Efficacy of an Intervention to Enhance Reading Comprehension of Students With High-Functioning Autism Spectrum Disorder

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Abstract
This study examines whether explicit reading comprehension instruction is relevant for students with high-functioning autism spectrum disorder (ASD). Forty-five students (Mage = 9 years) were randomly assigned to two conditions: control or intervention. Those assigned to the intervention condition received instruction on vocabulary, main idea identification, text structure, and anaphoric relations. Compared with their peers in the control condition, students in the intervention condition showed greater improvement on one measure of reading comprehension. They also knew the meaning of more words and were better able to identify main ideas and anaphoric relations, with some of these gains still being detectable at the follow-up. Although additional adaptations appear warranted, students with high-functioning ASD clearly benefited from instruction.

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

Students with high-functioning autism spectrum disorder (ASD) represent a rapidly growing segment of the population of school-age children with special needs (Centers for Disease Control and Prevention, 2012). By definition, these students do not meet the criteria for intellectual disability, and they could learn normally in a regular classroom environment. However, acquiring what is perhaps the most important learning skill, reading with comprehension, is a challenge for them (Frith & Snowling, 1983; Snowling & Frith, 1986). Reading with comprehension is critical because students are expected to learn content by reading from textbooks in a variety of subject areas. In fact, succeeding in school is almost impossible for students who do not understand what they read (Chall & Jacobs, 2003).

Unfortunately, well-known research-based interventions developed for students with ASD do not address reading comprehension problems. For example, because they primarily target preschoolers, the University of California, Los Angeles, Young Autism model (Lovaas & Smith, 2003) and the Picture Exchange Communication System (Bondy & Frost, 1994) focus on basic verbal communication skills rather than reading skills. Furthermore, although the Treatment and Education of Autistic and Communication Handicapped Children (TEACCH) model has been developed for school-age children, its focus has been on basic reading skills rather than complex cognitive skills (Schopler, Lansing, & Waters, 1983). These basic skills are necessary, but they are not sufficient for comprehension. Reading comprehension involves organizing, integrating, and memorizing the information presented in the text. According to current theoretical models, a student understands a text by elaborating a coherent and reasonably complete mental representation of its content (W. Kintsch & Kintsch, 2005; van den Broek, White, Kendeou, & Carlson, 2009). Elaborating this kind of representation requires the use of cognitively advanced skills.

The comprehension problems of students with high-functioning ASD 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 meaningful,
coherent wholes. This cognitive style has been associated with an undue focus on details as well as restricted and idiosyncratic fields of interest. It could explain why students with high-functioning ASD do not perceive the global meaning of texts and are unfamiliar with many words found in these texts, their vocabulary being underdeveloped except in specific 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 corrected 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, Clarke, Wright, and Williams (2006) showed that a generally 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 condition.

Adopting a different approach, Flores and Ganz (2009) systematically taught two students with ASD to use a skill useful for comprehension (making simple inferences based on information present in the texts). Modest gains were observed on a comprehension measure (see also Flores & Ganz, 2007).

Findings from small-scale intervention studies thus suggest that it is possible to improve the reading comprehension of students with ASD, perhaps especially those with high-functioning ASD (i.e., with an IQ in the normal range), when instruction explicitly targets comprehension rather than its precursors. However, these studies have been limited by small sample sizes and reliance on nonrandomized design. Two scientific panels (Lord et al., 2005; Smith et al., 2007) have encouraged researchers to conduct randomized controlled studies to determine the effectiveness of interventions developed for students with ASD.

The goal of the present study is to examine the efficacy of instruction that explicitly and systematically targets knowledge and skills considered essential for the reading comprehension of students with high-functioning ASD. Instruction addresses knowledge of word meaning (vocabulary) and discourages undue focus on details by teaching students to identify the main ideas in a text and logical links between these ideas (i.e., the structure of the text). We expected that this instruction would facilitate the reading comprehension of students assigned to the intervention condition.

