



Effects of Orton-Gillingham-Based Programme on Reading in Young Children with Developmental Delays in Singapore

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Abstract

In Singapore, when a child is assessed to be at risk of developing moderate to severe developmental needs, they are referred to early intervention centers under government funding called Early Intervention Programme for Infants and Children (EIPIC). As one of the primary goals of early intervention should be to reduce the need for special education services and prepare children for general education, children with developmental delays would benefit from reading intervention that could boost their level of reading proficiency which is a fundamental skill for successful inclusion in general education. Although early literacy skills are crucial for reading, there is a scarcity of literature about reading interventions for children with developmental delays. The purpose of this study was to find out if there was an improvement in letter-sound correspondences and word reading when an Orton-Gillingham-based (O-G-based) phonics intervention was introduced to three young children with developmental delays. A multiple-probe design across the children was used, with intervention conducted across 25 sessions. The Basic Phonics Skills Test-III (BPST-III) was used as a probe and the Wide Range Achievement Test-4th Edition (WRAT-4) Word Reading subtest was used as a supplemental measure. The findings showed that all children made marked improvement in their letter-sound identification. They also made reading gains to different extents, with the first two children being able to read some words after the intervention. The research findings suggest that Orton-Gillingham-based intervention may be effective for children with developmental delays.

Keywords: Orton-Gillingham, developmental delay, early intervention, letter-sound correspondences, word reading

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Early literacy skills are the foundation for reading and include phonological and phonemic awareness, knowing letters, letter-sound correspondences, and basic concepts about print (Pears et al., 2016). Children who begin formal education without these skills may struggle academically and find it difficult to catch up once they lag behind their peers (Greenwood et al., 2015), and this applies to children with developmental delays. Children are deemed to have developmental delay if they have difficulties in meeting their developmental milestones in the five developmental areas – physical, cognitive, communication, social/emotional, and adaptive development (Office of Special Education and Rehabilitative Services, 2016). Children with various diagnoses such as global developmental delay (GDD), Down syndrome (DS), and autism spectrum disorder (ASD) usually have developmental delays in at least one area of development.

Although early literacy skills are fundamental for academic and social-emotional development of young children and this has been researched and documented extensively (e.g., Lonigan et al., 2011; McKean & Reilly, 2023), there is scarce literature on reading intervention on these skills for children with developmental delays in the early childhood special education field before school entry (Goldstein, 2011; Pears et al., 2016). As children are only identified as struggling learners in the early elementary grades, the provision of reading intervention for early literacy skills at this stage may be too little and too late (Carta et al., 2015).

For children with disabilities, the current research base suggests that reading interventions should include phonological awareness and phonics skills (Hill, 2016; Lemons et al., 2016). Phonological awareness refers to the ability to detect, manipulate, or analyze the auditory aspects of spoken language independent of meaning (Greenwood et al., 2015). Phonics is the system where letter-sound associations or the correspondence between spoken sounds and their represented written letters are taught (Reed, 2013). The challenge for early childhood special education professionals is to find out how to teach early literacy skills that are most critical such as letter-sound correspondence and phonological awareness to ensure an appropriate foundation for reading (Goldstein, 2011). Recent research highlights the importance of explicit and systematic reading instruction for children and adolescents with intellectual disabilities (ID). Hill (2016) reviewed phonics-based reading interventions for students with ID published over a 12-year period and found that all 11 studies had varying degrees of reading outcomes and despite the difference in interventions, their commonality was the use of systematic and explicit approaches to phonics instruction.

Explicit instruction refers to teaching lessons in a straightforward approach, with the components of reading and its salient features overtly taught (Reed, 2013) and instruction is carefully designed to provide scaffolding necessary for individual learning (Greenwood et al., 2015). Systematic instruction includes focusing the instruction on one or two critical skills to be taught, sequencing skills in a theoretically logical way, where skills and simpler patterns such as letter-sound correspondences are taught first, before

less consistent or more complex patterns are taught, and breaking complex skills into smaller instructional units (Kaminski et al., 2015).

In their work regarding research-based tips for enhancing literacy instruction for students with ID, Lemons et al. (2016) recommend that educators provide instruction with sufficient intensity, provide explicit and systematic reading instruction, while scaffolding working memory with images, objects, letters and words to support working memory deficits. The researchers believe that using one comprehensive reading programme as a base will help teachers deliver instruction in a more systematic way, and it should encompass explicit models, corrective feedback, scaffolding, reinforcement and cumulative review in conjunction with systematic instruction in phonological awareness and phonics.

Research on reading interventions for children with ID, specifically DS, provided further insights into the effective components for reading instruction. Lemons et al. (2012) found that the reading programme, Road to Reading (RTR; Blachman et al., 2000), with additional emphasis on phonological awareness, was more effective in increasing word reading for phonetically regular and high frequency words, with limited functional relation displayed for letter-sound correspondences after an average of 25 sessions across approximately 12 weeks for children with DS between 5 to 13 years of age. Whereas children assigned to the Road to Code (RTC; Blachman & Tangel, 2008), another reading programme, made few, if any, improvements on letter-sounds, blending, initial sound fluency and segmentation.

