Enhancing Reading Comprehension Among Students With High-Functioning Autism Spectrum Disorder: A Randomized Pilot Study

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Abstract

Reading with comprehension is a challenge for students with high-functioning autism spectrum disorder. Unfortunately, research has little to offer to teachers trying to help these students. The present study pilots a new intervention targeting vocabulary, main idea identification, anaphoric relations, and text structure. Students ($N = 13$, M_{age} = 9 years) were randomly assigned to either a control or an intervention condition.

Descriptive analyses suggest that the intervention is effective; compared with their control condition peers, students in the intervention condition apparently made more progress on the vocabulary, main idea identification, and comprehension measures.

Keywords: autism spectrum disorder, high-functioning, reading, comprehension, instruction

Résumé

La compréhension en lecture constitue un défi pour les élèves présentant un trouble sur le spectre de l'autisme de haut niveau et la recherche a peu à offrir aux enseignants devant aider ces élèves. Nous avons pré-expérimenté ici une intervention ciblant le vocabulaire, l'identification des idées principales, les relations anaphoriques et la structure du texte. Les élèves ($N = 13$, $M_{âge} = 9$ ans) ont été assignés aléatoirement aux conditions contrôle et intervention. Les analyses descriptives suggèrent que l'intervention a aidé les élèves à progresser davantage sur le plan du vocabulaire, de l'identification des idées principales et de la compréhension.

Mots-clés : trouble sur le spectre de l'autisme, haut niveau, lecture, compréhension, enseignement

Introduction

Over the past decades, there has been a growth in the number of children diagnosed with what is now termed autism spectrum disorder (ASD) (Coo, Ouellette-Kuntz, Lloyd, Kasmara, Holden, & Lewis, 2008; Fombonne, 2005; Tidmarsh & Volkmar, 2003). This increased prevalence has been associated with a diversification of students' academic needs. In the past, a majority of students with ASD also presented intellectual disability (Edelson, 2006), but this is not the case anymore (e.g., Croen, Grether, & Selvin, 2002). Students with high-functioning (close to the norm IQ) ASD indeed represent a rapidly growing segment of the population of school-age children with special needs (Centers for Disease Control and Prevention, 2012). Unfortunately, very few research-based interventions have been developed to address the academic needs of this group (Chiang & Lin, 2007). As a consequence, it is possible that these students do not receive the kind of instruction they need to optimize their learning potential.

Despite their average to superior intellectual abilities, students with high-functioning ASD are likely to experience learning difficulties, especially with regard to advanced reading skills. Even if they master basic reading skills (e.g., knowledge of letter sounds) with relative ease, these students may struggle with reading comprehension. In other words, they find it hard to understand the meaning of the text as a whole. For instance, Nation, Clarke, Wright, and Williams (2006) observed that students with ASD showed, on average, age-appropriate basic reading skills but had comprehension scores that were one to two standard deviations below the population norm (see also, Frith & Snowling, 1983; Snowling & Frith, 1986).

These students' reading comprehension problems could be a consequence of their particular cognitive style. The central coherence theory (Frith, 1989; Frith & Happé, 1994) indeed suggests that, in contrast with the majority of their peers, students with ASD do not spontaneously perceive complex stimuli as coherent, meaningful wholes. This cognitive style has been associated with an exaggerated focus on details, as well as restricted and idiosyncratic fields of interest. It could explain why students with high-functioning ASD have difficulties perceiving the general meaning of texts and are unfamiliar with many words found in these texts, their vocabulary being underdeveloped except in their fields of interest. The theory also suggests the presence of a certain cognitive inflexibility that would lead to difficulties in interpreting words with context-dependent

meaning, notably pronouns (e.g., the referent of the pronoun "she" varies depending on the context in which it is used). Encouragingly, the theory states that the cognitive style of students with high-functioning ASD, a so-called weak central coherence, represents a bias rather than a deficit and, as such, that it can be overcome with appropriate support (Happé & Frith, 2006).

