Graphic novel reading comprehension in Chinese children with developmental language disorder (DLD)

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Abstract

Children with developmental language disorder (DLD) have consistently showed poor performances in reading comprehension. Extending from previous studies that presented pure-text, this study aims to test the performances of graphic novel reading. We tested 24 Chinese children who have been diagnosed as DLD and 24 typical readers matched with age and nonverbal IQ. These children were asked to complete a battery of tests assessing graphic novel reading comprehension and related visual-cognitive skills. The results of group comparison indicated that children with DLD performed similarly to the typical readers in graphic novel comprehension. Moreover, significant links between comic convention understanding and both passage and graphic novel reading were found in both groups. Our results imply the benefits of using graphic novel to facilitate reading to learn in children with DLD. (129 words).

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Introduction

Strengths and weaknesses in children with developmental language disorder (DLD)

Developmental language disorder (DLD) is a developmental disorder that is diagnosed when a child's language ability is impaired in the absence of obvious neurological, sensorimotor, nonverbal cognitive or social emotional deficits (Leonard, 1998). This terminology has recently been widely adopted in lieu of Specific Language Impairment (SLI), as experts believed that the former better reflected the seriousness of the issue by focusing on poor prognosis (see Bishop, 2017 for a thorough discussion). Children with DLD are impaired in one or more aspects of language, such as grammatical morphology, complex syntax, semantics and/or pragmatics (Cirrin & Gillam, 2008). Although this language impaired population is heterogeneous, deficits in oral language ability can affect reading ability to a large extent (Bishop & Snowling, 2004; Catts et al., 2005; Gray & Brinkley, 2011; Kan & Windsor, 2010; McArthur et al., 2000; Stanovich, 1988; Verhoeven et al., 2011). Due to their poor word recognition and reading comprehension skills, processing text-only materials has proven to be a daunting task for them. In the long run, the choice of reading will have an impact on children's cognitive development (Jerrim et al., 2020).

In addition to linguistic problems, they are also found to suffer from general cognitive capacity limitations and attentional allocation difficulties (Miller et al., 2001). When these children read cognitively demanding texts such as narratives, they are highly susceptible to the influence of limited working memory, which significantly affect the efficiency of integrating relevant details during linguistic comprehension (Montgomery et al., 2009). As such, these children would easily experience memory overload during the reading comprehension process, hence resulting in a sense of failure.

Despite their weaknesses in linguistic and cognitive aspects, researchers have found that these readers could excel at global (holistic) processing of visual information, which is typically mediated by the right-hemisphere (Martinez et al., 1997). As revealed in von Karolyi et al.'s (2003) study, children with reading difficulties demonstrated superior global visual-spatial skills as compared to the same-age counterparts. Moreover, these children show superior global visual-spatial processing of stimuli in a simulated real-life situation (Attree et al., 2009). Seen from this light, remediation efforts on helping these children should therefore be hinged on their exceptional talents in global visual-spatial skills.

Graphic novels as a plausible solution for children with DLD

On the practical side, applied researchers have been seeking effective strategies to alleviate reading difficulties to children with DLD, which utilizes their strengths as aforementioned. Earlier attempts include pre-exposing children with DLD to story grammar flash cards, which was found to result in better recall of text information

(Newby et al., 1989). This leads to recent conjecture that training on visual strategies, including the use of mental imagery, might be beneficial to these children, due to the additional visual support available (Hick et al., 2005), which is believed to operate through a non-verbal coding system (Paivio, 2006). As such, this reduces overall processing demand on verbal short-term memory, which is often impaired in this group (Dollaghan & Campbell, 1998; Gathercole & Baddeley, 1990). Mental imagery may facilitate comprehension of narrative texts like stories by encouraging the integration of story propositions. Imagery provides children with DLD with an alternative representational system that eases the memory load associated with the constructive processing required to represent meaning of connected prose, hence freeing up mental resources for more efficient linguistic comprehension and word identification.

Despite the benefits brought by mental imagery, the problem of comprehending texts remains. These children would still experience problems in word decoding and comprehending texts, if the texts are not adjusted in any ways to suit their needs. Hence, there is a need to consider alternative ways to foster reading comprehension of children with DLD. Graphic novels might emerge as a plausible candidate to this end, due to the special textual features inherent in this genre. The section below provides an overview of these features, and how it might better fit the linguistic and cognitive profile of these children.

Unique features of graphic novels

Textual information in graphic novel is presented differently from plain texts in a variety of ways, which may facilitate comprehension by children with DLD. For example, font size and font type words are manipulated to express more than the literal meaning of words. Another common feature is the voice qualities of the characters presented in the form of onomatopoeia. Words are also often drawn in a variety of ways for expressing the emotional state of the character, while texts are split into meaningful chunks and located in panels, captions and speech/thought/action bubbles.

Given these unique features of font presentation and textual layout in graphic novel, the processes responsible for skillful word decoding would be different from texts alone. More global processing should be elicited in order to facilitate the comprehension of graphic novels. This notion has been verified in some studies which adopted the Navon test. For instance, Richard and Lajiness-O'Neill (2015) distinguished between global and local letter processing, by using multiple letters (e.g., "A") to form a global pattern of a larger incongruent letter (e.g., "H"). Participants were asked to indicate whether the small or large letter contains a target letter, for example, an "A". The finding of their study was striking, as children with learning difficulties processed letters embedded within a Navon figure as efficiently as typically developing children, an observation that challenges the conventional conceptualization of skillful word decoding skills in the context of reading disabilities. If children with DLD were found to perform well in Navon test (i.e. a test of global processing skill), this area of strength may lead to more efficient processing if the

printed materials are designed to match the children's characteristics, as in the case of graphic novels. We speculate that children with DLD may employ global reading skill to link words with their proximal pictures in the same or even different panels of comics, thereby promoting the processing efficiency of graphic novel reading. In this study, we also aim to directly examine if performance of Navon test correlates with graphic novel reading.

