line touches two parallel lines at one point or more, or the line sticks out from the start or endpoint of the two parallel lines by less than 1.3mm.* ♦***0 point:*** *The drawn line sticks out from the space between the parallel lines, or is cut off in the middle, or sticks out from the start or endpoint of the parallel lines by more than 1.3mm, or is shorter than the parallel lines by over 3 mm.*	0～8
		spatial cognition tasks	2 questions ♦***1 point:*** *The line is completely identical to the model.* ♦***0 point:*** *The line is different from the model.*	0～2
		figure copying tasks	1 questions ♦***Tanaka-Binet Intelligence Scale*** *scoring criteria was used.*	0～1

date. Moreover, parents were requested to respond to questions using a four-point scale on opportunities that children had of contact with characters, the frequency of reading and writing activities, and the number of books or character learning materials at home. The total scores were calculated and regarded as the reading and writing activity at home score. Parents were also requested to respond to questions using a three-point scale on children's interest in the characters. The total scores were calculated and regarded as the children's interest in the characters scores.

Ethical considerations

This study was conducted after obtaining approval from the ethics committee of the institution in which the author is enrolled. Prior to conducting the survey, consent was obtained from the representatives of parents' associations and school principals. Moreover, written or oral explanations were given to parents in advance about the outline of the study, the time that was required, and ethical considerations, among others. The survey was conducted after obtaining their consent.

Methods of Analysis

Thirty responses were collected for the questionnaire on environmental factors from Children with DS's parents (the response rate=100%). Among them, 3 responses with missing values were excluded, and 27 data-sets were analysed. On the other hand, 50 responses were collected from TD children's parents (the response rate=85%). Among them, 4 responses with missing values were excluded, and 46 data-sets were analysed. Therefore, the number of participants in the analysis of the correlations with environmental factors was as follows. There are 7 children with DS with a MA four-years, 11 children with DS with a MA five-years, and 9 children with DS with a MA six-years. TD children: 17 four-year-old children, 19 five-year-old children, and 10 six-year-old children.

The assumption of a normal distribution was rejected for the character types in analysing the reading and writing task scores of children with DS. Therefore, a nonparametric test was used. First, differences in the scores of each task between children with DS and TD children were examined by classifying children with DS into MA of 4-, 5-, and 6-year-old groups and TD children into CA of 4-, 5-, and 6-year-old groups. The Mann-Whitney U test was conducted on the same age groups for the reading and writing task scores, cognitive processing ability task scores, and environmental factor scores as dependent variables and the presence of disabilities as an independent variable. Next, correlations between reading and writing task scores and cognitive processing ability task scores, as well as environmental factor scores were examined by calculating the Spearman's rank correlation coefficient with reading and writing activity scores, cognitive processing ability task scores, and environmental factor scores of children with DS and TD children as dependent variables.

RESULT

Comparison of reading and writing task scores, cognitive processing ability task scores, and environmental factors scores between children with DS and TD children

Table 3 shows differences in reading and writing task scores based on the MA and the CA. Significant differences were shown in reading and writing task scores for writing voiceless sounds, reading and writing voiced/semi-voiced sounds, and reading special syllables in the four-year-old group. In the five- and six-year-old groups, significant differences were shown in writing voiceless sounds and voiced/semi-voiced sounds. The mean score of children with DS in each task was higher than TD children. On the other hand, no significant difference was shown in reading voiceless sounds.

Moreover, significant differences in cognitive processing ability task scores were shown in the 4-mora nonword repetition task and 5-mora nonword repetition task between four- and five-year-old groups. In the six-year-old group, a significant difference was shown in the 5-mora nonword repetition task. The mean score of TD children in each task was higher than that of children with DS. On the other hand, no significant differences were shown in the visual information processing ability tasks such as the line drawing task, spatial cognition task, and figure copying task, or in the mora segmentation tasks.

Furthermore, there were significant differences in environmental factor scores in the number of years of being taught reading and writing as well as the number of years of reading and writing activities in all the age groups, such that the average number of years of both factors in children with DS was longer than TD children. On the other hand, no significant differences were shown in the reading and writing activity scores at home or the children's interest in the characters.

Correlations with factors related to reading and writing task scores

Correlations between reading and writing task scores and cognitive processing task scores as well as environmental factor scores of children with DS and TD children, were examined (Table 4).

Regarding the correlation between the reading and writing task and cognitive information processing task, in children with DS, positive correlations were shown between reading and writing all the types of characters and the task of mora segmentation, the task of reading special syllables and line-drawing task, the task of writing voiceless sounds and figure copying task, as well as the task of writing semi-voiced sounds and 5-mora nonword repetition task. In contrast, no correlation was shown with the 4-mora nonword repetition task. In TD children, positive correlations were shown between the tasks of reading and writing all the types of characters and visual information processing ability tasks including the line-drawing task, spatial cognition task, and figure copying task, between the task of reading voiceless sounds and mora segmentation task as well as 4-mora nonword repetition task, and between the tasks of reading voiced/semi-voiced sounds as well as special syllables and 4-mora nonword

Table 3 The mean scores of the reading and writing tasks, cognitive processing ability tasks, and environmental factor scores in each MA or CA group and the results of the examination.

	DS 4 year (N=8)		TD 4 year (N=24)			DS 5 year (N=12)		TD 5 year (N=23)			DS 6 year (N=10)		TD 6 year (N=12)		
	M	*SD*	*M*	*SD*	*U*	*M*	*SD*	*M*	*SD*	*U*	*M*	*SD*	*M*	*SD*	*U*
voiceless sounds reading task	42.38	7.50	27.88	17.49	5.09$^{\cdot}$	44.00	1.85	41.09	11.31	1.98	45.30	1.05	45.50	1.00	0.40
voiced/semi-voiced sounds reading task	19.63	9.05	8.33	9.77	**8.09**$^{\cdot\cdot}$	21.75	3.72	19.13	9.17	0.08	24.60	0.69	23.75	2.59	0.007
special syllables reading task	12.13	9.17	1.13	3.84	**16.21**$^{\cdot\cdot\cdot}$	17.50	6.92	11.48	8.71	3.50	21.10	1.66	17.67	7.45	0.750
voiceless sounds writing task	34.00	14.83	2.17	4.74	**16.56**$^{\cdot\cdot\cdot}$	43.42	3.17	18.22	17.19	**14.23**$^{\cdot\cdot\cdot}$	44.40	1.50	30.75	14.88	**9.33**$^{\cdot\cdot}$
voiced/semi-voiced sounds writing task	11.13	9.09	0.25	1.22	**21.75**$^{\cdot\cdot\cdot}$	16.33	7.15	6.74	8.91	**7.26**$^{\cdot\cdot}$	22.40	2.17	12.67	7.49	**11.83**$^{\cdot\cdot}$
mora segmentation	5.50	1.92	6.08	2.08	0.90	6.50	2.11	7.13	1.25	0.47	7.90	1.28	6.62	2.29	2.75
non-word repetition tasks of 4 mora words	5.50	2.72	8.42	2.06	**11.56**$^{\cdot\cdot}$	6.08	2.67	9.26	1.09	**13.50**$^{\cdot\cdot\cdot}$	7.60	2.50	8.83	1.40	1.41
non-word repetition tasks of 5 mora words	3.13	3.04	8.83	2.07	**14.82**$^{\cdot\cdot\cdot}$	4.17	3.09	9.00	1.12	16.88	6.40	2.63	9.17	1.03	**9.39**$^{\cdot\cdot}$
line-drawing tasks	7.13	3.60	4.88	2.86	2.83	8.50	4.01	6.96	2.94	1.75	9.60	2.91	9.08	2.57	0.58
spatial cognition tasks	1.38	0.91	0.54	0.83	4.85$^{\cdot}$	1.33	0.88	1.35	0.83	0.00	1.80	0.63	1.58	0.79	0.69
figure copying tasks	0.63	0.51	0.33	0.48	2.05	0.83	0.38	0.78	0.42	0.12	1.00	0.00	0.92	0.28	0.83
years of being taught reading※1	5.71	3.86	0.41	0.79	**16.21**$^{\cdot\cdot\cdot}$	7.27	2.68	0.89	1.10	**20.34**$^{\cdot\cdot\cdot}$	9.22	2.10	0.90	1.19	**13.14**$^{\cdot\cdot\cdot}$
years of being taught writing※1	5.14	3.28	0.35	0.70	**15.93**$^{\cdot\cdot\cdot}$	6.91	2.30	0.53	0.69	**21.50**$^{\cdot\cdot\cdot}$	8.33	2.64	1.00	0.81	**13.01**$^{\cdot\cdot\cdot}$
years of reading activities※1	4.71	4.07	0.47	0.80	**11.63**$^{\cdot\cdot}$	7.36	2.69	1.00	1.24	**19.65**$^{\cdot\cdot\cdot}$	8.22	1.98	1.20	1.31	**13.01**$^{\cdot\cdot\cdot}$
years of writing activities※1	4.14	3.43	0.18	0.52	**17.37**$^{\cdot\cdot\cdot}$	6.91	2.42	0.47	1.07	**22.28**$^{\cdot\cdot\cdot}$	8.44	2.06	0.80	1.13	**13.32**$^{\cdot\cdot\cdot}$
the reading and writing activity at home score※1	19.00	2.82	18.29	2.59	0.54	19.82	3.97	19.63	2.67	0.13	19.33	2.06	17.50	3.59	1.26
the children's interest in the characters score※1	16.43	2.44	16.53	3.16	0.05	15.91	2.42	17.42	3.45	2.86	14.22	3.15	17.60	2.71	3.87$^{\cdot}$

*p<.05,**p<.01,***p<.001

※1:DS: 7 four-year-old children, 11 five-year-old children, and 9 six-year-old children. TD: 17 four-year-old children, 19 five-year-old children, and 10 six-year-old children.

Table 4 Correlation between the scores of reading and writing tasks and cognitive processing ability tasks as well as environmental factors.

	voiceless sounds reading task		voiced/semi-voiced sounds reading task		special syllables reading task		voiceless sounds writing task		voiced/semi-voiced sounds writing task	
	DS N=30	TD N=59	DS N=30	TD N=59	DS N=30	TD N=59	DS N=30	TD N=59	DS N=30	TD N=59
voiceless sounds reading task										
voiced/semi-voiced sounds reading task	**0.57****	**0.88*****								
special syllables reading task	0.41*	**0.74*****	**0.47****	**0.87*****						
voiceless sounds writing task	0.28	**0.75*****	0.26	**0.77*****	0.39*	**0.78*****				
voiced/semi-voiced sounds writing task	0.41*	**0.67*****	**0.52****	**0.77*****	**0.51****	**0.81*****	**0.59*****	**0.89*****		
mora segmentation	**0.50****	**0.33****	**0.58****	0.31*	**0.72*****	0.33*	**0.50****	0.24	**0.66*****	0.24
non-word repetition tasks of 4 mora words	0.24	**0.39****	0.14	**0.34****	0.11	**0.37****	-0.03	0.31*	0.31	0.30*
non-word repetition tasks of 5 mora words	0.17	0.23	0.19	0.16	0.28	0.17	0.01	0.22	**0.47****	0.16
line-drawing tasks	0.32	**0.34****	0.14	**0.43****	**0.61*****	**0.52*****	0.44*	**0.58*****	0.34	**0.54*****
spatial cognition tasks	0.28	**0.50*****	0.14	**0.55*****	0.34	**0.61*****	0.41*	**0.58*****	0.29	**0.55*****
figure copying tasks	0.25	**0.47*****	0.27	**0.45*****	0.22	**0.57*****	**0.48****	**0.58*****	0.39*	**0.47*****
years of being taught reading※1	0.16	0.13	0.36	-0.02	**0.73*****	-0.03	0.27	0.06	0.44*	0.03
years of being taught writing※1	0.21	0.03	0.47*	0.01	**0.73*****	-0.04	0.25	0.11	0.40*	0.06
years of reading activities※1	0.08	0.21	0.35	0.07	**0.73*****	0.01	0.24	0.25	0.38*	0.17
years of writing activities※1	0.07	0.07	0.31	0.09	**0.68*****	0.05	0.17	0.24	0.35	0.21
the reading and writing activity at home score※1	-0.18	0.33*	-0.11	0.19	-0.22	0.17	0.06	0.14	-0.09	0.02
the children's interest in the characters score※1	0.11	0.03	0.03	0.08	0.005	0.15	0.10	0.11	-0.07	0.03
MA	0.34	-	0.45*	-	0.41*	-	0.43*	-	**0.67*****	-
CA	0.25	**0.57*****	0.41*	**0.59*****	**0.68*****	**0.66*****	0.27	**0.68*****	**0.47****	**0.65*****

*p<.05,**p<.01,***p<.001

※1:DS:27 children, TD:46 children

repetition task, whereas no correlation was shown with the 5-mora nonword repetition task.

Regarding correlations between reading and writing tasks and environmental factor scores, in children with DS, positive correlations were shown between the task of reading special syllables and the number of years of teaching reading and writing as well as the number of years of experiencing reading and writing activities, whereas no correlations were shown with other reading and writing tasks. In TD children, there were no correlations between reading and writing tasks and environmental factor scores.
As for correlations between reading and writing tasks and MA as well as CA, in children with DS, positive correlations were shown between the task of reading special syllables and CA and between the task of writing voiced/semi-voiced sounds and MA as well as CA. In TD children, a positive correlation was shown between the tasks of reading and writing all the types of characters and CA.

DISCUSSION

Comparison of reading and writing task scores, cognitive processing ability task scores, and environmental factors scores between children with DS and TD children
Utashiro et al. (2015) indicated that the reading ability of children with intellectual and developmental disabilities with a MA of four years was higher than TD children with a CA of four years. The same result was indicated in the present study on children with DS with a MA of four years. Moreover, the result of no difference in the single character reading task score between five- or six-year-old children with DS and TD children was consistent with Utashiro et al. (2015). It has been indicated that four-year-old TD children become able to read about half the voiceless sounds and syllabic nasals (Shimamura et al.,1994). The present study indicated the reading ability of Children with DS with a MA of 4 years was higher than TD children. Moreover, the writing ability of children with DS was higher than TD children of all age groups (4-, 5-, and 6-year-old groups), suggesting that writing ability might be affected by life experience. It was suggested that children with DS might be able to acquire reading and writing abilities that are higher than their MA level, assumed based on TD children, as a result of receiving continuous teaching and conducting continuous learning activities

Regarding cognitive processing ability task scores, no differences were shown in visual information processing ability tasks and mora segmentation tasks between children with DS and TD children, suggesting that these abilities might be acquired based on MA. On the other hand, differences were shown in the scores of 4-mora and 5-mora nonword repetition tasks between children with DS and TD children. Previous studies have indicated that children with DS have a poor memory of auditory verbal stimulation. In nonword repetition tasks, participants are required to reproduce words only by listening (Kanno, 1992). Therefore, the weakness of verbal short-term memory in children with DS might have affected these results.

Correlations with factors related to reading and writing task scores

Different tasks were correlated with reading and writing tasks between children with DS and TD children. In children with DS, positive correlations were shown between all the reading and writing tasks and mora segmentation tasks. Cossu et al. (1993) suggested that the phoneme segmentation ability in children with DS was lower, compared to TD children with an equal level of reading ability. In Japanese, character notation is performed based on the mora. Therefore, the awareness of mora would have a significant effect on reading and writing abilities. In other words, it is considered that mora segmentation ability of general syllables and long vowel sounds, as well as a double consonant, would be necessary for children with DS to acquire reading and writing abilities.

It has been indicated that the ability to read contracted syllables develops in TD children in the senior class of kindergarten without teaching (Endo, 1990). The present study indicated there was a low correlation between the ability to read special syllables and the number of years of teaching or reading and writing activities in 4~6-year-old TD children. On the other hand, in children with DS, a moderate to strong correlation was shown between the ability to read special syllables and the number of years of teaching or reading and writing activities, suggesting a strong effect of the learning experience. In TD children, line-drawing, spatial cognition, and triangle copying abilities had a significant effect on Hiragana writing ability, which is consistent with previous studies (Gunji et al., 2015). On the other hand, in children with DS, only the figure copying task had a moderate correlation with the ability to write voiceless sounds. It is considered that the ability to copy a triangle especially affects the writing ability of children with DS.

A moderate correlation was indicated between the ability to write voiced/semi-voiced sounds and the 5-mora nonword repetition task in children with DS, whereas no such correlation was shown in TD children. Charles et al. (2012) indicated that the word listening ability did not have a significant effect on children with DS's reading ability, whereas Cossu et al. (1993) indicated that listening and writing words task score in children with DS was lower, compared to TD children with an identical level of the reading ability. The writing task used in the present study was as follows; looking at the illustration drawn on the sheet and writing the name of the illustration. This task requires visual information, and participants do not need listening and discriminating characters. However, the discrimination between voiced and semi-voiced sounds might be affected by the auditory speech discrimination ability. Moreover, the score of the 5-mora nonword repetition task of 6-year-old children with DS was lower than 6-year-old TD children. It was suggested that poor verbal short-term memory in children with DS might affect the ability to write voiced/semi-voiced sounds.

LIMITATIONS

This study examined correlations between reading and writing abilities and cognitive processing abilities as well as environmental factors in children with DS. It was indicated children with DS with a MA of four could read most of the voiceless sounds and voices/ semi-voiced sounds. Since it was suggested that cognitive processing ability affects the reading and writing ability of children with Down syndrome, it is necessary to consider effective teaching of reading and writing ability. In the future, children with DS with a MA of under four should be examined. Moreover, it was indicated that the 5-mora nonword repetition task was correlated to the task of writing voiced/semi-voiced sounds, and a correlation with the auditory listening ability was suggested. Therefore, the level of the auditory speech discrimination ability that is necessary for phonological information processing should be investigated.

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Asia Pacific Journal of Developmental Differences
Vol. 8, No. 2, July 2021, pp. 286—301
DOI: 10.3850/S2345734121000139

Concrete-Representational-Abstract and Multisensory Strategies: An Inclusive Approach to Mathematics

Rameeza Khan[1*] and Masarrat Khan[2]

1. *B. A. F. Petit Girls' High School, Mumbai, India*
2. *Maharashtra Dyslexia Association, India*

Abstract

Maths is an area of processing which many students in school continue to struggle with, whether or not they have learning difficulties of any kind. In this article, the authors review the usefulness of an inclusive approach to Maths using the CRA, Concrete-Representational-Abstract, which builds on multisensory approach suitable for all learners. Outlining the Piagetian principles first underlying learning, the authors demonstrate in practical terms how this system is ideally delivered, providing supportive evidence for the impact of the approach in students with learning difficulties. The role of the skilled teacher in ensuring this is delivered effectively joining together the 3 sections explicitly to aid understanding, is emphasized here.

Keywords: Concrete-Representational-Abstract (CRA), Maths, Learning difficulties

* *Correspondence to:*

Rameeza Khan - B. A. F. Petit Girls' High School Email: rameeza_rk@rediffmail.com

INTRODUCTION.

Mathematics, for some reason, comes across as a challenging subject for the majority of the students, particularly those with learning differences (Baker, Gersten and Dae-Sik, 2002). According to Piaget's Four Stages of Mental Development, children around the ages of 7 to 11 years are said to be in the Concrete Operational Stage, a stage where the development of ideas and thinking tend to be closely tied to performing actions on physical objects. This is especially so as the concepts and instructional methods become more abstract.

The National Council of Teachers of Mathematics makes it known that all students benefit from the use of manipulatives and visual aids (Shaw, 2002). "A major responsibility of teachers is to create a learning environment in which students' use of multiple representations is encouraged, supported, and accepted by peers and adults." (NCTM, 2000, p. 139). Sadly, in our schools in India, concrete experiences are limited to pre-primary education.

When we solve mathematical problems, a core part of the solution process is how we represent the ideas in the problem. The form of representation we select allows us to manipulate the information (as opposed to manipulating symbols) to reach a sensible solution. With the Representation Standard, our goal is for young students to show their mathematical ideas and procedures in multiple ways. Through the use of representations, children develop their own mental images of mathematical ideas. Representations used in the early grades may not be those that are traditionally used by adults. Students' representations provide a record of their efforts to understand mathematics and to make that understanding accessible to others. It is through representations that we can get into a child's thinking, assess the child's understanding, and make instructional decisions.