Method

Participants

Six elementary schools from three francophone school boards (Montreal, Quebec, Canada) participated. These magnet schools served both regular students and students with ASD. These last students had been diagnosed by pedopsychiatrists applying the Diagnostic and Statistical Manual of Mental Disorders (4th ed., text rev.; DSM-IV-TR; American Psychiatric Association, 2000) criteria with the Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 1999). In the Quebec public school system, data on individual students’ family income or ethnicity are not collected. Based on census indicators, an average of 36.9% (range = 13.5%–55.9%) families served by these schools declared a yearly income below the poverty line (Ministère de l’Éducation du Loisir et du Sport, 2008). Among students diagnosed with ASD, a request for parental
consent was sent for those who (a) did not meet the criteria for intellectual disability according to the school psychologist and (b) demonstrated at least end of first-grade reading skills according to their teacher.

A selection assessment (see Figure 1) was conducted with all students for whom parental consent had been secured. Two students were excluded because they scored in the intellectual disability range on the Wechsler Intelligence Scale for Children, Fourth Edition (French version; Wechsler, 2005) and could not be considered to function at a high level (for a similar approach, see Centers for Disease Control and Prevention, 2012). Another 18 students were not selected because reading comprehension instruction would have been too challenging for them as their age equivalence score was inferior to 4 years on the Peabody Picture Vocabulary Test (PPVT; French version; Dunn, Thériault-Whalen, & Dunn, 1993) or because they read less than 20 words in 45 s on a word recognition scale (Desrochers, 2008). Finally, one student was not eligible because scheduling problems would have prevented his participation in the intervention.

Forty-five students (88% boys, $M_{age} = 9.0$ years, $SD_{age} = 1.3$, range = 6–12) formed the final sample randomly assigned to the control and intervention conditions. All participants had been diagnosed as presenting either autism, a pervasive developmental disorder-not otherwise specified, or Asperger syndrome. Most participants seemed to be of European descent or, in the case of a substantial minority, of North African descent. Among the 45 students, one (control condition) moved during the intervention period and another (intervention condition) asked to stop participating, probably because of the change in routine involved. Forty-three students (95% of the initial sample) were assessed at post-test and 39 students (87%) were assessed at follow-up (four students had moved between the last two waves of data collection and could not be located). Analyses were

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**Figure 1.** Flow chart of participants through each stage of the randomized study.
conducted separately for each wave of data collection on all available data.

Design

The intervention was offered by a research assistant in a small-group format outside the classroom. A randomized block design was used to assign the groups of students to the control and intervention conditions. In each school, participating students with similar oral (PPVT) and reading (word recognition) skills were assigned to groups of two to four members. The mean PPVT and word recognition scores were calculated separately for each of these homogeneous groups, and groups with similar mean scores were paired (i.e., blocked), irrespective of school. Within each block, one group was randomly assigned to the control condition and the other to the intervention condition (see Tables 1 and 2 for condition equivalence). Groups assigned to the control condition did not meet.

Pre-tests were completed before the beginning of the intervention. Post-tests were conducted 4 months later, approximately 1 week after the last intervention session. Follow-up assessments were completed 5 months after the post-test, during the first month of the following school year.

Teachers reported conducting reading instruction an average of 89.9 min per day, for a total of 449.5 min per week. To equate the amount of instruction received by students in the two conditions, intervention sessions (intervention condition) were normally scheduled during periods of regular reading instruction. These sessions (90 min per week) replaced only 20% (90/449.5) of the reading instruction students in the intervention condition would have normally received. Students in the control condition were not offered any intervention; they received only the regular reading instruction offered by their teacher.

Regular reading instruction in the control and intervention conditions followed the approved socio-constructivist program (Ministère de l’Éducation, 2001). This program emphasizes independent reading of texts and global word recognition (i.e., rather than decoding) and discourages all forms of explicit and systematic reading instruction. Furthermore, because of the province-wide adoption of the program, teachers do not have access to commercially available reading material to explicitly teach reading comprehension in French. Accordingly, this study compared students receiving some explicit reading comprehension instruction (intervention condition) with students receiving no such instruction.

