Remediating Comprehension Deficits in Hyperlexia: The Scaffolding Interrogative Method

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ABSTRACT

Children with severe reading comprehension deficits with no word recognition issues have traits associated with hyperlexia, which is advanced word recognition ability in children with language disorders. Scaffolding supports have been recommended for affected children they have difficulties in the formation and organization of schemata for processing information. The Scaffolding Interrogative Method (SIM) is a remediation strategy developed based on this recommendation. Post intervention results following six months of remediation indicated significant improvement in reading comprehension with a very large effect size for a sample of thirty-three subjects. Recommendations and limitations of the study are discussed for further research.

Keywords: Scaffolding interrogative method, reading comprehension, hyperlexia, cognitive impairment, savant children

INTRODUCTION

The purpose of this study is to investigate the effectiveness of the *Scaffolding Interrogative Method* (SIM) (Chia, 2002) for remediating the reading comprehension difficulties of children with hyperlexia. Initially noticed by clinicians (for e.g., Kanner, 1943; Parker, 1919; and Phillips, 1930) as an unexpected precocious reading ability in children with severe cognitive impairment, hyperlexia sparked interest and research as a savant ability (Grigorenko, Klin, & Volkmar, 2003). The discrepancy between children's advanced word recognition and poor comprehension became more of the focus after the term hyperlexia was coined by Silberberg & Silberberg (1967). Researchers started to use the term hyperlexia to refer to such discrepancies in children with typical (e.g. Niensted, 1968) and superior IQ (e.g. Jackson & Biemiller, 1985; Pennington, Johnson, & Welsh , 1987) as well. In addition, the unexpected compulsion to respond to print stimuli acquired by adults with brain dysfunction or lesion has been referred to as acquired hyperlexia (Suzuki, Itoh, Hayashi, Kouno, & Takeda, 2009).

Contemporary Definitions of Hyperlexia

In the guidelines on disorders from the American Speech-Language-Hearing Association (ASHA), hyperlexia is described as a developmental disorder in which children exhibit precocious printed language decoding abilities with deficits in reading comprehension. It is regarded as a language disorder in autism spectrum disorder (ASD), but it has a differential diagnosis owing to its occurrence in other developmental disorders such as specific language disorders (SLI) in children without ASD (American Speech-Language-Hearing Association, 2006). This corresponds to the description of hyperlexia provided for the Individualized Education Program (IEP) in the Educator's Diagnostic Manual of Disabilities and Disorders

(EDM) (Pierangelo & Giuliani, 2007). The EDM classifies hyperlexia as autism at Level 1 and differentiates it from autism at Level 2.

In order that the hyperlexia profile gives educators information to write more specific goals and objectives in the IEP, a descriptive-based system (see Cupples, 2011) using a prescribed set of parameters is likely to be more helpful than trying to determine the particular etiologic category (autism, SLI, etc.) for the affected child. Hence, the child with hyperlexia can be profiled, regardless of the etiology, as a poor-comprehender as illustrated in the model shown in Figure 1. The model simplifies the concept of reading disability by using only two components to constitute reading - decoding and comprehension (Aaron, 1989; Chia, Poh, & Ng, 2009; Gough & Tunmer, 1986; Ng, 2013; Ng & Chia, 2013). Dyslexia is characterized by word recognition difficulties with good comprehension; hence the good word recognition with comprehension difficulties in hyperlexia is considered the polar opposite.

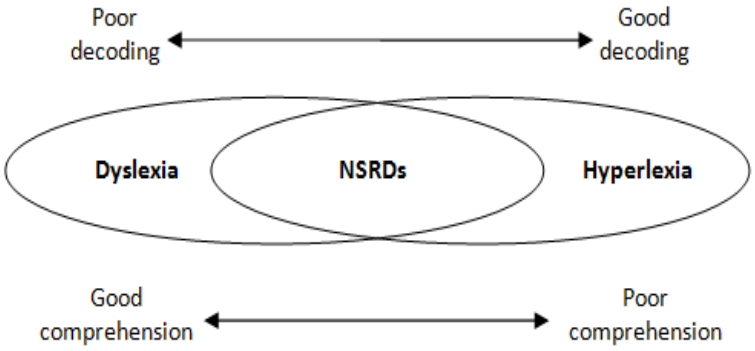

Figure 1. Bipolarity of reading disabilities (Chia, et al., 2009)

According to Healy (1982a), children with hyperlexia pursue their interest in the activity of word-reading itself with such focus and intensity that they do not search for the meaning of what they read. She pointed out that it is likely that they had failed to code what they were reading into meaningful schemata, which led to a lack of interaction with any content other than the printed words. Hence, it is unsurprising that storage and retrieval of meaning would not occur for them at all. To target their deficiency in the the organization of schemata, Healy has recommended remediation by using scaffolding supports (Healy, 1982b).