Most studies examining the weak central coherence hypothesis have focused on visual perception (Happé & Frith, 2006), with only a few touching on reading comprehension. Among such exceptions is Norbury and Bishop's (2002) study in which the inference skills of three groups were compared: students with ASD, students with language deficits and typically developing students. Participants had to infer information missing from a text, something that required them to discern the coherence of the text (i.e., to understand it). As expected, students with ASD performed more poorly than peers in the other two groups (see also Jolliffe & Baron-Cohen, 1999). Nation and colleagues (2006), for their part, showed that a general limited vocabulary is indeed associated with students with ASD's reading comprehension problems. Finally, O'Connor and Klein (2004) examined the ability of students with ASD to identify anaphoric relations, that is, the referent of pronouns (e.g., to whom "he" refers in "Max likes to run. He goes to the park."). Students read two texts: an unmodified one and another in which each pronoun had been replaced by a blank, underneath which multiple choices of pronouns were listed. Students showed a greater understanding of this last text, presumably because it required them to think about the logical relations between sentences (see also Colle, Baron-Cohen, Wheelwright, & van der Lely, 2008). Descriptive findings thus support the idea that the weak central coherence of students with high-functioning ASD impedes their comprehension.

The reading comprehension problems of students with ASD have been addressed in only a handful of intervention studies. In their pioneering study, Kamps, Barbetta, Leonard, and Delquadri (1994) helped three students with ASD improve the speed and accuracy of their oral reading, a key precursor of comprehension; findings from this study suggest a positive effect on comprehension. In a related study, the same team of researchers trained three students with ASD to work with typically developing students (Kamps, Leonard, Potucek, & Garrison-Harrell, 1995). Together, students from the two groups reviewed the meaning of difficult words and answered questions on texts they had to read. Positive effects on comprehension were observed, but only for the student with ASD with an IQ in the normative range (the other two participants with ASD had a low IQ). In the

studies by Kamps et al. (1994, 1995), only limited efforts were made to teach students with ASD the information and skills they needed to understand texts. Flores and Ganz (2007) took a different approach. They systematically trained two students with ASD to use a skill useful for comprehension (making simple inferences based on information present in the texts). Although comprehension was not assessed, both students were able to master the instructed skill. Using a similar instructional approach with two other students with ASD, Flores and Ganz (2009) presented findings suggesting modest gains on a comprehension measure. Findings from these small-scale intervention studies thus suggest that it is possible to improve the reading comprehension of students with ASD, perhaps especially when these students have an IQ in the normative range (i.e., when they can be considered high-functioning) and when instruction explicitly targets the information and skills needed for comprehension.

The Present Study

The present study innovates by piloting a theory-based intervention that aims at teaching, explicitly and systematically, skills and information hypothesized to be needed by students with high-functioning ASD to understand texts. The different elements of the intervention are adapted from evidence-based interventions developed for at-risk students or students with learning disabilities (see Baumann, 1986; Carnine, Silbert, Kame'enui, & Tarver, 2009; Dion, Roux, Lemire-Théberge, Guay, Bergeron, & Brodeur, 2009). To compensate for their undue focus on details, students with high-functioning ASD are taught to identify the main ideas of the text and to discern the logical relations between these ideas (i.e., the structure of the text). Instruction is also aimed at helping the students to expand their general vocabulary and, when appropriate, to consider the context when interpreting the meaning of words, specifically pronouns.

Method

Participants

The 13 participating students (M_{age} = 9 years) had been diagnosed with ASD by child psychiatrists applying the DSM-IV-R criteria with the Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 1999). Written parental consent had been secured for all these students. They all attended one francophone school (in Montreal, Quebec) with both regular and special classes. Two of the 13 students attended a regular education classroom on a full-time basis. The remaining 11 attended a special classroom based on the Treatment and Education for Autistic and Communication Handicapped Children (TEACCH) model (Mesibov, Shea, & Schopler, 1988), with part-time presence in a regular education class (e.g., for the music period).

The participants were selected among all students with ASD for whom parental consent was available. To be included they had to have a perceptual IQ (Wechsler, 2003) in the normative range and thus could be considered as high-functioning (e.g., Centers for Disease Control and Prevention, 2012), have mastered basic reading skills according to their teacher and as reflected by their score on a scale of word and nonword reading (Desrochers, 2008), and have a sufficiently developed general vocabulary to benefit from the intervention, that is, an age equivalent score of at least 3.5 years (Dunn, Thériault-Whalen, & Dunn, 1993). As can be seen in Table 1, students' perceptual reasoning scores were in the normative range, but their vocabulary age equivalent scores were approximately 1.5 years below their chronological age.