Intervention

Overview. Groups assigned to the intervention condition received three 30-min sessions each week during 16 weeks, for a total of 24 hr of intervention. Of the 48 sessions, 42 were vocabulary and text reading sessions. Six other sessions, occurring at regular intervals during the intervention period, focused on the identification of anaphoric relations. 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

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Table 1. Pre-Test Characteristics of Students by Condition.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control (n = 21)</th>
<th>Intervention (n = 24)</th>
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<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
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<tr>
<td>Diagnosis</td>
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<tr>
<td>Autism</td>
<td>8</td>
<td>38.1</td>
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<tr>
<td>PDD, not otherwise specified</td>
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</tr>
<tr>
<td>Asperger syndrome</td>
<td>13</td>
<td>61.9</td>
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<tr>
<td>Chronological agea</td>
<td>9.3</td>
<td>1.6</td>
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<tr>
<td>Girls</td>
<td>1</td>
<td>4.8</td>
</tr>
<tr>
<td>General vocabularyb</td>
<td>7.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Word recognitionc</td>
<td>45.7</td>
<td>15.2</td>
</tr>
<tr>
<td>WISC-IV</td>
<td></td>
<td></td>
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<tr>
<td>Verbal comprehension</td>
<td>79.0</td>
<td>14.6</td>
</tr>
<tr>
<td>Perceptual reasoning</td>
<td>87.5</td>
<td>17.4</td>
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</tbody>
</table>

Note. PDD = pervasive developmental disorder; WISC-IV = Wechsler Intelligence Scale for Children–Fourth edition (French Canadian version; Wechsler, 2005).

*In years and fractions of years. †Age equivalence score on the French version of the Peabody Picture Vocabulary Scale (Dunn, Thériault-Whalen, & Dunn, 1993). ‡Number of words read correctly in 45 s (Desrochers, 2008).
instruction principles, see Carnine, Silbert, Kame’enui, & Tarver, 2009). A preliminary version of the intervention was successfully tested with a small sample of students not participating in the current study (Roux, Dion, & Barrette, 2014).

**Vocabulary and text reading sessions.** Each of these session consisted of four activities. Eight words were taught during the first activity of each session. Five of these words were introduced for the first time, whereas three others were reviewed from previous sessions. A total of 201 vocabulary words were taught over the 42 sessions. These were all “second-tier” 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 board. On this board, there was a drawing of the meaning of the word with, underneath, the word divided in syllables, with its complex graphemes underlined and its silent letters in lighter characters (see Figure 2). After having demonstrated the decoding of the word, the assistant read it normally 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 who had to give the definition of the word. The texts were written to be of an appropriate, if challenging, (second-grade) level of readability.

The third activity, main idea identification, was conducted with the text introduced in the second activity, a text in which each paragraph was structured around an identifiable main idea (see Figure 2). 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 offered help when required and wrote the answers and the main idea on a
board. Once the main idea had been identified, a drawing illustrating it (see Figure 2) 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 elaborate for themselves a coherent representation of the central aspects of the story, which is a key element of comprehension (van den Broek et al., 2009).

Identification of anaphoric relations sessions. The content of these six sessions was adapted from Baumann (1986). Key notions were introduced during the first two sessions (Weeks 3 and 5 of the intervention) and put into practice during the four last sessions (Weeks 7, 9, 11, and 13). During the first two sessions, the assistant explained the use of nine personal pronouns (e.g., that “I” refers to the person who is speaking) and then modeled 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 four 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 in two read-aloud activities. The first activity was conducted with paragraphs in which pronouns were underlined. Each student first read a paragraph normally and then reread it using the strategy for identifying the referent of each of the pronoun. The second activity was conducted with paragraphs in which each pronoun had been replaced by a blank and a choice of three pronouns. Each student read a paragraph and tried to select the appropriate pronouns.