The SIM is an intervention developed to scaffold important information using the schemata of "Wh" questions. "Wh" questions are such as *who/what/where/when* interrogatives; hence the name for the intervention is SIM-Scaffolding Interrogatives Method. Various researchers (Deevy & Leonard, 2004; Goodwin, Fein, & Naigles, 2012; Hundert & van Delft, 2009; Schulz & Roeper, 2011) have pointed out that poor-comprehenders have difficulties coding text with respect to such interrogatives. Although the effectiveness of the SIM has been validated in two studies (see Chia, 2002; Chia & Kee, 2013), the generality and/or "boundaries" of an intervention are expected to be established through systematic replication of effects across multiple studies conducted in multiple locations and across multiple researchers (Birnbrauer, 1981). Therefore, the purpose of this study is to further validate the SIM as an evidence-based practice (EBP), and the following is the research question: Does the use of the SIM result in improved reading comprehension for children with hyperlexia?

LITERATURE REVIEW

For the purpose of gathering some insights to support the investigation, a selection of studies involving special-needs subjects on comprehension strategies was reviewed.

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In a study by Clarke, Snowling, Truelove, and Hulme (2010) on three types of treatments - training in text-comprehension (TC), oral-language (OL), and TC and OL combined (COM), a control group was used for comparison. The TC group was given inference training, metacognition and reciprocal teaching; the OL, vocabulary training; and the COM, a combination of TC and OL. All three experimental groups showed significant improvements in post-tests. The control group however, had decreased scores - this was noted as something that is expected when children with educational difficulties do not receive any interventions. 11-months after the treatment, the OL group showed greater gains than all the other groups in re-tests. Thus, it was implicated that OL (vocabulary) supports would be more needed to remediate comprehension difficulties.

Nevertheless, vocabulary supports alone may not suffice; but its use with comprehension scaffolding can help poor-comprehenders code what they read into meaningful schemata. The Idol-Maestas (1985) TELLS Fact or Fiction story-mapping uses a combination of supports as well. The treatment was: (T) study the story title, (E) examine and skim pages for clues as to what the story was about, (L) look for important words, (L) look for hard words, (S) think about the story settings, and (Fact or Fiction) decide whether stories were factual or fictional. During the treatment condition, the subjects' comprehension scores increased significantly from the baseline. The treatment effectiveness was also demonstrated by the marked decrease in scores when the treatment was removed. However, the author pointed out that the subjects had difficulties knowing the difference between important and hard words.

Using "Wh" interrogatives for the coding of important words so that hard words can be primed with vocabulary support may help in resolving the issue mentioned in the previous study. For instance, Yuill and Joscelyne (1988) first asked subjects to treat the implicit element in a story as a puzzle, then use "what" or "where" questions to prime subjects for making inferences as the scaffolding support. Poor-comprehenders were compared to a control group comprising normative subjects (referred to as good-comprehenders). The results showed that for the poor-comprehenders, the post-test comprehension scores were significantly higher for those given the treatment than those who were not. On the other hand, no significant difference was found between the post-test comprehension scores for the good-comprehenders given the treatment and those not given the treatment. It was implicated that scaffolding supports would be redundant for good-comprehenders as they instinctively perceive the linguistic relationships and organize scripts mentally. Poor-comprehenders lack such instinctive abilities; hence they need the scaffolding supports.

For discourse comprehension, a strategy called "Question-and-Answer Relationship" (QAR) was studied by Åsberg and Sandberg (2010) with subjects comprising high-functioning students with ASD. The QAR uses three types of visual answer cues ("right there/reflect and search/on my own") to scaffold independent practice on comprehension. At post-test, the experimental subjects had significantly better scores while the control had no significant improvement. This again provides evidence that scaffolding support can help poor-comprehenders' attain a higher level of comprehension than without.

