

Interventions for children with dyslexia: A review on current intervention methods

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ABSTRACT

Introduction: Dyslexia is a neurobiological impairment that primarily affects reading ability. It is commonly known as a reading disorder which is likely to be present at birth and is generally identified at pre-school level. Dyslexia is manifested through difficulties with accurate word recognition and also by poor performance in reading and writing.

Method: The main objective of this paper is to review the various methods or treatments that are used to manage the literacy and cognitive abilities for children with dyslexia particularly in Malaysia. The articles were obtained from online databases such as PubMed, Ebscohost and Medline during the time frame of six years starting from 2000 until 2016. An initial count of 300 articles were generated but only 13 articles met the inclusive criteria.

Results: There are a few types of interventions such as the multisensory method, the phonological intervention, and the cognitive training method which can be used to improve literacy and cognitive deficits among children with dyslexia. In Malaysia, most of the treatments are focused on the aspects of language such as word mastery, alphabet identification and writing skills. The cognitive training were carried out to improve specific domain such as visuospatial skills, memory skills and psychomotor skills.

Conclusion: There is yet no studies which has employed the comprehensive method of combining the intervention of cognitive functions and linguistics-literacy deficits. It is imperative that researchers in Malaysia go beyond literacy skills and take into consideration the underlying cognitive functions which contribute to the specific reading and writing difficulties of Malaysian children with dyslexia.

KEY WORDS:

Intervention study, dyslexia, cognitive deficits, review, children

INTRODUCTION

Specific Learning Disorder (SLD) with impairment in reading, or more commonly known as dyslexia, is a type of neurodevelopmental disorder. Individuals with SLD have

difficulties with precise and articulate word identification because they have low ability in decoding and spelling.¹ In today's society, dyslexia has increasingly been found to be the most common learning disability accounting up to 80 percent of the learning disabled population in general.²

Children with dyslexia have deficits in the higher-order processing or executive control processes.³ Besides that, they also have problems in visual attention span that greatly affects their reading skill.⁴ Children with dyslexia may also have difficulties with memorizing⁵ as well as difficulties in letter identification.⁶ Most students with dyslexia present with significant deficits in phonological processing, verbal working memory and processing speed.⁷

Based on a report by the International Dyslexia Association, dyslexia has affected 10%-15% of the population in the world.⁸ Similarly, in Malaysia where 10%-15% of the primary school children is reported by Harmonic Social Association (PSHM) for having symptoms of dyslexia.⁹ According to the statistics of Department of Special Education, Ministry of Education Malaysia, there are about 314,000 children in Malaysia who are suffering from dyslexia.¹⁰ On average, the Ministry of Education Malaysia reported that there is one dyslexic case identified in every 20 students.¹¹ Sin Chew Daily reported that nearly 10% of the students in primary and secondary school are affected with the disorder.¹²

In Malaysia, a child who is suspected to have dyslexia will be referred to either a paediatrician or child psychiatrist who will give an initial diagnosis which is subsequently confirmed by the clinical psychologists through further testing. The child would usually be required to undergo standard psychological testing such as the Dyslexia Screening Test (DST) and the Wechsler Intelligence Screening Test (WISC) along with an interview with parents or teachers. The diagnostic criteria are based on the Diagnostic Statistical Manual Fifth Edition (DSM-5). The DSM-5 diagnostic criteria for SLD requires that the child fulfill the following four criteria: a) the child had at least six symptoms of learning difficulties during the period of at least 6 months despite the provision of extra help or targeted instruction, b) the child with SLD usually have difficulties in literacy and mathematical skills such as reading single word, reading comprehension, writing and

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spelling, arithmetic calculation, and mathematical reasoning c) the deficits in keystone academic skills lead to poor academic achievement and they tended to lag far behind in age and intellectual ability from their peers and d) the lag in academic achievement are not due to intellectual disabilities, other mental or neurological disorders, visual or auditory problems or poor or inappropriate academic instruction.¹³