Further research in the use of adapted phonological awareness intervention using RTC found a functional relation between the intervention and learning of target words, but again there was no functional relation established in the rate of learning letter-sounds (Lemons et al., 2015). Closer inspection of the findings on the younger participants in the two studies showed that all five children with DS between 6 to 8 years of age demonstrated improvement in phonological awareness, and four children made notable gains while one child demonstrated a minor improvement in learning of target words after 24 to 45 sessions of intervention across 15 weeks. This provides support to start early literacy intervention, which includes phonological awareness and phonics components in the reading programme, for younger children with ID.

The Orton-Gillingham (O-G) approach is one of the most popular phonological interventions for children with reading disabilities which has an emphasis on phonological awareness and phonics instruction in an explicit and systematic manner (Ritchey & Goeke, 2006; Stevens et al., 2021). It was first developed for students with severe dyslexia (Rose & Zirkel, 2007) and focused on automaticity of subskills in phonological awareness and phonics using a multi-sensory approach. Being a systematic approach, students begin learning easier concepts before they are progressively taught more complex skills. They are explicitly taught to listen for, manipulate and identify individual phonemes in words. Next, they explicitly teach phonograms and after learning

these letter-sound correspondences or the alphabetic principle, children are taught to blend to read simple phonetically regular words. Subsequently, students learn syllables and sounds with multiple spellings, morphology, roots, and affixes, spelling of new words, and comprehension of text. Instruction of phonics incorporates the synthetic approach, using letters/sounds to form words, and analytic approach, breaking long words apart.

Even though the evidence for O-G-based approaches is still inconclusive (Stevens et al., 2021), Sayeski and Hurford (2022) noted that O-G-based approaches are in alignment with recommendations for structured literacy. There is still widespread use of the approach by teachers in a variety of settings, and it is widely popular among its advocates (Chia & Houghton, 2011; Sathiasilan et al., 2022; Sayeski & Zirkel, 2021; Stevens et al., 2021). In addition, many parents view O-G as the preferred reading method for their children with reading disabilities, and available research suggests that students who receive O-G-based intervention generally progress in one or more specific areas of reading (Rose & Zirkel, 2007; Wong & Sathiasilan, 2018).

In Singapore, there are several government-funded programmes that provide early intervention (EI) services to young children across a range of developmental needs (Early Childhood Development Agency, 2025). Children who require medium to high levels of EI support may receive 5-12 hours per week of center-based services at an Early Intervention Programme for Infants and Children (EIPIC) center. EIPIC centers have a team of professionals, such as EI teachers, speech and language therapists, occupational therapists, psychologists, and social workers, working with the child and family. In addition to receiving EI services at EIPIC centers, many young children with developmental delays also attend preschool alongside typically developing peers. When children with developmental delays reach compulsory school age, they would move on to either primary schools or special schools.

The purpose of the present research was to investigate the effectiveness of an O-G-based programme on the development of reading skills, in particular letter-sound identification and word reading, in three young children with developmental delays in Singapore. Singapore is a multiethnic and multilingual society with three dominant ethnic groups (i.e., Chinese, Malay and Indian). The medium of instruction in the education system is English but most young children are raised speaking a mother tongue language (e.g., Mandarin, Malay, Tamil) or are bilingual at home (Koh & O'Brien, 2020). Many young children start formal education as English language learners. Compared to monolingual English-speaking peers, children learning English as an additional language may have an English vocabulary deficit and face more difficulties in learning to read (Oxley & De Cat, 2021).

METHOD

Participants

The participants were three children who qualified for and received EI services daily at an EIPIC center in Singapore. The selection criteria for the participants were:

- (a) diagnosis of suspected or confirmed developmental delay based on a hospital doctor's report,
- (b) adequate vision and hearing, as assessed from their hearing and vision tests in the child's referral report,
- (c) aged between 5-7 years old,
- (d) able to verbally repeat sounds after teacher demonstration,
- (e) unable to read more than 15 letter-sound correspondences, and
- (f) word reading in the Below Average, Low or Lower Extreme on the Wide Range Achievement Test-4th Edition, Word Reading subtest (WRAT-4, Wilkinson & Robertson, 2006).

Ethics approval by the university's ethics review committee, parent written consent and child verbal assent were obtained before the commencement of this study.

On top of receiving EI services, all three children also attended public kindergartens where they attended classes with peers who were typically developing, and English was the main medium of instruction. Although they were exposed to bilingual general education in their kindergartens with concurrent reading instruction, they have not made meaningful gains from these as they had not learnt consistent letter-sound correspondences nor read words. All three children were transitioning to primary school in the following school year.