Thus far, various scaffolding interventions have been found to be effective stimuli for triggering the minds of poor-comprehenders to search for the meaning of what they read. As for a comparison of the types scaffolding, Hundert and van Delft (2009) used subjects with ASD to compare their efficiencies at answering questions without any scaffolding, or with visual or verbal scaffolding. In the first condition, pictorial sequences were used; the second, a verbal narrative; and the last condition required the subjects to draw on the knowledge they have in their mind to answer the questions. The results showed that the number of trials

needed to learn how to answer in the first condition was the lowest, followed by the verbal, then the last. Hence, it can be implicated that it is not merely the absence of scaffolding supports that is the issue, but that verbal support may be too abstract; hence, the visuals, being concrete, are more effective.

The SIM (see Chia, 2002; Chia & Kee, 2013) that uses a matrix to organize scripts with respect to "Wh" interrogatives would thus fit the bill as both a concrete visual and a support for poor-comprehenders' inability to perceive the linguistic relationships and organize scripts mentally. Based on the statistical learning style in hyperlexia (see Cardoso-Martins, 2010), there is a clear advantage in using the SIM - the matrix serves as a 'statistical' coding resource that stimulates the interest of poor comprehenders, so they are more likely to be early-adopters of this EBP. The subject in the Chia (2002) study had taken well to the idea of using the SIM as he had better scores when the treatment was given than during phases when the treatment was withdrawn. The effectiveness of the SIM was further demonstrated in the Chia and Kee (2013) study where a significant increase in the post-test comprehension age was found for a group of ten subjects. With the evidence on the effectiveness of the SIM from these two smaller scale studies, there is assurance that the present investigation can proceed on a larger scale without an ethical risk of experimental failure.

METHODOLOGY

To answer the research question "Does the use of the SIM result in improved reading comprehension for children with hyperlexia?" the following null hypothesis was tested:

There is no significant difference in the pre-/post-test means of the reading comprehension age (RCA) of the group receiving the SIM treatment.

Participant Information

The subjects in this study were children with comprehension difficulties enrolled in three learning disabilities centers in Singapore. After parental consent was obtained for the study, the children were screened for hyperlexia. Using a screening procedure based on a language disorder of hyperlexia operationalized by a discrepancy (RAA - RCA) of at least 2 years between the word recognition and comprehension, a convenience sample of 33 subjects was found. The Neale Analysis of Reading Ability (NARA) III (Neale, 1999) was used as a standardized instrument to measure the Reading Accuracy Age (RAA) and Reading Comprehension Age (RCA) for word recognition and comprehension respectively.

Table 1. Sample profile at pre-test

Variable	*N*	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
RAA (years)	33	10.3	11.8	10.93	0.51
RCA (years)	33	5.3	6.9	6.16	0.51
RAA - RCA (years)	33	4.3	5.4	4.77	0.26
CA	33	8.1	9.2	8.59	0.33
FSIQ	33	90.0	116.0	100.55	7.53
GARS	33	66.0	115.0	89.24	15.57

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The sample profile at pre-test/screening is summarized in Table 1. The discrepancy between the RAA and RCA for all 33 subjects is a minimum of 4.3 years. Thus, the operationalized symptoms of hyperlexia were confirmed. Data on their chronological age (CA), WISC-IV (Weschsler, 2003) test full scale IQ (FSIQ), and Gilliam Autism Rating Scale (GARS) II (Gilliam, 2006) was also collected. Their CA varied from 8.1 years to 9.2 years; FSIQ from an average of 90 to above average of 116; and GARS from a very low probability of autism (66) to an above average probability (115).

Table 2 shows the gender distribution of sample. There are more 11 more males (n = 22) than females (n = 11) in the sample, with the males making up about two-thirds of the sample (males - 66.7%; females - 33.3%).

Table 2. Gender distribution of sample

Variable	*Frequency*	*Percent*	*Valid Percent*	*Cumulative Percent*
Male	22	66.7	66.7	66.7
Female	11	33.3	33.3	100.0
Total	33	100.0	100.0	

Procedure

After the pretest screening, a 6-month treatment was administered. During this period, the subjects underwent weekly 45-minute training sessions at their respective learning centers. The teachers were trained by a consultant before carrying out the SIM intervention. A workbook written specially for teaching reading comprehension to children with hyperlexia (Ng & Chia, 2013) was used as the training curriculum. The comprehension passages in the workbook were produced to include important words (e.g. what person/place/time) and cover a range of interest topics under fact, fiction, and fantasy to appeal to children. In addition, the passages were graded by levels; hence passages suitable for the grade level of the subjects could be selected. A sample of a comprehension test is shown in Figure 2.