PROBLEM STATEMENT

It is obvious that the difficulties due to the disorder have affected children with dyslexia in many aspects. Thus, it is vital to have structured intervention plans in place to cater to their needs. To date, there are limited module or intervention programmes being conducted in Malaysia for children with dyslexia. In fact, there is currently no standardised module for dyslexia class in Malaysian public school. The teachers in schools mainly focus on improving literacy skills such as reading and writing skills among students with dyslexia but less emphasis is placed on cognitive skills training. Since teachers tended to use traditional methods in teaching these children to overcome their difficulties in the classrooms, their outcomes were found not to be encouraging and were not successful in overcoming their difficulties in reading.¹⁴ According to Brownell¹⁵ the traditional way of learning is not effective for children with dyslexia because it tended to be stereotypical, teacher-centered and passive. Irwin proposed that teachers emphasize on the multi-sense teaching and learning method.¹⁶ In addition, intervention studies to improve the cognitive functions in children with dyslexia in this country is rather limited.^{14,17,18} Quite a number of researchers had designed computerized interactive multisensory programmes to help students recognize words and reading.^{19,20,21} However, not much work has been done on modules to enhance cognitive skills such as attention, memory, and executive function.

Wagner and Torgesen categorized three linguistics-cognitive functions: phonological awareness, phonological working memory and rapid automatized naming which are strongly associated with reading and writing abilities.²² At the same time, visual skills, motor coordination and visual motor coordination are also vital in the writing process.²³ Gomes in his study found that children with dyslexia have insufficient fine motor skills which affected their calligraphy and letter drawing in the copying task.²⁴ More research is needed to find an effective training module to remediate the cognitive functions among children with dyslexia.

The aim of this paper is to review the interventions available for children with dyslexia in Malaysia and elsewhere in order to identify common techniques used to intervene cognitive functions, and to identify the more frequent cognitive functions domains that were frequently used in intervention studies.

MATERIALS AND METHODS

This narrative review is an online search using a few databases such as PubMed, EBSCOhost, Medline specified from 2000 until 2016. This is to explore the most current

development in intervention for children with dyslexia in Malaysia and other countries. The search produced about 300 articles but only 13 articles met the inclusion criteria. The inclusion criteria were that the articles must be (a) about intervention programmes, (b) with full-text English journal, (c) participants must be primary school children with reading disorder, (d) experimental study or single-case study was employed and (e) the articles was published from 2000 to 2016. The exclusion criteria is the presence of comorbidity such as dyscalculia and attention deficit hyperactivity disorder (ADHD).

This narrative overview summarizes the contents of each article. In conducting narrative review, some researchers suggested that a proper overview should critically critique each study while others disagree.^{25,26} This type of review does not describe the methodological approach that would permit reproduction of data nor answer to specific research questions. In contrast, the systematic literature review "is a well-planned review to answer specific research questions using a systematic and explicit methodology to identify, select and critically evaluate results of the studies included in the literature review."^{27,28} As this is a narrative review paper, we do not appoint any experts to evaluate the articles or to evaluate the intervention designs. Papers were selected as long as they met the inclusion criteria i.e the articles were full texts, were focused on the intervention of phonological skills and cognitive function of children in the primary school age group.

The literature search was done using the following keywords: intervention study, dyslexia, cognitive deficits, review, children. We also use combination of keywords such as "developmental dyslexia" AND cogniti* AND "intervention strateg*" AND "phonological skills."

RESULTS

The review focused on two main themes: intervention for language skills and intervention for cognitive skills. Many previous local interventions studies were targeted at improving the reading difficulties rather than the cognitive skills of children with dyslexia. Table I contains a summary of 13 intervention studies from Malaysia and other countries that met the inclusion criteria. Three of the studies were done on Malaysian children, while others were studies from countries such as China, Germany, Iran, Brazil, Italy and United Kingdom. The studies mainly focused on interventions for cognitive skills^{1,29} but there are a few studies which focused on linguistic aspects such as phonological awareness skills,³⁰ morphological skills,³¹ word mastery and identification,²¹ reading comprehension and writing skills.^{14,32}