The first child, Alan, was a 76-month-old Chinese male who was initially diagnosed with GDD and received a diagnosis of Mosaic DS later. He mainly communicated in English, usually in six- to ten-word statements, in his home and school settings and understood basic Mandarin instructions. Brandon, a 64-month-old Chinese boy, was diagnosed with speech and language delay. He received therapy at the hospital previously for behavioural concerns. In his home setting, his main mode of expressive communication was in Mandarin with some usage of English. He could understand conversations in English and usually communicated in three- to six-word phrases in English in his school settings. A psychologist collaborated with his EI teachers to enhance his compliance to instructions and participation in class activities as he would have frequent meltdowns. Charlie, a 66-month-old Malay boy, was referred for EI services for suspected GDD. His parents communicated with him in Malay and English in his home setting, and he usually communicated in five- to eight-word statements in English in both his home and school settings.

Setting

This study was conducted at an EIPIIC center in Singapore which served 200 young children with disabilities such as ASD, GDD, DS, speech and language delay, and multiple disabilities. The three children were taught in one-to-one settings in an unoccupied classroom in the center with distractions kept to a minimum for all baseline, intervention and maintenance sessions.

Measures

The dependent variable was reading skills measured by letter-sound knowledge and word reading using the Basic Phonics Skills Test-III (Shefelbine, 2006). The BPST-III was chosen as it is an untimed, informal measure, and allows multiple assessments to occur in the same way each time. It is a relatively quick way to assess students' knowledge of basic phonograms, letter names and words representing 12 different phonetic patterns in increasing complexity (Reed, 2013). The test was conducted in accordance with the BPST-III administration guidelines and scored on the BPST-III Recording Sheet.

The Word Reading subtest of the WRAT-4 was used as a supplemental measure to ascertain if there were differences in each child's reading prior to and after the intervention. The WRAT-4 is a norm-reference, standardized test that measures basic academic skills of reading, spelling and mathematical achievement for individuals aged 5-94 (Wilkinson & Robertson, 2006). Two psychologists administered the WRAT-4 Word Reading blue test form with the children prior to the intervention and subsequently administered this same test form approximately four months later.

Interventionists

The three interventionists, one of whom was the first author, were teachers with more than eight years of experience providing EI services at the EIPIIC center. The first author was a master's student in special education completing the research as part of her graduation requirement. Each interventionist had a prior certification with at least 35 hours of formal standardized training in the O-G-based approach. The interventionists were also trained and functioned as BPST-III assessors and observers for intervention fidelity of the sessions.

Research Design

A single-case research using a multiple-probe design across the three children was implemented to determine if there was a functional relation between the O-G-based programme and children's letter-sound identification and word reading. Multiple-probe designs are combinations of multiple-baseline designs and probe procedures, where probes are administered intermittently (Ledford & Gast, 2018). After three consecutive

stable baseline probes on the BPST-III were collected, intervention was introduced in a staggered succession for each child.

Procedures

Baseline Phase

During the baseline phase, the interventionist first brought the child to the room and spent 15 minutes playing with the child using his preferred toys. The play session was meant to be a transitional activity to the BPST-III probe assessment which was conducted thereafter. Depending on each child's performance, the assessment was administered between 10-20 minutes. The BPST-III Student Cards were presented, and the interventionist directly observed the child's oral responses. The oral responses were recorded and then scored on the BPST-III Recording Sheet. To prevent a practice effect, the interventionist did not provide any feedback to the children's responses, except for praising them for attempting to sound/read the items.

O-G-based Intervention Phase

The independent variable was 25-sessions of O-G-based intervention delivered in 45-minute sessions every alternate weekday, across 10 weeks. All sessions were conducted in English. Each intervention session consisted of New Concepts and Review Sections. The New Concepts section usually lasted for 25 minutes. Firstly, in the Letter Recognition section, the interventionist taught the letter formation of new letters. Next, children were explicitly taught the 26 basic phonograms in sequence using the Picture Deck which consisted of cards with a letter and a picture of the corresponding keyword. The child was asked to give the letter name, sound and keyword on each card. For example, for "c", child said, "c, /c/, cat". The interventionist instructed the child to write the letter(s) in the air concurrently while saying the sound three times (air-write). The child was then given a worksheet to write the letter(s) while saying the sound nine times.

Once automaticity was achieved and the child was familiar with a phonogram, the interventionist would proceed to use the Card Deck to replace the Picture Deck. The Card Deck consisted of only the printed phonogram, and children were taught to say only the sounds when the cards were presented. While the Picture Deck included only the 26 basic phonograms, the Card Deck also consisted of consonant digraphs, consonant letter combinations, suffixes, spelling rules, magic-e concepts, r-controlled, and vowel teams.

The 25 sessions were targeted to cover letter recognition, the 26 basic phonograms and blending from the O-G-based programme. The total number of concepts taught was directly related to each child's individual performance, so once a child had progressed and could accurately retain learning for previously taught concepts, new concepts would be sequentially taught.

Under the Words to Read and Spell section, only words related to new and past concepts were provided on the worksheets. Although the interventionists tried to avoid including words from both the BPST-III probes and WRAT-4 in the worksheets, there were some regular high frequency words that were too common in a child's repertoire of words to be excluded such as cat and it was the only common word also found in the WRAT-4. The common words that were found in all three children's worksheets and BPST-III probes were van, sun, map and kite.

