Reading Comprehension for Children with Hyperlexia - A Scaffolding Method.

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Abstract: *Children with language disorders can exhibit symptoms of hyperlexia, a superior level of word recognition relative to other linguistic or cognitive functioning. Language disorders have been described by the American Speech-Language-Hearing Association as deficits in comprehension and/or use of spoken, written and/or other symbol systems* [1]. *This study examines the effectiveness of an intervention known as the Scaffolding Interrogative Method (SIM) [2], [3] that mitigates the causal factors by leveraging on the learning style of such children. Measures of comprehension test scores using a repeated baseline-intervention method found higher scores during intervention as compared to the baseline conditions. A second dependent measure using standardized instruments for pre-/post-test found an improvement in the comprehension age with no corresponding increase in reading age for all the subjects. Moreover, the gap between the two variables was reduced to a level below the operationalized criteria of hyperlexia for them. Hence, the SIM is recommended as an intervention for use in withdrawal sessions in school and home tutoring as it can be applied on a one-to-one or small group instruction basis.*

Keywords: Hyperlexia, children, reading comprehension, scaffolding schemata**.**

INTRODUCTION

The focus of this study is on the comprehension deficits in school-aged children with hyperlexia. The term hyperlexia was created by Silberberg & Silberberg [4] to refer to children's word recognition ability that is significantly higher than their ability to comprehend the material that was read or evaluated verbal functioning level. From a language perspective, a child with hyperlexia can be profiled as a poor-comprehender as illustrated in the model shown in Figure 1. This model uses a simplified concept of reading disability that has only two components, decoding and comprehension, to constitute reading [5], [6], [7]. Hyperlexia is characterized by good word recognition with comprehension difficulties; hence, it can be considered the polar opposite of dyslexia which is characterized by word recognition difficulties with good comprehension.

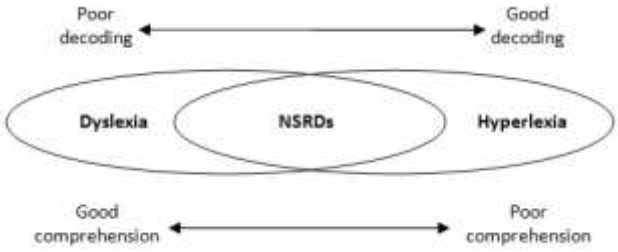

Figure 1 – Bipolarity of reading disabilities [5]

LITERATURE REVIEW

Studies on hyperlexia are considerably fewer that those on dyslexia. Take for example, a report by Joshi, Padakannaya, and Nishanimath [8] pointed out that in the period of 1999 to 2009, there were 2470 published studies on the dyslexia but only 22 studies on hyperlexia. Hence, in order to help educators understand hyperlexia and write more specific goals and objectives, the hyperlexia profile in the present study would be discussed from both the descriptive-based perspective in the parameters of poor comprehension, as well as the etiologic-based perspective.

According to the American Speech-Language-Hearing Association [1], language disorders refer to deficits in comprehension and/or use of spoken, written and/or other symbol systems. Having said that, this definition does not determine how different societies may use different yardsticks to measure comprehension as cultural norms can affect how deficits are evaluated. In a multi-cultural society like Singapore, the task of detecting language disorders in young children can be a difficult one for many and even parents themselves.

Generally, many might think that it is only a matter of time that young children would catch up in language comprehension. For children with hyperlexia who can read print before preschool, many might even more likely consider them to be disqualified from any language disorder. The assumption is that these children would eventually comprehend the meaning in the same way they easily figured out how to read the print [9]. Their ability to read well ahead of their peers would usually give adults the impression that they are very intelligent. Indeed, there are researchers such as Elliott and Needleman [10] who have taken a different perspective on hyperlexia and argued that it is the demonstration of a unique and enhanced cognitive ability, rather than a disorder. In their single-subject study, the child with a total absence of speech could recognize before age 2 and use sentence cards and even a typewriter to make known her needs.