Most research used experimental designs in their studies although some of them did not mention the type of study design that they used. There was only one study by Lee³² who recruited Annie, a 9-year old girl as a subject for a single case study. In terms of participants recruited for the intervention, some of the authors mentioned samples of the study obtained through screening and diagnostic evaluation.^{1,24} It is not clear whether they use Randomised Controlled Trial (RCT) in their studies. Most of the participants in all articles were

between 8 to 15 years old. Some of the authors stated grades and years of schooling of the participants.^{31, 34}

In terms of group's sample size, there is one study which used a single-case method.³² Most of the researchers recruited between 5 to 62 participants in their studies. Arnbak and Elbro³¹ stated that the smaller the group, the larger were the gains. The researchers believed that smaller groups sizes would enhance the intervention result. They stated that subjects were working more intensively with the morphological awareness training programme, resulting in better morphological analysis skills. Since the morphological awareness training was primarily oral, it may have been difficult for the experimental students in the bigger groups to focus on the oral training, especially when training dealt with less comprehensible, abstract morpheme units. Besides, remedial teaching of this kind is more gainful for students with dyslexia in small groups because the teachers could give maximum support.³¹ Since all of the studies generated are intervention-based studies, the reason above is applicable and could be the cause of smaller size groups other than strict inclusive criteria.

There were a few studies that applied multimedia training in their intervention program. Luo et al.²⁹ and Kast et al.³⁴ utilised computer-assisted training while Franceschini et al.³⁵ used video games in their remedial intervention. Qian and Bi adopted Magnocellular deficit theory in their treatment plan.³⁶ There were also a few studies that used multisensory teaching in their studies.^{1, 14, 21, 33, 34}

Some participants went through standard diagnostic procedures using International Statistical Classification of Diseases and Related Health Problems (Tenth Revision, ICD-100)28 and Statistical Manual of Mental Disorders (DSM). Some researchers used standard psychological tests, such as Bender Visual Motor Gestalt Test (BVMGT) and Rey Osterrieth Complex Figure Test (ROCF)^{1, 21} to screen their participants while some researchers used their own local version of screening test.^{30, 34}

The majority of the studies targeted language or literacy components such as writing skills, reading skills, word and alphabet mastery as the outcome of the study.^{14, 21, 30, 31, 33, 34} Many researchers in other countries carried out intervention or training based on specific impaired cognitive function^{1, 29, 35, 36, 37} such as visual-motor intervention and working memory training. In other words, they have chosen a specific difficulty to be treated in their intervention. This type of treatment are more focused and easier to analyse. For example, Franceschini et al. targeted attentional skill as a function to be improved using action video games.³⁵

Several studies have investigated the efficacy of intervention strategies using combination of language and cognitive functions.^{32, 38} For example, a single case study by Lee used the Davis Model to intervene perceptual problems and word recognition in a Malaysian child with dyslexia.³² The Davis Model consists of three main components. The first is the Davis Orientation Counselling procedure to correct her visual perceptual problem, while the second is the Davis Symbol Mastery procedure to help her with problems of reversals and

finally the Davis Reading Exercises to help her in word recognition.

Nourbaksh et al. conducted a study to examine the effects of cognitive (cognitive skills training) and developmental intervention (sensory-perceptual skills training) on the performance and reading ability of children with dyslexia in Tehran, Iran.¹ There were 60 third grade students who were divided into three groups including 20 students as the first experimental group (E1), 20 students as the second experimental group (E2), and 20 students as the control group (C). Both E1 and E2 groups were given 16-session intervention and their abilities were measured using Reading and Dyslexic test (RTD), Bender Visual Motor Gestalt Test (BVMGT) and Rey-Osterrieth Complex Figure Test (ROCF). The findings revealed that RDT, BVMGT, and ROCF performance were significantly improved after intervention. The cognitive interventions did not increase the performance of the students compared to the control group. This study combined both intervention for reading and cognitive skills, however, there were no clear description of the activities that were carried out each week. The study also did not include activities to improve executive functions.