Table 1. Students Pre-test Scores for the Selection Measures by Condition

| | Condition | | | |
| | Control (n = 7) | | Intervention (n = 6) | |
	M	*SD*	*M*	*SD*
Chronological age in years	9.2	0.8	8.9	1.3
General vocabulary				
(PPVT) [a]	7.5	3.2	7.8	2.2
IQ (WISC-IV)				
Verbal comprehension	68.7	14.4	73.3	10.9
Perceptual reasoning	96.4	18.1	87.2	23.5
Basic reading skills				
Words [b]	41.6	14.9	38.7	7.7
Nonwords [b]	29.4	10.2	31.2	8.7

Note. PPVT = Peabody Picture Vocabulary Test. French Canadian Version (Dunn et al., 1993); WISC-IV = Wechsler Intelligence Scale for Children, Fourth Edition. French-Canadian version (Wechsler, 2005).
[a] Age equivalent score. [b] Number of stimuli read correctly in 45 seconds (Desrochers, 2008). Range = 0–74.

Design

An experimental design with a control condition (regular instruction only) and an intervention condition was used. To ensure that the groups in the two conditions were equivalent (see Table 1), pairs of students with similar pre-test scores (i.e., words, nonwords, and vocabulary age equivalent) were created (irrespective of classroom) and a member of each pair was randomly assigned to each condition. Due to the uneven number of participants, one student could not be paired. This student was randomly assigned to the control condition.

Regular reading instruction followed the approved program (Ministère de l'Éducation, 2001). It focused on global word recognition and did not include systematic comprehension instruction. Students in the two conditions received approximately the same amount of reading instruction since intervention sessions were usually conducted during periods of regular reading instruction.

Intervention

Overview. Each week, for a period of 10 weeks, a research assistant offered three 30-minute sessions of intervention to small groups of three to four students, for a total of 15 hours of intervention. Of the 30 sessions, 27 were vocabulary and text reading sessions (see below). Three others, occurring at regular intervals during the intervention period, focused on the identification of anaphoric relations (the referent of pronouns). In the two types of sessions, instruction was structured (it followed a detailed protocol) and explicit (a clear and coherent terminology was used). Students' participation was also continuously required (for explicit instruction principles, see Carnine et al., 2009).

Vocabulary and text reading sessions. Each of these sessions consisted of four activities. During the first activity, eight words were taught. These were all tier-2 words, that is, words frequently encountered in texts but that are, nevertheless, likely to be unfamiliar to many students (Beck, McKeown, & Kucan, 2002). Each word was presented on a medium-size board of thick white paper. On this board there was a drawing of the meaning of the word with the word divided by syllables underneath (e.g., "splen/dide"), with its complex graphemes underlined (e.g., "en") and its silent letters in lighter characters (e.g., the common final silent "e" in French). After having demonstrated the decoding of the word, the assistant read it in a normal manner and asked the students to reread it. The assistant then gave a brief definition of the word (Beck et al., 2002), described the illustration, and used an example of a sentence including the word. The student whose turn it was had to repeat the definition and formulate a new sentence with the word. The routine was repeated for each word, soliciting the participation of each student in turn. The first activity concluded with a review. The assistant showed the group a board on which there was a randomly ordered list of the definitions, under which were the words and their illustrations. Taking turns, students had to read a definition, identify the corresponding illustration, and read the word underneath it.

During the second activity, story reading, the assistant read to the group a narrative text of approximately 350 words presented on a board. This text contained the words taught during the current session and a few words from previous sessions. When the assistant read a word (in bold) introduced in the current session, she mentioned the definition of this word and continued to read from the text. When she read a word (underlined)

introduced in a previous session, it was the students themselves that had to give the definition of the word.

The third activity, main idea identification, was conducted using the text introduced in the second activity. The board with the text was left within view of the students. The assistant began the activity by reminding the students what a main idea is and by repeating the two questions that must be asked to identify a main idea: "Who or what is the paragraph about?" and "What happens in the paragraph?" (Carnine et al., 2009). Taking turns, students reread a paragraph, answered the questions, and used their answer to formulate a sentence describing the main idea. The assistant wrote the answers and the main idea on a board, offering help when required. Once the main idea had been identified, a drawing illustrating the idea was shown to the group. This routine was repeated for all of the paragraphs of the text.

For the fourth and last activity, identification of text structure, the drawings illustrating the main ideas were shown to the group one by one, following the sequence of the story. Students took turns restating each main idea. The goal of this review was to encourage students to perceive the general coherence of the story.

Identification of anaphoric relations sessions. The content of these three sessions was adapted from Baumann (1986). Key notions were introduced during the first session and put into practice during the last two sessions. During the first session, the assistant explained the use of nine personal pronouns (e.g., that "I" refers to the person who is speaking) and then modelled a strategy to identify the referent of the pronoun in the text; students were instructed to ask themselves "Who is [pronoun]?" and look for the answer in the preceding sentence. The strategy was written on a board left within view of the group. At the beginning of each of the last two sessions, the assistant quickly reviewed the use of the personal pronouns as well as the strategy to identify anaphoric relations. The strategy was then put into practice with a text in which pronouns were underlined. The research assistant read the whole text and then asked students to take turns rereading each paragraphs and identifying pronoun referents.