Unfortunately, facility with the words of the text does not promise a corresponding comprehension [11]. Studies have shown that children with hyperlexia are unable to pass age-appropriate verbal and non-verbal Piagetian tasks [12], [13] - this signified their underlying cognitive deficits. To account for word recognition in cognitively disordered children, Goodman [14] and Cain [15] have reported that these children show symptoms of unusual memory for unrelated auditory and visual stimuli. Compulsive preoccupation with reading was also mentioned as a contributory factor. Unsurprisingly, several researchers such as Huttenlocher & Huttenlocher, [13] and Mehegan & Dreifus [16] have reported symptoms in hyperlexia that are characteristic of autism or neurophysiological anomaly.

Beyond the early childhood years, it is possible for adults to overlook the comprehension deficits of school-aged children with hyperlexia who are high-functioning enough to enter the mainstream school system. They may not be unable to answer questions per se as they can demonstrate this ability minimally - usually at a literal level only. As reported by Healy [17], their responses can be confined to repetition of irrelevant phrases or words from the text. With their advanced word recognition talent however, these children can surpass their

classmates in reading in the early years of school when decoding print is largely the subject matter. So, while their dyslexic counterparts are sending alarm bells off for poor decoding ability, their comprehension deficits might go unnoticed. Hence, detection might not occur until the later years of school when they transit from the stage of learning to read to one of reading to learn, as in Chall's [18] stages of reading shown in Table 1.

Table 1 - Stages of reading [18]

Stage	Age (years)	Primary Development
0	Birth to 5-6	Accumulation of knowledge about letters, words, and books.
1	5 - 7	Initial reading or decoding.
2	7 - 9	Decoding becomes more automatic; beginning of reading for comprehension.
3	9 - 14	Reading to learn; decoding skills become fully automatic.
4	14 - 18	Multiple viewpoints due to increased cognitive skills, which enable abstract thinking.
5	18+	Construction and reconstruction in critical reading, development of hypothetical-deductive reasoning.

For the purpose of helping these children overcome comprehension difficulties encountered in school, the effectiveness of an intervention called the Scaffolding Interrogative Method (SIM) [2], [3] is investigated in the present study. It is believed that with appropriate support of an evidence-based intervention, they might not only have a smoother transition to the stage of reading to learn, but social-emotional issues that can develop from it would possibly be reduced as well.

History of hyperlexia

Before the term hyperlexia was coined, the advanced word recognition ability was noted as an "idiot savant" disorder as it was first discovered in cognitively impaired populations and is more prevalent in children with PDD as reported in the studies of Kanner [19], Parker [20], and Phillips [21]. Nevertheless, clinicians have noted the talent in other populations with normative [4], [22] and superior IQ [23], [24] where their comprehension is not below the norm.

To revamp the "idiot savant" reference, Healy [16] called hyperlexia an "enigma" instead. She also took issue with the inclusion of those with no comprehension impairment for hyperlexia. Using clinical studies as the basis, she pointed out additional symptoms such as a spontaneous ability to read before age 5, difficulty with language processing in both listening and reading modes, an impairment of expressive language and a compulsive preoccupation with reading together with echolalia - the repeating of speech sounds.

Language impairment, echolalia and preoccupation with print material in brain-damaged children [16] and adults [25] have been described as symptoms of an acquired form of hyperlexia. The added difference in the developmental form is the early reading, which can take parents by surprise. Clinicians such as Pennington, Johnson, & Welsh [24] have even called it an unexpected reading precocity.

Unfortunately, the preoccupation with reading substituting other customary childhood activities can further reduce social-emotional experiences that are needed to stimulate language growth. Hence, parents, such as those in the study by Healy [17] who take pride in their child's precocious reading and encourage it, may not realize that it can be counter-productive to language development. Only one out of the twelve parents in that study had concerns, saw it as a manifestation of abnormality, and made efforts to encourage alternative activities. Family services in the form of parent education would thus be helpful in early intervention.

Prognosis

For the atypically developing population, the prognosis for the child with hyperlexia is better than one without. For example, Mehegan & Dreifus [16] found severe retardation on psychologic testing of their subjects, but a re-evaluation several years later found scores within normal range. Hence, they have reported a better lifelong outcome for them as compared to those without hyperlexia; and this is in agreement with Huttenlocher & Huttenlocher [13] as well. Studies by Burd, Fisher, Knowlton, & Kerbeshian [26] and Burd, Kerbeshian, & Fisher [27] even reported markedly increased IQs for their samples of children with PDD and hyperlexia.