Luo et al. focused on working-memory training, including training in visuospatial memory, verbal memory, and central executive tasks among 30 children with dyslexia aged 8-11 years in China.²⁹ They were trained for forty minutes per day, for five weeks. The findings showed that the working-memory training has improved visuospatial, verbal domains and central executive tasks in children with developmental dyslexia. The visual rhyming task and reading fluency task were also significantly enhanced after the training. Although the researchers of this study have selected working memory to be treated in this study, the visual rhyming task and reading fluency task were also improved by the training. The author suggested that working memory can help the children to become more proficient in reading. However, the study did not include other cognitive or phonological skills.

Capellini et al. conducted a research to verify the efficacy of a perceptual and visual-motor skill intervention programme for students with dyslexia.³⁷ The participants, aged from 8 to 11 years old, were distributed into two groups. The first group consisted of 10 students diagnosed with developmental dyslexia while the second group comprised of 10 students with good academic performance. The reason for selecting this control group of students was that they were students without learning disabilities but may have poor quality of handwriting. The perceptual and visual motor intervention was applied to both groups. The result showed group 1 increased the average of correct answer in Test of Visual-Perceptual Skills (TVPS-3) and improved quality of handwriting. The comparison of group I and group II was not appropriate as group II have discrepancies in academic performance.

Franceschini et al. conducted a research on action video games on two matched group of children with dyslexia.³⁵ The subjects underwent action or non-action video games for nine sessions of 80 minutes per day. The reading, phonological, and attentional skills in both groups were tested before and

after they played the video games. The findings suggested that playing games could improve their reading speed and also attention skill. However, the method of study was not described adequately.

Faramarzi et al. did a study on the effect of phonological educational intervention on the reading performance of students with developmental dyslexia.³⁰ The aim of the study was to observe the effectiveness of phonological educational intervention on the reading performance of students with developmental dyslexia. Sixteen third grade female students with dyslexia were randomly assigned to one experimental and one control groups respectively. The experimental group showed a significant improvement in reading performance compared to the control groups. The limitations of this study were that only female participants took part in the study and also the method focused on the auditory recognition, motor, tactile senses abilities without other cognitive skills such as executive functions or memory being tested.

A study by Ho et al.³³ aimed to compare the effectiveness of multisensory and traditional approach in teaching students with dyslexia. The participants were 36 Chinese children with dyslexia of grade 3 to grade 5. The result revealed that the multisensory training group showed greater improvement in reading, writing and understanding trained and non-trained materials compared to the traditional group. The duration of the intervention i.e 5 weeks was quite short and this might have affected the outcomes.

A research on computer-based multisensory learning among children with developmental dyslexia was conducted by Kast et al.³⁴ The aim of the study was to examine whether establishing a multitude of visuo-auditory associations might help to mitigate errors among the participants. After three months of training, the participants showed significant improvement in writing skills. However, this study did not include other cognitive skills such as executive functions and phonological skills.

Lee carried out a single study on Annie, a nine-year old girl diagnosed with dyslexia.³² The subject was found to have major deficit in visual perceptual skill, which affected her reading and writing skills. The researcher aimed to investigate whether Davis model was effective to improve her symptoms of dyslexia. The finding revealed that the Davis method has helped Annie to identify and correct her problems with reversals, helping her in word recognition and also with her visual perceptual problems. However, the findings could not be generalized to other children with dyslexia in Malaysia.

Qian and Bi conducted a Magnocellular-based visual-motor intervention on Chinese children with developmental dyslexia (DD) in order to examine the relationship between Magnocellular deficit and Chinese DD.³⁷ The intervention method comprised of coherent motion detection, visual search, visual tracking and juggling which are related to the Magnocellular function. The findings revealed that the Magnocellular function and phonological awareness of training of the dyslexics group have improved their reading abilities to a normal level as age-matched normal children

after intervention, while non-trained dyslexics did not show improvement.