Research on the effectiveness of graphic novels

Given the unique features of graphic novels as aforementioned, some studies have sought to unravel its benefits on school students with reading difficulties. It has been speculated that graphic novels as a kind of genre create the impression of 'ease' (Aleixo & Norris, 2010), create a friendly learning atmosphere, promote a higher sense of curiosity and interest to the subject-matter (Keogh & Naylor, 1999) and arouse children's interest to more advanced learning (Greenfield, 2009). This first impression is especially important for reading disabled children who are less motivated and less confident to read. However, these studies did not explicitly examine the underlying mechanisms behind these benefits (Smetana et al., 2009) or examined samples of elder age groups (e.g., Domyancich-Lee et al., 2021; Gyogi & Lee, 2022; Wong et al., 2017a).

In graphic novels, there are mixtures of textual and visual information as well as a storyline (Nakazawa, 2005). Pictures that depict objects, actions and even the internal state of characters (e.g., emotion and motive) hint the meaning of word (Nakazawa & Nakazawa, 1993) and save many words. The storyline in graphic novel was shown to create a less formal learning environment and foster less motivated learners to have a higher interest to the subject-matter (Keogh & Naylor, 1999). The storyline can also connect the context, actors, speech, and action. In an early study, children with reading difficulties found it easier to follow the story during reading comprehension when authentic events rather than abstract verbal information were presented (Newby et al., 1989). If designed beautifully, colorful and visually appealing graphic novels with personified characters can direct and even maintain attention during reading, as postulated by the emotional design hypothesis in the cognitive affective theory of learning with media (CATLM; Moreno, 2007; Moreno & Mayer, 2007; Plass et al., 2014; Um et al., 2012). In additional to emotional factors, pictures are better suited to represent spatial relations or complex imagery that cannot be described by text efficiently (Larkin & Simon, 1987). Weber and Rall (2017) argued that carefully designed comics prompted readers to feel that the events being documented are more authentic. Recently, the influence of presentation mode on reading comprehension is evidenced in multiple empirical studies. For example, Pike, Barnes and Barron (2010) administered a Bridging Inference task, which comprises a set of illustrations that match with some story-like passages and a follow-up question which requires students to choose a sentence that accurately depicts the likely development of the story, to examine the effect of illustrations on drawing appropriate inferences. The researchers discovered that illustrations were found to facilitate inferential comprehension among 7 to 11-year-old children without any learning

disabilities. In similar vein, another study demonstrated that grade 4 students used a variety of meta-cognitive reading comprehension strategies when reading graphic novels (Brenna, 2013). Some of these strategies include a) locating narration, b) examining narrative distance and time changes provided by visual information and c) interpreting lettering style, format and color. There is a possibility that children with DLD, who are found to experience trouble integrating information within the story and drawing inferences (Bishop & Adams, 1990; Botting & Adams, 2005; Norbury et al., 2002), may be benefited from the strategies in Brenna's study when reading graphic novels.

Despite the potential benefits induced by graphic novels, it is still unknown as to whether children with DLD are better able to interpret the comic conventions, as compared to their same-aged counterparts. Thus, there is an urgent need to refine our current understanding of comic convention among these children.

The present study

Previous studies of DLD focused mainly on children's deficit areas, with little attention on their potential strengths that may be beneficial to *reading to learn*. Inspired by the findings of normal or even superior visual skills in children with reading disabilities, and the unique features of graphic novels, the present study aims to address four major research questions.

First, does graphic novel promote children with DLD's understanding of narrative stories? We hypothesize that these children can perform as good as those normally developing readers.

Second, do children with DLD have comparable comic conventions comprehension and global–local visual processing skills in comparison to their age-and IQ-matched typically developing counterparts? Performance of the two groups of children is compared in this study.

Third, which skills are most important for graphic novel comprehension? The two candidate skills we test in this study are comic conventions understanding and global–local visual processing skill.

Last, does children's comic reading habit have an effect on their comic reading comprehension skills? There is a possibility that those with reading difficulties read less pure text and comics. Our analysis will compare the comic reading habit across groups.

Method

Participants

Participants in this study were recruited from an ongoing longitudinal study. The present sample consisted of 24 children with developmental language disorder (DLD group) and 24 normally developing children (control group) matched with age and Raven's IQ (see Table 1 for demographics). All of them passed a hearing

Table 1 Demographic information and descriptive statistics of the two groups of participants (N = 48)

	Control (n = 24)	Children with DLD (n = 24)	df = 46, p-value
	Mean (SD)	Mean (SD)	
Age (year; months)	9; 10 (6 months)	9; 8 (7 months)	.253
Gender (male: female)	11:13	15:9	
Raven's IQ	109.91 (7.11)	108.87 (11.31)	.704
Chinese word reading	108.00 (17.22)	73.66 (25.42)	.000*
Chinese passage reading comprehension (max = 32)	23.33 (5.33)	13.20 (4.54)	.000*
Working memory (max = 42)	23.25 (3.42)	18.87 (4.71)	.001*
Desire to learn through comics[a]	3.54 (1.21)	3.54 (1.14)	1.00
Expect textbook to be integrated with comics[a]	3.96 (1.08)	3.92 (1.24)	.902
Number of hours of comic reading per week	1.13(1.16)[b]	0.67 (0.90)[c]	.176

[*]Significant group difference at $p < .004$ after Bonferroni correction

[a]Rated on a 5-point Likert scale from 1 = definitely no; 2 = no; 3 = neutral; 4 = yes; 5 = definitely yes; [b]Seven of them indicated no experience with comics before; [c] thirteen of them indicated no experience with comics before

screening, received no prior diagnosis of autism spectrum disorder or attention deficit disorder. Children from the DLD group received diagnostic testing and met the conventional criteria for specific language impairment (SLI) (Leonard, 1998), instead of DLD. That is, they performed below the age level in oral language, in the absence of a concomitant hearing loss, cognitive or psychosocial impairment. Specifically, they scored 1.25 standard deviation below the mean for age on two or more of the six subtests in the Hong Kong Cantonese Oral Language Assessment Scale (HKCOLAS; T'sou et al., 2006). Using this criteria, HKCOLAS was reported to have strong diagnostic accuracy with sensitivity equaled to 94.6% (53/56) and specificity 98.2% (55/56).