The prognosis mentioned here attest to a report by Treffert [28] who believes that hyperlexia can masquerade as an autistic disorder due to the "autistic-like" traits and behaviors; this is also true of children who speak late or are blind. Hence, he warned that a diagnosis of "autism" can be erroneously and prematurely applied to children when there is a failure to make that critical distinction. The issue is that it can lead to unnecessary worry and distress for parents or other caregivers. Nevertheless, it is still vital for children with the symptoms of hyperlexia to be provided with appropriate interventions and support for language growth.

Remediation strategies

Campbell [29] suggested that hyperlexia can be attributed to the fascination for word reading at the imagery level, short of an attachment of symbolic meaning. Healy [17] purported that there is a generalized cognitive disability in structuring incoming experiences for children with hyperlexia. This could have hindered their growth towards higher thinking processes for comprehension. The normative population on the other hand, has the automaticity that they take for granted in structuring incoming experiences. For example, Yuill and Joscelyne [30] pointed out that the scaffolding treatment in their study was redundant for the good-comprehenders when no significant difference was found in the their performance between treatment and withdrawal conditions. This was attributed to their ability to perceive the linguistic relationships instinctively and organize the text mentally. Contrastingly, the treatment significantly improved the performance of the poor-comprehenders - this signified their deficits with respect to the good-comprehenders' natural abilities. Thus, only the poor-comprehenders would find the treatment useful.

According to DeHirsch [31] it is imperative to assimilate content into a pre-existing conceptual structure to support the comprehension deficits. Such a structure should be based on cognitive "schemata" [32], [33] that would aid in selecting important ideas, remember content, and relate text to prior experience. In addition, Mehegan & Dreifus [16] had found that written instructions work better than verbal ones.

Furthermore, Hundert and van Delft [34] had found that poor-comprehenders' efficiency at answering questions was higher with visual than verbal scaffolding; and the absence of scaffolding would take the biggest toll on this efficiency.

A study by Idol-Maestas [35] is an example of how the strategy of assimilating content into a pre-existing conceptual structure can be applied to support the comprehension deficits. Their story-mapping intervention called TELLS Fact or Fiction story-mapping involves the following: (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. While it did help to improve comprehension, Idol-Maestas [35] pointed out that the subjects had difficulties knowing the difference between important and hard words.

The SIM [2],[3] would be a useful intervention for resolving the issue mentioned as it uses a schema based on interrogatives to scaffold important information. In this intervention, a schema of "Wh" (Who/What/Where/When) questions is assigned in a matrix framework so that the contents of a comprehension passage can be assimilated into the matrix. Written instructions for assimilating the content are further given by assigning *What person/What happened/What place/What time* to *Who/What/Where/When* respectively. Based on the statistical learning style in hyperlexia [36], there is also a clear advantage in using the SIM - the matrix serves as a 'statistical' coding structure that appeals to the learning style of poor-comprehenders; hence, they are likely to be early-adopters of this intervention.

This literature review has provided the basis to believe that the SIM can be effective by mitigating the causal factors of hyperlexia by leveraging on the learning style of such children. The rationale for choosing the SIM as the intervention in the present study is thus grounded by this conviction. In order to use preceding studies that were successful to guide the investigation, the design of the present study is modeled after the single-subject studies on the effectiveness of the SIM [2],[3] and the story-mapping intervention by Idol-Maestas [35] mentioned earlier. With the effectiveness of the SIM conducted in Singapore found in two earlier studies, there is some assurance that the present investigation can proceed without an ethical risk of experimental failure.

METHODOLOGY

Participant Information

Three male subjects of a similar academic level (Primary 3) in the mainstream were recruited by convenience sampling, via referral from a learning disability center in Singapore where they were seeking treatment for comprehension difficulties. Following the consent from both the subjects and their parents, pre-test data was collected as shown in Table 2.

The chronological ages (C.A.) of all three were comparable; and they were all in Stage 2 - the beginning stage of reading for comprehension in Chall's Reading Stages [18] (see Table 1). The Wide Range Intelligence Test (WRIT) [37] revealed that their *Visual IQ* is significantly higher than their *Verbal IQ*; and their matrices subtest scores were in the range of *High Average - Superior*. Therefore, their learning preference and strengths in using the visual and matrix type of support in SIM is highly probable.