Majzub et al. also applied a multisensory programme on students with dyslexia and observed its effectiveness on the identification and mastery skills of the alphabet.²¹ The subjects were 8 and 9 years old primary school children who in attending remedial education classes from 12 schools in the District of Hilir Perak. The quasi experimental design was used in this study. The overall results showed that there were significant differences for alphabet identification and alphabet mastery after the implementation of the programme.

Subramaniam, Mallan and Che Mat did a study on multi-senses explication activities in words mastery among five children with dyslexia aged 8 and 9 years old in a primary school in Malacca.¹⁴ The sample size used was too small to generalize the results. The study aimed to apply the multi-senses explication activities and language game in the words mastery of the subjects. The data collected employed survey via using questionnaires, interview sessions and observation method. The findings revealed that the multi-senses explication activities could provide the learning mode on the mastery of words among the subjects. The activities also managed to create a fun learning experience for the students and managed to capture their attention in learning the Malay language subject.

Arnbak and Elbro conducted a research on the effects of morphological awareness training on the reading and spelling skills among young dyslexics.³¹ The participants were 33 students with dyslexia in grades 4-5. They received 36 lessons of morphological training for about 15 minutes for each session. The training centered on the semantic aspects of morphemes. The outcome of the study suggested that the experimental group were able to do better in reading, comprehension and in spelling morphologically complex words. The control group, together with experimental group made similar accomplishments on measures of phonological awareness, phoneme discrimination and picture naming. The results also proposed that it is possible to develop morphological awareness task for children with dyslexia.

Lorusso et al. did a research to examine effects of visual hemisphere-specific stimulation versus reading-focused training in children ranging in the ages of 7-15 years old and diagnosed with dyslexia.³⁸ Test of phoneme awareness and test of memory and learning were used in the research. The specific intervention used was Visual-Hemisphere Specific Stimulation (VHSS). The result of the study suggested improvement in reading accuracy was greater in VHSS memory phonemic skills among the participants.

DISCUSSION

To date, there are multiple treatments or intervention programmes available to ameliorate dyslexia symptoms in children.³⁹⁻⁴¹ Snowling reiterated that an understanding of the aetiology of a disorder is important in the setting up of an intervention program.⁴² He added that aiming for particular

Table 1: Summary of reviewed articles

No	Author	Title	Location of the studies	Method	Psychological tests used	Type of functions to be improved	Themes Type of intervention	Outcome
i	Nourbakhsh et al. (2013)	The effects of multisensory method and cognitive skill training on perceptual performance and reading ability among dyslexics students in Tehran, Iran.	Tehran, Iran.	60 Primary 3rd grade students participated in this experimentally design study.	Reading and dyslexics test (RTD) as screening test followed by the Bender Visual Motor Gestalt Test (BVMGT) AND Rey-Osterrrieth Complex Figure test (ROCF).	Visual motor, visual memory and reading ability.	Cognitive intervention. Cognitive skills training and Multisensory skills training.	Sensory-perceptual skills training significantly improves RDT, BVMGT and memory scale of ROCF performance.
ii	Luo et al. (2013)	Working-memory training improves developmental dyslexia in Chinese children.	Wuhan, China.	30 children with dyslexia aged 8-11 recruited in the double-blind, paired design study. scale (digit span).	Dyslexia checklist for Chinese children, Stroop task, Corsi span task, Wechsler intelligence	Working memory	Cognitive intervention. Visuospatial working memory task, visual verbal working memory task, central executive task using computer-assisted training.	Working memory training improved working memory in children with developmental dyslexia.
iii	Capellini et al. (2014)	Efficacy of a perceptual and visual-motor skill intervention program for students with dyslexia.	Marilia, Sao Paulo, Brazil.	20 students with developmental dyslexia aged from 8-11 years involved in this experimental-design study.	Test of visual-perceptual skills (TVPS-3), dysgraphia scale.	Visual perceptual and motor skill.	Cognitive intervention. Exercises that involve linguistic stimuli.	The result showed the GI group (students with developmental dyslexia) increased in performance, the average of correct answers in TVPS-3 and improved quality of handwriting.
iv	Franceschini et al. (2013)	Action video games make dyslexic children read better.	Lecco, Italy.	20 children with dyslexia took part in the experimentally design study.	Not stated in the study.	Attentional skill.	Cognitive intervention. Training using action video games.	Attentional abilities, reading speed has improved during action video game training.