Measures

Knowledge of definitions. Standardized vocabulary measures such as the PPVT are not sensitive to intervention effects (e.g., Coyne, Simmons, Kame’enui, & Stoolmiller, 2004), probably because they assess the knowledge of words that were not instructed. Accordingly, as recommended by the National Reading Panel (2000), learning of instructed (specific) word meanings was assessed at pre-test, post-test, and
follow-up with a researcher-developed measure, the content of which was aligned with the intervention. Twenty words were randomly selected among the 200 instructed words and, following Biemiller and Slonim (2001), a sentence was composed for each of the selected words (e.g., “Short sleeve shirts are common in summer.”). The research assistant read the sentence and asked the student, “What does [word] mean?” (the assessment was conducted orally). The answer was considered correct (1 point) when all key elements of the definition were mentioned (a verbatim of the definition was not required). It was considered partially correct (0.5 point) when only one key element was mentioned and, finally, unknown or incorrect (0 point) when no key elements were present. A total score was computed by summing up the individual item scores. The internal coherence of this score was adequate (α = .87). It has been demonstrated that such scores are sensitive to intervention effects (e.g., Coyne et al., 2004). A second research assistant blindly coded a random selection of 20% of the assessments, yielding an inter-rater agreement of 85.3%.

**Main idea identification.** Main idea identification was assessed at the three measurement occasions with a procedure adapted from Jitendra, Hoppes, and Xin’s (2000) work. The student had to read three narrative paragraphs (65–89 words) each time. After having read each paragraph, the student had to tell, with the paragraph left in view, what was the “important thing” this paragraph was saying. A coding scheme was devised for the present study. A maximum of 5 points was allowed for each main idea formulated by the student. Specifically, 1 point was given for a mention of the subject of the paragraph (i.e., the name of the character) and 4 points were given for a brief description of the central action described in the paragraph (e.g., going to see a movie). More points were allowed for the action because this element proved more discriminant than the subject (many students formulated main ideas including only the subject). Also, 1 point was subtracted for each superfluous element (invented or concerning a detail), for up to two elements. A score of zero was attributed to main idea responses with three or more superfluous elements. This prevented long answers with many superfluous elements from being given as many points as answers with only relevant elements. An average of the points obtained for the three main idea responses was calculated. A second assistant coded 20% of the assessments, yielding an inter-rater agreement of 96%.

To establish validity, four teachers blindly and independently rated the students’ three main idea descriptions. These teachers had experience with students with ASD but did not know any of the participants. They used a simplified scale (0 = “the idea is not there or diluted in details,” 1 = “the idea is incomplete or includes a few superfluous elements,” 2 = “the idea is complete and does not include superfluous elements”) to rate each idea description, and the teacher’s impressions were averaged for each student (and measurement occasion). As the agreement between teachers was good (intra-class correlation = .70), their (four) impression scores were averaged for each student. The idea was to create a consensus-based criterion against which our score could be compared. The correlation between our score and this criterion is strong (r = .83), demonstrating the (criterion) validity of our score.

**Identification of anaphoric relations.** At post-test and follow-up, the ability to identify the referent of pronouns was assessed with a procedure adapted from Baumann (1986). The student had to read a short narrative text (126 words) and find the referent of 10 singular (e.g., “I”) or plural (e.g., “they”) pronouns. To this end, the student first read the text without interruption and then reread it, sentence by sentence. During the second reading, the assistant pointed to the underlined pronouns and asked the student, “Who is [pronoun]?” Responses were categorized as correct (1 point) or incorrect (0 point) and summed to form a global score (α = .90). The inter-rater agreement, calculated for 20% of assessments, was 99%.

**Comprehension.** Comprehension was assessed by asking students to read aloud one or two second-grade–level narrative texts that were eight paragraphs in length and contained 258 to 271 words. Following McKeown, Beck, Omanson, and Perfetti (1983), one of the texts contained 14 instructed vocabulary words (out of a total of 270 words in eight paragraphs), and the other text contained 14 noninstructed vocabulary words of an equivalent difficulty level (out of a total of 271 words in eight paragraphs). Because of time constraints, only the text with noninstructed vocabulary words was read at pre-test. Both texts were read at post-test and follow-up.