Danny had a good dinner at home today.	
His mom had spent hours cooking it in the kitchen.	
His dad helped in clearing up after dinner.	
When all the washing was done, they all sat down to watch TV in the living room.	
The phone rang and dad took the call to the study room.	
Thereafter, the clock struck nine, and it was time for Danny to go to bed.	
Danny washed himself and changed into his pyjamas before climbing into bed.	
Soon after, mom came to kiss him goodnight and switched the lights off.	
Questions	
1	Where did Danny have his dinner?
2	Who cooked the dinner?

Figure 2. A partial sample of a comprehension test passage (Ng & Chia, 2013)

The treatment involved filling in the SIM matrix for each comprehension passage before using it to answer the questions. The matrix is designed with a top row consisting of the *who/what/where/when* interrogatives, each in individual columns as the respective grouping label. The second row consists of the scaffolding for the respective interrogatives, known as the *What-Interrogatives Method* (WIM) (Chia, 2002). The WIM indicates *What person*/*What happened/What place/What time* for the *who/what/where/when* interrogatives respectively.

Each subject was taught to first number the sentences of the passage sequentially, and then writes the sentence numbers into the first column of the matrix. Following that, the subject was guided to search for the *What person/What happened/What place/What time* of each sentence in the passage in order to write the information in the respective columns. When the matrix was completely filled in, the subject was taught how to systematically find the answers to the comprehension questions using the rows and columns in the matrix. A sample of a partially filled SIM matrix is shown in Figures 3.

Scaffolding Interrogatives Method (SIM) Matrix				
Sentence No.	Who?	What?	Where?	When?
	What person(s)?	What happened?	What place?	What time/period?
1	Danny	had dinner	at home	today
2	Danny's mom	spent hours cooking	in the kitchen	X
3				

Figure 3. A sample of a SIM matrix (partial)

Outcome Measures

To evaluate the improvement in comprehension, the pre-/post-test mean difference of the comprehension age in NARA III was calculated. After that, a repeated t-test was conducted to find out if there were any significant differences between the pre- and post-test means.

Reliability

The NARA III used as the instrument for the outcome measures has a high test-retest reliability index of .93. This shows that the tool is satisfactorily reliable for the single-sample repeated t-test design to test the hypothesis on the effectiveness of the intervention. As for scoring reliability, the answers for the outcome measures were scored by the researcher and a blind-rater. The result of the inter-rater agreement for the test scores was calculated by dividing the number of agreements by the total number of agreements plus disagreements multiplied by 100 (Kazdin, 1982).

Implementation of Procedures

The fidelity of teacher implementation of the study procedures was determined by ratings completed by a rater who did not participate in this study and was not informed of its purpose. The rater observed at least 30% of the intervention sessions and used a checklist to rate whether each component of study procedures was implemented correctly.

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RESULTS AND DISCUSSION

The results of pre-/post-tests in Table 3 and Figure 4 show that the use of the SIM has resulted in an increase in the post-test age for comprehension (RCA). There was also an increase in the post-test age for reading (RAA) as well. Nevertheless, a comparison of the % change shows that there is a greater increase in comprehension (RCA) than reading (RAA).

Table 3. Pre-/post-test measures

Variable	*Pretest* *(age in years)*	*Posttest* *(age in years)*	*Post-Pre* *(age in years)*	*% Change*
RAA	10.93	12.01	1.08	9.90%
RCA	6.16	7.82	1.66	26.92%