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Table I: Summary of reviewed articles

No	Author	Title	Location of the studies	Method	Psychological tests used	Type of functions to be improved	Themes Type of intervention	Outcome
v	Faramarzi et al. (2014)	The effect of phonological educational intervention on the reading performance of students with developmental dyslexia.	Iran.	16 3rd grade female dyslexic students participated in the experimentally design study.	The dyslexia symptoms form adapted by Bazrafshan (1997), The 3rd grade reading test, Rion's Intelligence Test.	Reading performance.	Language intervention. Phonological educational intervention.	The experimental group showed a significant improvement in reading performance compared to control groups.
vi	Ho et al. (2009)	The effectiveness of multisensory training in improving reading and writing skills of Chinese children with dyslexia.	Beijing, China.	36 children with dyslexia from Grade 3-5 took part in this experimental-study design.	Raven's standard progressive matrices, word reading, word dictation, Training reading and dictation of passage in Chinese.	Reading and writing Chinese script	Language intervention. Multisensory training using stimuli like pictures and verbal questions. The traditional training involve copying exercises and reading aloud.	Training Group, as compared to the Traditional Training Group, showed greater improvement after training in reading, writing and understanding of the trained and non-trained materials.
vii	Kast et al. (2007)	Computer-based multisensory learning in children with developmental dyslexia.	German.	43 children with developmental dyslexia and 37 carefully matched normal reading children participated in this experimental-study design.	Salzburger-Lese und Rechtschreibtest SLRT and Z'urcher Lesetest ZLT (local test).	Writing skills.	Literacy intervention. Computer-based writing training.	Three-month visual-auditory multimedia training strongly improved writing skills in children with developmental dyslexia and non-dyslexic children.
viii	Lee (2010)	The Davis Model of Dyslexia Intervention: Lessons from one child.	Malaysia.	A 9-year-old girl, Annie participated in this single-case study.	Davis Perceptual Ability Assessment.	Visual perceptual problem, reversals problems and word recognition.	Combination intervention (cognitive and literacy). Davis orientation counselling procedure, Davis symbol mastery procedure, and Davis reading exercises.	The Davis strategies has helped to correct Annie dyslexia symptoms.

Table 1: Summary of reviewed articles

No	Author	Title	Location of the studies	Method	Psychological tests used	Type of functions to be improved	Themes Type of intervention	Outcome
ix	Qian & Bi (2015)	The effect of magnocellular-based visual-motor intervention on Chinese children with developmental dyslexia (DD).	Beijing, China.	17 children with developmental dyslexia and 11 chronological age-matched took part in this experimental design study.	Combined Raven's Test and Standard character recognition test.	Magnocellular function and phonological awareness.	Cognitive intervention. Coherent motion detection task, Visual search and visual tracking task and juggling.	The result showed that M-function and phonological awareness of training dyslexic group were improved. to normal level as aged-matched normal children after intervention, while non-training dyslexics did not.
x	Rohaty et al. (2012)	Effects of a multisensory programme on dyslexic students: identification and mastery of the alphabet.	Perak, Malaysia.	62 students with dyslexia aged 8-9 years old took part in this Quasi-experimental study.	Dyslexia checklist (ISD) developed by the Ministry of Education, Dyslexic Malay Language Reading Test and Jordan oral screening test.	Alphabet recognition and alphabet mastering skill.	Language intervention. Multisensory method and Traditional method. Details of the training were not stated.	There were significant differences for alphabet identification and alphabet mastery through using multisensory method
xi	Subramaniam Mallan & Che Mat (2013)	Multi-sense explication activities in word mastery among children with dyslexia	Selangor, Malaysia.	5 aged 8-9 years old primary school students diagnosed with Dyslexia participated in the study. The study design is not mentioned.	Not stated in the study	Word mastery	Language intervention. Multisensory method using stimuli like clays and sand paper. Language games involve informal language questions.	The multi-sense application activities could provide the language learning mode, especially on the mastery of the suitable words based on the mind of children with dyslexia.