Procedure

Ethical approval was obtained from the Research Ethics Committee at the Education University of Hong Kong, and written parental consent was obtained before the testing. The experimenters informed the children the nature of the testing and their rights such as voluntary participation. Participants were tested individually in a quiet meeting room by trained Psychology undergraduate students under the supervision of the authors of this paper. The whole testing session normally lasted for an hour with intermittent breaks given upon the children's request. The tests were administered at a fixed sequence.

Materials

Chinese word recognition Word recognition skills were measured with the Chinese Word Reading subtest in the Hong Kong Test of Specific Learning Difficulties in Reading and Writing for Primary School Children – Second Edition (HKT-P(II); Ho, et al., 2007). Children were asked to read aloud 150 Chinese two-character words in order of graded difficulty. The test was discontinued when a child failed to read 15 words consecutively. One mark was given to each word pronounced correctly. The maximum possible score for this task was 150. The internal consistency reliability measured by Cronbach's alpha was 0.99.

Chinese passage reading comprehension Children's comprehension competence in Chinese was measured using the reading comprehension subtest adopted from Hong Kong Chinese Literacy Assessment for Junior Primary School Students (CLA-P) (Ho, et al., 2011). The test, which comprises 9 passages in total, has been standardized and norm on Hong Kong Chinese children aged between 6 and 9. There are 3–4 questions for each passage which contains about 130 to 180 words. The passages are of different genres, including narrative and expository texts, fables and practical writings. Both factual questions and questions requiring inferential skills, such as summarization or logical reasoning are included. The words use in the passage were selected from Hong Kong Corpus of Primary School Chinese (Leung & Lee, 2002), hence were believed to be developmentally appropriate for the children in our study. Each child was asked to select the right answer from one of the four choices shown on a computer screen. No time limit was imposed for this test.

Working memory test Students were also tested on their working memory capacity using a Chinese reading span task adopted from Wong et al., (2005) and (2017b). It comprises 12 trials. Each trial begins with a set of short, five-character sentences (e.g. 汽車要有轆 [The vehicle has wheels]). Children were then asked to memorize the last character of each sentence (e.g., 轆 [wheels]), then answer a true-or-false question for each sentence (e.g., 汽車要有轆嗎? [Does the vehicle have wheels?]). Upon the completion of a few sentences, children were required to recall all of the final characters of the sentences in order. The accuracy of the true-or-false questions had to be greater than 85%. The all-or-nothing unit scoring method was adopted to assess the reading span (Conway et al., 2005). The Cronbach's alpha reliability was 0.88 for word recalling and 0.94 for true-or-false questions.

Graphic novel reading comprehension The two graphic novels created by the first author presented two narrative stories. The story titled "Piggy and birdy's fruit party" had 890 Chinese words and 52 panels; while the story titled "An arrogant athlete" had 1058 Chinese words and 61 panels. Upon the creation of a text version of the two stories, a student major in Visual Arts was instructed to create the graphic novel format of the same stories. Having one single artist, we could control for the drawing style of the two graphic novels.

We conducted a pilot study with the main aim of estimating the difficulty level and discriminatory power of the comprehension questions. By adopting the open interview approach (Lamminpää et al., 2020), the child participants expressed their thoughts about the questions and we prompted them to elaborate their answers. The children's responses verified our initial thought about the difficulty level and discriminatory power of the questions. We discarded items that either all children failed or all children answered correctly to minimize the occurrence of floor effect or ceiling effect, respectively. Moreover, we modified some of the questions to balance the demand for rote memorization and making inference of the content of the graphic novels. We also collected the children's comments about on their interacting with the graphic text, which were useful for our comic artist to polish the graphic novels.

Participants were given unlimited amount of time to read. Our data showed that the children spent 5 minutes on average to read the two graphic novels. After reading each of the two graphic novels, children were asked to complete a reading comprehension test presented in written form for the evaluation of children's comprehension skills.

There are 15 open-ended questions which asked for literal or inferential information. Two types of inferences, namely causal and informational (Van Kleeck, 2008), were assessed in the present study. Causal inferences entail linking two parts of a text by incorporating world knowledge to fill in missing information about cause-and-effect relationships (Wright & Newhoff, 2001). Informational inferences involve using world knowledge to elaborate information explicitly stated in the text. Such inferences create a richer representation of the text. One mark is awarded for each correct item. The maximum score for this task is 15 and the internal consistency of these 15 items is moderate (Cronbach's alpha$=0.65$).

Understanding of comic convention This test assesses children's abilities in comprehending visual conventions employed in graphic novel. Our tests are created with reference of similar tests such as Chiba University Comic Comprehension Test (CCCT; Nakazawa & Nakazawa, 1993) and Visual Convention Test (Yannicopoulou, 2004). To include a more comprehensive collection of comic conventions, we reviewed a good collection of graphic novels and identified more comic conventions and included them in our new test. To promote readers' interest, a colored version was made.

This test comprises 27 items and has reasonable internal consistency (Cronbach's alpha$=0.65$). The comic conventions include 1) the use of different types of speech and thought bubbles, 2) the meaning of the same picture in different context (e.g. a puff represent 'smoke' or 'fart', 3) the voice volume and qualities presented by various symbols, 4) the use of sign (e.g., question mark, arrows, equal sign), 5) emotion and facial expression, and 6) the link between multiple panels, and 7) metaphor (e.g. 'a bandit stick on an electrical appliance' means 'out of order').