The child was taught to read words by blending the first and second sound, then blending the third sound with the initial two sounds together. Subsequent letters were blended in the same way, before the child read the entire word. For spelling, the interventionist asked the child to listen to a word, repeat it, fingerspell by 'catching' the word, place out one finger on his non-dominant hand for each sound of the word, and finally say the sounds of the word while he writes on the worksheet. Each child received worksheets customized for him, based on his individual level of progress following the O-G-based programme's scope and sequence.

After the New Concepts section, the child was given a short 5-10 minutes play break. For the subsequent 20 minutes after the break, the Review Section was conducted, and the child was given the Card Drill using the Picture Deck or Card Deck where the interventionist arranged the cards in sequence and included all sounds the child had learnt. After the Card Drill was administered, the interventionist would proceed to the Words to Read section, with 4-8 words for the child to read. The Sound Drill was administered, and the child had to write the sounds that the interventionist dictated.

Modifications. All three children's intervention sessions adhered to the O-G-based approach, but other teaching strategies and scaffolding were also used in conjunction with it. As Alan had been previously taught Jolly Phonics (Lloyd & Wernham, 2012), the interventionist used some of the Jolly Phonics keywords instead of the O-G-based keywords for certain letters that he was more familiar with (e.g., egg instead of elephant). Brandon's first language was Mandarin, therefore his English vocabulary was limited and the interventionist used keywords that he was interested and familiar with (e.g., train instead of top). For Charlie, he had difficulty remembering the letter-sounds after repeated teaching and the interventionist thus used different activities and games to facilitate his recall of letters and letter-sound correspondences. For example, he used play-doh to form letters, a laser pointer to trace letters and some keywords were paired with gestures.

Intervention Probes. After every fifth intervention session, the child played with preferred toys for 15 minutes as a transitional activity before the BPST-III probe was administered.

Maintenance Phase

The one-on-one intensive O-G-based intervention ended after 25 sessions, and the children continued to attend their EI and typical kindergarten classes. The maintenance probe was administered in the same manner as the baseline probe six weeks after the last intervention session to evaluate the effects after intervention had been withdrawn.

Materials

The Picture Deck consisted of 4-inch by 6-inch cards of the 26 basic phonograms. The Card Deck consisted of 4-inch by 6-inch cards with printed lowercase letter(s) of the 26 phonograms, and the rest of the O-G-based concepts. Customised worksheets with typed words in Comic Sans MS font were used to teach new concepts and blending.

Procedural Fidelity (PF) and Inter-Observer Agreement (IOA)

The researcher conducted two sessions of systematic training with the two interventionists prior to the study for them to gain a common understanding about how to conduct sessions using the O-G-based approach, rate the Procedural Fidelity Form, and record children's responses on the BPST-III Recording Sheet.

PF checks were conducted where another interventionist functioned as an observer and scored the procedures on a checklist. The PF checklist included eight items related to the delivery of the O-G-based intervention and PF checks were conducted for at least 30% of all intervention sessions for all three children. PF was calculated by dividing the total number of observed procedural steps by the total number of expected procedural steps, multiplied by 100. Across the intervention phase for all three children, the PF was 100% for all sessions.

During assessment probes, when one interventionist was implementing the BPST-III probe, another interventionist was present and served as the observer for IOA. Both the interventionist and observer independently scored each child's responses on the BPST-III Recording Sheet and a percentage IOA score was determined by calculating the extent to which both the interventionists' ratings concurred. The IOA was calculated for 100% of the probe sessions by dividing the number of agreements of occurrence of the target sounds and words by the total number of agreements plus disagreements, multiplied by 100. The IOA for Alan, Brandon and Charlie were 99.4% (range, 94.4-100%), 99.7% (range, 97.2-100%), and 100% respectively for all the probe sessions.

Data Analysis

Visual analysis on graphed data was conducted with consideration of trend, level, variability, overlap and immediacy of effect (Gast & Spriggs, 2014).

RESULTS

Letter-Sound Correspondences

The results for Alan, Brandon and Charlie for correct letter-sound correspondences are presented in Figure 1. During baseline, Alan produced an average of 13.6 letter-sounds correctly with little variability in the data. A gradual increasing trend was observed from the first to the fourth intervention probe, where he reached the maximum of 26 letter-sounds and maintained this performance on the fifth intervention probe assessment, and in the maintenance phase. There was an immediate change in level with an increase of seven additional letter-sounds from the baseline phase to the first intervention probe.

Brandon did not identify any letter-sounds correctly throughout the baseline probes. His pattern of error observed was randomly naming letter names and saying nonsense words. His letter-sounds identification showed an increasing trend throughout the intervention phase and there was an immediate change from baseline with a jump to five accurately identified letter-sounds during the first intervention probe. Examining Brandon's responses showed that he consistently demonstrated confusion between letters that looked similar, such as "b" and "d". By the fourth and fifth intervention probes, he automatically recalled 18 and 25 letter-sounds respectively. He identified 20 letter-sounds accurately during the maintenance phase.