The student was allowed 4 min to read each text. After the reading of each text, the text was hidden and the research assistant asked the student, “Tell me what was important in the story as if I had never heard it.” Allowing a maximum of two minutes, she noted the retell verbatim and, if needed, encouraged the student to elaborate. The relevance of assessing comprehension through retell is well established (e.g., Kame’enui, Carnine, & Freschi, 1982).

To code the retell protocols, we identified the sequence of central elements representing the gist of each story (Kendeou, van den Broek, White, & Lynch, 2009). One point was awarded for mentioning the element, and another point was awarded for mentioning it in the correct order. For instance, a student would receive 6 points for enumerating the second, fourth, and sixth elements of the story in that order but only 3 points for mentioning the same elements in reverse order. In line with recent theoretical models (van den Broek et al., 2009), this score indicates the degree to
which the student’s representations of the texts are complete and well structured. Although retell protocols are sometimes difficult to code reliably (Reed & Vaughn, 2012), this was not an issue here: A second research assistant coded 20% of the retell protocols, yielding an inter-rater agreement (intra-class correlation) of .94.

The assessment was validated with a reasonably large sample (N = 297) of typically developing French-speaking second graders (Arcand et al., 2014). This study showed that, as expected, the scores for the two texts correlated with the oral vocabulary of the students and the fluency of their reading. To further establish the validity of our comprehension scores, four teachers were asked to blindly and independently score the retell protocols of this sample of typically developing students. Teachers used a 6-point scale to indicate the level of comprehension, in grade equivalent (1 = beginning of first grade, 3.5 = middle of third grade), demonstrated by the student. Because of the high degree of agreement among the four teachers (intra-class correlation = .84), their ratings were averaged. The correlation (r) between the average teacher’s impression and our retell score was .78.

**Fidelity of implementation.** The fidelity with which assistants implemented the intervention and the extent to which students participated as expected was formally observed once, toward the end of the intervention period. A randomly selected session from one group of each assistant was recorded. Fidelity of implementation was coded based on this audio recording with a checklist of behaviors expected on the part of the assistant (16 items, e.g., “The assistant read the definitions”) and the students (eight items, e.g., “Students take turn reading the words”). Each item was scored as occurring, not occurring, or not applicable (e.g., D. Fuchs, Fuchs, Mathes, & Simmons, 1997). To establish inter-rater agreement, a second observer rated the recordings. Agreement was 96%.

**Procedure**

**Assessment.** Pre-tests (two 45-min sessions) were conducted in mid-January, post-tests (one 45-min session) in mid-May, and follow-up (one 45-min session) at the end of September of the next school year. Assessments were administered on a one-to-one basis in a quiet room close to the classroom by a research assistant, either an undergraduate or doctoral student in psychology or a master’s student in education. To avoid introducing a bias, the assistant assessing the student at post-test or follow-up was not the one who offered the intervention to this student (see below). The assistants conducted the assessments following a verbatim protocol, after having received 4 hr of training. They also made sure that the student felt at ease before beginning each assessment session.

**Intervention.** The intervention was offered by three research assistants, two doctoral students in psychology, and one master’s student in education. Following a schedule arranged with the teachers, the assistants offered the 16-week (January to May) intervention in a small-group format, outside the classroom. When a session could not be conducted as planned (e.g., because of a special activity), it was rescheduled later in the week or, exceptionally, the next week. Assistants implemented the intervention following a detailed protocol after a day of training offered by the main researcher. Throughout the intervention period, the principal investigator and the assistants met every other week and listened to audio recordings of intervention sessions conducted by the three assistants. Discussions focused on occasional difficulties with individual students (e.g., students who answered out of turn) and on strategies for maximizing the fidelity of implementation. Assistants worked in one to three schools and were responsible for two to three groups. On a typical week, they devoted an estimated 5 hr to commuting and meetings and intervened for another 4.5 hr.

**Results**

**Fidelity of Implementation**

The assistants offered all of the planned intervention sessions. Fidelity of implementation, expressed in percentage of observed expected behaviors, was adequate both for the assistants (range = 94%–100%) and the students (range = 88%–100%).