Students in the early grades would benefit from using multiple modes to represent their thinking. Because of the Concrete Operational Stage that Piaget suggested they are in, most of them would be comfortable with moving physical objects to show their thinking about a problem. This is what is termed as the Concrete Stage of thinking. It should be an expectation, even in the earliest grades, that students use multiple representations. For example, children might use manipulative materials to model their thinking about a problem, then translate that model to a drawing on paper, and eventually move toward the use of more conventional symbols in expressing their thinking. Multiple representations support students' thinking by allowing them to see the same idea expressed in different ways. With this experience, the students will be able to translate this thinking into a pictorial form by drawing on paper. Adults can then guide the students toward using symbolic representations to express thought by helping them to draw on the connections between the concrete representations and pictorial representations.

It has been suggested that one goal of mathematics instruction is for lessons to occur in a step-by-step manner allowing the learners to move from needing concrete manipulatives to solve a problem to a point where they are able to think abstractly through the steps to solve the problem (Miller and Mercer, 1993). Jean Piaget, the Swiss psychologist, introduced a developmental epistemology that focused on the growth of intelligence from infancy to adulthood. He proposed four stages of cognitive development which reflect the increasing sophistication of children's thoughts:

- **Sensorimotor Stage** (Birth to 2 years of age): During this stage, infants and toddlers acquire knowledge through sensory experiences and manipulating objects. At this point in development, children's intelligence consists of their basic motor and sensory explorations of the world. Piaget believed that developing object permanence or object constancy, the understanding that objects continue to exist even when they cannot be seen, was an important element at this point of development. By learning that objects are separate and distinct entities and that they have an existence of their own outside of individual perception, children are then able to begin to attach names and words to objects.

- **Preoperational Stage** (2 years to 7 years): At this stage, children learn through pretend play, but still struggle with logic and taking the point of view of other people. They also often struggle with understanding the ideal of constancy. During this stage, young children are able to think about things symbolically. This is the ability to make one thing - a word or an object - stand for something other than itself. Thinking is still egocentric, and children have difficulty taking the viewpoint of others.

- **Concrete Operational Stage** (7 years to 11 years): Children, at this point of development, begin to think more logically, but their thinking can also be very rigid. They tend to struggle with abstract and hypothetical concepts. Children can work things out internally in their head (rather than physically try things out in the real world). Children can conserve number (age 6), mass (age 7), and weight (age 9). Conservation is the understanding that something stays the same in quantity even though its appearance changes.

- **Formal Operational Stage** (11 years and above). During this stage, people develop the ability to think about abstract concepts and logically test hypotheses. It should, however, be acknowledged that more recent research has suggested that many teenagers never reached the stage of formal operations (Shayer, Kucheman and Wylam, 1976).

Each child goes through the stages in the same order, and a child's development is determined by biological maturation and interaction with the environment. Although no

stage can be missed out, there are individual differences in the rate at which children progress through the stages, and some individuals may never attain the later stages. Piaget did not claim that a particular stage was reached at a certain age - although descriptions of the stages often include an indication of the age at which the average child would reach each stage.

Researchers have explained how features of Piaget's theory can be applied to teaching and learning. Piaget has been extremely influential in developing educational policy and teaching practice. For example, a review of primary education by the UK government in 1966 was based strongly on Piaget's theory. The result of this review led to the publication of the Plowden Report (1967). The report's recurring themes are individual learning, flexibility in the curriculum, the centrality of play in children's learning, use of the environment, learning by discovery, and the importance of evaluation of children's progress - teachers should not assume that only what is measurable is valuable. 'Discovery Learning' – the idea that children learn best through doing and actively exploring - was seen as central to the transformation of the primary school curriculum.

Because Piaget's theory is based upon biological maturation and stages, the notion of 'readiness' is important. Readiness concerns when certain information or concepts should be taught. As per Piaget's theory, children should not be taught certain concepts until they have reached the appropriate stage of cognitive development. According to Piaget (1958), assimilation and accommodation require an active learner, not a passive one, because problem-solving skills cannot be taught, they must be discovered.

Within the classroom, learning should be student-centered, accomplished through active discovery learning. The role of the teacher is to facilitate learning, rather than direct tuition. Therefore, teachers should encourage the following within the classroom:

- Focus on the process of learning, rather than the end product of it.
- Use of active methods that require rediscovering or reconstructing "truths".
- Use of collaborative, as well as individual activities (so children can learn from each other).
- Devising situations that present useful problems, and create disequilibrium in the child.
- Evaluation of the level of the child's development so suitable tasks can be set.

We know that children begin to develop understanding of mathematical ideas on a concrete level. Physical materials give students an opportunity to express their ideas before they are able to record them with pencil and paper; they also give students the flexibility to make, test and refine their conjectures. This does not imply that once students have developed writing skills, physical models should be eliminated. Many mathematicians and scientists rely on concrete models to test and refine their conjectures!

A successful approach that encapsulates Piaget's links between the concrete, representational and abstract for Mathematics is the CRA strategy. This strategy is an intervention for mathematics instruction that research suggests can enhance the mathematics performance of students in a classroom (Nugroho and Jailani, 2019) as well as of those with Learning Disabilities (LDs), (Bouck, Satsangi and Parks, 2017). It provides a graduated, conceptually supported line of work to create meaningful connections among concrete, representational, and abstract levels of understanding. It is a three-part instructional strategy, with each part building on the previous instruction to promote student learning and retention, and to address conceptual knowledge (American Institute for Research, 2016). The CRA strategy has its roots in the work of Bruner and Kenney (1965), who defined learning through "Stages of Representation":

- **Enactive** – learning through movement and action
- **Iconic** – learning through pictures
- **Symbolic** – learning through abstract symbols

The CRA strategy combines effective components of both behaviourist (direct instruction) and constructivist (discovery-learning) practices (Sealander, Johnson, Lockwood & Medina, 2012; Mercer & Miller, 1992). This strategy is especially effective when used to teach individuals with LDs across grade levels and in many different topic areas in mathematics (Witzel, Riccomini & Schneider, 2008). CRA uses demonstration, modeling, guided practice followed by independent practice, and immediate feedback, which are aspects commonly found in direct instruction. Prior literature reviews have found using direct and explicit instruction for students with LDs in mathematics to have strong effect sizes (e.g., Baker, Gersten & Dae-Sik, 2002; Gersten, Chard, Jayanthi, Baker, Morphy & Flojo, 2009; Zheng, Flynn & Swanson, 2013).

CRA also includes discovery-learning strategies involving representation to help students transition between conceptual knowledge and procedural knowledge (Sealander, Johnson, Lockwood & Medina, 2012). Note that this will be particularly important for children with dyslexia and other learning disabilities, as these have been linked to a deficit in procedural learning, (Nicolson and Fawcett, 2007).

The C-R-A instructional sequence consists of three stages, concrete, representational and abstract:

Concrete: This is known as the 'doing' stage and involves physically manipulating objects to solve a math problem. The teacher begins instruction by modelling each mathematical concept with physical materials also known as concrete manipulatives (e.g. red and yellow chips, cubes, base10 blocks, pattern blocks, fraction bars and geometric figures) not to solve, but rather to visualize the problem or a concept. Students are guided by the teacher to meaningful interactions with the hands-on materials to model the concept or skills.

Representational: It is known as the "seeing" stage and involves using images to represent objects to solve a math problem. The teacher transforms the concrete model into a representational (semi-concrete) level, which may involve drawing pictures; using circles, dots and tallies; or using stamps to imprint pictures for counting. Students draw pictures that represent the concrete objects previously used.

Abstract: It is known as the "symbolic" stage. The teacher models the mathematics concept at a symbolic level, using only numbers, notation and mathematical symbols to represent the number of circles or groups of circles. The teacher and students use operation symbols (+, x, -) to indicate addition, multiplication or subtraction.

As the teacher moves through the concrete-to-representational-to-abstract sequence of instruction, the abstract numbers and/or symbols should be used in conjunction with the concrete materials and the representational drawings. CRA is an interconnected instructional sequence, and these explicit connections between lessons and stages are crucial in order for students to learn the targeted skill as well as comprehend the associated concepts (Witzel, Riccomini & Schneider, 2008). However, the power of C-R-A lies in its ability to help students transform their thinking from the physical to the mental. This instructional sequence is only powerful if teachers are able to help students join the dots between what is similar in the three modes of representation: students' experience with concrete materials, the picture representation, and the symbolic representation.

Mathematics teaching involving the C-R-A teaching sequence often includes the following steps:

1. Teach the math concept using manipulatives (concrete level).
2. Allow ample opportunities for students to practice the concept using various manipulatives.
3. Make sure students understand the concept at the concrete level before moving on to the representational level.
4. Introduce pictures to represent objects (representational level). Model the concept.
5. Provide plenty of time for students to practice the concept using drawn or virtual images.
6. Check student understanding. Do not move to the abstract level if students haven't mastered the representational level.
7. Teach students the math concept using only numbers and symbols (abstract level). Model the concept.
8. Provide plenty of time for students to practice the concept using only numbers and symbols.
9. Check student understanding. If students are struggling, go back to the concrete and representational levels.

Once the concept is mastered at the abstract level, periodically bring back the concept for students to practice and keep their skills fresh.

Modelling the concept and providing lots of opportunities to practice is extremely important at all the three levels. Also, one should not rush through the levels. Students need time to make connections and build on what they already know. It is important to give them the time to process the information before moving on to the next level. The CRA strategy is compliant with Universal Design, as it involves the following:

- Multiple ways to teach Math concepts
- Multiple means of representation offered through the use of various manipulative items, visual images and technology (Smart Board, computer games/software, video.
- Allows options for how students learn and express their understanding of a math concept (assessment example: Use Smart Board clickers to ease student anxiety when having them give answers to math problems. This will, in turn, increase student engagement and participation.)
- Flexible methods for engaging students (able to incorporate student interests and use real life examples)
- Accessible to all students regardless of ability level
- Allows for accommodations to be made
- Learning is active

Many students with LDs struggle to attach meaning to abstract concepts and symbols (Anstrom, n.d.). Introducing a concept using hands-on manipulatives gives the students a concrete way to understand it. This is beneficial not only for the students with LDs, but also for the entire class.

In addition, the CRA strategy is multi-modal, appealing to students whose brain strengths lie in several different areas [multiple intelligences (Gardner, 2011)]. The manipulatives of the concrete stage satisfy the needs and desires of students with a strong bodily/ kinaesthetic intelligence, the drawings and diagrams from the representational stage are able to take account of students with a visual-spatial intelligence, and the numbers and symbols of the abstract stage play to the strengths of students with a logical/ mathematical intelligence. The multiple forms of representation benefit the rest of the student body as well, since regardless of personal strengths and weaknesses, everybody learns better when the concept is reinforced through a variety of media. The manipulatives and visual aids are not just provided for students with disabilities, but instead are an integral part of the lesson for everyone - thus making the concept accessible for students of all abilities and learning styles. The CRA strategy is multisensory (use of all senses simultaneously), accounting for students' senses of touch, sight and hearing. It is the concrete-kinaesthetic-tactile "prove by construction" level that

allows the student to create memory other than with words. It is directional, spatial and visual all at once. Thus, it addresses not only the physical manipulation of objects, but also engages the visual and spatial areas of the brain. It creates tactile memory just as movement around one's room creates a spatial memory that can be utilized when the lights go out.

For many students, this portable memory is foundational. They draw on it to "see the math" in applications. They visualize construction and deconstruction of quantity relationships as they apply them across operations.

The representational and abstract stages are visual. As the students progress in age and math education, they are capable of creating more complex visual models. They acquire the fine motor skills necessary to draw solutions to complex problems. They rationalize the way quantities "go together" as they illustrate solutions which also become place holders for language. They use these drawings to justify solutions, and reason through solving problems in which they must defend their results. For some students these drawings become visual cues from which they may recall the steps they took to reach a conclusion. They can use the drawings to rationalize and describe the process. This is at the heart of the new standards-based curricula. Students are asked to describe and defend solutions, and explain why the result they achieved is a reasonable solution. For the students with language impairment, this is a difficult task, and the ability to refer to the drawing may be a better guide than the computations themselves.

All three stages of the CRA strategy have auditory components as well, since the teacher has to explain the concept verbally at each stage. This means that the process demands simultaneous processing, a very useful strategy for teaching mathematics to struggling learners. This means employing as many sensory areas as possible and all at the same time. So, if we consider the child listening to the teacher, and concentrating on their own performance, it can be seen that the pencil point provides a focus to the eye (visual senses), while the internal voice is engaged to talk through a sequence or process (auditory processing). The pencil point anchors the hand in place until the correct word or answer is retrieved before moving on. The internal self-talk that leads a student through multiple steps to a solution also enables that student to retrace those steps because the language is the same, repetitive and reliable. In terms of attention and focus, simultaneous processing is the single most effective way to slow the impulsive student down, to make the inattentive student attend, and the body-voice-internal auditory mechanism sustain performance. By tying as many modalities to a single pursuit, each sensory area restrains the others. The unity of performance is the talk aloud and trace or point. For students with learning differences, it should be practiced aloud before becoming internal. Later, as the processes and procedures become automatic, levels which were previously needed become less important and can be eliminated. It is in the simultaneous performance that automaticity can be improved, rapidly developed, and eventually become computational habits which sustain accuracy.

Great diversity among students can be a challenge for many teachers. English Language learners and students with weak language skills may experience difficulty with new vocabulary, often because the definitions use new words they do not know. For these students, the use of concrete manipulatives and visual imagery is a bridge to meaning. Multisensory methods are truly a gift for these students because the manipulatives and the imagery help to teach new words quickly through association. By using general images to teach mathematical concepts, teachers can help these students grasp the meaning of Maths terms easily. The visual and tactile memories associated with using manipulatives and imagery can guide them through concepts and operations in a way too many new words cannot do.

The predominance of language-based LDs in the population with Learning Disability demands that teachers become knowledgeable about the impact of language-based problems and the associated remedial strategies which help these students succeed. These students require explicit instruction using precise terms that are mathematically accurate. The teacher should strive to reduce the language load and should use a moderate rate of speech with frequent "processing pauses" for the students to comprehend, re-verbalize or associate with a visual or concrete model. These students will benefit from frequent use of summary sheets which tie concepts and procedures together with repetitive, retrievable phrases. They will benefit from "wait time" as an accommodation as they organize their words for a response. These are the students who will benefit from drawing solutions to the problems where appropriate, and using the visual imagery as a road map to expressive language demands.

Benefits of the CRA Strategy (Research-Based Education Strategies and Methods, Making Education Fun, 2012)

- Provides students with a structured way to learn math concepts
- Students are able to build a better connection when moving through the levels of understanding from concrete to abstract
- Makes learning accessible to all learners (including those with math learning disabilities)
- Follows Universal Design for Learning guidelines
- Aligned with National Council for Teaching Mathematics standards
- Multimodal - has kinaesthetic, visual-spatial, and logical/mathematical components.
- Multisensory – able to take account of visual, auditory and kinaesthetic learning styles.
- The approach builds on itself: students first develop a concrete understanding of the concept, and then can use that to bridge to a more abstract understanding (Anstrom, n.d.).
- Manipulatives and visual aids improve students' ability to retain

understanding of the math concepts (Boggan, Harper & Whitmire, 2009)

- The manipulations in the concrete and representational stages allow students to rationalize the conceptual mathematical procedures into logical steps and understandable definitions (Witzel, Riccomini & Schneider, 2008) when students encounter difficulty with representations to assist in finding the solution (Witzel, 2005).
- Research has shown that students who use hands-on methods tend to show more motivation, develop more precise and comprehensive representations, and understand and apply ideas more easily than students who do not (Anstrom, n.d.).
- Manipulatives have been found to decrease math anxiety (Boggan, Harper & Whitmire, 2009).
- Students learn better when they have concrete examples in front of them.
- Using manipulatives in the Maths lesson can help to improve students' interest and curiousity in learning.
- Research performed by the Access Center in 2004, demonstrates that CRA works well in both the elementary and secondary levels, and that it can be used successfully in a classroom setting, a small-group setting, or with individual students (Arefeh, Dragoo, Luke & Steedly, 2008).
- When students are taught using CRA, they have been able to generalize and maintain the progress they made during the CRA intervention period (e.g., Bryant et al., 2008; Sealander, Johnson, Lockwood & Medina, 2012; Witzel, 2005).

In terms of evidence for the effectiveness of this approach, numerous studies have shown the CRA instructional strategy to be effective for students both with LDs and those who are low achieving across grade levels, and within topic areas in mathematics such as:

- basic facts and place value (Bryant et al., 2008; Miller & Mercer, 1993),
- addition, subtraction, multiplication and division (Mancl, Miller & Kennedy, 2008; Miller & Kaffar, 2011; Miller & Mercer, 1993; Sealander, Johnson, Lockwood & Medina, 2012),
- fractions (Butler, Miller, Chrehan, Babbitt & Pierce, 2003; Jordan, Miller & Mercer, 1999; Misquitta, 2011)
- word problems (Hutchinson, 1993; Maccini and Hughes, 2000)
- algebra (Witzel, 2005; Witzel, Mercer & Miller, 2003

With regard to mathematics students (first and third graders), Fuchs, Fuchs, and Hollenback (2007) also advocate the use of the CRA sequence to teach place value, geometry and fractions. Their study consisted of two third-grade classes in which the same geometry unit was presented. The teacher of one class used only charts and drawings to teach the unit concepts, and the teacher of the other used manipulatives. The class that used manipulatives scored "significantly higher" on the test both groups

took at the end of the unit (Boggan, Harper & Whitmire, 2009). This suggests that, perhaps, the concrete stage of the CRA strategy is vital in terms of having physical experiences to build conceptual understanding. (Butler et al., 2003). However, it is important to keep in mind that the concrete stage is not the only stage. Studies have also proven that when teachers introduce manipulatives as an exercise completely separate from the abstract math concept, students do not make the connection between the manipulatives and the abstract math (Boggan, Harper & Whitmire, 2009). More recently, Flores and colleagues (Flores et al, 2018) found that CRA intervention was successful for 5th grade children receiving tier two interventions for fractions, and Peltier and colleagues established that students with emotional and behavioural difficulties who struggle with abstract representations of number, can be successful using the concrete manipulatives of CRA (Peltier and Vannest 2018).

One benefit of the CRA approach is that teachers can develop their own CRA methodology adapted to the topic they wish to enhance. Witzel, Riccomini and Schneider (2008) developed an acronym that teachers can use to assist them in creating their own CRA instructional sequence.

CRAMATH outlines **seven steps** teachers can use to create a mathematical unit:

1. **C**hoose the math topic to be taught.
2. **R**eview procedures to solve the problem.
3. **A**djust the steps to eliminate notation or calculation tricks.
4. **M**atch the abstract steps with an appropriate concrete manipulative.
5. **A**rrange concrete and representational lessons.
6. **T**each each concrete, representational and abstract lesson to student mastery.
7. **H**elp students generalize what they learn through word problems. (p. 273.).

The 'Concrete' segment of CRA, in particular, has been the theoretical basis for the use of manipulatives in learning mathematics (Reisman, 1982; Ross & Kurtz, 1993). According to the research cited by Terry Anstrom (n.d.), "students who use concrete materials develop more precise and more comprehensive mental representations, often show more motivation and on-task behavior, understand mathematical ideas, and better apply these ideas to life situations." Research shows that using the CRA strategy is very effective for students who have a learning disability in math (Anstrom, n.d.). A study performed in 1993 showed that CRA instruction helped students with LDs acquire and learn basic mathematics skills. Research suggests that this was because CRA ensures that students have a firm understanding of the underlying concepts of math before they learn the "rules" (Anstrom, n.d.).