During the baseline phase, Charlie identified an average of one letter-sound accurately with little variability in the baseline probes. He frequently responded that he did not know the letter-sound, and when he attempted to sound them, his errors during baseline showed two consistent patterns of error where he randomly named letter names or sounded letter-sounds. There was a steep increasing trend during the intervention phase, and he attained 23 letter-sounds by the fifth intervention probe. During the maintenance phase, he identified an additional letter-sound accurately, with a total of 24 letter-sounds. The effect was not immediate during the first intervention probe, but Charlie showed an increase of eight letter-sounds during the second intervention probe. Examination of his performance during the intervention phase showed that Charlie took a longer time to recall sounds and usually recalled them after a time delay of approximately three seconds. At times, he had to say the keywords before the corresponding letter-sounds.

Word Reading

Figure 2 shows the results for word reading. During baseline, Alan did not read any of the target words correctly. His consistent pattern of error during baseline was naming only the first letter of the word and not reading the word. The effect was not immediate during the first intervention probe, but Alan showed an increase of 11 words read correctly during the second intervention probe. By the fifth intervention probe, Alan read 31 words from these seven sections – short vowels and consonants, short vowels and

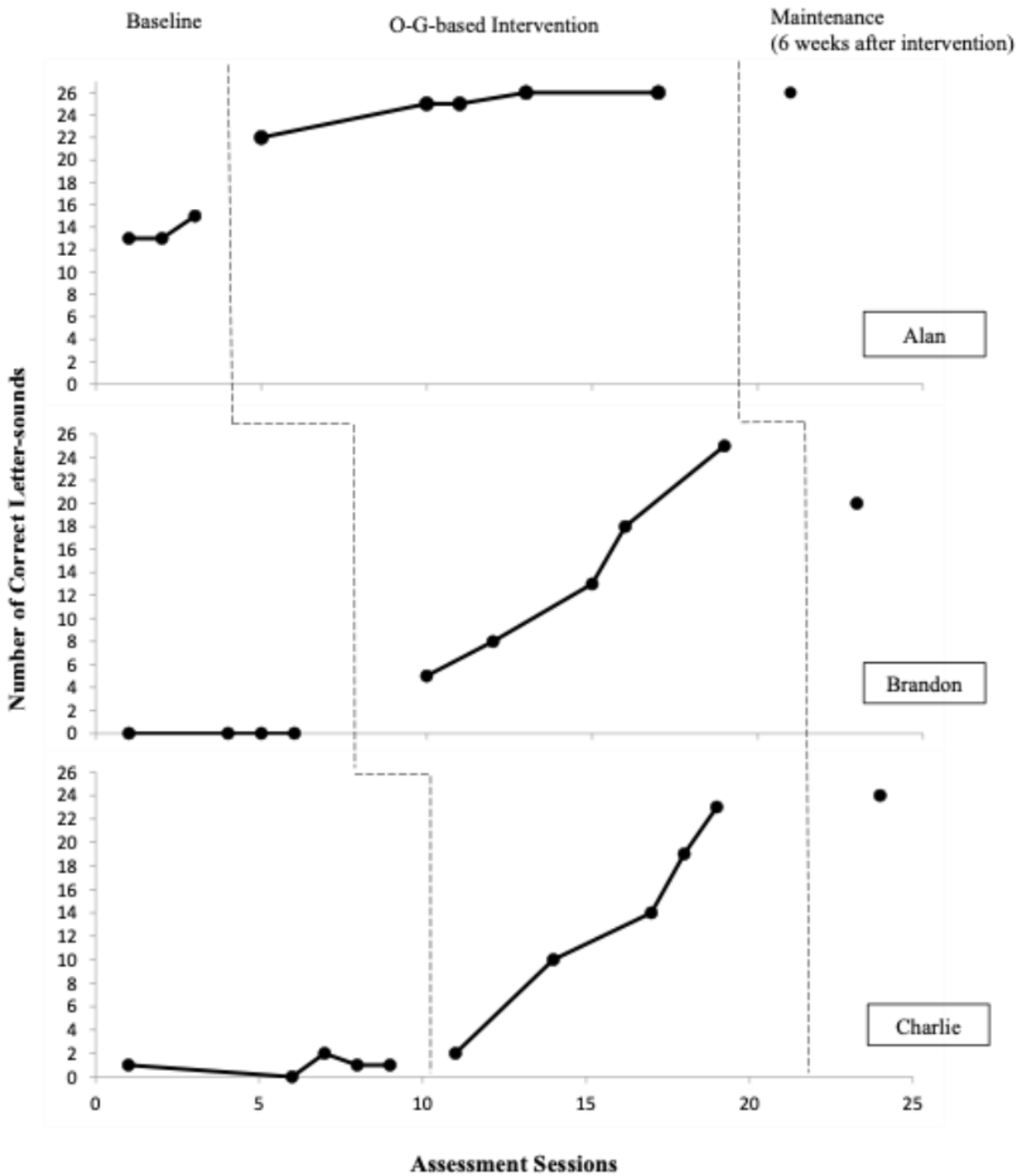


Figure 1. Number of Correct Letter Sounds

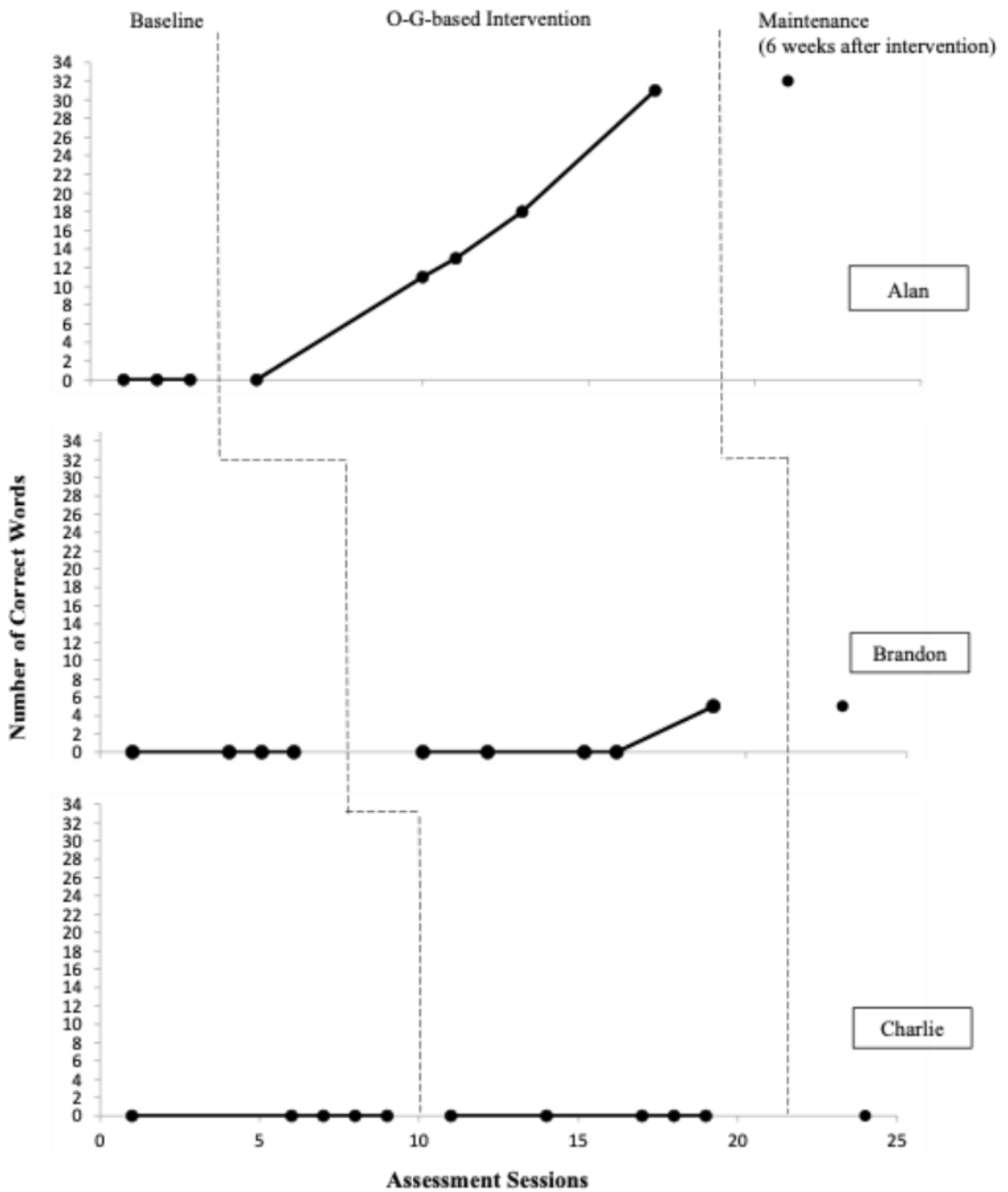


Figure 2. Number of Correct Words