Table I: Summary of reviewed articles

No	Author	Title	Location of the studies	Method	Psychological tests used	Type of functions to be improved	Themes Type of intervention	Outcome
xii	Arnbak & Elbro (2000)	The effects of morphological awareness training on the reading and spelling skills of young dyslexics.	Copenhagen, Denmark.	33 students with dyslexia in Grade 5-6 took part in the experimentally design study.	An extensive test battery of 17 different tests such as Passage Comprehension Test and Tests of Oral Linguistics Abilities.	Morphological awareness and reading and spelling performance.	Language intervention. Morphological awareness training.	Experimental group progressed significantly more than the control group in reading comprehension and in spelling of morphologically complex words.
xiii	Lorusso et al. (2006)	Effects of visual hemisphere-specific stimulation versus reading-focused training in dyslexics children.	Bergamo, Italy.	25 children with developmental dyslexia ranging in age between 7-15 years old.	Test of phoneme awareness and Test of Memory and Learning.	Reading performance, spelling abilities, phonemic awareness and verbal memory.	Combination intervention. Visual-hemisphere specific stimulation.	Improvements in reading accuracy greater in memory phonemic skills, based on VHSS memory.

defective process is helpful in deciding the content and design of the intervention programme.

Thomson stated that effective teaching methodologies for dyslexia must consider the content of teaching and also the process of teaching.⁴³ For example, the key best features of best practice for content teaching includes: i) explicit training in phonological awareness, ii) strong focus on phonological decoding and word-level work, iii) supported and independent reading of progressively more difficult texts, and iv) practice of comprehension strategies while reading texts. Some key points of best practice for teaching process should incorporate a few approaches such as phonetic, multisensory, cumulative and sequel.³⁴

Overall, each intervention in the articles reviewed were effective insofar as the targeted functions. Unfortunately, some of the procedures in the training were not well-explained thus it was not fully understood on how the strategies had worked on helping subjects to overcome their difficulties. Based on the results, the functions that were selected for interventions were perceptual skills, visual motor skill, memory and attention. However, since the difficulties treated varied, it is difficult to conclude which intervention had worked best for the specific deficit. Besides, it was also hard to select the most practical intervention for our population as the majority of the approaches have yet to be tested among the local Malaysian children.

In Malaysia, limited research has been done on alleviating cognitive functions in children with dyslexia. The review of the literature showed that researchers in Malaysia mostly used multisensory and multimedia methods in dyslexia intervention. A majority of them targeted language components such as identification and mastery of the alphabet as outcomes of the study. Some studies in the country employed morphological awareness in training subjects to read, spell and learn words.

Hence, it is suggested that local future researches should attempt to focus on alleviating cognitive function deficits among children with dyslexia by incorporating aspects of mental functions which can include attention, working memory and psychomotor speed in training children with dyslexia to read and write. It is also recommended that interventions should be more specific in targeting certain deficit domain and be comprehensive in considering many cognitive and linguistic factors in order to ensure better outcomes. A complete and effective module, incorporating cognitive and linguistic i.e. phonological and morphological awareness skills could best serve the needs of local children with dyslexia in coping with the demands of the current educational examination-based system. The designed module design should be practical and applicable to be used by teachers at school and also user-friendly for parents to use in facilitating their child's learning needs at home.

CONCLUSION

This review highlights the various intervention methods used to improve literacy and cognitive function of children with dyslexia including the use of multisensory and multimedia

methods. There are no studies which employed the comprehensive method of combining the intervention of cognitive functions and linguistics-literacy deficits. Researchers in Malaysia often focused on literacy and linguistic skills only. It is imperative that researchers in Malaysia go beyond literacy skills and take into consideration the underlying cognitive functions which contribute to the specific reading and writing performance of children with dyslexia. This comprehensive combined model of intervention might bring about better ways of management with better outcomes for Malaysian children with dyslexia.

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