In studying the effects of using manipulatives and the CRA instructional sequence, Ojose and Sexton found that: "The importance of providing students with direct experiences with concrete material is supported by evidence from the classroom and an

understanding of how learning takes place. While children can remember information taught through books and lectures, studies show that deep understanding and the ability to transfer and apply knowledge to new situations requires learning that is founded on direct, concrete experience. Research shows that using manipulatives in conjunction with other methods can deepen students' understanding of abstract concepts" (Ojose and Sexton, 2009). They advocate the use of manipulatives to strengthen a student's understanding of concepts and provide a direct link to meaning. This is certainly necessary for those students for whom abstraction itself is a challenge.

Representations are valuable tools in problem solving, reasoning, and communicating about mathematical ideas. Young students can and should use a variety of representations to show and explain their thinking. We should also remember that representations are not an end in themselves, but rather a fundamental part of the process of learning mathematics.

Young children enter school with limited ability to express ideas in writing. With formal language instruction in the early grades, students begin to develop the ability to express themselves mathematically by using written words and symbols. However, young children enjoy drawing pictures regardless of their writing skills. They move naturally from the physical representations to written representations by drawing pictures of mathematical ideas. Young children often invent ways to represent mathematical actions.

As students progress through the early grades, they should continue to express their thinking with pictures and (by second grade) with verbal explanations to describe their pictorial representations. The transition from pictures to more abstract mathematical symbols should be an integral part of students' representations, but it should not be forced on the students. For some students, the connection to numeric and operational symbols comes easily. Others take a longer time to use abstract symbols to represent their ideas. It is important to remember that the goal here is understanding of those symbols and not a rote memorisation of abstract symbols. Inventing strategies, using models and pictorial and symbolic representations, and explaining their ideas should be an essential part of young children's mathematics experience.

The job of a teacher is not to "cover" a list of mathematical concepts, but rather to give students ample time and opportunities to discover the relationships between their world and the world of mathematics, and the meaning of these relationships.

The gifted student may also have LDs, display impulsivity, or be inattentive. Structured procedures and repetitive exercises can lead to automaticity and absence of words, or this student will sub-vocalize procedures coded with specific words as cues which occur automatically and lead to rapid, but accurate computations. An example would be in solving equations, another would be the long division algorithm. By sub-vocalizing repetitive questions, the student with LDs can be fully competent with multi-step

procedures. Structured procedures can organize mental chaos, and encourage real math reasoning as the student is freed from the tedium of the computation words.

The gifted student without LDs must also be challenged. Engaging applications and problem-solving activities can encourage creativity. Many of these students enjoy challenges such as exploring engineering concepts through geometry, building bridges with craft sticks, and discovering which geometric shapes are the sturdiest for construction. They might demonstrate applications in robotics or building construction.

To deal with the diversity of learners in each classroom, the teacher must begin to think outside the book. Games are a great way to practice skills maintenance and fluency, and students with disabilities can be given games as a way to practice restricted numbers of facts.

All students will benefit from a multisensory inclusion approach. It is appropriate for all though essential for some. All students can be offered academically appropriate materials in grade level content using simple modifications in format and facts. All students will benefit from inclusion and collaboration in problem solving activities which encourage both expressive and receptive language in small groups.
Using restricted number facts for new introductions and then providing computationally appropriate practice through differentiation allows all students to apply grade level concepts in meaningful ways.

To conclude, the CRA strategy for teaching mathematics, stemming from the socio-constructivist paradigm, is an excellent instructional approach when used correctly and followed exactly. For the strategy to be effective, the teacher must reinforce the connections between the concrete and representational stages, and then between the representational and abstract stages. There is little to be gained if each stage is completely isolated from each other, and the linkage is never explained. However, if the students understand that the manipulatives, the pictures, and the written maths equation are always representing the same problem, they will come out with a firm understanding of the meaning behind the maths, and will have multiple strategies from which to choose when it comes to solving that kind of problem. It is particularly important here to emphasize the role of the teacher in helping to facilitate learning by providing guidance and direct instruction for the students' exploration, and ensuring that students pay attention to key features that are common in the Concrete-Representational-Abstract mode.

SUMMARY

As per Piaget's Four Stages of Mental Development, till 11 years of age, children are at the concrete operational stage - thinking still tends to be tied to concrete reality, and ideas are obtained from action on concrete objects. The National Council of Teachers of

Mathematics, USA, makes it known that all students benefit from the use of manipulatives and visual aids.

The Concrete-Representational-Abstract strategy is an intervention for mathematics instruction that research suggests can enhance the mathematics performance of students in a classroom as well as of those with learning disabilities. The CRA strategy uses demonstration, modeling, guided practice followed by independent practice, and immediate feedback, and is compliant with the Universal Design for Learning. Learning at the concrete stage becomes more meaningful when it is multisensory in nature, i.e., all learning pathways in the brain are used simultaneously. The strategy is effective when students make the connection between the concrete and representational stages, and then between the representational and abstract stages.

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Asia Pacific Journal of Developmental Differences
Vol. 8, No. 2, July 2021, pp. 302—334
DOI: 10.3850/S2345734121000141

An Instrumental Single Case Study: The development of a Multi-Dimensional Interactive Model that Illustrates Barriers faced by a man with Developmental Dyslexia

Lynn C. Holmes[1*], Jean V. Fourie[1*], Martyn P. Van Der Merwe[1], Alban Burke[1] and Elzette Fritz[1]

1. *University of Johannesburg, South Africa*

Abstract

The variety of difficulties that individuals with developmental dyslexia face makes it challenging to diagnose, to develop appropriate intervention strategies, and teach coping and learning skills. An instrumental single case study was used to explore the experiences of a young man who had been formally diagnosed with severe developmental dyslexia. The various barriers he faced because of having developmental dyslexia were examined. A multi-dimensional interactive model was developed from the results of the study, as well as from cases of people with developmental dyslexia diagnosed before and after this case study was conducted. This multi-dimensional interactive model illustrates the five primary barriers or factors, which a person with developmental dyslexia may have to deal with on a daily basis, and thus have to compensate for, in order to pass secondary school. All five factors form a continual flow or interplay between one another. This means that there is a constant influence of one or more factors on another. The model assists to illustrate the complexity of developmental dyslexia and the difficulty in diagnosing and treating the disorder, as each individual presents with a different set of difficulties or factors. This multi-dimensional model includes: the neurological factors, the intrapersonal factors, the interpersonal factors, the behavioral factors, as well as the emotional factors.

Keywords: Developmental dyslexia, brain-based disorder, barriers to learning, compensatory skills, multi-dimensional interactive model, instrumental case study.

**Correspondence to:*
Lynn C. Holmes: University of Johannesburg, South Africa. Email: lynn@holme.co.za
Jean V Fourie: jeanf@uj.ac.za (Jean V Fourie: https://orcid.org/0000-0002-1367-0156)

INTRODUCTION

Developmental dyslexia has been described as a life-long, neurologically based condition that is often inherited (Dyslexia International, 2018; Reid, 2011; Rutter, 2008; Snowling, 2000; Thomson, 2009). In addition, developmental dyslexia also affects reading, spelling, writing, motor skills, development of automaticity, emotions, and many other areas of functioning; and its nature changes with maturation and development (Alexander-Passe, 2010, 2015; Dyslexia International, 2018; Fletcher, 2009, Nicolson and Fawcett, 2010; Reid, 2011; Rutter, 2008; Scott, 2004; Snowling, 2001; Thomson, 2009). In his recent review of literature, Stein (2018) wrote that defining and diagnosis has generally stuck closely to the early 20th Century view that developmental dyslexia is the inability to learn to read despite normal oral and non-verbal abilities, with a strong hereditary (genetic) background. Hence, to diagnose dyslexia, we needed to show a big difference between a child's non-verbal and oral intelligence, and his reading abilities—in short, a significant discrepancy. Fortunately, Stein (2018) postulates that, in the near future, recent advances in neuroscience should mean that much greater understanding of the causes of reading failure will emerge. So diagnosis should no longer depend on the demonstration of discrepancy between general oral and nonverbal reasoning abilities compared with very poor reading, which is at best only an indirect indicator of its underlying causes. Instead, we should be able to directly measure the deficient visual and auditory processing that causes the discrepancy in the first place, in order to make a diagnosis of dyslexia (Stein, 2018).

Snowling, Hulme & Nation (2020) wrote a fascinating article that developmental dyslexia is far more than just a reading, spelling and writing disorder. Snowling, Hulme & Nation (2020) query the validity of the discrepancy definition of dyslexia, which was also questioned by Stanovich as far back as 1992. Dropping the IQ-discrepancy definition of dyslexia has proven controversial for many, particularly for those who see 'dyslexia' as a special category of disorder and reject the view that it is only a reflection of poor reading. Snowling, Hulme & Nation (2020) argue that it is important is to have a better understanding of the dimensionality of reading disorders and how they frequently occur with other (co-morbid) difficulties. Therefore, individuals with developmental dyslexia are at a distinct disadvantage, especially when they have a more severe form of this disability, as they struggle to learn to read, and therefore perform poorly at school, despite intensive remedial intervention. Given the aforesaid, this may lead to several barriers and other co-morbid difficulties that they must compensate for, if they are to succeed, pass secondary school, and go on to tertiary studies.

In this article, an attempt to produce an appropriate model incorporating all of these aspects into one will be presented. This builds on previous work presented in an earlier article published in this journal (Holmes, Fourie, Van Der Merwe, Burke and Fritz, 2021).

LITERATURE

Owing to the complex nature of developmental dyslexia and unique combination of traits everyone may exhibit, it has taken many years for consensus to be reached about a universally recognised definition for this disorder (Holmes et al., 2021). Although most definitions cover similar basics, all agree that dyslexia is a brain-based disorder, characterised by a difference in the way the individual with dyslexia processes information.

Early diagnosis and treatment is vital, if individuals with developmental dyslexia are to reach their full potential. As a result of this early intervention, and the formation of new brain pathways due to brain plasticity, many go on to complete secondary school and eventually pass tertiary studies (Holmes et al., 2021; Reece, Booth & Jones, 2016).
In his recent research, Stein (2018) concludes that:

> *"Developmental Dyslexia is a hereditary temporal processing defect, associated with impaired magnocellular neuronal development that impacts selectively on the ability to learn to read, leaving oral and non-verbal reasoning powers intact".*

Armed with this definition, we should soon be able to test children specifically for these visual and auditory temporal processing deficits. This will not only enable us to diagnose dyslexia earlier, but also to set in motion remediation programmes tailored to each child's particular, individual, pattern of needs (Stein, 2018).

Snowling, Hulme and Nation (2020) propose that

> *"First, the term dyslexia should not be used as a shorthand for 'reading disorder' but should be used to refer to a difficulty with decoding and spelling fluency which is evident from the early school years and persistent over time. Second, it should affect academic functioning, such that progress is less good in literacy-based areas of the curriculum than that of peers in a similar setting. Third, if there are co-occurring features, these should be labelled as such but should not be considered core to the 'diagnosis'. Finally, the diagnosis should be qualified as mild (fully compensated when appropriate arrangements are in place), moderate or severe; we hypothesise that those with 'severe' difficulties are often those with a range of comorbid conditions".*

The Information Processing Model (IPM) (Ashcraft, 2006; Anderson, 2005; Ehri, 1995; Frith, 2002; Hunt & Ellis, 1999; Morton & Frith, 1995; Seymour, 1997) and Causal Modelling Framework (CMF) (Frith, 1997, 1999, 2002; Morton & Frith, 1995) link suitably with the primary focus of this study, which is to identify what unique barriers and difficulties individuals with developmental dyslexia experience at all levels – biological, cognitive, behavioural and environmental; what compensatory skills they develop to cope with

these barriers; and thus go on to pass secondary school in spite of having this life-long condition. Additionally, the CMF model addresses a further focus of the study which was to determine how and by whom people with developmental dyslexia are supported to assist them to successfully complete their schooling and go on to tertiary studies.

Much research into the causes and effects of developmental dyslexia has been conducted worldwide over the past few decades. Moreover, a fair number of studies have discussed the use that people with dyslexia make of both positive and negative compensatory skills to cope better and to assist in this task. Furthermore, the earlier the intervention the more likely that people with developmental dyslexia will learn to read to some extent and succeed better at school, because of brain plasticity and the development of new neural pathways (Reece, Booth, & Jones, 2016; Reid, 2011; Spitzer, 2012).

The published literature and research findings that I accessed have been conducted in other countries, primarily in the UK, USA, various European countries, Canada, China, and Australia. I could find no studies conducted within the Sub-Saharan context on barriers caused by developmental dyslexia, as well as for those in the South African context, within which the study was conducted.

AIMS OF RESEARCH

An instrumental single case study was used to explore the experiences of a young man who had been formally diagnosed with severe developmental dyslexia. Firstly, the various barriers he faced as a result of having developmental dyslexia were examined. Secondly, the compensatory techniques and skills he used in order to learn to read sufficiently in order to pass secondary school, go on to tertiary studies and to realise his lifelong dream of becoming a pilot were also explored. These first two aims were discussed in detail in a previous article entitled "Developmental Dyslexia and Compensatory Skills: The man who could not read but learned to fly" (Holmes et al., 2021). Additionally, the study described how and by whom the male participant with developmental dyslexia was assisted to pass secondary school and go on to tertiary studies.

The final aim of the study was to create a new multi-dimensional, interactive model from the results of the study, as well as additional information from the researcher's exposure to other people with developmental dyslexia over the course of the research period, as well as prior to, and after this. This article will discuss the development of the model and how it can be used to assist people with developmental dyslexia, as well as the people who teach, help, and work with them.

The model assists to illustrate the complexity of developmental dyslexia and the difficulty in diagnosing and treating the disorder, as each individual presents with a different set

of difficulties or factors. This multi-dimensional interactive model includes: the neurological factors, the intrapersonal factors, the interpersonal factors, the behavioural factors, as well as the emotional factors.

DEVELOPMENT OF A MULTI-DIMENSIONAL MODEL

Step 1: Integrating the Causal Modelling Framework (CMF) and the Information Processing Model (IPM)

In an attempt to construct a model to explain the barriers faced by people with developmental dyslexia, and how they compensated for these barriers, the CMF (see Figure 1) and the IPM (see Figure 2) were first integrated or combined. These were used in this study as part of the theoretical framework to better describe and explain the barriers and other difficulties the participant, Paul, faced because of having developmental dyslexia, and had to compensate for in order to learn to read sufficiently well to pass secondary school. This worked well and fitted with the literature study and theory, as illustrated in Figure 3.

The CMF (see Figure 1) was developed and expanded over a number of years, based on the premise that "dyslexia is a neuro-developmental disorder with a biological origin and behavioural signs which extend far beyond problems with written language" (Frith (2002, p. 45). When a person has developmental dyslexia; this can be traced back to a genetic or a brain-based abnormality, which is linked to neurology or brain function at the biological level (Frith, 2002).

The genetic or biological level is shown in yellow in Figure 1. This in turn, gives rise to cognitive deficits, which include specific deficits such as poor learning of the reading and writing system and many others (Frith, 2002). The cognitive level is illustrated in blue in Figure 1. These cognitive deficits lead to behavioural symptoms. These behaviours can be observed as poor literacy skills and specific impairments such as poor reading, spelling, writing difficulties and phonological difficulties (Frith, 2002). The behavioural level is illustrated in pink in Figure 1.

Interacting with all three of these levels – biological, cognitive and behavioural – is the environment illustrated in green in Figure 1, which would include input from school, teachers, experiences from home, parents, psychosocial problems, emotional difficulties and so on (Frith, 2002). All of these might affect and have an influence on the person's initial biological input or genetic/brain input (Frith, 2002), especially if one of the parents carried a genetic disposition for developmental dyslexia; if the mother smoked, drank or took drugs; if the mother did not have sufficient nutrients during pregnancy; or had some sort of illness that may have predisposed the foetus to some type of abnormality.

Therefore, environmental factors may affect the cognitive level if there is inadequate

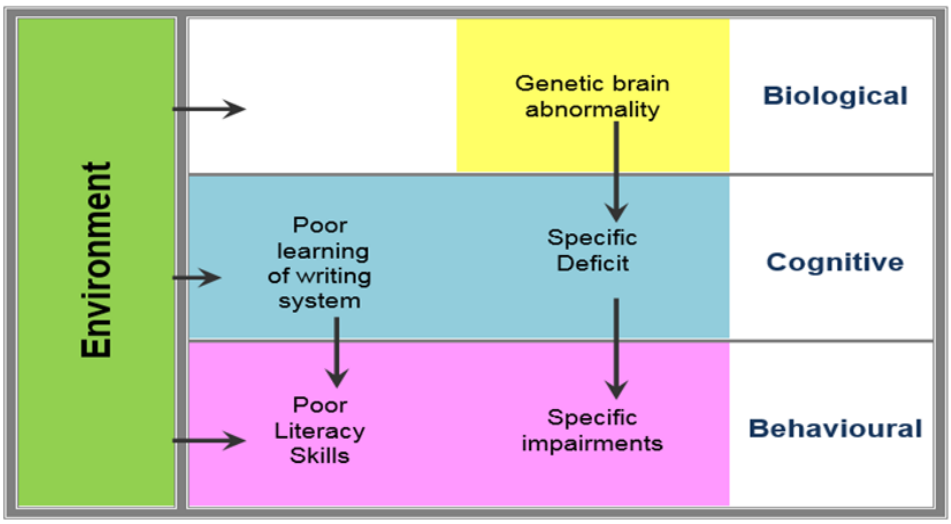

Figure 1: Causal modelling framework for developmental dyslexia. (Adapted from Frith, 1999, 2002)

early input, poor teaching, and insufficient follow up at home; or an inflexible curriculum (Frith, 2002). Environmental factors all affect learning either positively or negatively, and hence the behaviours, that is reading, spelling, writing, phonemic awareness and other difficulties that one might observe (Frith, 2002).

This framework should be seen as being fluid and flexible and incorporates many overlapping dimensions (Frith. 2002). This implies that some aspects such as phonological processing may have an impact on three levels – biological (neurological), cognitive and behavioural (educational) dimensions. It is also important to note that a cause of neurological origin does not mean that nothing can be done to assist a person with developmental dyslexia (Thomson, 2009, p. 106). The earlier the diagnosis is made, the earlier intervention may commence, as each person has unique deficits and individual differences (Nicolson & Fawcett, 2010).

The CMF provides an overall or common framework for developmental dyslexia. However, it does not give sufficient detail when exploring the difficulties people with developmental dyslexia experience with processing of information, as well as various specific cognitive deficits that are commonly found in people with developmental dyslexia. These may include poor short-term and working memory skills; as well as poor attention and visual and auditory processing difficulties. Thus, the IPM was included as part of the theoretical framework, to address the various cognitive processing difficulties that people with developmental dyslexia experience which the CMF does not include.

The IPM therefore adds to the CMF, as it addresses the cognitive processing difficulties experienced by people with developmental dyslexia at the cognitive level or domain of

the CMF in more detail. Furthermore, the IPM explains the complexity of the processing that must take place at the cognitive level; and how much can "go wrong", leading to the large variety of difficulties people with developmental dyslexia experience. Additionally, the IPM is one of the theories that explain how the brain processes and remembers incoming information. There are several theories of memory, but the most well-known, and most commonly used are the information processing explanations (Ashcraft, 2006; Anderson, 2005; Ehri, 1995; Frith, 2002; Hunt & Ellis, 1999; Morton & Frith, 1995; Seymour, 1997). A simplistic model of the IPM, which was adapted for explanation purposes, is shown in Figure 2.