On each trial, participants were instructed to read a panel of comics and then describe the panel. Their verbal responses were transcribed on the record form for further analysis. From the children's verbal responses, we judged whether the child could understand the function of the comic conventions. We awarded one

mark for a correct answer; otherwise, a zero mark was given. The testing material can be obtained by emailing the first author.

Chinese version of the Navon test This test was adapted from the original Navon test (Navon, 1977) that measured the global and local visual processing of English letters. We created a Chinese version with reference to the divided attention condition in Plaisted et al. (1999). A high frequency Chinese character "天" (sky; /tin1/) was chosen as the target character. Figure 1 illustrates the six conditions resulted from a 3 (compatible vs. incompatible, local vs. incompatible, global) $\times 2$ (presence vs. absence of the target Chinese character) design. The Chinese characters were presented on a computer screen with the large characters subtending no larger than $4.90^{\circ} \times 4.90^{\circ}$, and the small characters subtending no larger than $0.29^{\circ} \times 0.29^{\circ}$ at a viewing distance of 140 cm.

Two practice blocks with 24 trials each were presented first. In the first practice block, the same stimuli were presented four times in random order. The participants pressed one of the two keys on the keyboard to indicate whether the target character "天" was present or not. In the second practice block, each stimulus was presented for 1000 ms only before the screen went blank. There was a 500 ms interval after the participants' response before the next stimulus was shown.

In the actual experiment, there were a total of twelve blocks consisting of 288 trials. The flow of presentation in the testing phrase was the same as the second practice block. We recorded the accuracy and latency data for analysis. Reaction time of corrected responses was collated. As a general practice, trials with reaction time deviated from the mean by two standard deviations were counted as invalid responses and discarded. Trials with very short reaction time implied finger errors or repeated key-strokes from previous trials, while trials with very long reaction time indicated that participants did not fully attend to the stimuli presentation. In addition, *d'* was computed for each condition (i.e. compatible, incompatible global, incompatible local). Adjustments to perfect performance (i.e., P(Hit) = 1 or P(False Alarm) = 0) follows the standard suggested by Macmillan and Kaplan (1985) (1/(2 N) for N equals to the number of trials of a particular type) and Brown & White (2005) (0.25 to 0.5 for a type with 100 trials).

Comic book reading habit questionnaire In this questionnaire developed by our team, children were asked to indicate the amount of time they usually spend on comic book reading, whether they would like comics to be integrated into their textbooks and their desire to read comic books.

Results

A series of group comparisons were conducted to examine the performances of graphic novel reading comprehension in children with DLD. Correlational and regression analyses were conducted to examine the skills that might be linked to

	Condition in which the Chinese character "天" (sky) is present	Condition in which the Chinese character "天" (sky) is absent
Global & Compatible		
Global & Incompatible		
Local & Incompatible		

Fig. 1 The six stimuli used in the Chinese version of Navon Test. *Note* Global = The participants made their decision based on the global pattern; Local = The participants made their decision based on the small Chinese character; Compatiable = The global and local Chinese characters are the same; Incompatiable = The global and local Chinese characters are not the same

graphic novel reading comprehension. All data was analyzed by a statistical software package (Statistical Package for the Social Sciences [SPSS], 2002).

Group comparison

A series of group comparisons were conducted using independent sample t-test. Effect size r is calculated using the formula $\sqrt{t^2/(t^2 + df)}$ (Field, 2008, p.341). The descriptive statistics (means and standard deviation) are shown in Table 2.

First of all, independent sample t-tests were carried out to compare age and Raven's IQ scores between the DLD and control groups. No significant difference between the two groups was observed for age, $t(46) = -1.15$, $p = .25$, $r = .16$ and nonverbal IQ, $t(46) = -.38$, $p = .70$, $r = .05$. Thus, these two variables were not controlled in subsequent analysis.

To correct for multiple group comparison and minimize type I errors, Bonferroni correction (α/number of hypothesis testing) was adopted such that only an obtainment of p-value less than 0.005 (0.05/9) was considered as a significant group difference. The results showed that children with DLD performed significantly poorly than children from the normal group in both word reading, $t(46) = 5.47$, $p < .001$, $r = .62$ and passage reading, $t(46) = 7.07$, $p < .001$, $r = .72$; with substantial-sized effect. Children from the DLD group also showed significantly poorer working memory, $t(46) = 3.67$, $p < .001$, $r = .47$; with medium-sized effect.

With regard to comic-related skills, children with DLD had significantly lower scores than those from the normal group in comic convention test, $t(46) = 4.91$, $p < .001$, $r = .58$, with substantial-sized effect..

Children from both groups had similar comic reading experiences, $t(46) = 1.37$, $p = .17$, $r = .19$, although it should be noted that there are 13 children with DLD and 7 typical readers who have no experiences with comic at all. Moreover, children from both groups showed similar level of desire for learning through comic reading, $t(46) = .00$, $p = 1.00$, $r = .00$, as well as had similar expectation on the application of comic in their textbooks, $t(46) = .12$, $p = .90$, $r = .01$.

Children from both groups had similar graphic novel reading comprehension performances, $t(46) = -2.85$, $p = .006$, $r = .38$. Moreover, children from both groups showed similar level of performances in Navon test in terms of d' in the 'compatible' condition, $t(46) = -.66$, $p = .51$, $r = .09$, 'incompatible_global' condition, $t(46)$

Table 2 Descriptive statistics for the hypothesized variables between the two groups

	Control ($n=24$)	DLD ($n=24$)	p-value
	Mean (SD)	Mean (SD)	
Compatible (d'prime)	3.44 (0.61)	3.31 (0.75)	.512
Incompatible_Global (d'prime)	3.22 (0.58)	2.88 (0.65)	.067
Incompatible_Local (d'prime)	3.16 (0.79)	3.02 (0.74)	.539
Comic convention (max=27)	20.88 (1.72)	18.08 (2.12)	.000*
Graphic novel reading (max=15)	11.37 (1.81)	9.83 (1.92)	.006

[*] Significant group difference at $p < .005$ after Bonferroni correction

= −1.87, p =.06, r = .26. and 'incompatible_local' condition, t(46) = −.61, p =.53, r = .09.