consonant digraphs, consonant blends, inflectional endings, final-e (magic-e), long vowel digraphs, and r-controlled words. He not only maintained his performance during the intervention phase but also read one additional word correctly during the maintenance phase. Moreover, he read two words correctly from an additional section, words with other vowel digraphs and diphthongs. Analysis of Alan's errors on words read during both the intervention and maintenance phases showed consistent patterns of error leading to blending approximations instead of reading the actual words. Overall, Alan made a significant improvement in accurately sounding out each letter-sound in the target words and blending them during both the intervention and maintenance phases.

During the baseline sessions, Brandon read none of the target words accurately and he responded by either saying he did not know, randomly named letters or said nonsense words. When the O-G-based intervention was implemented, Brandon did not read any words on the first four intervention probes, however, he read five words on the last intervention probe. The first author observed that he had the emerging skill of blending starting from the second intervention probe when he attempted to blend one of the words and said the individual sounds of the letters he knew but did not blend the word together. On the fourth intervention probe, he produced blending approximations and said individual sounds of the letters, but when he tried to blend the whole word, he missed out the beginning sounds for four words. He blended and read five words independently on the fifth intervention probe and sustained this performance during the maintenance phase. In addition to these five words accurately read in the maintenance phase, he also read three other words without their initial sounds.