**Preliminary Analyses**

As the intervention was offered to groups rather than individuals and data could lack statistical independence, we considered conducting multilevel analyses (Raudenbush & Bryk, 2002). However, after controlling for group characteristics, statistical dependence for the post-test and follow-up scores proved negligible (mean intra-class correlation = .04). Consequently, to maximize statistical power, conventional analyses were used. Effect sizes are Cohen’s d.

**Condition Equivalence at Pre-Test**

An examination of the pre-test characteristics (see Table 1) and the pre-test scores (see Table 2) suggests that students in the two conditions were generally similar. In fact, no t-test comparison reached or approached significance. The only possible difference concerns a nonsignificantly greater proportion of girls in the control condition than in the intervention condition, \( \chi^2(1, n = 45) = 3.05, p = .08 \). This possible difference does not appear to have influenced the results. Of the 18 comparisons between girls and boys, only one reached significance, \( \chi^2(1, n = 45) = 4.00, p < .05 \), the one
involved dichotomized scores of identification of anaphoric relations at follow-up. More importantly, controlling for gender did not alter results from between-condition comparisons. Accordingly, this variable was not included as a control in the final version of the analyses. Similarly, comparisons of post-test and follow-up scores were first conducted by including, when available, the pre-test score as a control. As the inclusion of this control also failed to alter results, we simply present findings from independent sample t tests.

Regarding the sample as a whole, students’ age equivalence score on the general vocabulary measure (PPVT) was clearly inferior to their chronological age, a delay that was also apparent on the verbal IQ scale. However, as is typically the case for students with high-functioning ASD (e.g., Oliveras-Rentas, Kenworthy, Roberson, Martin, & Wallace, 2012), their scores on the performance (nonverbal) scale were generally higher and close to the population average.

**Between-Condition Differences at Post-Test**

At post-test, a significant difference was observed on knowledge of definitions, \( t(dl = 41) = 2.55, p < .01 \), whereby students in the intervention condition obtained higher scores than their control condition counterparts, with an effect size of 1.06. In comparison with those in the control condition, students in the intervention condition also identified main ideas with greater accuracy, \( t(dl = 41) = 3.40, p < .001 \), with an effect size of 0.92. Because of a strong ceiling effect, the distribution of scores on the measure of anaphoric relations was not normal (42% of students obtained an elevated score). To circumvent this problem, scores were dichotomized to make the distinction between students with a high score (of 8 or more on 10) from their peers with a lower score. Close to four times more students obtained a high score in the intervention condition (65.2%) than in the control condition (15.0%), a significant difference, \( \chi^2(1, n = 43) = 9.11, p < .001 \).

Regarding comprehension, students in the intervention condition had higher scores than their peers in the control condition for the retell of the text without instructed vocabulary words, \( t(dl = 41) = 2.18, p < .05 \), with an effect size of 0.67. However, the difference between students in the two conditions was not significant for the retell of the text with instructed vocabulary words, \( t(dl = 30) = 0.40, ns \) (nonsignificant).

**Between-Condition Differences at Follow-Up**

At follow-up, students in the intervention condition continued to score higher than their peers in the control condition on knowledge of definitions, \( t(dl = 37) = 2.20, p < .05 \), and identification of main ideas, \( t(dl = 37) = 2.47, p < .05 \), with effect sizes of 0.81 and 0.86, respectively. In contrast, although the percentage of students with an elevated score on anaphoric relation identification was twice as large in the intervention condition (50%) than in the control condition (26.3%), the difference did not reach significance, \( \chi^2(1, n = 39) = 1.42, ns \). Similarly, students in the two conditions no longer differed at follow-up on their comprehension of the text without instructed vocabulary, \( t(dl = 37) = 0.78, ns \), and of the text with instructed vocabulary, \( t(dl = 37) = 1.25, ns \), even if an effect size of .41 was observed for the latter.

**Discussion**

In this study, we examined the relevance of offering explicit reading comprehension instruction to students with high-functioning ASD. Compared with their peers who did not receive this instruction, students in the intervention condition made important gains in vocabulary knowledge and identification of main ideas. Although not entirely consistent, there were also indications that these students had improved their ability to identify anaphoric relations and understand texts. We interpret these findings as suggesting that explicit instruction of reading comprehension is relevant for students with high-functioning ASD but also that additional adaptations to the instructional approach are warranted.