Correlational and regression analyses

Zero-order correlations among all the variables were computed for the whole sample combining children from the DLD and normal groups (Table 3). Graphic novel comprehension was significantly positively correlated with passage comprehension (r=0.44, p<0.01), word decoding (r=0.52, p<0.01) and understanding of comic convention (r=0.30, p<0.01). It is interesting to note that understanding of comic convention not only significantly correlated with graphic novel comprehension, but also passage comprehension (r=0.45, p<0.01), word decoding (r=0.41, p<0.01) and comic reading experience (r=0.31, p<0.05). While none of the three conditions of Navon test correlated with the cognitive-linguistic measures, the 'compatible' condition was significantly positively correlated with the 'incompatible-global' (r=0.66, p<0.01) and 'incompatible-local' (r=0.61, p<0.01) conditions. The children's desire to learn through comics is significantly positively correlated with their expectation of integrating textbook with comics (r=0.53, p<0.01).

Multiple linear regression analysis was conducted to test the amount of variance explained by each of the variables that were found to be correlated with graphic novel reading comprehension. The result indicated that the model was a significant predictor of graphic novel reading comprehension, F(3,44)=5.87, p<0.01, and explained 28.6% of the variance. While Chinese word recoding contributed significantly to the model (B=0.41, p<0.05), passage comprehension (B=0.08, p=0.62), and understanding of comic convention (B=0.08, p=0.56) did not.

Discussion

The main purpose of the present study is to examine whether DLD children can be benefited from reading graphic novel and perform better in comprehending this type of text, as the unique features of graphic novels may fit well with the strengths of these children. Results of between-group comparison showed that children with DLD who had inferior word decoding and passage reading skills performed similarly with typical readers. This offers initial evidence to bolster the claim that texts in graphic novels are comparatively less demanding than the passages in reading comprehension tests. Similar to studies on mental imagery, the presence of graphics can also prompt the activation of visual coding system and assist these children in representing story information using an alternative (or additional) coding system, which would ease their verbal memory load associated with constructive processing. Still, it is important to bear in mind that poorly designed graphic novel may divert children's attention to irrelevant information that do not aid comprehension of texts (Sweller & Chandler, 1994).

The finding of the present study also indicates that the ability to understand comic convention is closely associated with the performances of graphic novel reading comprehension, highlighting the important role of comic convention comprehension

Table 3 Correlation among the hypothesized variables (*n* = 48)

	1	2	3	4	5	6	7	8	9	10
1. Graphic novel reading comprehension	–									
2. Passage reading comprehension	.44**	–								
3. Word decoding	.52**	.73**	–							
4. Working memory	.20	.40**	.24	–						
5. Comic convention understanding	.30*	.45**	.41**	.05	–					
6. Comic reading experiences (hours/week)	.07	.12	.21	–.08	.31*	–				
7. Navon test (compatible condition)	–.08	.16	.06	.02	–.12	–.10	–			
8. Navon test (incompatible_global)	–.00	.16	.07	.22	.00	.05	.66**	–		
9. Navon test (incompatible_local)	–.15	.23	.16	–.06	–.17	–.09	.61**	.53	–	
10. Desire to learn through comics	–.14	–.03	–.00	–.08	.18	.26	.00	.13	.04	–
11. Expect textbook to be integrated with comics	–.02	.08	.04	.00	.02	.24	.13	.23	.20	.53**

* *p* < .05; ** *p* < .01

for understanding the narrative stories presented in graphic novel format. To date, very little is known regarding how knowledge about comic convention is acquired. The laymen assumption is that processing of pictorial information is automatic and does not require explicit teaching. Although it is true for a lot of symbols and figures, comic convention may contain more subtle meaning. Thus, skill-based training on the understanding of comic convention may be needed. As demonstrated in the current study, comic reading experience and comic convention understanding are closely related, hence the potential benefits of graphic novels should merit greater attention. This particular finding suggests a new model for graphic novel comprehension, which comprises the "linguistic comprehension" and "word identification" as summarized in traditional text reading comprehension model process (e.g., Perfetti et al., 2005) with the addition of another component called "comic convention understanding". Under this model, it is conjectured that activation of "comic convention understanding" component can boost the efficiency of other two processes, yet the exact mechanisms have yet to be addressed in future studies. For remediation of reading comprehension, training on word decoding skills, linguistic comprehension skills and other essential skills (e.g. drawing inference about the implicit meaning) remain important (Moore et al., 2018). As implied in the current study, practitioners may consider using graphic novels when devising new remedial strategies for helping children with DLD to read. More intervention studies can therefore be conducted to explore its effectiveness.

The present study revealed that children from both DLD and control groups have similar quest for comics in their learning, such as learning through comics and expecting their textbooks to be in comic format. Although no mean difference between the two groups for the comic reading experiences was found, 7 out of 24 children from the control group and 13 out of 24 children from the DLD group indicated that they had no experience with comic books. This issue of availability requires some attention. As reported in some reading surveys, graphic novels are rated as the top three choices of reading materials for primary school children (Davis & Brember, 1993; Worthy et al., 1999). Similar finding was obtained by Millard and Marsh (2001) who showed that these children like reading graphic novels with their family members. However, schools do not provide enough graphic novels, especially those carrying educational values, therefore limit the choices children have. It is high time that comic and graphic novels be introduced, at least alongside the traditional textbooks to these students in schools.

The result of regression analysis showed that word decoding dominated the prediction of graphic novel comprehension. In addition to understanding comic convention, graphic novel comprehension still requires good word decoding skills, mainly because words are present in graphic novels.