Hyperlexia as operationalized by Silberberg & Silberberg's [4] definition of a word recognition ability that is significantly higher than the ability to comprehend the material was verified by the difference between Reading Age (R.A.) and Reading Comprehension Age (R.C.A.) of more than 2 years (3.0 years - 3.7 years) for all three subjects.

Table 2 - Participant information at pre-test

Variable	Subject A	Subject B	Subject C
Verbal IQ	72	89	78
Visual IQ	107	138	125
Full Scale IQ (FSIQ)	87	114	101
Matrices	116	121	111
Chronological Age (C.A.) (years)	8.7	9	8.5
Reading Age (R.A.) (years)	11.7	12	11.8
Reading Comprehension Age (R.C.A.) (years)	8.0	9.0	8.5
Difference between R.A. and R.C.A. (years)	3.7	3.0	3.5

Instructional Stimuli

The subjects were trained and tested with new passages for each trial taken from a comprehension book called Teaching Reading Comprehension to Children with Hyperlexia (With 40 Passages ready for Use) [38]. The passages were written by the first author of the present study to include important words (e.g. place, person, time) in each sentence, and a range of interest topics under fact, fiction, and fantasy to appeal to children. Each passage is graded so as to facilitate the selection of a passage compatible to the reading age of a child.

Independent variable

The SIM matrix was the independent variable (IV) for scaffolding comprehension passages. The subject would need to assimilate the passage contents into the matrix before using it as a reference for a plausible answer to the comprehension questions. A partial sample of a comprehension test and a SIM matrix are shown in Figures 2 and 3 respectively.

Danny had a good dinner at home today.

His mom had spent hours cooking it in the kitchen.

His dad helped in washing 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 [37]

SIM Matrix				
Sen-tence 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	Danny's dad	helped in clearing up	X	after dinner

Figure 3 - A partial sample of a SIM matrix [37]

Dependent variables

The primary dependent variable (DV) is the percentage score of each discrete trial on the comprehension tests in both the baseline (no IV) and intervention (with IV) conditions. A standardized instrument was used as a secondary DV for the pre-/post-test difference in comprehension age.

Procedure

Teacher. The researcher who was trained by the developer of the SIM [2] was the sole teacher for the study.

Setting. The trials were all conducted in the subjects' home on a one-to-one basis at their usual study area, as the natural environmental was deemed more conducive for eliciting positive responses. Undesirable stimuli that could cause distraction or sensory discomfort were removed.

Primary DV. Discrete trials were carried out twice weekly on a one-to-one basis using the single-subject ABAB (A: Baseline; B: Intervention) design. Baseline data was first collected without the use of the IV in Condition A_1. Following a downward trend, training in the use of the IV was introduced. The training consisted of weekly 45-minute guided practice sessions on the use of the SIM. Upon mastery set at a level of 80%, discrete trials under Condition B_1 were conducted with the use of the IV until there was a steady performance pattern. Thereafter, the baseline and intervention conditions were repeated for Condition A_2 and B_2.

During the discrete trials, no teacher assistance was given for answering the comprehension questions or filling in the matrix. Nevertheless, the subjects were encouraged to complete the tasks and the each completed task was marked with a star. The approximate time frame for each trial with the use of the IV was:

Duration	Activity
3 min.	Read the passage aloud in its entirety.
2 min.	Re-read silently.
7 min.	Fill in the matrix
3 min.	Answer the comprehension questions.

Secondary DV. The *Schonell Graded Word Reading Test* (SGWRT) [39] for children aged 5 years to 14 years was used to measure the pre-test R.A. To eliminate the possibility of a practice effect in repeating the SGWRT for the post-test R.A., a different but comparable instrument - *St Lucia Graded Word Reading Test* [40] was used. For the R.C.A., the *GAP Reading Comprehension Test* [41], also for children aged 5 years to 14 years, was used. This instrument has two different sets of tests for pre-/post-tests; hence the possibility of a practice effect was also eliminated.

Data analysis

The percentage of correct answers across the conditions for the primary DV and the pre-/post-test age for the secondary DV were respectively computed, tabulated and charted.