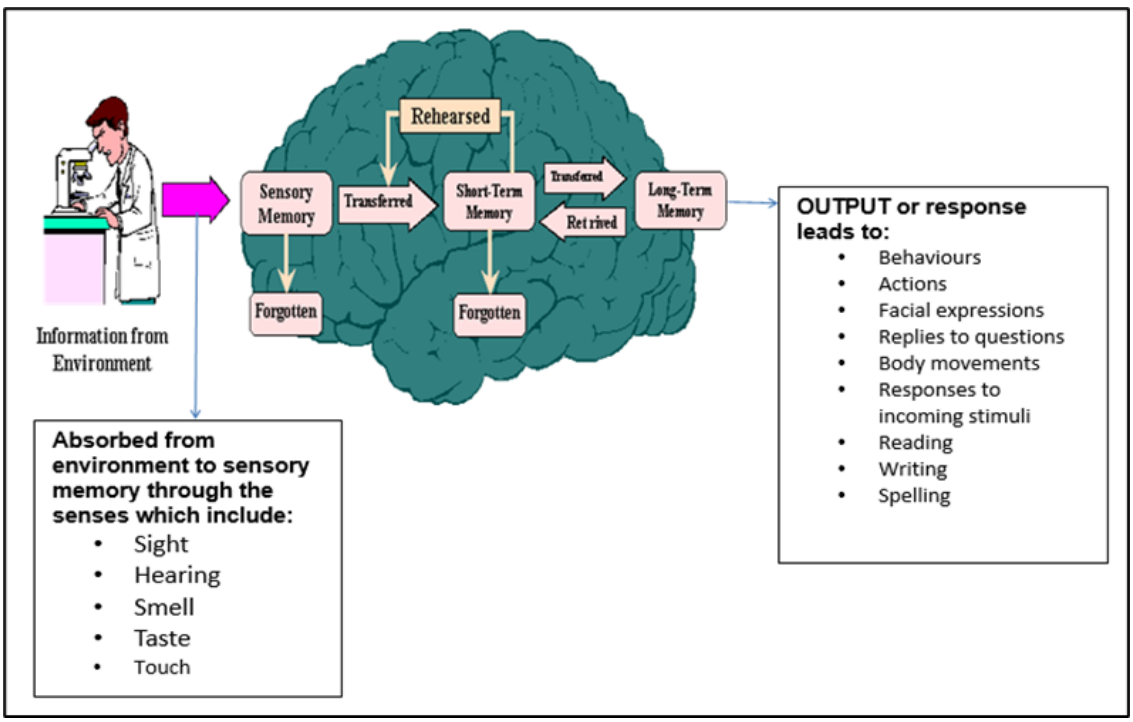

Figure 2: Information processing model
(Adapted from APA, 2016; Baddeley, 2001; Woolfolk, 2007)

Stimuli or information from the external environment is received via the senses, which include sight, hearing, smell, taste, and touch, regarding our surroundings, which equates to the environment level or domain of the CMF (Woolfolk, 2007). This information is received into the first part of the information processing system called the sensory memory (APA, 2016). This first step is concerned with analysis of the stimuli which takes place in the sensory memory (Woolfolk, 2007). Thus, the sensory memory is the initial processing that transforms the incoming stimuli into information that makes sense to the person. Even though sights and sounds may last only fractions of a second, the sensory register or memory can briefly hold information for a duration of between 0,5 to 3 seconds for this initial processing to take place, before this information is forgotten (APA,

2016; Baddeley, 2001). The sensory memory can cope with 3 to 7 units of information at a time (Woolfolk, 2007).

The process of detecting a stimulus and assigning meaning to it is called perception (Woolfolk, 2007, p. 251). The person has to take more notice of the stimulus, pay attention to it, or perceive it, and assign meaning to it. Attention takes effort, as it means ignoring other stimuli, is a limited resource and most people can only pay attention to one cognitively demanding task at a time (Driscoll, 2005). If sufficient attention is paid to the incoming information this moves to the working memory (WM), also known as the short-term memory (STM), which has a memory capacity duration of between 5 to 30 seconds without rehearsal, practice or repetition, before it is forgotten (APA, 2016; Baddeley, 2001).

The WM has a capacity of 7 to 9 units of information (Woolfolk, 2007). It is the WM or STM which assists and directs the process of attention in the sensory memory. People with developmental dyslexia struggle with STM and WM, thus remembering oral instructions or more than one instruction at a time can be problematic for them (Reid, 2011, p. 5). Additionally, many struggle to maintain attention on the correct stimuli, and this is even further exacerbated if they have co-morbid attention deficit hyperactivity disorder (ADHD) (Reid, 2011, p. 6).

If the information is maintained, elaborated upon, and rehearsed, practiced, or repeated sufficiently, the information is able to be encoded, learnt or saved and then can move to the long-term memory (LTM) store, which has an infinite storage capacity (APA, 2016). In the LTM storage, coding and manipulation of data and stimuli occur, which can also be transferred back to or retrieved by the WM. The WM can thus activate and retrieve memories stored in the LTM (Woolfolk, 2007).

However, new information stored in the LTM needs to be organised and categorised, to understand and remember sequences of events. People with dyslexia often struggle with understanding, organising and categorising information which may negatively affect storage and retrieval of information from the LTM (Reid 2011). Information stored in the LTM is responsible for preparing an output process which leads to appropriate responses, behaviours, actions, facial expressions, replies to questions, or body movements, as a response to the original incoming stimuli. This equates to the behavioural level or domain of the CMF, and will also include reading, writing, and spelling (See Figure 1).

Therefore, to summarise, the information is encoded in the sensory memory where perception and attention determine what will be held in the WM or STM for further use. In the WM, new information connects with knowledge from the LTM, and can be activated to return to the WM.

Thus, there is significant synergy between the IPM and CMF, and if viewed together, they provide a relatively robust explanation of the underlying processes in developmental dyslexia. The two models explain the majority of the difficulties experienced by people with dyslexia as all sensory information comes from the environment, the cognitive processing takes place at a cognitive level, and the output occurs at a behavioural level. Additionally, the IPM clarifies dyslexia as a difference in how people process information. That is, how they take information in (input), how they understand it, memorise it and organise it in their mind (cognitive processing), and how they demonstrate they know this information (output) (Reid 2011, p. 3). People with dyslexia can therefore experience different difficulties at all or any of these stages above – input, cognitive processing, or output.

Many people with developmental dyslexia have sensory difficulties, especially in the visual and auditory area; short-term and/or working memory difficulties; as well as other processing difficulties (Reid, 2011, p. 4). This is part of the complexity involved when attempting to diagnose developmental dyslexia, as it may present very differently for each person. Generally, these differences can be seen in relation to print, but other areas of learning may also be affected. Therefore, dyslexia can persist even when reading skills improve.

In Figure 3 it can be seen that the IPM integrates into and further clarifies the cognitive domain of the CMF (Frith, 2002). The incoming stimuli that the senses receive come from the environmental domain, shown in green in Figure 1. The brain then processes the information cognitively which involves the short-term and working memory. This occurs in the blue section in Figure 1. The outputs can be seen as various behaviours, shown in pink in Figure 1. These behaviours could manifest as reading, spelling or writing deficits or even compensatory skills and strategies used.

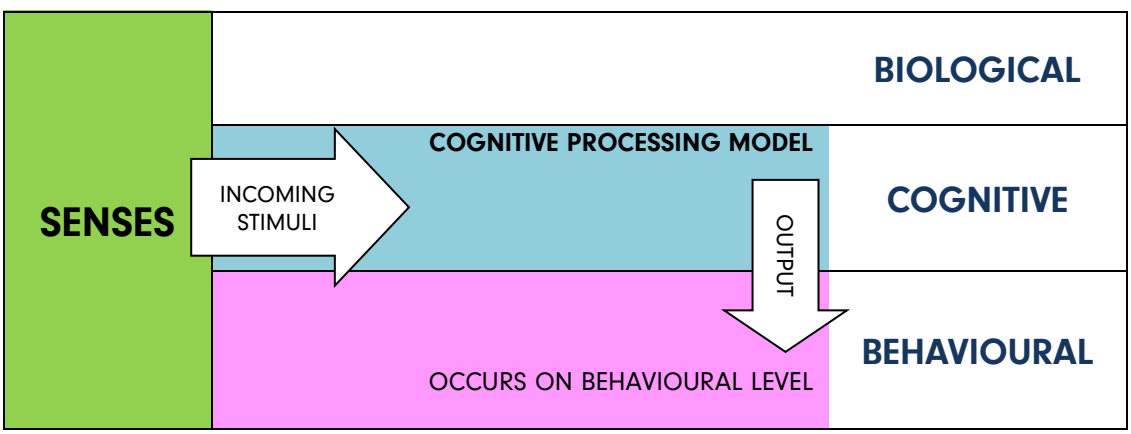

Figure 3: Integrated causal modelling framework and information processing model (as proposed by the researcher)

This integrated model of the CMF and IPM as shown in Figure 3, could explain in a limited manner, some of the compensatory strategies and skills used by Paul, on both the cognitive and behavioural levels, but did not show that they also occur at other levels simultaneously. It was not clear where to place emotions that emerged as a major theme from the data which posed an added dimension to the picture.

Step 2: Adding Emotions to the model

The second attempt at devising a model from the findings, comprises three levels of barriers linked to developmental dyslexia, each represented as three concentric circles placed one inside the other. These will be explained one level at a time and then the final combined model will be shown. It should be noted that emotions affect neurological or brain functioning as well as cognitive functioning, physical functioning, interpersonal and intrapersonal functioning; and are thus included in each of the levels, as was found from the data in this study as well as from research studies linked to trauma (Alexander-Passé, 2010, 2015; Levin, 1997; Perry, Pollard, Blaicley, Baker & Vigilante, 1995; van der Kolk, 2015).

Level 1: Compensating for biological or neurological, emotional and behavioural barriers linked to developmental dyslexia

The first circle or level 1 (illustrated in pink) represents the biological, neurological, hereditary, brain-based deficits or barriers that are linked to developmental dyslexia. This is shown in Figure 4. Additionally, these can be noted through observable behaviours. Emotions may have both positive and negative effects on brain function.

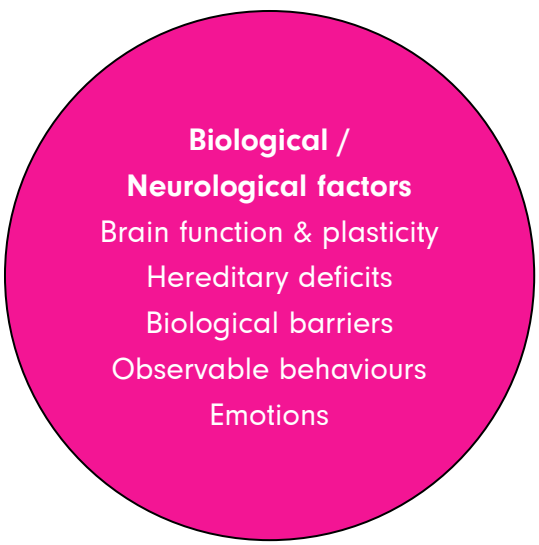

Figure 4. Biological or neurological, behavioural and emotional barriers linked to developmental dyslexia

Compensation can occur in various ways and can be seen through observable behaviours.

It should be noted that in this study, neurological changes could not be observed, as expensive scanning machines were not available, so interviews regarding hereditary factors/deficits and observable behaviours/characteristics had to be relied upon. The model for this area was based mainly on current research available, as well as the small amount of data captured during the interviews, and interaction with Paul and the other participants in the study.

The literature suggests that developmental dyslexia has a strong biological, hereditary origin, with various "defective" genes identified such as those found on chromosome 6 (Berninger, Raskind, Richards, Abbott & Stock, 2008; Cardon, Smith, Fulker, Kimberling, Pennington & De Fries, 1997; Fisher, Marlow, Lamb, Maestrini, Williams, Richardson et al., 1999; Gayan, Smith, Chemy, Cardon, Fulker, Brower, Olsen et al., 1999; Gilger, Pennington & De Fries, 1991; Grigorinko, Gombart, Fay, Bouazzaoui, Isingrini et al., 1997), on chromosome 15 (Smith et al., 1982; Grigorinko, et al., 1997), the DCDC2 gene and a variant on the gene regulator the READ1 within it (Gruen & Eicher, 2013; Meng, Powers, Tang, Cope, Zhang, Fuleihan et al., 2011), as well as the variant gene KIAA0319 (Cope, Harold, Hill, Moskvina, Stevenson, Holmans et al., 2005; Gruen & Eicher, 2013), which all lead to various deficits and behaviours. Paul likely inherited the dyslexia from his father and grandfather who both had significant signs of this disorder, although neither had been formally diagnosed. Which gene was responsible, is unknown as genetic testing was not conducted, and a number of genes have been implicated.

Neural pathways connected to memory may have degraded and volumes of grey and white matter fluctuate (Gogtay, Giedd, Lusk, Hayashi, Greenstein, Vaituzis et al., 2004; Lenroot & Gied, 2006; Schmithorst & Yuan, 2010). The cognitive assessment conducted, showed that Paul has deficits in short term and working memory, as the working memory scale on the Wechsler Adult Intelligence Scale (Wechsler, 1997) was in the average range compared to Paul's superior verbal skills on this test. Whether this discrepancy is due to degraded volumes of grey or white matter is unknown, as no scanning was done.

Decreased connectivity between the superior temporal regions and left inferior frontal regions, leads to difficulty processing speech sounds (Boets, Op de Beek, Van der Mosten, Scott, Gillebert, Mantini et al., 2013). Neurological, biological and brain-based deficits that may have occurred during development, such as irregular neuronal migration (Scerri & SchulteKőrn, 2009), visual stress (Evans, 2001; Everatt, 2002; Irlen; 1983; Meares, 1980; Reid, 2009; Wilken, 2003); cerebellar abnormalities, causing magnocellular deficits (Fawcett & Nicolson, 2004; Frith, 2002; Stein, 2008); structural differences in brain hemispheres (Galaburda, Rosen & Sherman, 1990; Hynd, Semrud-Clikeman, Lorys, Novey & Eliopulos, 1990); as well as the presence of misplaced cells in the outer layer of the cortex (Galaburda & Rosen, 2002; Knight & Hynd, 2002).

Many of these brain-based difficulties may well be present in Paul, but without brain scans, these are difficult to prove. However, the likelihood of Paul having these difficulties can be shown by many of the observable behaviours that Paul exhibited and link to Frith's Causal Modeling Framework (1999, 2002). The fact that Paul reported seeing words "float or move" across the page at times when reading is possible evidence of magnocellular deficits (Stein, 2001). Furthermore, Paul found phoneme-grapheme mapping challenging, which is also linked with possible magnocellular difficulties (Stein, 2001). Magnocellular abnormalities lead to deficits within the auditory and visual systems which then result in observable behaviours such as poor reading; poor tone discrimination; which leads to poor speech discrimination; as well as poor motion detection. Paul found the visual glare of the white paper made reading more difficult and was issued with green tinted glasses.

Fawcett, Nicolson and Dean (1996) noted that there are magnocells in the cerebellum and in the motor output systems, which make it difficult to distinguish the Magnocellular Deficit Hypothesis from the Cerebellar Deficit Hypothesis. Fawcett and Nicolson (1999,2001, 2004, 2008), Nicolson and Fawcett (2010), and Frith (1999, 2002) found that people with developmental dyslexia who had cerebellar impairments often had serious consequences and one could see these as observable behaviours such as poor rapid naming skills, balance difficulties, motor skills difficulties, and poor phonological awareness, all of which should have become automatic, but had not developed in many cases. These affect reading, writing, and spelling. Paul struggled his whole life with poor balance, poor fine motor skills, he still cannot catch a ball, and was teased as a child because he could not take part in ball sports – his hands would close before the ball reached him due to poor co-ordination; he took many years to tie his shoelaces and his tie; and riding a bicycle was extremely difficult for him. He had years of occupational therapy which helped a little, but he never fully gained complete control or automaticity of many of these skills.

Brain plasticity, is the brain's ability to form new and alternative pathways through intervention (Caleo, 2015; Keller & Roberts, 2009; Meyler, Keller, Cherkassky, Gabrieli & Just, 2008; Reece, Booth & Jones, 2016). The earlier the intervention, the more successful this is likely to be (Aylward, Richards, Berninger, Nagy, Field, Grimme et al., 2003; Simos, Fletcher, Bergman, Breier, Foorman, Castillo et al., 2002). Although Paul had a severe form of developmental dyslexia, through hard work, constant drilling, practice, the strategic use of colours, his senses and various study strategies, he managed to form new brain pathways, due to brain plasticity, and learnt to read sufficiently well (an observable behaviour) to pass high school and tertiary studies and become a pilot (Holmes et al., 2021).

Finally, in the absence of early support, emotional factors such as depression, anxiety, low self-esteem, isolation, loneliness, frustration, anger, poor reaction to criticism, amongst others; have an additive impact on dyslexia. These co-morbid conditions require

compensatory skills to develop to cope with them and survive in the world (Alexander-Passe, 2009 a, b; Nelson & Gregg, 2012; Nicolson & Fawcett, 2010; Sundheim & Voeller, 2004; Thomson, 1995; Yoshimoto, 2005). Paul faced bullying, and almost all the emotions described above, which did affect his functioning negatively (Holmes et al., 2021).

Level 2: Compensating for intrapersonal barriers

The intrapersonal barriers experienced by the participant, shown in the purple circle in Figure 5 include all the cognitive barriers Paul faced, his personality, his disposition, his worldview, his self-esteem, his emotions, and other personal issues. These can be observed through various types of behaviours. Emotions are also included in this level. These intrapersonal barriers are illustrated in Figure 5.

Figure 5: Intrapersonal barriers linked to developmental dyslexia

Compensation had to occur because of the following intrapersonal barriers:

Executive control links Level 2 closely to Level 1. This link is shown in the combined diagram in Figure 7 below. The brain or neurological functioning from the frontal brain may lose many of its functions because of the developmental dyslexia (Gombart et al., 2016; Smith et al., 2016). However, certain executive functioning can be adapted, such as planning, shifting and inhibition skills and used to compensate for various deficits caused by developmental dyslexia (Cohen et al., 2007; Locascio, et al., 2010). Developmental dyslexia is primarily a difference in the way information is processed and so much of the compensation takes place at this level in some form. Moving information to the LTM through rehearsal and repetition was often more effective for Paul because of poor STM and WM.

Cognitive, learning, and behavioural compensation skills occur at this level. Learning how to study and learn using various techniques such as rehearsal and multi-sensory approaches are some examples of the compensatory skills Paul used to succeed (Banai & Ahissari, 2010; Fry, 2012; Reid, 2011). Personality and dispositional factors such as tenacity, courage, perseverance, determination, stubbornness, diligence, his competitive nature, as well as an internal drive to succeed and achieve best possible results contributed to Paul overcoming barriers to learning. Emotional difficulties such as dealing with bullying, teasing and name-calling, as well as being introverted and shy, hampered Paul's social interaction, and he had to learn to compensate for these.

Paul had to deal with and compensate for numerous co-morbid emotional conditions such as anxiety, depression, trauma, as well as dyspraxia, ADHD and loneliness. These resulted in low self-esteem and the need to prove his worth and value. He had to manage guilt and shame. Paul compensated and sought assistance by going for therapy with a psychologist, seeing a psychiatrist, taking medication, and allowing others to assist. Other coping skills that had to be learnt included: organisational skills, time management, difficulties with procrastination, as well as improving poor short-term and working memory. Compensatory strategies and other skills that assisted Paul included escaping from reality by going into his own imaginary world, using his imagination, listening to soothing music, his spirituality, and other relaxing pursuits such as going to gym.

Level 3: Compensating for Interpersonal Barriers:

Interpersonal barriers faced by Paul, shown in the circle in Figure 6, represented in blue, include the external environmental, cultural, language, social, home, family and school factors, which are all observable through various behaviours, actions or outputs, as well as emotions.

Compensation had to occur because of the following interpersonal barriers experienced by Paul because of having developmental dyslexia:

There were no official government/school policies in place for most of Paul's schooling career; the teachers were poorly trained; no concessions/accommodations were available to him until Grade 12; he had to endure hostile teachers and peers; no or very little assistance was offered to him at school; and there was a severe lack of knowledge and education about developmental dyslexia on the part of his teachers and the education system in general at that time in South Africa.

Paul's mother was his greatest asset but may have overcompensated. He had to learn to work alone without his mother's assistance when he left home and develop his own strategies and compensation skills.