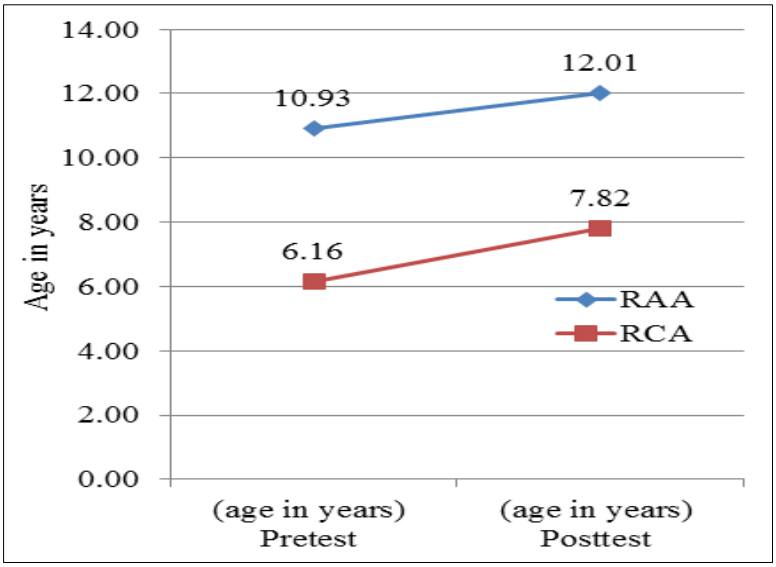

Figure 4. Pre-/post-test measures

Hypothesis Testing

Table 4 shows the results of the hypothesis testing using paired samples t-test on the comprehension pre-/post-test mean age (RCA) of the 33 participants. The increase in the mean comprehension age (RCA) was found to be significant, t(32) = - 21.225, p< .001, 95% CI (-1.81665, -.1.49850). Therefore the null hypothesis that there is no significant difference in the pre-/post-test means of the reading comprehension age (RCA) of the group receiving the SIM treatment is rejected.

In addition, using $r^2 = t^2 / t^2 + df$ (where t = - 21.225; df = 32); the effect size is found to be 0.9337 or 93.37%. This value is the percentage of variance accounted for by the treatment (Gravetter & Wallnau, 2013). Thus, removing the treatment effect reduces the variability by 93.37%. According to the criteria for interpreting the value of r^2 as proposed by Cohen (1988), this value indicates a very large treatment effect. It is possible for a very small treatment effect to be statistically significant especially when the sample size is very large; nevertheless, sample size has no effect on the measures of effect size (Gravetter & Wallnau, 2013). Hence, the purpose of reporting it here is to underscore the fact that the null hypothesis is not just rejected on basis of the significant difference but the effect size as well.

Table 4. Pre-/post-test paired samples t-test for reading comprehension age

Paired Differences	*Mean*	*Std. Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*		*t*	*df*	*Sig. (2-tailed)*
				Lower	*Upper*			
RCA Pre - RCA Post	-1.65758	.44863	.07810	-1.81665	-1.49850	-21.225	32	.000

Other Findings

Table 5 shows a comparison of the comprehension deficit at pre-tests and post-tests. The post-test difference between R.A. and R.C.A. of 4.2 years is smaller with respect to the pre-test difference of 4.77 years. On the basis of operationalizing hyperlexia as a language disorder by a discrepancy (RAA - RCA) of at least 2 years between the word recognition and comprehension, this shows that all 33 subjects still meet the criteria for hyperlexia despite the improvement in comprehension. This can be attributed to the corresponding increase in the RAA to the RCA. Given that children with hyperlexia have the predisposition to read well, the corresponding increase in RAA is not unexpected.

Table 5. A comparison of the comprehension deficit at pre-test and post-test

Variable	*Pre-test*	*Post-test*
RAA (years)	10.93	12.01
RCA (years)	6.16	7.82
RAA - RCA (years)	4.77	4.20

The fidelity of teacher implementation was 100% and the result of the inter-rater agreement for the test scores was also 100%.

CONCLUSION AND LIMITATIONS

The present study has provided strong and conclusive evidence through the hypothesis testing and effect size that the SIM is an effective tool for teaching reading comprehension to children with hyperlexia. The evidence from this study builds on the strengths of two preceding studies (Chia, 2002; Chia & Kee, 2013) on the SIM for it to be recommended as an EBP.

It is, however, instrumental to note that the results of this study are based on the validity of the design in terms of testing procedure, participant mortality, history, maturation and selection. Sufficient validity of constructs and reliability of tools must be ensured for testing, as shown by the use of NARA - III here. As for the participant mortality, Creswell (2012) stated that a sufficient sample size for a group experiment should be 15 participants but larger sample sizes would reduce sampling error. Hence, the sample size of 33 in this study has limited the threat of participant mortality and reduced the potential of sampling error as well.

In terms of participant history, the sample was controlled for similar levels in word recognition and reading comprehension. The participant selection may be generalized for the profiles in this study in terms of gender distribution and age range, but extraneous factors such as race and socio-economic status were not controlled for. Lastly, the results are limited

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by the single-sample design of this study as the effect of participant maturation was not accounted for by comparison to a control group's performance. Therefore, it is recommended that further investigations be made with considerations to overcome the limitations stated here to extend the validity of the intervention.

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