The intervention was highly effective in improving students’ vocabulary knowledge and their ability to identify main ideas, positive effects that were still detectable at follow-up. One explanation for these substantial gains is that the intervention is based on explicit instruction principles (Carnine et al., 2009), principles whose soundness is well established, at least for students without ASD. As its name indicates, explicit instruction relies on a presentation of content that is as engaging and unambiguous as possible. It appears that notwithstanding their distinctiveness, students with high-functioning ASD respond well to this type of instruction. Informal observations also suggest that the students enjoyed the small-group format, the fast pace of instructional activities, the illustrated reading material, and the clarity of explanations. Students with high-functioning ASD might thus benefit from other evidence-based explicit instruction programs, for instance, programs for teaching students without ASD mathematical problem solving (L. S. Fuchs et al., 2010). More work is needed, however, before it can be assumed that explicit instructional programs found effective for students without ASD will also meet the instructional needs of their peers with high-functioning ASD.

Although the intervention had a strong effect at post-test on identification of anaphoric relations and on one of the comprehension measures, no such effect could be detected at the follow-up assessments conducted at the beginning of the next school year. A certain instability in the gains made as a result of a reading intervention is perhaps to be
expected. Indeed, many students without ASD will remain at risk of reading problems unless long-term improvements are brought to instruction (Dion, Brodeur, Gosselin, Campeau, & Fuchs, 2010), and this may also apply to students with high-functioning ASD. Nevertheless, considering that the intervention had a significant effect on only one of the two post-test comprehension measures, additional adaptations to the instructional approach seem warranted. Individualization, an interesting option, was not considered here because it made sense to start by offering the same intervention to all students. Individualizing instruction based on each student’s specific evolving needs is challenging; the student’s progress needs to be monitored continuously so that modifications can be brought to the instruction this student receives when progress is insufficient (Stecker, Fuchs, & Fuchs, 2005). Work with younger children with ASD suggests that individualization could nevertheless be worth the effort (Schreibman, Dufek, & Cunningham, 2011).

The present study has notable strengths in addition to its randomized design. It also has limitations. Screening was described in detail, making it easy to determine for which students with ASD the instructional approach is most relevant. Many studies conducted with students with ASD still rely on small sample sizes, limiting generalizability of their findings; our sample was comparatively large. Furthermore, even if it would have been preferable to formally observe fidelity of implementation more than once, there is little reason to suspect that the implementation was not uniformly adequate. The intervention was indeed implemented by closely supervised research assistants, a procedure for delivering instruction that can be associated with very large effect sizes (e.g., L. S. Fuchs et al., 2010), presumably because implementation is optimal and because of assistants having fewer responsibilities and facing less conflicting demands than teachers. However, using assistants as implementers leaves open the possibility that teachers may be unable to integrally implement the intervention, a question that can be settled only in a scale-up study conducted in normal practice conditions. Finally, researcher-developed measures were used. Even if evidence was presented to support the fidelity and validity of these measures, our sample cannot be compared with the general population.

In conclusion, it is encouraging to see that the reading comprehension of students with high-functioning ASD can be improved. Our findings generally support the idea that this group of students do not spontaneously perceive the coherence and meaning of complex stimuli (e.g., texts), but that they can learn to do so with appropriate help (Happé & Frith, 2006). We have focused here on a specific type of texts (narrative texts) and on the subset of skills and knowledge domains most relevant for understanding these texts. In all likelihood, students with high-functioning ASD could also benefit from high-quality instruction on inference making and comprehension of informative texts, to name only two examples.

Acknowledgment
We gratefully acknowledge the contribution of the principals, teachers, and students who made this study possible and thank Nathalie Plante, Johanne Rouleau, and Sophie Turcotte for their help in the planning of this study.

Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was supported by the ministère de l’Éducation, du Loisir et du Sport with additional support from the Fonds québécois de recherche sur la société et la culture (Grant 125020).

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