Figure 6. Interpersonal barriers linked to developmental dyslexia

Other interpersonal barriers included environmental, cultural, language, social, school, family, emotional, and behavioural issues. Paul experienced language and cultural difficulties because, in the Afrikaans culture in which he grew up, boys were expected to play rugby. However, he was unable to play rugby because of poor co-ordination. Paul's home language is Afrikaans, which has a shallow orthography. Studying in English, which has a more complex orthography, at a tertiary level, proved to be a challenge for Paul. English is an international language used in flying, and it is compulsory for pilot training. There were high cultural expectations from family, peers, and self. His maternal family are highly educated, thus, there was emphasis on education and academic achievement within the family ethos. Paul was able to emulate this culture of learning and excellence, set for him by his maternal side of the family.

Paul experienced poor interpersonal and social skills outside of his home environment because he had limited time between studies to develop these life skills. Due to long hours studying, as well as poor co-ordination; he could not take part in sports with the other boys; so he did not develop appropriate peer relationships. He thus identified more with girls, his grandmother, his mother, his aunt, and sisters.

This led to social isolation, loneliness, guilt, shame, as well as humiliation and bullying by peers, especially boys. He tended to "use" and manipulate people and make friends with them to get what he needed. He became shy, introverted, and unsure of how to approach people. This resulted in him compensating and developing these skills late in his life. Many people assisted Paul during his school years as well as during his tertiary studies to compensate for the barriers he experienced because of the developmental dyslexia.

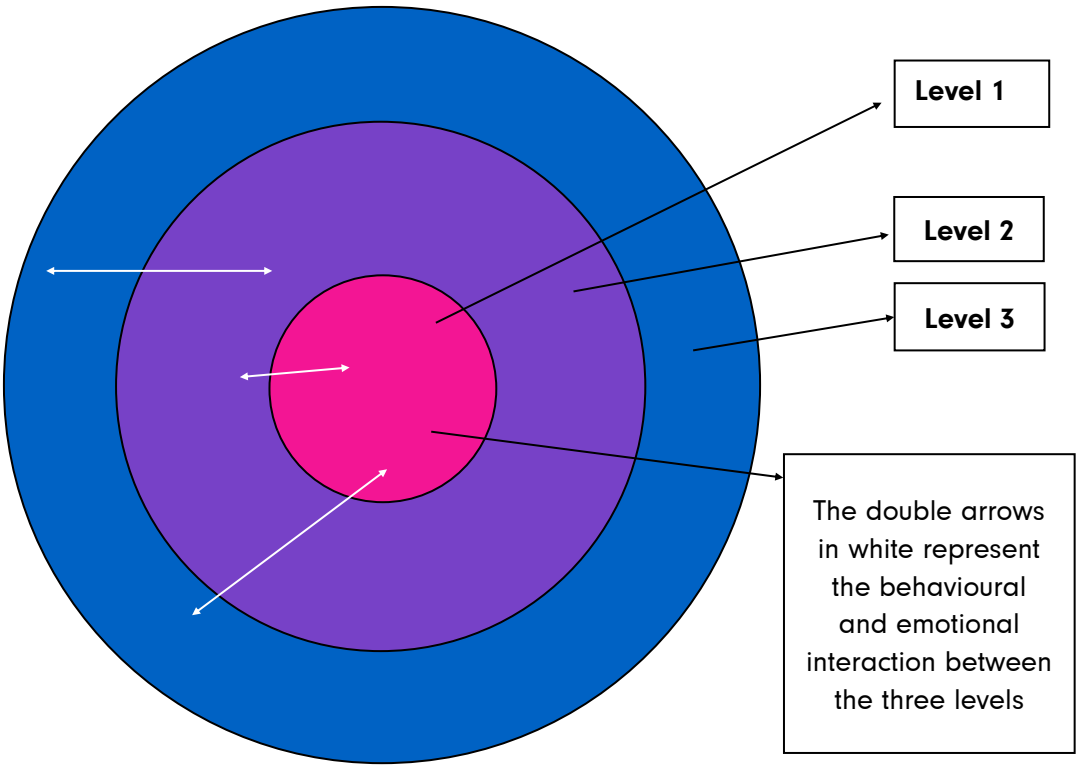

Figure 7: Combined model: Compensating for barriers linked to developmental dyslexia at three levels

Paul compensated by wearing a mask of competence. Participating in this research has given him the confidence to speak out and no longer be ashamed of having developmental dyslexia.

Behavioural and emotional factors have an influence on all three of the abovementioned levels and are illustrated with the red arrows in the combined model diagram shown in Figure 7.

BEHAVIOURAL AND EMOTIONAL FACTORS

Behavioural and emotional factors have an influence on all three of the above-mentioned levels and are illustrated with the red arrows in the combined model diagram shown in Figure 7. Behavioural factors originate in each of the three levels and result in a myriad of different outward symptoms, which is why developmental dyslexia is so difficult to diagnose, as each individual person, may present with a set of unique combinations of symptoms and behaviours. These include poor automaticity; slow rapid naming speed; difficulties with direct lexical access; delayed and poor reading fluency and speed; poor

spelling (spelling may be phonetically correct or bizarre/may spell the same word in various different ways); poor reading comprehension; confusion of left and right (laterality)/mixed handedness/ambidexterity; poor sequencing ability and sequential memory; poor organisational skills; poor short term and working memory skills; problems acquiring mathematical tables & mathematical word sums cause difficulties; auditory processing difficulties; poor phonemic awareness; poor fluency and reading speed; visual difficulties linked to magnocellular deficits; poor motor skills; poor balance; difficulties expressing ideas in written form although verbally strong; poor graphic (handwriting) skills; poor time management skills; slow/poor decoding ability even of familiar words; as well as poor ability to read whole words or remember sight words.

In addition to behavioural difficulties that occur on all three levels, individuals with developmental dyslexia can also be affected emotionally by being unable to learn as well as their peers, commonly resulting in low self-image, low self-concept, frustration, poor social skills, bullying, exclusion, loneliness, isolation, anxiety, and even depression (Alexander-Passe 2008, 2010; Edwards, 1994; Riddick, 1996). Nicolson and Fawcett (2000) note that a skill that would normally take a non-dyslexic child 400 hours to develop, learn and master, may take a dyslexic child up to 20 times longer to achieve. This could lead to frustration, loneliness, exclusion, and poor social skills as hours of extra work are required to master basic skills. Paul, the participant in this study experienced all these emotions which affected him on all three levels, as he, too had to work for hours longer than his peers to pass. Whilst they played sport and enjoyed themselves socialising, he had to go over everything that he had done at school every day and repeat things over and over to move the work to his better developed long term memory store. The quotation below illustrates just how difficult studying and learning was for the participant Paul.

> *"It comes with hard work and I had to put in far more effort than anybody else. At school I had to work ten times as hard as everyone else… it's impossible … you, you're doomed. Now people can argue with me … I'm telling you only a dyslexic will know you are doomed before you even started … but then later I learnt to work smarter not harder, this is a difference, only four times more … but it was far more productive" (Interview 2 lines 635–646).*

Finalisation and limitations of a model for compensating for barriers linked to developmental dyslexia

Although the barriers Paul experienced have been broken down for simplicity and description purposes into the three different levels, there is a constant recursive pattern or feedback loop occurring between the levels which is difficult to fully explain in a two-dimensional model. There is an ongoing interplay between the different barriers at all three levels which leads to different compensatory skills, because of the developmental dyslexia, which makes it is difficult to determine cause and effect. The barriers are

described at different levels, and it became more difficult to separate one from the other. Recurring themes and barriers appeared as well as much overlapping, especially between levels 2 and 3. There was constant interplay between behavioural and emotional factors which occur at all three levels. This is shown in the combined model. (See Figure 7).

Two-dimensional combined model

The two- dimensional combined model shows the three levels combined into one. One can determine some causes on the genetic or biological level, but the resulting interplay between the social and environmental influences on the third level is crucial for development of personality. Additionally, this interplay reveals Paul's sense of self, cognition, and the way he learns to process information differently as a means of compensating for his barriers due to having developmental dyslexia. In the same way, developmental dyslexia itself and all the associated barriers, will also play a crucial role as to the type of personality and character a person develops, which will determine how he interacts socially and with his environment. This whole process is far more complex than it initially appeared to be.

Additionally, Paul's behavioural and emotional compensation skills, both positive and negative, thread their way throughout all three levels, and one sees different elements of these from both an internal and external context. The double arrows in red in Figure 7 represent the behavioural and emotional interaction between the three levels.

Thus, it was necessary to go "back to the drawing board" and to look at some other options. A more complex, multi-dimensional, interactive model began to develop, and this is how the final model evolved.

Step 3: A Multi-Dimensional, Interactive Combined Model

Multi-dimensional combined model: Process 1

The first attempt at forming a more complex multi-dimensional, interactive model is illustrated in Figure 8. This shows the five factors or barriers that Paul had to compensate for. However, this multi-dimensional model, takes the process shown in Figure 7 shown as three concentric circles; one step further, as it illustrates that there are multiple dimensions within which a person compensates for their barriers to learning. There are five factors or barriers that are at play here, which interact in a dynamic and continual flow of energy, which include neurological factors (shown in yellow); intrapersonal factors (illustrated in blue); interpersonal factors (in green); behavioural factors (in red) and emotional factors (in pink). Each of the first three factors interacts with the other in a continual flow of energy, as shown by the black arrows. Thus level 1, the neurological factors interact with level 2, the intrapersonal factors as well as level 3 the interpersonal

factors, as shown by the black lines. Similarly, there is a reciprocal interaction between each of these factors back with the others, thus the double arrow on the black line. In the same way, the behavioural and emotional factors interact with all three of the other levels 1, 2 and 3, simultaneously. This is illustrated in Figure 8. As one can see, the behavioural factors (shown in red) and emotional factors (shown in pink), interact with and penetrate through each of levels 1, 2, and 3; the neurological, intrapersonal and interpersonal factors respectively.

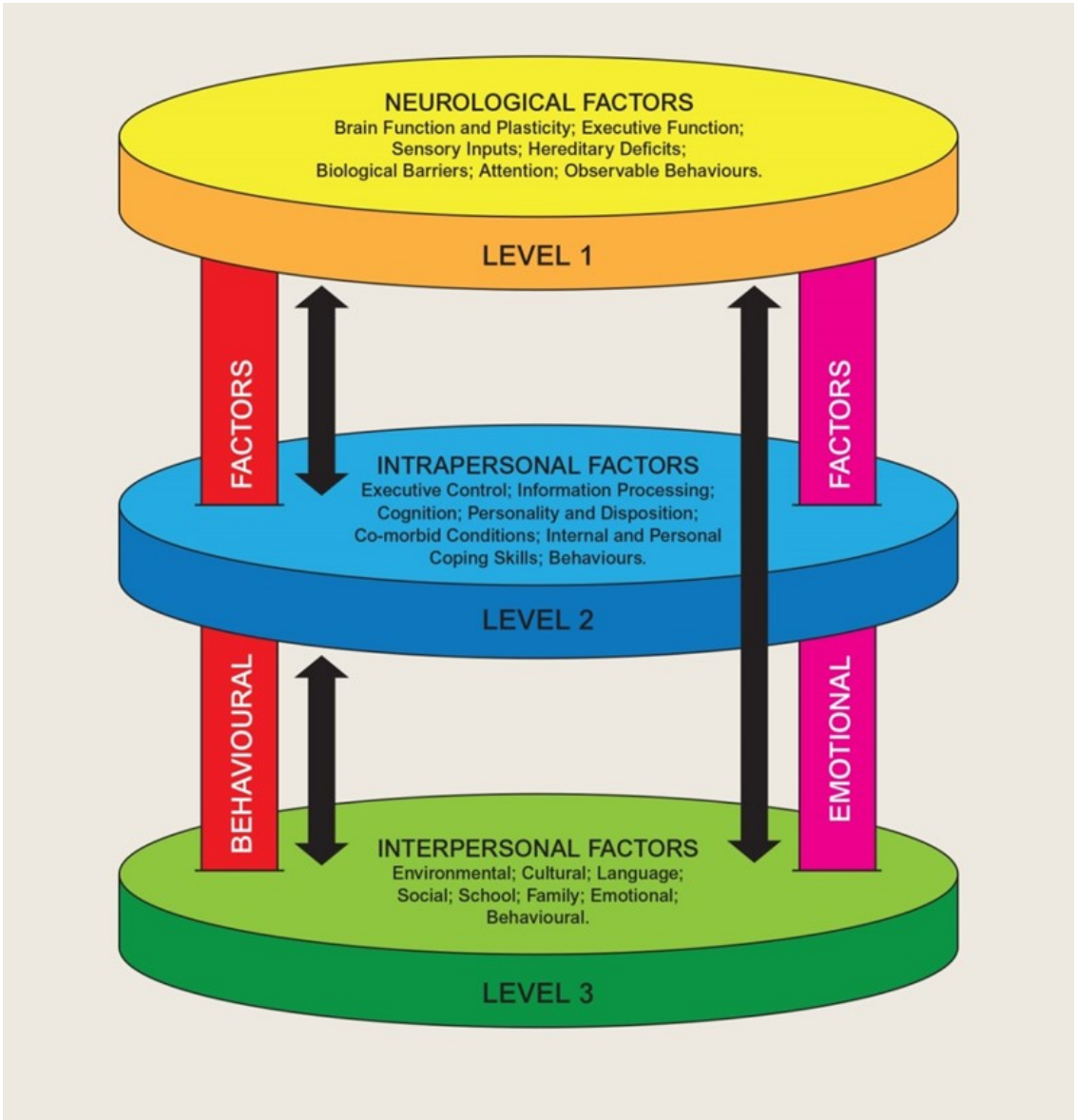

Figure 8: A multi-dimensional model explaining the barriers linked to developmental dyslexia: Process 1

Multi-dimensional combined model: Process 2

The black arrows did not seem entirely satisfactory, as they did not give the exact "feel" of a multi-dimensional interaction or flow of energy between the first three levels and the behavioural and emotional factors. The model was therefore refined and process 2 was developed, as illustrated in Figure 9. The red arrows, make the interaction between the five different factors or barriers, seem to be more three dimensional and makes the interaction appear to "flow" better, as illustrated in Figure 9

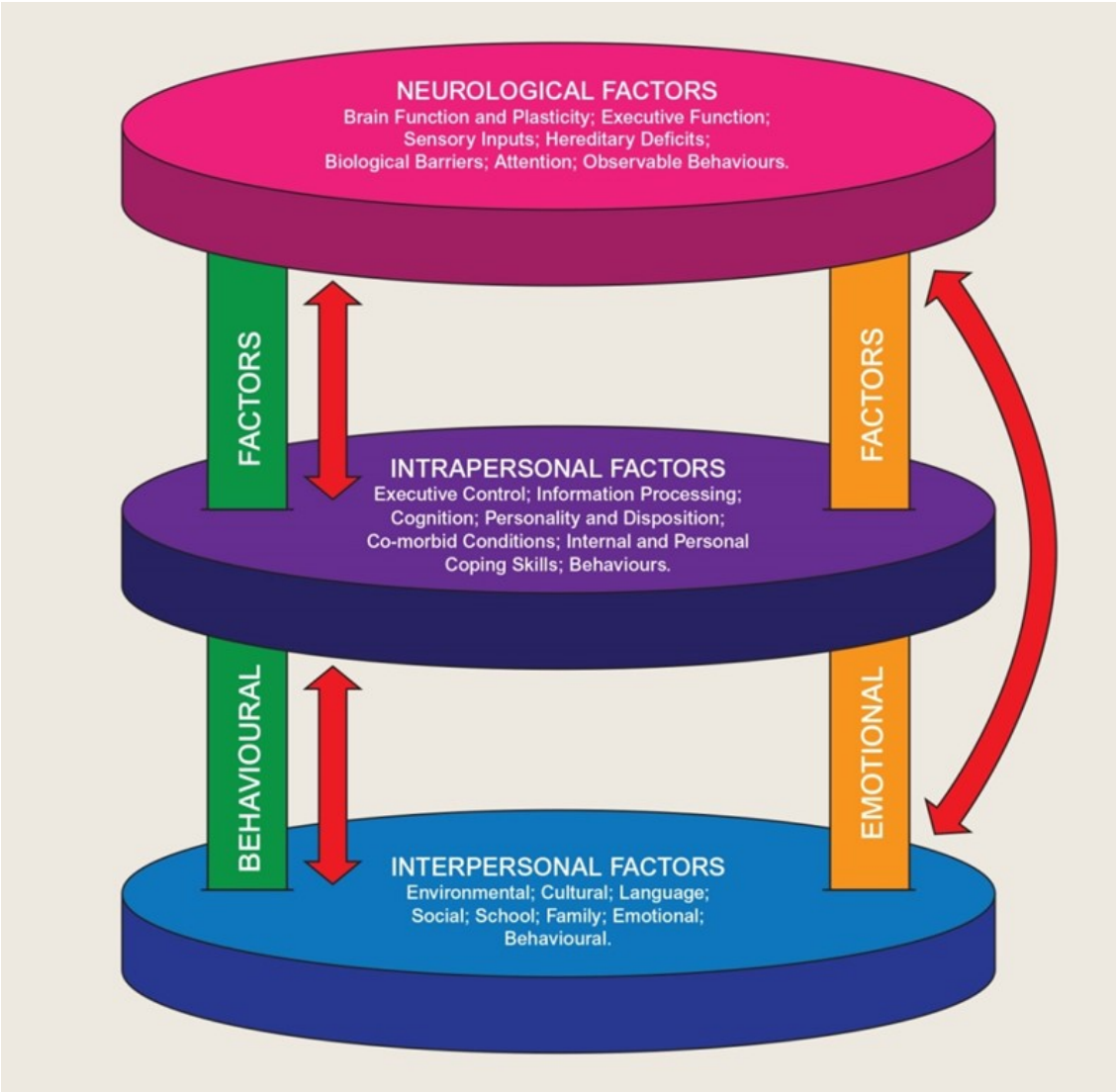

Figure 9: Multi-dimensional combined model explaining the barriers linked to developmental dyslexia: Process 2

The straight red arrows show the flow or interception between the neurological and intrapersonal factors and then the flow or interaction between the intrapersonal and interpersonal factors, respectively. The slightly rounded red arrow shows that continual flow or interaction of the interpersonal and neurological factors, as the model although multi-dimensional, makes it difficult to illustrate this interplay between these two factors, without "bending" the model over into an arch.

Three-dimensional combined model: Process 3

Although the multi-dimensional model shown in Figure 9 illustrates the "flow" of energy (red arrows) between the neurological (shown in pink), inter-personal (shown in blue), and intra-personal (shown in purple) factors or barriers, this model was still not completely satisfactory. A colleague showed the researcher a model she had bought at a toy shop which demonstrated the mixing of pink and blue coloured oil, which combined to form the colour purple. This triggered the idea of an hour-glass instead of the circles in the initial combined model, illustrated in Figure 10.

Figure 10: Image of an "hour-glass" toy

In the toy shop an "hour-glass" toy which contained blue oil was found, as shown in Figure 10. This single hour-glass toy was used to represent one of the factors or barriers to learning. Three of the hour glasses in different colours, were then placed one on top of the other to represent the neurological (orange), interpersonal (blue), and intrapersonal (green) dimensions of the model, as shown in Figure 11. In this manner, a three-dimensional, flowing form of the interaction of the five factors or barriers that Paul faced living with developmental dyslexia began to be conceptualised.

Figure 11: Image of three "hour-glasses"

However, because the three hour-glasses were sealed, it was impossible for the three colours to mix or "flow" between one another, or for the "energy" between the three factors or dimensions to be shared, as it was envisaged by the researcher. The three oils or liquids would have to be three different densities, so that they could mix and then separate again with the least dense at the top (orange) and the densest at the bottom (green), so that each colour could maintain its identity as a specific factor or dimension.

However, the emotions and behaviours that were included across all three of these dimensions could not be explained using the hour-glass model, so this explanation was too limiting.