Another interesting finding from our research is that comparable performances were observed for the three conditions of the Navon test. Contrary to our assumptions that this visual-perceptual skill is useful for identifying textual information in the graphic novel environment, for instance, when the readers isolate target words from an array of words, the results did not support our initial prediction. Although the task performance was not linked with the reading abilities, the intact word decoding abilities in children

with DLD could potentially be deployed for alleviating some of their learning difficulties. Future research is needed to examine the potential ways to utilize this skill.

It is also worth noting that working memory was found to correlate with passage but not graphic novel comprehension. This result may suggest the domain-specificity of working memory: verbal working memory task used in this study plays a less significant role in graphic novel reading comprehension which requires text and picture processing. Although text is present in graphic novels, the textual information can be mentally translated to pictorial representations for retention when reading graphic novels. Graphic novels which are purposefully drawn for educational purpose include a range of visual metaphors that symbolize textual information (Smith et al., 2021). Thus, the demand of verbal working memory is reduced. Another possible explanation is that shorter sentences are used in graphic novels and therefore a shorter working memory span is demanded. Given the multimodal nature of graphic novel, a more direct link with other kind of memories such as pictorial memory or procedural memory is anticipated in children with DLD. Future research is warranted to evaluate this possible linkage.

Limitations and future directions

Apart from facilitating information processing, comic convention understanding may also contribute to reading comprehension through a non-linguistic path, such as sustaining interest or attention in reading, an aspect of reading that the present study has not addressed. Also, as postulated by the emotional design hypothesis in cognitive affective theory of learning with media (CATLM; Moreno, 2007; Moreno & Mayer, 2007), making essential elements visually appealing initiates and guides cognitive processing during learning by directing attention and maintains cognitive processing during learning. In one study, less motivated learners who learn through reading graphic novels become more engaged in the learning process and were reported to show higher interest to the subject-matter (Keogh & Naylor, 1999). Still, additional skills such as understanding humor and exaggeration are critical to the level of engagement induced by graphic novels (Scavone et al., 2021). The affective aspect of comics merits greater attention in future studies with a mix of qualitative and quantitative methods (Cook, 2017).

The graphic novels used in this present study contained narrative stories only. Children's performance of the comprehension of other forms of writing, such as expository, argumentative, analytical, remains unanswered and it requires further clarification with future studies. Additionally, the inclusion of comic convention in the present study was not exhaustive. Future studies may consider including more varieties of comic conventions.

Conclusion

We have presented clear evidence that children with DLD had satisfactory performance when comprehending text in the format of graphic novel. Although the specific roles of text and comic in graphic novels merit further investigation, the claim that narratives presented in the form of graphic novel are able to benefit both children with DLD as well as typical readers is beginning to stand firm. Our study has also laid the foundation for future studies to examine how multimodal texts can be utilized to promote reading behaviors. In addition, we have also added a new essential component, namely comic/picture comprehension to traditional models of reading comprehension and thus prompted the investigation of this component and its interplay with word decoding and linguistic comprehension in children with DLD. The common assumption that progression in literacy is exemplified by less and less reliance on illustrations and more and more on the written word alone is again being questioned (Aleixo & Norris, 2010).

References

Aleixo, P., & Norris, C. (2010). The comic book textbook. *Education and Health, 28*, 72–74.

Attree, E. A., Turner, M. J., & Cowell, N. (2009). A virtual reality test identifies the visuospatial strengths of adolescents with dyslexia. *Cyber Pscyhology & Behavior, 12*(2), 163–168. https://doi.org/10.1089/cpb.2008.0204

Bishop, D. V. M. (2017). Why is it so hard to reach agreement on terminology? The case of developmental language disorder (DLD). *International Journal of Language & Communication Disorders, 52*(6), 671–680. https://doi.org/10.1111/1460-6984.12335

Bishop, D. V. M., & Adams, C. (1990). A prospective study of the relationship between specific language impairment, phonological disorders and reading retardation. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 31*, 1027–1050. https://doi.org/10.1111/j.1469-7610.1990.tb00844.x

Bishop, D. V. M., & Snowling, M. J. (2004). Developmental dyslexia and specific language impairment: Same or different? *Psychological Bulletin, 130*, 858–886. https://doi.org/10.1037/0033-2909.130.6.858

Botting, N., & Adams, C. (2005). Inferential and semantic abilities in children with communication disorders. *International Journal of Language and Communication Disorders, 40*, 49–66. https://doi.org/10.1080/13682820410001723390

Brenna, B. (2013). How graphic novels support reading comprehension strategy development in children. *Literacy, 47*(2), 88–94.

Catts, H. W., Adlof, S. M., Hogan, T. P., & Ellis Weismer, S. (2005). Are specific language impairment and dyslexia distinct disorders? *Journal of Speech, Language, and Hearing Research, 48*, 1378–1396. https://doi.org/10.1044/1092-4388(2005/096)

Cirrin, F. M., & Gillam, R. B. (2008). Language intervention practices for school-age children with spoken language disorders: A systematic review. *Language, Speech, and Hearing Services in Schools, 39*(1), 110–137. https://doi.org/10.1044/0161-1461

Conway, A. R. A., Kane, M. J., Bunting, M. F., Hambrick, D. Z., Wilhelm, O., & Engle, R. W. (2005). Working memory span tasks: A methodological review and user's guide. *Psychonomic Bulletin & Review, 12*, 769–786. https://doi.org/10.3758/BF03196772

Cook, M. P. (2017). Now I "see": The impact of graphic novels on reading comprehension in high school English classrooms. *Literacy Research and Instruction, 56*(1), 21–53. https://doi.org/10.1080/19388071.2016.1244869

Davies, J., & Brember, I. (1993). Standards in reading at key stage 1- a cause for celebration? A Seven-Year Cross-Sectional Study. *Educational Research, 40*(2), 1–9.