Scoring reliability. Scoring for the primary and secondary DV were both done by the researcher and a blind-rater. The inter-rater agreement [42] for each respective DV was calculated by dividing the number of agreements by the total number of agreements plus disagreements multiplied by 100.

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. The fidelity checklist items are shown in Figure 4.

No.	Procedural Fidelity Checklist	YES	NO
1	At the start of the comprehension test, the participant was told to read the passage aloud in its entirety.		
2	The participant was told to read the passage a second time silently.		
3	The participant filled in the SIM matrix independently.		
4	The participant answered the comprehension questions using the matrix independently.		

Figure 4 - The Fidelity Checklist

Social validity. A social validity questionnaire was used to gather student perceptions of the intervention to see if it could be easily adopted. The question topics covered the level of fun, difficulty and usefulness of the intervention. To suit the comprehension level of the child subjects, the questionnaire was modified from an elementary reading attitude survey [43]. The response format was made simple with a three-point Likert scale (with answering options 'always', 'sometimes', and 'never'). The middle response is positive rather than neutral.

RESULTS AND DISCUSSION

Outcome of primary measures (ABAB design)

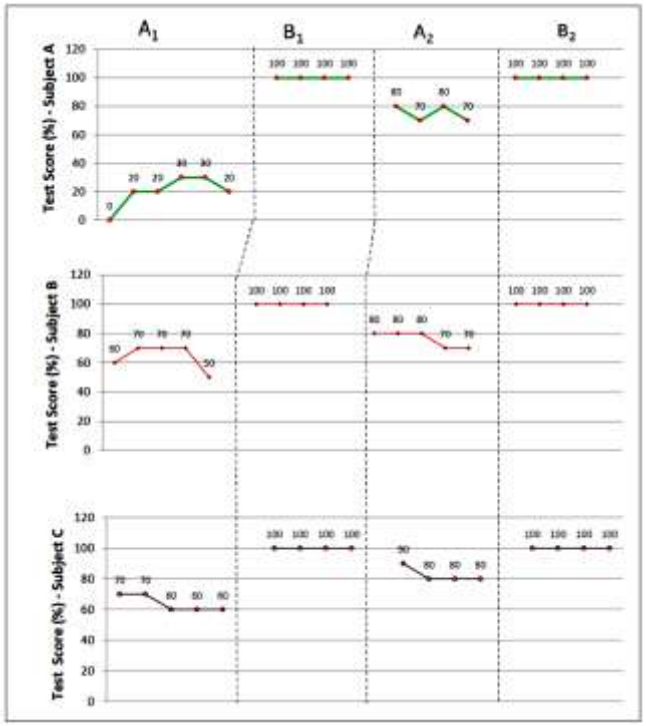

Figure 5 - Performance across conditions.

Table 3 - Mean Scores across conditions

Mean Score (% points)	Subject A	Subject B	Subject C
Condition A_1	20	64	64
Condition A_2	75	82.5	76
Condition A_2 - Condition A_1	55	18.5	12
Condition B_1	100	100	100
Condition B_2	100	100	100
Condition B_2 - Condition B_1	0	0	0

Figure 5 illustrates the subjects' performance across the conditions; and Table 3 shows their respective mean scores. The mean scores in Condition A_1 ranged from 20% - 64%. After the training in the use of the SIM, all three subjects scored 100% throughout Condition B_1. In the return to baseline (Condition A_2), the means fell to the range of 75% - 82.5%. This performance was nevertheless better than that in Condition A_1. The implication is that there was already some increase in their ability to organize the text mentally in the second baseline. The increase ranged from 12 - 55 percentage points. Incidentally, Subject A has the highest increase while he has the lowest mean and FSIQ before the intervention. This reinforces what Idol-Maestas [35] had pointed out - scaffolding would benefit low-aptitude youngsters the most. The reintroduction of the SIM in Condition B_2 saw a sustained 100% score throughout for all three, implicating their dependence on the SIM to ensure success whenever it was made available.