Instruments

Knowledge of definitions. Biemiller and Slonim's (2001) procedure was used to determine whether students were learning the meaning of instructed words (for the

importance of proximal measures, see National Institute of Child Health and Human Development, 2000). Twenty words were randomly selected from the 200 instructed words and a sentence was composed for each of the selected words (e.g., "In summer, T-shirts are common."). The research assistant read the sentence and asked the student, "What does [word] mean?" (the assessment was conducted orally). Answers were coded as correct (1 point), partially correct (0.5 point), or incorrect (0 point), and summed (α = .86). A total score was computed by summing up the individual item scores. The sensitivity of similar scores to intervention effects has also been demonstrated (e.g., Vuattoux, Japel, Dion, & Dupéré, 2014). A second research assistant blindly coded a random selection of 30% of the assessments, yielding an inter-rater agreement of 97%.

Main idea identification. Mastery of the instructed strategy of main idea identification was assessed directly with a procedure adapted from Jitendra, Hoppes, and Xin (2000). The student had to read three narrative paragraphs. After having read each paragraph, the student had to tell, with the paragraph left in view, what the "important thing" was in this paragraph. The subject and the action of each idea were coded separately. A maximum of 1 point was given for the subject and 2 points for the action. In both cases, half the points were awarded for generic or partially correct answers (e.g., "she" for "Anne"). Points for the three paragraphs were summed. Jitendra et al. have demonstrated the sensitivity of this kind of score to intervention effects. A second assistant coded 30% of the assessments, yielding an inter-rater agreement of 87%.

Identification of anaphoric relations. The ability to identify the referent of pronouns, another instructed strategy, was assessed using a procedure adapted from Baumann (1986). The student had to read a short narrative text (126 words) and find the referent of 12 singular (e.g., "I") or plural (e.g., "they") pronouns. For each pronoun, the student had to answer the question "Who is [pronoun]?" Students' answers were coded as correct (1 point) or incorrect (0 point) and summed to form a global score (α = .66). A second assistant coded 30% of the assessments, yielding an inter-rater agreement of 100%.

Comprehension. Reading comprehension was assessed by allowing students four minutes to read aloud a second-grade level narrative text (296 words), and by asking them seven short-answered questions on this text. Although comprehension is a complex, multifaceted construct, it has been shown that simple measures such as the one used

here are valid (e.g., Fuchs, Fuchs, & Maxwell, 1988). Answers were scored as correct (1 point), partially correct (0.5 point) or incorrect (0 point) and summed (α = .77). A second assistant coded 31% of the assessments, yielding an agreement between the two raters' total scores of r = .99.

Procedure

Selection and pre-test assessments (30 minutes) were conducted in mid-January and post-test assessments (30 minutes) were conducted in May. Assessments were administered on a one-to-one basis, in a quiet room close to the classroom. The small-group intervention was offered for a period of ten weeks, from January to May, with a one-week break in March (for the spring break). Because some students with ASD may have difficulties adapting to change, the intervention was offered by the same research assistant in charge of the assessments. To avoid introducing biases, the assessments were conducted following a detailed protocol.

Results

Given the small size of the sample, the statistical power of inferential analyses would have been very limited. By definition, however, it is not necessary to conduct such analyses or to demonstrate significant effect in a pilot study. This kind of study, rather, aims to provide a "proof of concept," showing that it is feasible to use the intervention and that this intervention might be useful (e.g., Gersten, 2005). In this context, Lemire-Théberge et al. (2013) recommend examining effect sizes to determine whether the intervention is promising enough to warrant further investigation.

Accordingly, only descriptive analyses were conducted. Table 2 presents means and standard deviations for the two conditions.