Dollaghan, C., & Campbell, T. F. (1998). Nonword repetition and child language impairment. *Journal of Speech, Language, and Hearing Research, 41*, 1136–1146.

Domyancich-Lee, S. C., Cleeland, L. R., & McCleary, J. S. (2021). Teaching note - comics in the classroom: Teaching with graphic novels. *Journal of Social Work Education*. https://doi.org/10.1080/10437797.2021.1942353

Gathercole, S. E., & Baddeley, A. D. (1990). Phonological memory deficits in language disordered children: Is there a connection? *Journal of Memory and Language, 29*, 336–360.

Gray, S., & Brinkley, S. (2011). Fast mapping and word learning by preschoolers with specific language impairment in a supported learning context: Effect of encoding cues, phonotactic probability, and object familiarity. *Journal of Speech, Language and Hearing Research, 54*, 870–874. https://doi.org/10.1044/1092-4388(2010/09-0285)

Greenfield, P. M. (2009). Technology and informal education: What is taught, what is learned. *Science, 323*, 69–71. https://doi.org/10.1126/science.1167190

Gyogi, E., & Lee, V. (2022). Multimodality in translation: A look into EFL and JSL classrooms. *Language Awareness*. https://doi.org/10.1080/09658416.2021.20235

Hick, R., Botting, N., & Conti-Ramsden, G. (2005). Cognitive abilities in children with specific language impairment (SLI): Consideration of visuo-spatial skills. *International Journal of Language and Communication Disorders, 40*(2), 137–149. https://doi.org/10.1080/13682820400011507

Ho, C.S.-H., Chan, D.W.-O., Chung, K.K.-H., Tsang, S.-M., Lee, S.-H., & Cheng, R.W.-Y. (2007). *The Hong Kong Test of Specific Learning Difficulties in Reading and Writing for Primary School Students Second Edition [HKT-P (II)]*. Hong Kong Specific Learning Difficulties Research Team.

Ho, C.S.-H., Wong, H.Y.-K., Lo, J.C.-M., Chan, D.W.-O., Chung, K.K.-H., Tsang, S.-M., et al. (2011). *The Hong Kong Chinese Literacy Assessment for Junior Primary School Student (CLA-P)*. Hong Kong Specific Learning Difficulties Research Team. https://doi.org/10.1371/journal.pone.0047872

Jerrim, J., Lopez-Agudo, L., & Marcenaro-Gutierrez, O. (2020). Does it matter what children read? New evidence using longitudinal census data from Spain. *Oxford Review of Education, 46*(5), 515–533. https://doi.org/10.1080/03054985.2020.1723516

Kan, P. F., & Windsor, J. (2010). Word learning in children with primary language impairment: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 53*, 739–756. https://doi.org/10.1044/1092-4388(2009/08-0248)

Keogh, B., & Naylor, S. (1999). Concept Cartoons, teaching and learning in science: An evaluation. *International Journal of Science Education, 21*(4), 431–446.

Larkin, J. H., & Simon, L. H. A. (1987). Why a diagram is (sometimes) worth ten thousand words. *Cognitive Science, 11*(1), 65–100. https://doi.org/10.1111/j.1551-6708.1987.tb00863.x

Lamminpää, J., Vesterinen, V.-M., & Puutio, K. (2020). Draw-a-science-comic: Exploring children's conceptions by drawing a comic about science. *Research in Science & Technological Education*. https://doi.org/10.1080/02635143.2020.1839405

Leonard, L. (1998). *Children with developmental language disorder*. The MIT Press.

Leung, M.T., & Lee, A. W.Y. (2002). *The Hong Kong Corpus of primary school Chinese*. Paper presented at the 9th meeting of the International Clinical Phonetics and Linguisitics Association, Hong Kong.

Martinez, A., Moses, P., Frank, L., Buxton, R., Wong, E., & Stiles, J. (1997). Hemispheric asymmetries in global and local processing: Evidence from fMRI. *Neuroreport: an International Journal for the Rapid Communication of Research in Neuroscience, 8*, 1685–1689.

McArthur, G. M., Hogben, J. H., Edwards, V. T., Heath, S. M., & Mengler, E. D. (2000). On the specifics" of specific reading disability and developmental language disorder. *Journal of Child Psychology and Psychiatry, 41*, 869–874. https://doi.org/10.1111/1469-7610.00674

Millard, E., & Marsh, J. (2001). Sending Minnie the minx home: Comics and reading choices. *Cambridge Journal of Education, 31*, 25–38. https://doi.org/10.1080/03057640123853

Miller, C., Kail, R., Leonard, L., & Tomblin, B. (2001). Speed of processing in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 44*, 416–433. https://doi.org/10.1044/1092-4388(2001/034)

Montgomery, J., Polunenko, A., & Marinellie, S. (2009). The role of working memory in children's understanding spoken narratives. *Applied Psycholinguistics, 30*, 1–25.

Moore, A. B., Nowostawski, M., Frantz, C., & Hulbe, C. (2018). Comic strip narratives in time geography. *ISPRS International Journal of Geo-Information, 7*(7), 245. https://doi.org/10.3390/ijgi7070245

Moreno, R. (2007). Optimizing learning from animations by minimizing cognitive load: Cognitive and affective consequences of signaling and segmentation methods. *Applied Cognitive Psychology, 21*, 765–781. https://doi.org/10.1002/acp.1348

Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments: Special issue on interactive learning environments: Contemporary issues and trends. *Educational Psychology Review, 19*, 309–326. https://doi.org/10.1007/s10648-007-9047-2

Nakazawa, J. (2005). The development of manga panel reading literacy. *Manga Studies, 7*, 6–21.

Nakazawa, J. & Nakazawa., S. (1993). Development of manga reading comprehension: How do children understand manga? In Y. Akashi (Ed.) *Manga and child: How do children understand manga?* Research report of Gendai Jidobunka Kenkyukai.

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive Psychology, 9*, 353–383.