Charlie did not read any words correctly during the baseline phase. He either gave no response or displayed a consistent error pattern of naming letter names for the target words. On both the intervention and maintenance phases, he did not read any word accurately with no change in level. Charlie displayed two consistent patterns of errors: he identified some letter-sounds incorrectly, especially those that were at the end of the word, and did not blend the sounds together. However, it should be noted that during the third intervention probe, even though he did not accurately blend words, he started to try to use letter-sound correspondences to produce blending approximations when reading (e.g., "/mo/-/p/" for mop). During the maintenance phase, although he did not read any word correctly, he also tried to use letter-sound correspondences to read eight words.

The WRAT-4 Word Reading subtests conducted before and after the intervention phase provided supplemental data on the children's reading development. The findings are shown in Table 1. Alan and Charlie both improved in one standard deviation, and this is a considerable improvement in scores bearing in mind that the intervention took place for only 25 sessions in a span of 10 weeks. For Brandon, there was an improvement in his subtest scores from a standard score of 71 to 79 but it was less than one standard

deviation. The first author observed that by the twenty-fifth intervention session, Brandon independently read at least 20 regular consonant-vowel-consonant words on his worksheets independently. However, he did not attempt to read any words when asked by the psychologist during the subtest conducted after the intervention phase and this may not be an accurate reflection of his actual performance.

Table 1. WRAT-4 Word Reading Subtest Results

Student	Pre-test			Post-test			Results Based on Change in Performance Level
	Standard Score (Percentile rank)	Performance Level	Standard deviation (SD) (below the mean)	Standard Score (Percentile rank)	Performance Level	Standard deviation (SD) (below the mean)	
Alan	77 (6th)	Low	-2	88 (21st)	Below Average	-1	Improved
Brandon	71 (3rd)	Low	-2	79 (8th)	Low	-2	Maintained
Charlie	62 (1st)	Lower Extreme	-3	73 (4th)	Low	-2	Improved

DISCUSSIONS

Based on the results garnered from the intervention and probe sessions, there was a marked improvement in the letter-sound identification of all three children with developmental delays with the introduction of the O-G-based programme. However, there was no clear functional relation between the O-G-based intervention and word reading across the three children. The supplemental data from the WRAT-4 Word Reading subtest showed that both Alan and Charlie, with Brandon on a lesser scale, made some reading gains after the introduction of the O-G-based intervention. Hence with the O-G-based intervention, the three children made reading gains to different extents after the intervention was introduced.

In Scarborough's (2001) woven-strand model, the word-recognition strands in phonological awareness, decoding and sight recognition of words have to work together to be increasingly automatic through repeated practice and repetition. Concurrently, the language comprehension strands such as background knowledge, vocabulary, language structures, verbal reasoning and literacy knowledge must be increasingly strategic and when the language comprehension strands are weaved together with the word

recognition strands, skilled reading occurs. While the initial learning of letter-sound correspondences begin prior to word reading, the complete integration into fluent reading entails sustained practice across an extended period before it becomes fully automated, and failure to develop automated letter-sound integration might result in an impairment of reading fluency (Beck et al., 2025). Hence children's lack of automaticity in recalling letter-sound correspondences may have contributed to difficulties with blending. Cohen et al. (2008) found that blending sounds together into a word was the most difficult step in their three-step decoding strategy with constant time delay for five students aged 9 to 14 with mild ID.

Similar to the current research, the students in their study could identify a higher percentage of letter-sound correspondences as compared to the percentage of words read correctly. Lemons et al. (2016) reiterated that deficits in working memory may limit response to reading intervention, and students with ID may have difficulties meeting the cognitive demands that are required to blend sounds together to say the whole word. Consistent with students who experience working memory deficits, Charlie may forget the first sound by the time he tries to blend the second sound. To address this, teachers should provide deliberate practice (Ericsson & Harwell, 2019) to build competency and automaticity. Teachers could incorporate various forms of scaffolding to assist students in manipulating letter-sound correspondences, limit the number of taught concepts per lesson, and intensify intervention over longer durations.

In comparison with the adapted RTC intervention by Lemons et al. (2015), this study on O-G-based intervention also demonstrated gains in letter-sound correspondences for children with developmental delays. Both studies utilised explicit instruction to teach letter-sound correspondences and paired keywords and pictures, used cumulative and repeated practice of mastered letter-sounds and words, and taught blending of sounds to read words, and these are generally agreed upon to be components of an effective reading intervention (Goldstein, 2011; Lemons et al., 2016). The adapted RTC intervention showed better performance in word reading compared to the current study, and several factors may have contributed to this outcome.