Table 2. Pre-test and Post-test Scores by Condition

Measure/ Time administered	Control (n = 7)		Intervention (n = 6)		Cohen's d
	M	*SD*	*M*	*SD*	*d*
Knowledge of definitions [a]					
Pre-test	6.5	4.2	6.6	2.8	
Post-test	5.1	5.1	10.3	4.9	
Difference	-1.4	1.1	3.7	3.1	1.50
Main idea identification [b]					
Pre-test	1.7	1.4	3.0	1.2	
Post-test	2.3	1.3	4.3	0.7	
Difference	0.6	1.1	1.3	1.2	0.59
Anaphoric relations identification [c]					
Pre-test	2.6	1.7	3.3	1.7	
Post-test	5.0	2.7	5.7	1.4	
Differences	2.4	1.9	2.3	0.8	-0.06
Comprehension [d]					
Pre-test	2.2	1.9	2.3	1.7	
Post-test	2.6	1.8	3.6	2.6	
Difference	0.4	0.8	1.2	2.4	0.48

Note. [a] Number of words correctly defined (0–20). [b] Sum of point for the three main ideas (0 – 9). [c] Number of correctly identified pronoun referents (0–12). [d] Number of correctly answered questions (0–7).

Students from both conditions had similar pre-test knowledge of definitions and comprehension scores. However, in comparison to their peers in the control condition, intervention students had slightly higher main idea identification and anaphoric relations scores. This apparent initial advantage was controlled by computing difference scores (post-test versus pre-test) reflecting the amount of progress between the two measurement occasions. Mean difference scores in the two conditions were compared using effect sizes (Cohen's d).

As can be seen in Table 2, there was a very strong effect size for knowledge of definitions and a moderate one for main idea identification. However, the intervention had apparently no effect on anaphoric relations. Finally, a moderate effect size was observed for comprehension.

Discussion

Our goal was to examine, in a preliminary manner, the efficacy of a reading comprehension intervention for students with high-functioning ASD. The intervention targeted these students' limited vocabulary—through vocabulary and anaphoric relations instruction—and their exaggerated focus on details—through main idea identification and text structure instruction. Conclusions on the efficacy of this intervention cannot be drawn because of the small size of the sample. Nevertheless, findings suggest that the intervention is a potentially useful one, but also that further adaptations are required.

As recommended by Gersten et al. (2005), we assessed the effect of the intervention both on instructed skills (e.g., identification of main ideas) and on its distant pedagogical goal (i.e., improving reading comprehension). Instructed skills were mastered to varying degrees. For knowledge of definitions, there was a strong effect size favoring students in the intervention condition. Students with high-functioning ASD thus seem to respond well to the form of vocabulary instruction used in this study. By contrast, the effect size was moderate for main idea identification, suggesting that it is feasible to teach this key comprehension strategy (e.g., Jitendra et al., 2000) to students with high-functioning ASD, but also that our instructional approach could be improved. We suspect that some of the main ideas in the texts used for instruction were too implicit or too abstract. Using texts with more clearly structured paragraphs could lead to a better mastery of main idea identification. Finally, no effect was observed on anaphoric relations identification, possibly because of the relatively small number of sessions (three) dedicated to the teaching and practice of this skill.

Our findings suggest that learning these skills, even partially, helped students with high-functioning ASD improve their comprehension. This is particularly encouraging. Even if the effect for comprehension is moderate according to conventional standards (Cohen, 1988), it compares favourably with effect sizes observed in studies conducted with at-risk or typically developing students of the same age group as our participants (for a review, see Suggate, 2010). This could mean that the cognitive style of students with ASD, characterized by weak central coherence, is indeed a bias amenable to intervention (Happé & Frith, 2006). Practically speaking, because the ability to read with comprehension plays a crucial role in school achievement (e.g., Chall, Jacobs, & Baldwin, 1990), it appears crucial to further investigate the efficacy of our intervention.

This study was a pilot, and it is important to assess its strengths and limitations with this consideration in mind. The goal of this kind of study is not to provide a formal demonstration of the efficacy of an intervention, a demonstration that could lead to the generalized adoption of this intervention by practitioners. Such a demonstration requires one or, ideally, several reasonably large-scale randomized controlled studies. The more modest goal of the pilot study is to provide preliminary findings that justify the conduct of these (labour-intensive and costly) randomized controlled studies. It also provides critical information on the modifications that should be brought to the intervention. This is important since even seemingly minor modifications can significantly improve the efficacy of an intervention (Fuchs & Fuchs, 1998; Gersten, 2005; Lesser, 1974; Palmer, 1972). Among the strengths of the present study, let us mention its experimental design, the detailed assessment of instructed skills, and the reasonable size of its sample for a pilot. Data from both this pilot and previous small scale studies (Kamp et al., 1994, 1995; Flores & Ganz, 2007, 2009) are promising enough to justify a full-fledged effort aimed at identifying, creating, and testing effective approaches for teaching reading comprehension to the growing number of students with high-functioning ASD in our schools.

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