Newby, R., Caldwell, J., & Recht, D. (1989). Improving the reading comprehension of children with dysphonetic and dyseidetic dyslexia using story grammar. *Journal of Learning Disabilities, 22*, 373–380. https://doi.org/10.1177/002221948902200609

Norbury, C., Bishop, D., & Briscoe, J. (2002). Does impaired grammatical comprehension provide evidence for an innate grammar module? *Applied Psycholinguistics, 23*, 247–268. https://doi.org/10.1017/S0142716402002059

Paivio, A. (2006). *Mind and its Evolution*. Lawrence Erlbaum Associates Inc.

Perfetti, C. A, Landi, N. & Oakhill, J. (2005). The acqusition of reading comprehension skill. In M. J. Snowling & C Hulme (Eds.), *The science of reading. A handbook* (pp. 227–247). Oxford, UK: Blackwell.

Pike, M. M., Barnes, M. A., & Barron, R. W. (2010). The role of illustrations in children's inferential comprehension. *Journal of Experimental Child Psychology, 105*(3), 243–255. https://doi.org/10.1016/j.jecp.2009.10.006

Plaisted, K., Swettenham, J., & Rees, L. (1999). Children with autism show local precedence in a divided attention task and global precedence in a selective attention task. *Journal of Child Psychology and Psychiatry, 40*, 733–742.

Plass, J. L., Heidig, S., Hayward, E. O., Homer, B. D., & Um, E. (2014). Emotional design in multimedia learning: Effects of shape and color on affect and learning. *Learning and Instruction, 29*, 128–140. https://doi.org/10.1016/j.learninstruc.2013.02.006

Richard, A. E., & Lajiness-O'Neill, R. (2015). Visual attention shifting in autism spectrum disorders. *Journal of Clinical and Experimental Neuropsychology, 37*(3), 671–687. https://doi.org/10.1080/13803395.2015.1042838

Scavone, P., Carrasco, V., Umpiérrez, A., Morel, M., Arredondo, D., & Amarelle, V. (2019). Microbiology can be comic. *FEMS Microbiology Letters, 366*(14), 171. https://doi.org/10.1093/femsle/fnz171

Smetana, L., Odelson, D., Burns, H., & Grisham, D. (2009). Using graphic novels in the high school classroom: Engaging deaf students with a new genre. *Journal of Adolescent and Adult Literacy, 53*(3), 228–240. https://doi.org/10.1598/JAAL.53.3.4

Smith, P. L., Goodmon, L. B., Howard, J. R., Hancock, R., Hartzell, K. A., & Hilbert, S. E. (2021). Graphic novelisation effects on recognition abilities in students with dyslexia. *Journal of Graphic Novels and Comics, 12*(2), 127–144. https://doi.org/10.1080/21504857.2019.1635175

Stanovich, K. E. (1988). Explaining the differences between the dyslexic and the garden-variety poor reader: The phonological core variable difference model. *Journal of Learning Disabilities, 21*, 590–604.

Sweller, J., & Chandler, P. (1994). Why some material is difficult to learn. *Cognition and Instruction, 12*, 185–233. https://doi.org/10.1207/s1532690xci1203_1

T'sou, B., Lee, T.H.-T., Tung, P., Man, Y., Chan, A., To, C. K. S., et al. (2006). *Hong Kong Cantonese Oral Language Assessment Scale*. City University of Hong Kong.

Um, E. R., Plass, J. L., Hayward, E. O., & Homer, B. D. (2012). Emotional design in multimedia learning. *Journal of Educational Psychology, 104*, 485–498. https://doi.org/10.1037/a0026609

Van Kleeck, A. (2008). Providing preschool foundations for later reading comprehension: The importance of and ideas for targeting inferencing in storybook-sharing interventions. *Psychology in the Schools, 45*(7), 627–643. https://doi.org/10.1002/pits.20314

Verhoeven, L., Steenge, J., van Weerdenburg, M., & van Balkom, H. (2011). Assessment of second language proficiency in bilingual children with specific language impairment: A clinical perspective. *Research in Developmental Disabilities, 32*, 1798–1807. https://doi.org/10.1016/j.ridd.2011.03.010

Von Karolyi, C., Winner, E., Gray, W., & Sherman, G. F. (2003). Dyslexia linked to talent: Global visual-spatial ability. *Brain and Language, 85*, 427–431. https://doi.org/10.1016/S0093-934X(03)00052-X

Weber, W., & Rall, H.-M. (2017). Authenticity in comics journalism. Visual strategies for reporting facts. *Journal of Graphic Novels and Comics, 8*(4), 376–397. https://doi.org/10.1080/21504857.2017.1299020

Wong, A. M. Y., Stokes, S. F., & Yung, E. (2005). *Cantonese-Chinese competing language processing task*. Unpublished manuscript.

Wong, S. W. L., Miao, H., Cheng, R. W.-y., & Yip, M. C. W. (2017a). Graphic novel comprehension among learners with differential cognitive styles and reading abilities. *Reading & Writing Quarterly, 33*(5), 412-427. https://doi.org/10.1080/10573569.2016.1216343

Wong, A. M. Y., Stokes, S. F., Yung, E, & Au, C. W. S. (2017b). *Cantonese-Chinese competing language processing task: Expanded version*. unpublished manuscript.

Worthy, J., Moorman, M., & Turner, M. (1999). What Johnny likes to read is hard to find in school. *Reading Research Quarterly, 34*, 12–27.

Wright, H. H., & Newhoff, M. (2001). Narration abilities of children with language-learning disabilities in response to oral and written stimuli. *American Journal of Speech-Language Pathology, 10*(3), 308–319. https://doi.org/10.1044/1058-0360(2001/027)

Yannicopoulou, A. (2004). Visual aspects of written texts: Preschoolers view comics. *L1- Educational Studies in Language and Literature, 4*(2-3), 169-181. https://doi.org/10.1007/s10674-004-1024-9