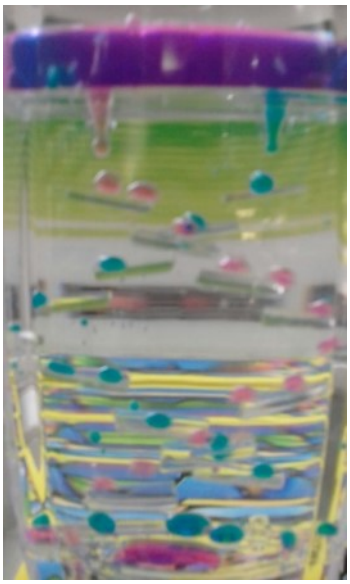

Figure 12: Toy showing mixing of blue and pink oil to form purple

A more unusual toy was found, which showed the type of flow and mixing that was attempting to be illustrated by the model far better than the hour-glass models. This is shown in Figure 12.

The pink and blue colours interacted together and formed the colour purple, which better explained the flow of energy and integration between the different factors of the model in Figure 9. This "mixing of colours" also assisted to include the emotions and behaviours that the hour-glass model could not illustrate. However, even this model was too limiting, and further thought had to go into developing a more complex model.

This then led to the final model as illustrated in Figure 13 which shows the continual flow of energy and interaction between the five factors or barriers that Paul faced because of having developmental dyslexia.

Figure 13 Illustrates the final multi-dimensional interactive model that shows the dynamic interaction of the biological or neurological factors (in pink), the intra-personal factors (in purple), and inter-personal factors (in blue); while there is also a continual flow of energy and interaction between all three of these factors from the behavioural and emotional factors; which vary in colour, depending on with which of the three of these former factors they interact. This is a similar colour interaction illustrated by the toy in Figure 12, where the blue and pink combine to form purple. Compensation occurs continually and

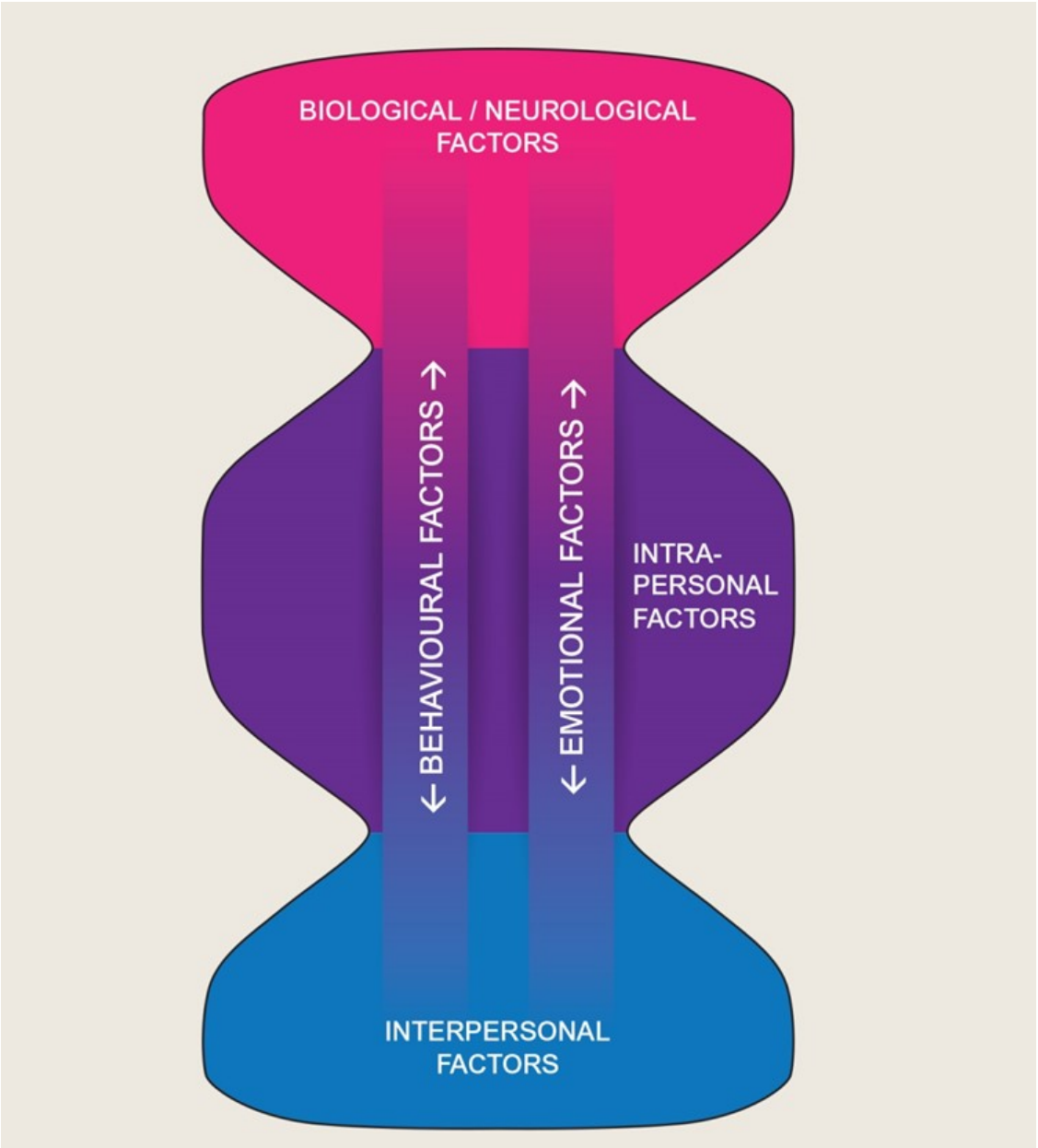

Figure 13: A multi-dimensional interactive model explaining the barriers linked to developmental dyslexia: Process 3

simultaneously as required, at some or all of these levels in a positive or negative manner in order to assist the person with developmental dyslexia to cope more effectively in life.

This explanation illustrates the complexities of the human brain. Furthermore, this model illustrates the interplay between the intrapersonal and interpersonal factors or barriers that a person with developmental dyslexia faces, and these cannot be reduced to a simple model. However, this model was developed for explanation purposes and to simplify and illustrate the level of complexity of the barriers Paul faced because of having developmental dyslexia, and thus the complexity of the compensatory skills and techniques he had to learn and use to cope with these barriers.

A three-dimensional (3D) computer-generated model may have illustrated this in a more meaningful manner. However, when an attempt was made to construct this 3D model using a computer programme, besides the fact that this was well beyond the researcher's computer expertise, it become too complex, and the explanation lost its meaning. Thus, this final third attempt at a model given in Figure 13 best suited this purpose.

Implementation of the model

It is evident from the aforementioned model (Figure 13) that the person compensating for their barriers linked to developmental dyslexia, must do so at five different levels, sometimes simultaneously at two or more levels. Firstly, the neurological or biological barriers, which include hereditary factors, brain-based hereditary deficiencies such as magnocellular and cerebellar deficits, executive function, attention, as well as visual stress, brain function and brain plasticity. Sensory input occurs through the neurological system and links closely to trauma as well as to sensory integration difficulties experienced by individuals with developmental dyslexia. Thus, one can see how complex and multi-dimensional the links are even within one of the levels. Secondly, intrapersonal factors, which include executive control functions, which links levels 1 and 2, information processing difficulties, cognition, personality and disposition, co-morbid conditions such as ADHD and motor difficulties, as well as internal and personal coping skills. Thirdly, the intrapersonal factors that include the environment, cultural and language influences, social and psycho-social interactions including those with family, peers, colleagues, and others such as teachers and lecturers. This factor also includes the educational system, policies, and other external factors. Fourthly and fifthly are behavioural and emotional factors, respectively.

It is recommended that the above barriers be addressed in the following manner because of the researcher's experience with Paul, and other people with developmental dyslexia of a wide variety of ages. Paul used a multi-sensory approach; which has been proven to work effectively for people with developmental dyslexia (Banai & Ahissari,

2010; Fry, 2012; Reid, 2011). His compensatory techniques in these areas when studying/ learning included drawing, making diagrams, talking to himself, teaching himself, listening to tapes, using different coloured paper, and using coloured pens and highlighters. He used his body (kinaesthetic approach) by walking around, moving his arms to follow sequences using the charts. He used authentic illustrations to assist him to remember what the instruments looked like in the cockpit as he rehearsed and memorised the sequences. Both children and adults learn far better using as many senses as possible, rather than using just one or two by reading (visual) or listening (auditory)(Banai & Ahissari, 2010; Fry, 2012; Reid, 2011).

Currently in South Africa, children and students diagnosed after a full assessment by an educational psychologist or other suitably qualified professional are entitled to various accommodations from Grade 4, provided they meet the criteria. These accommodations were first introduced in Education White Paper 6 (DoE, 2001) and then revised and updated when the Policy of Screening, Identification, Assessment and Support (SIAS) document (DoE, 2014) was introduced. Accommodations could include a reader, a separate venue, extra time, spelling concessions, the use of oral assessment, use of a scribe, or a computer, voice recognition software, and various other accommodations depending on the severity of the developmental dyslexia and other co-morbid conditions that occur. Paul and his teachers were unaware of these accommodations until he reached Grade 12, although they were already available from when he was in Grade 10 in 2001. He was only granted extra time, whereas he was entitled to a spelling concession, a reader, and a separate venue from Grade 10 (DoE, 2001). One will never know what Paul might have achieved if he had been given this opportunity. In the researcher's personal dealings with parents and teachers, many are unaware of the fact that children with developmental dyslexia and other difficulties are entitled to accommodations if they have been accurately assessed and diagnosed and qualify for these. This means many children are struggling unnecessarily.

Furthermore, dealing with emotional issues was essential for Paul to function better. Most children and adults with developmental dyslexia tend to have co-morbid emotional difficulties such as anxiety, depression, frustration, or anger, and may have been bullied or exposed to long-term trauma (Alexander-Passe, 2010, 2015; Nelson & Gregg, 2012; Scott, 2004). Seeing a psychologist, psychiatrist or neurologist and taking suitable medication if they require this is important for optimal functioning.

Similarly, it is essential that children with suspected dyslexia are screened and diagnosed as early as possible, as the sooner intervention begins, the more likely they are to learn to read more efficiently (Elbro, Nielson & Pietersen, 1994; Hulme & Snowling, 2009; Reid, 2009, 2011). At a younger age, the brain is more plastic and early intervention has been shown to be more effective than later intervention. Assistance and assessments by speech therapists, occupational therapists, and other professionals to address speech and motor difficulties will also minimise long-term effects in these areas.

Unfortunately, in the South African context, resources are severely limited, and many children and schools have no or very limited access to any of the above-mentioned specialists. This means that many children, students, and adults, will remain undiagnosed in South Africa and thus may never reach their full potential. This will probably result in their dropping out of school because of frustration and failure that may not be any fault of their own.

CONCLUSION

This study aimed to explore the experiences of a male with developmental dyslexia, and the barriers he faced because of having developmental dyslexia. Given the results of the study an attempt was made to develop a multi-dimensional, interactive model that showed the barriers faced by people with developmental dyslexia, and for which they have to compensate.

The current research models did not explain or incorporate the rapid advances being made and knowledge being generated by the brain-scanning techniques used in the last decade. Therefore, based on the assumptions about developmental dyslexia, and the barriers faced, and using the IPM and CMF as a sound theoretical basis to explain developmental dyslexia, I set out to develop a model to show the barriers faced by people with developmental dyslexia.

LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

One of the potential criticisms levelled against this model in Figure 13 is that the model could not possibly be valid if the data from only one person with developmental dyslexia had been used. This was, however, never the case from the beginning, as a large amount of data from other participants had already been gathered along with Paul's data; as the initial study was to be a multiple case study. However, the data from the participant "Paul" that was used to present the single case study was so rich and had so much depth, that the thesis was eventually based on his information. However, the model itself was developed with a far larger number of participants' information at hand.

A total of 8 participants' initial information was used, and as more data became available over the past seven years, the model could be recognised as more credible. In the future, it would be useful to follow up this article with additional information gleaned over the 7 year period from up to 30 people between the ages of 9 and 52 with developmental dyslexia, and how they compensated for their challenges. However, the written permission to use the information from these assessments, and interviews conducted (mostly for accommodation purposes), would have to be obtained from the people involved to make a further article ethical. This permission is in the process of being sought and the data is being processed along with other data from another South African colleague, Sandra Stark, who is the director of The Stark Griffin Dyslexia

Academy of South Africa (SGDA); who will assist with additional data for a more comprehensive article to support the model and validate it further in the future.

It is hoped that through this study, that there will be increased awareness of the large numbers of children, students and adults in South Africa who could have developmental dyslexia. In a country where the mid-year population in 2020 was reported at 59.62 million (Statistics South Africa, 2020), and where approximately 10% of the population may have developmental dyslexia, this could be as many as 5.962 million people; the majority of whom may never be diagnosed, due to a severe lack of resources and access to necessary assistance. By educating teachers, parents and other professionals through workshops, courses and through internet platforms, it is possible to make them more vigilant and to teach them how to identify children or students who may have developmental dyslexia so that they can be sent for testing as early as possible. In this way, they can receive maximum early support and appropriate intervention through effective, tailor-made treatment plans, to achieve their optimum potential.

This process has already begun through training programmes for teachers throughout South Africa, specific lectures targeted at students at UJ, in the teaching and educational psychology programmes, as well as talks at conferences.

This may be a dream, to reach so many with so few resources, but to make a difference, one must start somewhere. One person cannot change the world, but we can start in the small area of influence where we live and work. It is hoped that the few thousand teachers and parents that have heard the dyslexia talks based on the research and literature summarised from this study; or attended workshops about developmental dyslexia: how to identify it and how to assist their children at home and in the classroom; may be a small drop in the ocean on a worldwide scale, but to each of those children, it has made a significant difference to how they function in the world and to their future prospects. Reaching a wider population with the publication of this article would move this dream one step closer to being achieved.

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NOTE:

This research was conducted in fulfillment of the requirements of the degree Philosophiae Doctor Educationis at the University of Johannesburg (UJ).

The research was partially funded by the UJ Department of Education project on Educating Children with Neurodevelopmental disorders, through an earmarked grant allocated as part of the Teaching and Learning Capacity Improvement Programme that was implemented through a partnership with the South African Department of Education and Training, and the European Union.

No influence from the funding organisations or UJ, were exerted on the researcher to ensure any particular outcome, and results have been published after proper ethical research was conducted. Additionally, the work was independently examined by three external examiners.

UNITE SpLD 2021 CONFERENCE

Uniting Ideas in Teaching Excellence:
Specific Learning Differences 2021
24 to 25 June 2021

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The UNITE SpLD Conference seeks to bring together parents, teachers and practitioners working with children with specific learning difficulties and special educational needs. This conference will be showcasing research that covers aspects of behavioural, literacy and social emotional support, intervention and assessment for children with special learning needs. Come and listen to our SpLD experts share their research. Research will be presented it short, engaging and entertaining sessions accompanied by poster presentations and the chance to talk directly with researchers who are making a difference in the Asian region.

Asia Pacific Journal of Developmental Differences
Vol. 8, No. 2, July 2021

Keynote Presentation—Conference Day 1—24 June 2021

Does Developmental Dyslexia Really Exist?

John Stein[1*]

1. *University of Oxford, UK*

Abstract

For most of the 20th C. developmental dyslexia was diagnosed on the basis of finding a discrepancy between normal or high oral and nonverbal reasoning ability, yet unexpectedly low reading and spelling skills. This discrepancy criterion has now been undermined by the claim that dyslexics all suffer a phonological deficit. Hence it is argued that we should measure this to identify dyslexia. However, since grasping the phonological principle is essential for learning to read, this phonological criterion makes it impossible to distinguish developmental dyslexia from any of the many other causes of reading failure. Instead, we need to understand the specific physiological mechanisms that underlie dyslexics' failure to acquire phonological skills. An important cause is probably impaired development of the brain's rapid temporal processing systems; these are required for sequencing accurately the order of the sounds and letters in a word. Such temporal, 'transient', processing is probably carried out in all parts of the brain primarily by a distinct set of 'magnocellular' neurones, and the development of these has been found to be impaired in most people with dyslexia. Therefore, assessing poor readers' auditory and visual temporal processing skills should enable dyslexia to be reliably distinguished from other causes of reading failure and this will suggest principled ways of helping these children to learn to read, such as magnocellular training, blue or yellow filters and omega 3 fatty acid supplements.

Keywords: IQ, discrepancy, phonology, temporal processing, magnocellular, visual, auditory, colour filters, rhythm, omega 3.

* *Correspondence to:*
John Stein, Emeritus Professor of Neuroscience, Dept. Physiology, Anatomy and Genetics and Fellow of Magdalen College, University of Oxford mail: john.stein@dpag.ox.ac.uk

Asia Pacific Journal of Developmental Differences
Vol. 8, No. 2, July 2021

Keynote Presentation—Conference Day 1—24 June 2021

The Inclusion of Students with Special Educational Needs in Singapore

Levan Lim[1*]

1. *National Institute of Education, Nanyang Technological University, Singapore*

Abstract

There has been much progress achieved towards the inclusion for students with special educational needs in Singapore during the past two decades. There are currently many more students with special educational needs in mainstream schools compared with numbers in the past and in special education schools. This keynote presentation provides a contextual understanding of how the inclusion of students with special educational needs has evolved to become a key educational agenda in Singapore through national initiatives, educational systemic enhancements, and teacher education playing an important role in the preparation of school personnel. This presentation concludes with a discussion of issues, challenges and future directions that are relevant to the evolvement of inclusion for students with special educational needs in Singapore.

Keywords: Inclusion, integration, special educational needs, education in Singapore,

* *Correspondence to:*
Dr Levan Lim, Associate Professor, Psychology and Child & Human Development Academic Group , National Institute of Education, Nanyang Technological University. Email: mjoshi@tamu.edu

Asia Pacific Journal of Developmental Differences
Vol. 8, No. 2, July 2021

Keynote Presentation—Conference Day 2—25 June 2021

Dyslexia, the Whole Picture and the 360 degree Perspective

Geetha Shantha Ram[1*] and Deborah Hewes[1]

1. *Dyslexia Association of Singapore*

Abstract

Through an exploration of current literature, various studies by the Dyslexia Association of Singapore such as the 2020 "Part Strong part weak and bullied" and 2019 "High ability and Entrepreneurial success", we offer 'Embrace Dyslexia' as a possible framework for individuals and organisations keen to participate in the global movement highlighting the strengths of people with dyslexia as they urge for change within their communities.

This talk will be framed by the 5 principles under the Embrace dyslexia commitment which are:

1. Educate - raise awareness about dyslexia,
2. Explore opportunities to work with Dyslexia organisations,
3. Champion the strengths of dyslexic individuals,
4. Donate to support low-resourced families and
5. Declare commitment as an Advocate who Embraces Dyslexia.

Through an exploration of current literature, various studies by the Dyslexia Association of Singapore such as the 2020 "Part Strong part weak and bullied" and 2019 "High ability and Entrepreneurial success", we offer 'Embrace Dyslexia' as a possible framework for individuals and organisations keen to participate in the global movement highlighting the strengths of people with dyslexia as they urge for change within their communities.

Keywords: Entrepreneurship, dyslexia strengths, inclusion, bullying,

* *Correspondence to:*
Geetha Shantha Ram, Director, SpLD Assessment Service, English Language and Literacy Division, Staff Professional Development , Email: Geetha@das.org.sg

Asia Pacific Journal of Developmental Differences
Vol. 8, No. 2, July 2021

Keynote Presentation—Conference Day 2—25June 2021

From Helplessness To Empowerment: RE-Engaging Students with Dyslexia

Dean Bragonier[1*]

1. *NoticeAbility Inc, USA*

Abstract

Students with dyslexia demonstrate paradoxical behaviour in the classroom. At times, they appear withdrawn, insecure, and even cynical. In the blink of an eye, these same students may show moments of enthusiasm, engagement, and an eagerness to learn.