Outcome of secondary measures (pre-/post-test)

The pre-/post-test data in Table 4 shows that over the period of study of about three months, there was no difference in the Post-Pre R.A. for all three subjects. Contrastingly, the Post-Pre R.C.A. results show the increase of (1.7 - 2.9) years, which is a range of 19.44% - 36.25% increase. The increase implies that by the end of the study, the subjects had acquired some level of automaticity in structuring text mentally as scaffolding supports were not provided for this secondary measure. With the smaller discrepancy between R.A. and R.C.A. at post-test (0.8 - 1.7) years, their symptoms of hyperlexia are diminished as compared to the discrepancy at pre-test (3.0 - 3.7) years.

Table 4 - Outcome of pre-/post-tests

Variable	Subject A	Subject B	Subject C
Pre-test R.A. (years)	11.7	12	11.8
Post-test R.A. (years)	11.7	12	11.8
Post-Pre R.A. (years/% change)	0/0%	0/0%	0/0%
Pre-test R.C.A. (years)	8	9	8.5
Post-test R.C.A. (years)	10.9	10.75	10.2
Post-Pre R.C.A. (years/% change)	2.9/ 36.25%	1.75/ 19.44%	1.7/ 20%
Pre-test R.A. - R.C.A. (years)	3.7	3.0	3.5
Post-test R.A. - R.C.A. (years)	0.8	1.25	1.6

Treatment fidelity and inter-rater agreement

The fidelity of teacher implementation was 100%, as observed by a blind-rater using the fidelity checklist (see Figure 3) for about 30% of the Condition B trials. The inter-rater agreement for both the primary and secondary DV was also 100%.

Social validity

Table 5 shows the results of the Student Satisfaction Survey for all three subjects. They indicate a generally high level of satisfaction in the use of the SIM. The subjects indicated very favorably (Always - 80%), and favorably (Sometimes - 20%), for the use of the SIM. More importantly, there was no unfavorable (Never - 0%) feedback. This implies a strong endorsement of the intervention and an early-adopter attitude. These results can be corroborated with the observation that whenever the teacher did not present the SIM matrix at start of the session, the subjects would seem disappointed and ask if the teacher had forgotten to bring it. They also appeared to treat it as a novelty for assimilating the contents of the passage and enjoy color-coding both the headings and the matching parts in the passage. Topping it all is the exuberance on their faces when they get perfect scores owing to the use of the SIM matrix. Hence, there is basis for optimism that the SIM will be easily adopted by other new users.

Table 5 - Results of the Student Satisfaction Survey

No.	Item	Always	Sometimes	Never	Total
1	I know how to use the SIM matrix.	2	1	0	3
2	The SIM matrix helps me understand the passage.	3	0	0	3
3	The SIM matrix helps me answer the questions.	2	1	0	3
4	It is easy to use the SIM matrix.	2	1	0	3
5	I like to use the SIM matrix.	3	0	0	3
Total		12	3	0	15
(% of total)		80	20	0	100

CONCLUSION

Based on the results of this study, there is evidence that the SIM can be an effective tool for the remediation of reading comprehension deficits in the early stages of reading for children with hyperlexia. While such effects may be limited to the context of the study, the evidence has built on the effectiveness from the two preceding studies on the SIM (see [2], [3]). Hence, there is reason to believe that the SIM is effective by mitigating the causal factors by leveraging on the learning style of such children.

It is hoped that by helping these children overcome their initial difficulties with comprehension attributed to their deficits in structuring for incoming experiences, it will increase the probability of them experiencing success in the language curriculum. With this, they can be more motivated to continue to access and participate in both academic and social pursuits. Nevertheless, they might still need the support of caregivers to help them steer away from activities can further reduce social-emotional experiences that are needed to stimulate language growth.

Educators can be encouraged by the effectiveness of scaffolding strategies such as the SIM and be spurred on to create more scaffolding structures based on various schemata needed for the understanding and growth of language concepts and curriculum content. This would be needed to continue supporting the children's progress, such as to the higher stages of reading where they have the ability to have multiple viewpoints due to increased cognitive skills to enable abstract thinking, as shown in Chall's stages of reading [18].

One final note here is that the advantage of the systematic form of experimental analysis in this single-subject study is in its relevance for building individualized educational and support plans. As the intervention can be applied on a one-to-one or small group instruction basis, it is highly recommended for use in withdrawal sessions at school and home tutoring as well.

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