First, in the adapted RTC intervention, practice effect may have contributed to the better outcomes, as the same words were used for teaching and testing. Second, the length of intervention could have contributed to the better word reading outcome in the adapted RTC intervention as it was delivered between 24 and 45 sessions, while the O-G-based intervention was conducted across 25 sessions. Third, unlike the study by Lemons et al. where eligibility requirements include that the participants should be native English speakers, this was not a prerequisite for the current study. English was a second language for both Brandon and Charlie, and all three children were exposed to bilingual education in their kindergarten settings. Educators should consider students' language abilities in the planning of reading intervention, as language skills are the underlying foundation for successful reading (Spencer et al., 2013). In a phonics-based reading

instruction study using a waitlist randomized control trial with 57 children with DS between ages of 5 to 10 years, Burgoyne et al. (2012) found that there was a variation in response to their intervention and positive effects were associated with younger ages, greater number of intervention sessions, and having higher initial receptive language skills. Hence results in the current study may have been impacted by the differential verbal abilities of the children, and their familiarity and use of English in conjunction with another language. This dual language issue may have been a confounding variable for Brandon and Charlie in this study.

IMPLICATIONS FOR PRACTICE

The Singapore education system is a high-performing education system that prioritizes students' academic performance with high-stakes examination (Deng & Gopinathan, 2016). Children with developmental delays may start school with poorer reading skills than their typically developing peers, and these reading difficulties may also then exacerbate their behavioral and/or social problems. The early literacy skills targeted in this study is an important component of school readiness particularly contributing to the area of academic achievement (Pears et al., 2016). By implementing O-G-based early reading intervention, we are exploring if these young children can develop early literacy skills that not only enhance their academic achievement but also support positive social and behavioral adjustment in primary school settings. For young children who will go to special schools, developing early literacy skills can support their acquisition of functional literacy, promoting community participation and social inclusion.

The positive findings from the present research invite further discussions about the intriguing question of the variables influencing reading gains, such as behavioural support, multiple approaches to facilitate reading, and intensity of the intervention. Children who demonstrate difficulties in engagement during reading lessons tend to make less reading progress (Lindström & Roberts, 2023). During the study, Brandon occasionally displayed challenging behaviours such as sudden refusal to follow instructions, or insistence on leaving the room. There were occasions that the interventionists had to reschedule their intervention sessions as he displayed challenging behaviours in his EI setting before being pulled out for the O-G-based intervention. Lemons et al. (2017) found that nonresponsiveness in their study could be associated with student engagement as the two children with the lowest response also had the lowest level of engagement during their phonics-based reading instruction. Hence, comprehensive reading intervention should include behavioural supports to promote academic engagement and reduce inappropriate behaviours (Lindström & Roberts, 2023).

Individualisation is a hallmark of special education, and therefore it is essential for teachers to make learning relevant, meaningful and familiar to the child. Teachers should consider the target students' needs and the context of instruction (Sayeski &

Hurford, 2022). Students need a variety of experiences and activities, in addition to repetition, to learn how to read effectively, and teachers need to follow the child's lead and interests to facilitate child engagement in the learning activity (Hong & Kemp, 2007). Effective reading intervention has to not only promote increased motivation of the child but also integrate different strategies and incorporate a variety of activities, materials and games within multiple learning opportunities (Greenwood et al, 2015). Student learning should be monitored closely and if there is inadequate response to the intervention, instructions should be adapted for each individual.

LIMITATIONS AND FUTURE RESEARCH

The first limitation may be the duration of the O-G-based intervention, which was short term and restricted to 25 sessions that only focused on letter-sound correspondences and word reading. Reading has many other different components such as phonological awareness, automatic word recognition, fluency and language comprehension included in the O-G approach (Gillingham & Stillman, 1997) which were not covered during the course of this intervention. O-G-related scope and sequences reflect comprehensive phonics instruction moving from basic concepts to more complex ones that requires several years to move through the prescribed phonics skills (Sayeski & Hurford, 2022). Further research with a longer duration could be done encompassing the entire reading components of the O-G approach to accurately assess its overall effectiveness.

Second, there were differences in the modifications of the O-G-based intervention for each child, based on the child's learning needs. While Alan and Brandon's modifications were kept to changing of the keywords based on their familiarity and interests, Charlie had more modifications such as the use of different activities and games to facilitate and concretize learnt concepts. These modifications may have affected how each child responded to the intervention.

The final limitation is the children's differing verbal abilities, with Alan most proficient in using the English language, as it was his first language. Charlie used both the English and Malay language equally in his home and school settings while Brandon was the least proficient in using English as it was a second language for him, and Mandarin was the preferred language used in his home setting. The children's differing verbal abilities in English may have impacted the extent and speed of learning to read during the intervention.

CONCLUSION

Understanding the effectiveness of early literacy programmes is crucial for Singapore's EI sector, especially since there is high focus on academic performance in the general education system. It would be imperative to start reading intervention early, before the start of formal school education, so that children are geared for successful transition. This

research extends our understanding of the effectiveness of the O-G-based programme in teaching letter-sounds and word reading, and adds to the limited but growing research that supports the importance of including phonics instruction in reading interventions for young children with developmental delays. The findings present preliminary evidence that the O-G-based approach could be a suitable and promising method to teach reading in an explicit, structured, intensive, individualised and multi-sensory manner for young children with developmental delays. By identifying these strategies for enhanced literacy instruction within the EI setting, this research provides insights to bridge the gap between EI and general education, contributing not only to children's academic success but also fosters greater social inclusion and independence, ultimately leading to long-term educational and life outcomes.

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