In his talk, Dean shares anecdotes from his academic journey, giving a unique glimpse into the psychological impact of being a student with dyslexia. Dean explores the intersection between classroom instruction and contemporary behavioural theories that underscore strategies and techniques that bolster student self-esteem and academic tenacity.

Keywords: dyslexic strengths, teaching, self-esteem, dyslexia.

* *Correspondence to:*
Dean Bragonier, Founder and Executive Dyslexic of NoticeAbility Inc, www.NoticeAbility.com Email: dean@noticeability.org

Asia Pacific Journal of Developmental Differences
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The Magical World of Technology and Dyslexia

Carol Allen [1*]

1. *Advisor for ICT and Inclusion*

Abstract

We are working in a time of change in education – our buildings; our curriculum and assessments guidance and this combined with the speed of innovation and progress in technology can lead to a feeling of, 'missing out,' or, 'being unsure how to keep up'. In addition, despite the ever-increasing demands being made upon teachers and schools, particularly over the recent world-wide response to the pandemic, resource allocations are often reduced, or tied to 'projects'. Throughout all of this, the students we teach are the same; their needs, abilities and disabilities remain the same.

For students with Dyslexia, both diagnosed, or those who are experiencing barriers to reading and writing but have not been formally assessed; the use of carefully chosen supports is vital to allow learning to take place with a reduction in the immense effort required if no support is given. This impacts on so many areas beyond accurate academic performance; anxiety, avoidance behaviours, well-being and mental health are all part of the picture for those for whom the educational system presents a daily diet of literary confusion.

Technology has a central role to play in this access to learning; indeed the recent emergency move to remote learning has brought its importance to the fore. When the match between need and technology is perfect, the results are magical, not only for the learning outcome but additionally for the empowerment and wellbeing of the Dyslexic student. This session will look at a range of practical, technological solutions from low to high tech, all of which offer success for our students.

Keywords: dyslexia, inclusion, assistive technology, special needs education

* *Correspondence to:*
Carol Allen, Advisor for ICT and Inclusion, UK, Email: carol.allen.work@gmail.com

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Dyslexia: What's the Story?

Carol Allen [1*]

1. *Advisor for ICT and Inclusion*

Abstract

Communication is at the heart of all teaching and learning. For Dyslexic learners, barriers in two of the four communication elements, that is reading and writing, can reduce access to learning and prevent outcomes that reflect ability. As educators, our focus has to be on supporting their development in these areas in order to increase access to the wider curriculum. Evidence-based precision teaching provides a clear, structured approach to learning to read and write and is our essential baseline. To complement this, we need to embed and extend our structured teaching by utilising creative opportunities in order to consolidate and generalise learning; to motivate and engage, and most importantly, to allow creativity to flourish and ideas to be shared.

This session will look at stories and storytelling as vehicles for enhancing communication both in terms of academic activities and additionally, personal growth and wellbeing. Many Dyslexic students restrict their written output to 'safe zone' work based on the words and phrases they feel comfortable with, however, these can be far from the level of writing that they are capable of imagining. We will share a range of online storytelling opportunities that are free to use and that produce excellent learning. From considering how to use sensory elements to create evocative and effective classroom stories, through active learning to using technology to capture and share stories for all, this session will offer practical ideas to take away and use with your students.

Keywords: dyslexia, communication, creativity, storytelling, sensory, technology

* *Correspondence to:*
Carol Allen, Advisor for ICT and Inclusion, UK, Email: carol.allen.work@gmail.com

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Bullying and the SEN student

Madinah Begum[1*], Sujatha Nair[1] and Geetha Shantha Ram[1]

1. *Dyslexia Association of Singapore*

Abstract

As part of a parent advocacy initiative by the Dyslexia Association of Singapore's (DAS), a survey of DAS parents was conducted in 2020 to find out about the incident rates of bullying that our students faced. The aim was to analyse the prevalence of the various types of bullying experienced by the students and how bullying affects them. Through this research, we hoped to find out more about how we could mitigate the bullying rates among SEN students. Ultimately, we want to empower both teachers and parents by providing meaningful knowledge on how they can support students to minimise bullying.

A total of 185 parents of students studying at DAS were given online questionnaires, which asked them about their children's prior experiences with bullying and what they felt could be done to eliminate bullying. For qualitative data, we first came up with a group of common responses that parents had for each question, followed by recording the frequency of those responses. Afterwards, we tabulated and analysed both 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 contribute to bullying prevention among SEN students. Moreover, our data show that support from parents and schools were the most important factors to help reduce bullying rates. Lastly, it was found that males experienced higher rates of bullying than females for all types of bullying.

Keywords: bullying, dyslexia, SEN, Special Educational Needs,

* *Correspondence to:*
Madinah Begum, Educational Advisor/ Senior Educational Therapist, Dyslexia Association of Singapore .
Email: Madinah@das.org.sg

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THE 'word' GAME'S AFOOT! Inductive Approach for Vocabulary Learning and Teaching

Isabelle Shanti Benjamin [1*]

1. *ELCOT Consultants, Singapore*

Abstract

What if Sherlock Holmes decided to teach vocabulary? What teaching approach would he likely use? The answer is obvious - it was the way he solved all his cases - using inductive reasoning. He made observations, noted critical clues and drew conclusions. Traditional vocabulary lessons tend to largely rely on a deductive approach where the meaning of words are provided for students to apply to the interpretation of meaning in texts. The problem with this approach, while seemingly efficient, is that the knowledge of the meanings taught is seldom retained long enough by learners, much less applied spontaneously in production tasks. Sherlock instead, would have used the inductive approach making students figure out the meaning of unknown words through the 'power of observation'. Studies have shown that teaching and learning approaches that involve inductive reasoning lead to better retention of the content delivered, in this case, meanings of words. This approach also helps learners develop higher-order thinking and analysis skills, greatly valued in the competitive economies of today's world. For reading comprehension tests where students often encounter unknown words which they would have to interpret without the help of their 'walking dictionary' teacher or the online dictionary on their smartphones, this capacity to 'guesstimate' meanings of words is not only critical but an expected capacity. This workshop will share techniques teachers can use to help students hone their 'powers of observation' to 'notice' the textual clues that point to the intended meaning of words in a text.

Keywords: inductive learning; vocabulary learning, vocabulary teaching

* *Correspondence to:*
Dr. Isabelle Shanti Benjamin is the Founder & Principal Consultant of ELCOT Consultants, Email: elcot_consultants@yahoo.com

Asia Pacific Journal of Developmental Differences
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A Comparative Analysis of 7112 Dyslexics to a Population of Dyslexics from A Neuroscientific Study

Angelica Benson[1*] and Rosie Shand[2]

1. *Lindamood-Bell Learning Processes—USA*
2. *Lindamood-Bell Learning Processes - Hong Kong & Singapore*

Abstract

This investigation evaluates both the behavioral and neurophysiological outcomes of a reading intervention designed to address the symptoms associated with dyslexia. In this post-hoc meta-analysis, a statistically similar population of dyslexic participants from a research collaboration at the University of Washington ILABS (UW) was compared to 7112 dyslexics who attended Lindamood-Bell Learning Centres in the United States, the United Kingdom, and Australia. All subjects were administered pre- and post-test standardized behavioral assessments measuring reading skills in key domains associated with dyslexia. The dyslexic participants from UW also received pre- and posttest neurophysiological measurements. All subjects received one-to-one intensive reading intervention developing mental representations of letters and sounds within words, on average for 120 hours, 2-4 hours daily, 5 days a week.

In the neurophysiological intervention study, significant correlations were found in brain white matter conductivity as related to significant improvements in reading, compared to controls (Huber, Donnelly, Rokem, & Yeatman, 2018). Corresponding to these changes was an increase in reading behaviors for those 7112 dyslexic students in clinics, who showed statistically similar gains in key areas associated with the symptoms of dyslexia. This investigation contributes to a deeper understanding of the cause(es) of dyslexia, its' diagnosis, and the behavioral and neurophysiological results of the intervention protocol developed for individuals who express symptoms of dyslexia. Collectively, these findings offer important insight into the question of whether or not dyslexia can be remediated.

Key words: reading intervention, behavioral and neurological research results, sensory-cognitive instruction, imagery-language foundation

* *Correspondence to:*
Angelica Benson, Director of International Development, Lindamood-Bell Learning Processes
Email: angelica.benson@lindamoodbell.com

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

See Me, Hear Me: Concerns Of Students With Special Educational Needs At University In Singapore

Damaris Carlisle[1*]

1. *LASALLE College of the Arts, Singapore*

Abstract

Education in Singapore has been undergoing a gradual shift towards a social model of inclusive education since the Compulsory Education Act came into force in 2003. With the aim of supporting students with disabilities and special educational needs, the Singapore government has increasingly provided resources and facilities in schools, resulting in larger numbers of these students continuing to tertiary education. This presentation discusses the findings of a phenomenological case study, where 26 individual interviews were conducted with students studying at different universities across Singapore as they reflected on their first-year experiences. One area that was discussed was the issues the participants faced as students with varying educational needs. Whilst there have been improvements since the introduction of disability support offices at institutes of higher learning since 2014, challenges still remain ranging from attitudes to academic barriers, from systemic hurdles to concerns about career prospects. The lived experiences of these learners presenting a wide range of differing needs provide insights into their realities and concerns. This, in turn, has possible implications for policy and practice at the tertiary level in Singapore.

Key words: disability support, first-year, special educational needs, transition, university

* *Correspondence to:*
Damaris Carlisle, Lecturer-in-Charge, The Learning Centre, LASALLE College of the Arts Email: damaris.carlisle@lasalle.edu.sg

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Technology for supporting reading in exams

Jack Churchill[1*]

1. Scanning Pens, UK

Abstract

Technology is changing the way we conduct our lives, and it's happening faster than ever. How we test our children in school is thankfully also moving forward. Examinations present a major obstacle for many young people who struggle with reading difficulties like dyslexia. The objective of most exams is to test the student's knowledge of a given subject, i.e. geography, not to test their reading ability. Reading is a pre-cursor skill. Without it, reading and answering the questions is yet another challenge for the candidate. It is therefore hugely important that all students receive the necessary accommodations to read the exam questions.

Over the last 8 years, I have worked with exam boards around the world to modernise the reading support that children receive. Technology, like pen scanners, means students can be back in the main exam hall, reading on their own and not reliant on another human to sit with them. Technology importantly also prepares them for later life when they will have to work independently.

I was fortunate to get support for my own dyslexia whilst at school. This extra support enabled me to pass my exams, go onto university and now the workplace with the confidence of knowing I had achieved. Breaking down barriers for young struggling readers is an important part of my life mission. My presentation will talk about the importance of a toolbox approach when using assistive technology in everyday education and exams.

Keywords: Assistive Technology, Reading in Exams, dyslexia, scanning

* *Correspondence to:*
Jack Churchill, Co-Founder of Scanning Pens. Email: jack@scanningpens.com

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

The Learning Outcomes of Reader Pens in Supporting Reading for Dyslexic Learners

Julia Clouter[1*]

1. *SpLD Specialist, Scanning Pens, UK*

Abstract

Scanning Pens is a wi-fi free and portable assistive technology tool that supports reading by decoding at both word and sentence level for learners with difficulties such as weak literacy, developing English as a second language (EAL) and SpLD dyslexia. This presentation outlines the research conducted in the United Kingdom by three researchers, Franklin, Mortimore and Coleman, who have each independently corroborated the impact of Scanning Pens to accelerate the reading progress of learners and enable them to achieve accelerated success in examinations.

In the research conducted by Mortimor with 46 Year 11 students, she states that the 83% who made use of the Exam Pen in their examinations achieved a real increase in their results. These learners also agreed that the use of the Scanning Pen supported their emotional well-being and identified that it had improved their confidence and attitude to learning. In addition to exploring and comparing the findings of this study, the key elements of multi-modal learning and multi-sensory teaching methodology will be explored. We will also investigate the views of the learners about the gains made in their confidence and well-being through the ability to learn independently with Scanning Pens assistive technology.

Keywords: Dyslexia, memory, multi-modal, well-being

* *Correspondence to:*
Julia Clouter, Head of Education for Scanning Pens and SpLD Specialist Scanning Pens UK, Email: julia@scanningpens.com

Asia Pacific Journal of Developmental Differences
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Leaving nothing to chance: a coaching approach to improving teacher knowledge, skills and understanding of teaching reading.

Jessica Colleu Terradas[1*] and Margo Leatch[1]

1. *Literacy Guarantee Unit, South Australia Department for Education, Australia*

Abstract

The latest Programmes for International Student Assessment (PISA) results have confirmed that Australian schools are not doing enough to achieve a functional level of literacy and numeracy in at-risk adolescents. From 2000 to 2008, mean reading literacy scores dropped from 528 to 503, the equivalent of a year's learning. This is a wake-up call. In response, a new Literacy Guarantee Unit has been established in the South Australia Education Department, with a focus on improving the achievement of all students through strong foundations in literacy. The 14 literacy coaches support South Australian schools by offering intensive professional learning to primary school teachers as well as direct teacher coaching in the most up-to-date evidence-based methods and practices- including explicit teaching of synthetic phonics. With expertise in phonics and teaching students with dyslexia and other learning difficulties, the unit ensures that schools are well placed to provide quality wave one teaching to support all students to achieve strong literacy outcomes.

In this session, participants will overview the evidence-based recommendations for improving literacy outcomes for primary students (ages 6 to 11). They will learn about the latest global research on what strategies are leading to improved literacy outcomes. This workshop will also provide examples of how these recommendations are being translated into the classroom in South Australian schools. Finally, the participants will explore the use of a coaching model for teachers at school and classroom levels.

Keywords: instructional coaching, literacy, reading, building teachers' capacity

* *Correspondence to:*
Jessica Colleu Terradas, literacy coach in the Literacy Guarantee Unit with the SA Department for Education, Australia
Email: jessica.colleuterradas@sa.gov.au

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Strategies for supporting older struggling readers – how do we ensure the effectiveness of our teaching?

Jessica Colleu Terradas[1*]

1. *South Australia Department for Education, Australia*

Abstract

If students are not competent readers, they are at risk for academic, behavioural, social and emotional difficulties. There has been a great body of research supporting the Simple of Reading and providing with recommendations to prevent reading difficulties in young learners. However, many students reach upper elementary and middle school without having acquired strategies and skills to become strong, independent readers. This has a cumulative impact on their capacity to both engage with the curriculum and to learn the increasingly vast amount of work that is being presented to them. Teachers can change this trajectory for children at risk for failure in reading by intervening early and providing explicit, intensive and systematic instruction.

In this session, participants will :

- identify the impact of poor reading on older learners
- explore the implications for classroom teachers in designing targeted instructions to meet the individual learning needs of each student

Keywords: Adolescents struggling readers, reading, literacy intervention, instructional strategies

* *Correspondence to:*
Jessica Colleu Terradas, Literacy Coach in the Literacy Guarantee Unit with the SA Department for Education, Australia
Email: jessica.colleuterradas@sa.gov.au

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Explicit Instruction, Science of Learning and Cognitive Load Theory in practice

Jessica Colleu Terradas[1*]

1. *South Australia Department for Education, Australia*

Abstract

This workshop aims to explore brain research to help teachers determine the most effective strategies to maximise student learning. It will focus on how Explicit Instruction (EI) is informed by the Science of Learning, specifically the impact of Cognitive Load Theory and 'load reduction instruction', and discuss how instructional strategies can impede or enhance learning. Indeed, EI teaching model incorporates a strategic collection of instructional practices that teachers can implement and use in all learning areas. It encourages students to be actively engaged in the lessons and has "engagement norms" to help students process information so that they master the skill.

By the end of the session, participants will have:

- an understanding of high impact classroom strategies
- identified the lesson design and delivery components of an EI lesson
- an increased level of confidence in implementing key instructional strategies

Keywords: Explicit instruction, optimizing work load, classroom strategies, lesson design

* *Correspondence to:*
Jessica Colleu Terradas, Literacy Coach in the Literacy Guarantee Unit with the SA Department for Education, Australia
Email: jessica.colleuterradas@sa.gov.au

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Vol 8, No. 2, July 2021

Multisensory Grammar Instruction

Siti Mariam Binte Daud[1,2*] and Agaisteen Rebecca Shalinah[1,2*]

1. *Dyslexia Association of Singapore*
2. *DAS Academy, Singapore*

Abstract

Dyslexia is a learning difficulty that primarily affects the skills involved in accurate word reading and spelling. However, writing has been recognized as an area that has not been comprehensively researched. Writing is a multi-faceted task that draws on different skills such as grammar, vocabulary, as well as the organization of words and ideas. As such, learners with dyslexia often struggle with writing. Drawing upon the principles from the Orton-Gillingham approach, research has found that direct, explicit and multisensory instruction is necessary to support learners with dyslexia. Project Read is a curriculum that recognizes these needs and incorporates them in its teaching methodology. One of the key features of this curriculum is to provide explicit grammar instruction through a system of diagrams and distinctive graphic symbols to represent sentence parts. Its structured, cumulative and multisensory approach aims to help learners progress from sentence level to paragraph level and eventually to text level writing.

Keywords: Multisensory, Grammar

* *Correspondence to:*
Siti Mariam, Lead Educational Therapist, Dyslexia Association of Singapore Email: mariam@das.org.sg
Rebecca Shalinah, Senior Educational Therapist, Dyslexia Association of Singapore Email: rebecca.shalinah@das.org.sg

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Procedural Learning, Dyslexia and Maths

Angela Fawcett[1*]

1. *Dyslexia Association of Singapore*

Abstract

In recent research, we have argued that a procedural learning deficit underlies the learning difficulties in dyslexia, and this has been well-supported by ongoing research in the area. This theory suggests that dyslexic children have strengths in declarative learning, that is learning facts, and their performance is most impaired when they are forced to rely on their weaker procedural skills. Procedural and statistical learning also underlies key stages in learning maths, and in this talk I shall consider how far maths learning difficulties could be accounted for by a similar process, emphasising similarities and differences between the two conditions. The impact of anxiety on both conditions can be devastating, causing learners to switch to their least efficient mode. Interestingly, procedural learning deficits can lead to a variety of strengths in dyslexia, but how far does this apply to maths difficulties? Experience suggests that learners with maths difficulties plus anxiety may suffer lifelong struggles, with a tendency to give up hope of ever becoming even marginally successful in this field.

Keywords: procedural learning, anxiety, maths, dyslexia

* *Correspondence to:*
Angela Fawcett, Editor-in-Chief, Asia Pacific Journal of Developmental Differences; Research Consultant, Dyslexia Association of Singapore. Email: angela@das.org.sg

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Vol 8, No. 2, July 2021

Trials, tribulation and triumphs: Our son Matt's story…

David Fawcett[1*]

1. *Parent Advocate, United Kingdom*

Abstract

In this talk, David will outline many of the trials and tribulations that he faced as a parent in trying to obtain help for his dyslexic son, Matthew, who was diagnosed as dyslexic at the unusually early age of 5 and a half. David will recall how difficult it was to fight for his son, given his own negative experiences in school and how the smell of cabbage and distemper would evoke the memory of these dismal childhood school experiences during open nights. The talk will be richly illustrated with examples of Matt's work and moves from pre-school through primary, secondary school and university, culminating in Matt's struggles to achieve and his attempts to deal with the system without enlisting any further support. Despite these many early struggles, once Matt had finished with school and education he was able to come into his own, triumphing in a range of settings. These ranged from the kibbutz to voluntary work with the Peace Brigade International in Guatemala, before working to ignite a passion for sustainability, working with the Kindling Trust, and most recently the Carbon Co-op and leading the campaign against Trident for the North of England for the Campaign for Nuclear Disarmament. The talk will emphasise the need for determination from all involved and the importance of having an understanding advocate who believes in you, in order to break through the difficulties of childhood dyslexia and become a successful adult dyslexic in your chosen field.

Keywords: Advocacy, strengths, primary school, secondary school, university, career

* *Correspondence to:*
David Fawcett, Parent Advocate, United Kingdom Email: prof.angelafawcett@gmail.com

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Vol 8, No. 2, July 2021

The Experience of Dyslexia as an Adult

Fong Pei Yi[1*]

1. *Dyslexia Association of Singapore*

Abstract

With increasing awareness of dyslexia and the recognition that it is a life-long difficulty, there has been a focus on the experience of adults who are undergoing tertiary-level education and those who are working. This paper sets out to review the available literature on the subjective experience of adults who struggle with performing literacy tasks. Additionally, two case studies of individuals who were diagnosed with dyslexia in adulthood will be presented. Specifically, the academic and social-emotional impact of their learning difficulties, along with coping strategies they have employed will be explored. It is hoped that findings from this paper can inform further steps in improving the lives of adults seeking further education, as well as those who are working.

Keywords: Adult Dyslexia

* *Correspondence to:*
Fong Pei Yi, Manager & Educational Psychologist, Dyslexia Association of Singapore Email: peiyi@das.org.sg

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Vol 8, No. 2, July 2021

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

Amrit Kaur Gill[1*] and Muzdalifah Hamzah[1]

1. *Dyslexia Association of Singapore*

Abstract

Communication is an important aspect of life. Every day we use varied forms of communication to communicate meaning to one another. Whether we are acquiring information or conveying 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 (Flem & Frostad, 2008). This research examines the literature of drama approaches in relation to children with special educational needs (SEN), particularly children diagnosed with dyslexia and Speech and Language Impairment. A child with SEN may require alternative approaches to education that not only accommodate their conditions but also work towards creating ways for them to further develop their own capacity to learn. In instances where a child with SEN has difficulties in communicating, their education may require expertise in addressing such issues and finding methods to connect with them.

Hence, with drama, it does not solely rely on cognitive and verbal skills, but instead comprises other skills such as improvisation, role-play and story-telling. Hence, this research will analyse the difficulties faced by children with SEN and examine how drama can be used to support these difficulties and enhance communication skills with children with SEN, where teachers and educators alike would find drama as the bridge to foster and enhance communications skills among children with SEN.

Keywords: SEN, Dyslexia, SLI, Drama, Communication

* *Correspondence to:*
Amrit Kaur Gill, Senior Educational Therapist Dyslexia Association of Singapore Email: amrit@das.org.sg

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Perspectives of Trainee Educational Therapists in Singapore

Sathi Menon[1*]

1. *Dyslexia Association of Singapore*

Abstract

Kumar, Muhammad and Nair (2017) did a comparative analysis of two mentoring approaches at the DAS. It examined the perceptions of two groups of trainee educational therapists who received mentoring with two different approaches, with a particular focus on the mentoring approach. However, the experience of an educational therapist does not solely rely on this for there are other factors in play. This article presents findings from a semi-structured interview, questionnaire and diamond ranking activity that explored the trainee educational therapists' perspectives on the initial training and subsequent mentoring support provided. Trainees had a mixture of positive and less positive experiences during their training stint. The positive experiences were related to lectures, mentoring support and the practicum aspect of the training. Most of the less positive experiences were administrative related issues and trainees had even given suggestions on how to enhance the existing training program. This article ends by arguing that trainee educational therapists have positive experiences and they were in agreement on the significance and importance of the initial training and subsequent mentoring support. The findings of this paper would add value and provide further opportunities for research in the area of the professional development of educational therapists. It would also shed light on the important role that educational therapists play in teaching learners with special educational needs and specific learning differences. It may also help to inform future teaching practices at the administrative and management level.

Keywords: perspectives, educational therapists, training, teacher's training, mentoring, qualitative research, special education support, coaching

* *Correspondence to:*
Sathi Menon, Senior Educational Therapist, Dyslexia Association of Singapore. Email: sathi@das.org.sg

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Parent-child interactive stress of children with ADHD.

Kitty Mo Yen Han[1*] and Chan Tak Mau[2]

1. *Caritas Institute of Higher Education*
2. *Hong Kong Baptist University*

Abstract

Parents of children with ADHD often experience high levels of stress. They also experience great difficulties in caring for their children and in their daily interaction with them. However, stress resulting from parent-child interaction is under-explored in literature. The purposes of this study are to explore the current state of stress resulting from parent-child interaction and to make recommendations for future measures to tackle the problem of stress parents experience. The research questions are:

1. What are the characteristics and symptoms of Chinese children with ADHD?
2. What are the characteristics of Chinese parents with children with ADHD?
3. What are the environmental factors such as sociocultural conditions, social support, and children school environment affecting children with ADHD and their parents?
4. What is the current state of research involving stress resulting from parent-child interaction and future measures to tackle the problem of stress parents experience?

Eighteen parents of children formally diagnosed with ADHD in Mainland China were interviewed, and the data were analyzed using thematic analysis. The findings revealed four categories of causes of parental stress, namely individual, family, social-cultural, and school factors. The findings extend thinking around social and cultural constructions of parental stress, the power, control issues in the school environment, and give social workers new perspectives on how to support these families. It is argued in the discussion that parent-child stress of families of children with ADHD should be investigated in the current context of the social service system and socio-cultural context. This presentation is mainly focused on revealing and understanding stress resulting from parent-child interaction.

Keywords: parental stress, parent-child interaction, children with ADHD

* *Correspondence to:*
Dr Kitty Yuen Han MO, Assistant Professor, Caritas Institute of Higher Education. Email: moyuenhan@yahoo.com.hk

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Taking It Online - The Realities of Online Remediation.

Soofrina Mubarak[1*] and Geetha Shantha Ram[1]

1. *Dyslexia Association of Singapore*

Abstract

The rising number of COVID-19 cases in Singapore led to the shift to home-based learning. This affected not only the mainstream schools but almost all educational institutions and services, including the Dyslexia Association of Singapore.

This presentation will cover how the English Language and Literacy Division handled the shift which came with little warning.

- Preparation and planning for online lessons
- Trialing online lessons
- Options when online lessons were not feasible
- Support provided to educators and students by various ELL Teams
- Lessons learnt
- Normalising online lessons and the extended use of online platforms (for parent meetings, as an alternative for students who are on medical leave etc)

Overall, our experience confirms that the quick transition to the online form of education went successful and the gained experience can definitely be used in the future. The experience of the DAS can be useful for other organisations that have not found ways of transition yet.

Keywords: Online Learning, COVID-19, home-based learning

* *Correspondence to:*
Soofrina Mubarak, Senior Educational Therapist, EdTech Coordinator - English Language and Literacy Division, Dyslexia Association of Singapore. Email: soofrina@das.org.sg

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Register of Educational Therapists (ASIA) RETA - Case Management Discussion - Supporting Learners with Dyslexia and Language Difficulties

Hani Zohra Muhamad [1*] and Ho Shuet Lian[1]

1. *Dyslexia Association of Singapore*

Abstract

Dyslexia, characterised by poor decoding abilities, word recognition and spelling, is typically the result of a deficit in the phonological component of language (Lyon et al., 2003). On the other hand, language difficulties manifest when children's language development is deficient (Bishop, 2006). Children diagnosed with both dyslexia and language difficulties face many challenges to sustain language learning although they possess normal intelligence. With phonological difficulties, reading and spelling can be an arduous task. Additionally, despite effective classroom instructions on grammar and vocabulary, these children often struggle with receptive and expressive language skills which can be seen in their poor ability to use the right grammar and vocabulary in their speech and written work. These challenges, when compounded, can impede learning and educational development such that they do unsatisfactorily in school and underachieve in their academic pursuits. At the Dyslexia Association of Singapore (DAS), such students are given phonics instructions and explicit teaching of language skills to remediate literacy and language difficulties. This presentation will highlight 2-3 case studies on how these students are supported on the Main Literacy Programme and Specialised Educational Services such as Speech and Language Therapy as well as Speech and Drama Arts.

Keywords: dyslexia, language difficulties

* *Correspondence to:*
Hani Zohra Muhamad, Lead Educational Therapist and Educational Advisor, Dyslexia Association of Singapore
Email: hani@das.org.sg

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Vol 8, No. 2, July 2021

Hyperlexia in 3-year-old twins with and without Autistic Spectrum Disorder.

Patricia Mui Hoon Ng[1*]

1. *Society for Reading & Literacy*

Abstract

This article presents a case study on hyperlexia in a pair of non-identical twins of chronological age (CA) 3 years 9 months, with and without Autistic Spectrum Disorder (ASD). The aim is to provide a better understanding of the two types of hyperlexia by establishing their profiles using various sources of psycho-educational assessment reports. Results show a word recognition age (WRA) of 5 years 9 months for the ASD male and 8 years 11 months for the neurotypical female. With a verbal functioning estimated at 1 year 6 months, the male twin exhibited an unexpected level of ability that is advanced for his CA in not only literacy skills but in numeracy as well. His hyperlexia is considered a savant ability as his splinter skills are in significant disparity to his overall impairments. Unlike her brother, the female twin has a reading comprehension age (RCA) well above her CA, but her RCA is still lower than her WRA by more than 1.5 years.

Keywords: Word recognition, splinter skills, comprehension, Hyperlexia, Autistic Spectrum Disorder, Savant Syndrome

* *Correspondence to:*
Patricia Ng Mui Hoon, Honorary Vice-President, Society for Reading & Literacy. Email: patngmuihoon@gmail.com

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Harnessing Growth Mindset Principles in fostering motivation and engagement in lower primary students with SEN in a Singapore mainstream school.

Elizabeth Ow Yeong Wai Mang[1*]

1. *National Institute of Education, Nanyang Technological University, Singapore*

Abstract

This qualitative research study serves to analyse and evaluate a programme at a mainstream primary school that aims to promote a growth mindset in students with special educational needs (SEN). The programme was developed through the researcher's collaboration with the school and evaluated over a five-session intervention programme. The research has shown that students who were explicitly encouraged to develop a growth mindset demonstrated significant improvements in their motivation and sense of achievement. These results suggest the importance of inculcating a growth mindset amongst students with SEN given the challenges that they face. This study offers suggested approaches and possible directions for activities and programmes that will aid students with SEN. By leveraging their areas of needs as opportunities for growth, students with SEN can build greater confidence while improving not just in terms of academic achievement but, more importantly, their holistic development.

Keywords: Growth mindset, students with SEN, customised programme

* *Correspondence to:*
Dr Elizabeth Ow Yeong Wai Mang, Teaching Fellow, Psychology and Child & Human Development Academic Group, National Institute of Education. Email: elizabeth.owyeong@nie.edu.sg

Asia Pacific Journal of Developmental Differences
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The role of mindfulness and positive psychology in job crafting for educators: A diagnostic and prescriptive approach to supporting educators through mindfulness and positive psychology during a crisis

Harsheeni Rajoo[1*]

1. *Dyslexia Association of Singapore*

Abstract

Work is enormously important in our lives, not only because it takes up about half of our waking time, or provides us with a means of existence, but also because of the psychological impact that it has (Boniwell, 2011). As such, well-being at the workplace has become a primary feature in many organisations. The encouraging results from the growing body of research in mindfulness & positive psychology have been pivotal in encouraging the DAS to enrich their approach towards wellness for Educators significantly, through CalmEd, a well-being initiative. In 2019, an 11 months long Mindfulness-Based Intervention & Positive Psychology training curated for 8 Educational Advisors, saw the result of 57% who felt that they were starting to develop mindfulness practices more consistently after 10 weeks into the training, and 43% found themselves to be reaching a good proficiency towards the end of the course of the training. Additionally, from the latest follow-up survey during the Co-Vid 19 pandemic, 100% were more aware of having to practise mindfulness during a crisis, and 60% were able to practise composure during this time. The training intended to improve the responsibility towards the well-being of self, and innovatively improve their approach towards work through job crafting.

Keywords: Mindfulness, Positive Psychology, Job crafting, Professional development, Well-being

* *Correspondence to:*
Harsheeni H Rajoo, Educational Advisor, Dyslexia Association of Singapore. Email: Harsheeni@das.org.sg

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Occupational Therapy-a supportive structure for children with Specific Learning Difficulties

N Rasu[1*] and Gowri Ramanathan [1]

1. *Madras Dyslexic Association, India*

Abstract

Occupational therapy promotes skill development and independence in daily occupations like play, school, self-care, home-tasks and work. Occupational therapists work collaboratively with family and staff within the school. A child with dyslexia battles difficulties in reading, spelling, writing, and math related skills. These could arise partly due to issues in fine-motor, gross-motor, grapho-motor, sensory integration and other such other areas of development. In this presentation, we will discuss how Occupational Therapy brings direct and indirect benefits to help children with dyslexia to fulfil their role as students by supporting their academic achievement and promoting positive behaviour necessary for learning.

At Madras Dyslexia Association, Occupational Therapy is integrated with the curriculum in the learning centre. This presentation delineates the importance of OT intervention in a learning centre and goes on to describe the systematic process, followed to assess the strengths and needs of a child, followed by planning and implementation of a protocol to promote, maximize and maintain the skills of the child, with a wide range of abilities and disabilities. Finally, a discussion of case studies will be taken up to highlight how Occupational Therapy has empowered children with Dyslexia to gain from remedial teaching.

Occupational Therapy provides the essential buttress readying the child to receive the remediation. Without this peg, even the best remedial methods may not elevate a child with dyslexia.

Keywords: Occupational therapy, Dyslexia, Pre academic skills

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* *Correspondence to:*
N Rasu, Occupational Therapist, Madras Dyslexia Association, Chennai, India. Email: rasusrmot@gmail.com

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Student Voice on Teachers' Attributes that Resulted in Positive Learning Outcomes for Students with SEN in Mainstream Schools in Singapore.

Steven Sim[1*]

1. *Dyslexia Association of Singapore*

Abstract

The Singapore mainstream classroom is seeing increasingly diverse learning capabilities. Although there is a growing involvement of students in educational research, there is little done from the perspectives of students with Special Educational Needs (SEN) in Singapore. To bridge this gap, this study investigated the perceptions of students with SEN on teacher attributes and student outcomes in mainstream classrooms in Singapore. In a focus group setting, five students (aged between 13 and 15) were asked to share their opinions and thoughts about their school experiences regarding teacher attributes that led to positive student outcomes in an inclusive mainstream classroom. Pictorial cards and the Diamond 9 ranking approach were used to help the students describe their experiences, as well as rate the teacher attributes and student outcomes. 'Respect', 'caring' and 'patience' were top ranking teacher attributes that the students felt are important to their learning in school. For student outcomes, 'self-concept' in terms of self-awareness, and their 'performance in relation to their peers' were found to be important. These outcomes were ranked higher than 'praise and rewards by teachers' and 'competition with their peers' by the students. The study also raised issues around victimisation and the development of reciprocal friendships, as well as the teacher's role in helping students overcome or enhance such experiences in an inclusive classroom setting. Teacher training was highlighted as well, particularly in developing skills and knowledge to handle a classroom of students with diverse learning abilities.

Keywords: student voice, teacher attributes, student outcomes, Singapore, special educational needs (SEN), dyslexia,

* *Correspondence to:*
Steven Sim, Senior Educational Therapist, Dyslexia Association of Singapore Email: steven@das.org.sg

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Constructing the personal Educational Ecology of Children with dyslexia.

Wang Lei[1*] and Liang Yueyi[1]

1. *Shenzhen Sparkling Education and Shenzhen Weining Dyslexia Education Centre, Shenzen China*
2. *Xingmeng- Weining Dyslexia Education Centre, Shenzhen, China*

Abstract

In places with low awareness of dyslexia, children with dyslexia are often misunderstood as stupid, lazy, and so on. Parents and school teachers tend to focus more on the development of children's reading and writing abilities, while neglecting the development of their other abilities. Instead of stripping away the problem of dyslexia from the development of other abilities, we should help children with dyslexia enhance their educational development as a whole. First of all, we should stimulate the children's interest in learning by starting with their advantageous subjects or subjects of interest, which will build their self-confidence. Secondly, we should leverage on their advantageous subjects or subjects of interest to help them improve their reading and writing abilities through professional intervention and subject learning. Finally, we need to develop the abilities that were previously constrained by dyslexia through dynamic observations of their abilities. This will support the children's holistic development and construct positive individual educational ecology.

Keywords: educational ecology; dyslexia children； self-confidence

* *Correspondence to:*
Wang Lei, General Manager of Shenzhen Sparkling Education. Chairman of Shenzhen Weining Dyslexia Education Center
Email: wangleivvv88@126.com

Asia Pacific Journal of Developmental Differences
Vol 8, No. 2, July 2021

Relationships between Test Anxiety and Metacognition in Chinese Young Adults with and without Specific Learning Disabilities

Wang Li-Chih [1*]

1. *National Tsing Hua University, Taiwan*

Abstract

The influence of test anxiety on academic difficulties has been investigated in typically developing students, but the underlying mechanism of the influence remains unclear, especially for those with specific learning disabilities (SpLD). This study examined the role of metacognition in the relationship between test anxiety and literacy difficulties among Chinese young adults with and without SpLD in Taiwan. A total of 239 first-year undergraduate students were recruited from 11 universities in South Taiwan. Among the 239 students, 105 were identified to have SpLD, and 134 were typically developing students. These students were asked to complete questionnaires on demographics, test anxiety, metacognition, and literacy difficulties (i.e., reading and writing). Structural equation modeling analyses showed that Chinese young adults' test anxieties were linked with literacy difficulties but that only those with SpLD experienced a direct effect (without mediation by other factors). For those without SpLD, the influence of test anxiety on literacy difficulties was not direct but significantly mediated by metacognition. Various components of these students' metacognition had mediating effects on different literacy difficulties. Test anxiety may influence the reading and writing difficulties of students with and without SpLD through different mechanisms. Moreover, teachers at the university level are encouraged to consider students' test anxiety and metacognition in teaching designs, evaluations, or even the setting arrangements.

Keywords: test anxiety, metacognition, young adults, specific learning disabilities, Chinese

* *Correspondence to:*
DR Wang Li-Chih, Assistant Professor Department of Special Education at National Tsing Hua University, Taiwan, Adjunct Associate Professor, Department of Special Education and Counselling at The Education University of Hong Kong
Email: wanglca@eduhk.hk

Asia Pacific Journal of Developmental Differences

Guidelines for Contributors

Overview

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.

Frequency of Journal

The Journal will be published twice a year in January and July.

Contributions Considered for the Journal

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
- They contain organised and clarity of writing
- They contribute to the local Asian context
- They should be original papers that have not been submitted to other journals or publications.

Editorial Policy—Retractions

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.

Articles published in the APJDD should be original work that has not been published in this form elsewhere. In rare instances where previous publication has been made, this will be fully acknowledged.

Submission of Manuscripts

All manuscripts are to be sent in electronic copy (MS WORD) as well as a PDF copy of the final edited document. PDF copy is required to verify the word copy and for publishing purposes. There is no need to submit hard copies of manuscripts.

Images, charts and diagrams should be sent separately where possible to ensure high quality reproductions.

Submissions are to be emailed to the editor at both email addresses below:

Angela Fawcett
DAS Academic Director
Dyslexia Association of Singapore,
Emeritus Professor, Swansea University,
angela@das.org.sg

Deborah Hewes
Managing Editor
Dyslexia Association of Singapore
www.das.org.sg/publications/journal
deborah.hewes@das.org.sg

Preparation of Manuscripts

It is expected that all manuscripts be submitted using the American Psychological Association (APA) standard of referencing and publication. APA style is detailed in the Publication Manual of the American Psychological Association (6th ed), which offers sound guidance for writing with clarity, conciseness and simplicity. Authors should follow the APA style in preparation of their manuscripts.

DYSLEXIA ASSOCIATION OF SINGAPORE

HELPING DYSLEXIC PEOPLE ACHIEVE

Our Mission: Helping Dyslexic People Achieve

Our Goal: To build a world class organisation dedicated to helping dyslexic people 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).

Like DAS, the Academy is also a registered charity with the Commissioner of Charities. DAS Academy delivers a wide range of workshops and courses including a Master of Arts in Special Educational Needs. DAS Academy provides the bridge that links professionals, caregivers and people with special needs.

Asia Pacific Journal of Developmental Differences

Volume 8 ♦ Number 2 ♦ July 2021

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