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**The Role of Learning Strategies in the Enhancement of  
Reading Comprehension of Expository Texts in  
Students with High-Functioning ASD and Typical  
Development**

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## Abstract

**Background.** Textual comprehension is the goal of each and every reader (Talmor, 2003). Many children, including those with High Functioning Autism Spectrum Disorder (HFASD) (IQ>75), struggle with reading comprehension. There are several popular theories concerning the root cause of these difficulties, among which are the theory of mind, weak central coherence theory, meaning focusing on the details and the whole picture and executive function challenges (working memory, planning, inhibitory control and cognitive flexibility) (Bauminger-Zviely & Kimhi, 2013). Learning strategy use is considered to be an assistive factor in helping children cope with reading comprehension tasks (Meyer & Ray, 2011). Nevertheless, the single study to explore the differences between strategies among children with HFASD is that of O'Connor and Klein (2004), who found that learning strategies are beneficial for high-functioning students on the autistic spectrum. Writing while reading was found to improve reading comprehension (McCarthy & Raphael, 1992) when answering close and open-ended questions. Two such strategies are main-idea extractor (Howorth, Lopata, Thomeer & Rodger, 2016) and visual-graphic organizers (Carnahan & Williamson, 2013; Carnahan, Williamson, Birri, Swoboda, Snyder, 2015; Zakas, Browder, Ahlgrim, & Heafner, 2013). Effectiveness was found for children with HFASD, but the two have never been compared.

**Research objectives.** The current study has several objectives: The first is to compare between third grade students with HFASD and students with typical development (TD) (central coherence, working memory, planning, inhibitory control and cognitive flexibility). The second objective is to compare reading comprehension capabilities of expository texts by answering close and open-ended questions by the two groups. The third is to examine the effectiveness of using a reading strategy for both groups. The fourth is to compare between the two strategies – main-idea extractor and visual-graphic organizers – employed by these students. The final objective is to identify correlation between central coherence, executive functions and reading comprehension of expository texts, and correlation between central coherence, executive functions and improved reading comprehension.

**Research questions and hypotheses.** We hypothesized that students with HFASD would demonstrate lower central coherence and lower executive functions

compared to students with TD. We also expected to see differences in performance between the groups in tasks that test implicit information comprehension when children did not use any learning strategies; that is to say, we expected children with HFASD to present lower results. Since no prior comparison has been made between children with HFASD and TD in regards to improved comprehension of expository texts following the use of strategy, we could not hypothesize as to the degree of improvement. We were unable to assess which strategy would be preferable for TD children. We assumed that for children on the autistic spectrum, a visual strategy that presents the correlation between pieces of information (visual-graphic organizers) would prove more beneficial compared to a main-idea extractor strategy. We also presumed that we would find a correlation between central coherence and explicit message understanding. We could not hypothesize about executive functions (working memory, planning, inhibitory control and cognitive flexibility) and reading comprehension (explicit and implicit messages), since it was not examined before in a full-length expository text. We also could not hypothesize about the correlation between central coherence capabilities, executive functions and improved reading comprehensions, since they were not examined before.

**Method.** The sample included 28 participants with TD, and 28 children with HFASD, all in the third grade. The TD group was comprised of 17 boys and 11 girls, whereas the HFASD group was comprised of 26 boys and 2 girls. The group of children with HFASD was comprised of clinically-diagnosed participants, per DSM-IV-TR definition (APA, 2000), who attend different public elementary schools in central Israel and attend the same language class as the TD students. The groups were distributed according to linguistic ability and mothers' education. Linguistic ability was measured using the PPVT-III linguistic assessment (Dunn & Dunn, 1997). The assessment was also used to establish the HFASD diagnosis. First, a teacher report was received, confirming that the child's level of interpretive reading is standard. Next, participants were asked to read out loud two lines of expository text to confirm the report. The study was comprised of two sessions, and tests were conducted in different order, so as to prevent bias.

To assess reading comprehension, participants first read the expository text "Houses" which appears in the standardized second-grade level test for students in

Israel (2009). They then had to answer eight open and close-ended questions (four that examine explicit message comprehension, and four that examine implicit message comprehension). The researcher wrote down the answers as they were told by the children. Participants in each group were randomly divided into two groups, so that four groups formed, 14 participants in each group (participants with TD that used main-idea extractor strategy, participants with TD that used visual-graphic organizers strategy, participants with HFASD that used main-idea extractor strategy and participants with HFASD that used visual-graphic organizers strategy). Each group was shown one of the strategies and how to use it. Following a demonstration, the children applied the learning strategy to the text "Houses" that they had previously read, and then asked to apply the same strategy to a second expository text, "Which plants are beneficial and which are harmful". The latter was also taken from the standardized second-grade level test for students in Israel (2008), and was followed by eight questions, similar in nature to those appearing in the first text. Each text was 130 words long.

To assess cognitive functioning, participants performed the following tasks over the two sessions: one for assessing central coherence using the Children's Embedded Figures Test (CEFT) (Witkin, Oltman, Raskin, Karp, 1971), and additional ones for assessing executive functions that include working memory using digital span (WISC-III; Wechsler, 1995), planning using the Tower of London (TOL) assessment (Shallice, 1982), inhibitory control and cognitive flexibility using the Delis-Kaplan Executive Functions System (D-KEFS) (Delis et al., 2001).

**Results.** The results of the study partially affirmed our first hypothesis and revealed differences between the groups in three indices: working memory, inhibitory control and cognitive flexibility. Surprisingly, no distinct differences were found between the groups in central coherence and planning, contrary to prior studies (e.g., Frith, 1989; Norbury & Bishop, 2002; Norbury & Nation, 2011). Looking into differences between groups in regards to reading comprehension, the hypothesis was confirmed: no distinct differences were found between the groups in terms of explicit information comprehension, but we did find a distinct difference in implicit information comprehension. Children with HFASD achieved lower results than their TD peers. Moreover, no difference was found in responses to close-ended questions, but we did find a tendency for variance between the groups when it came

to open-ended questions. As for improvement following strategy application, no distinct differences were found for any of the reading comprehension capability indices. Nevertheless, we did find that in both groups, students who started out at a lower baseline improved, compared to those who started out at a higher level. The hypothesis stating that the visual- graphic organizer strategy will be more beneficial for students with HFASD than main- idea extractor strategy was confirmed. TD students displayed equal improvement with each of the two strategies; visual- graphic organizers appeared to be more beneficial for students with HFASD than main- idea extractor strategy. In exploring the correlation between cognitive capabilities and reading comprehension among students with HFASD, we found a significant positive correlation between planning and their ability to comprehend implicit messages in expository texts. We also found a distinct negative correlation between central coherence and improvement in comprehending explicit messages. Additionally for these children, we found a positive correlation between inhibitory control and implicit message comprehension, and a negative correlation between inhibitory control and improved explicit message comprehension capability. In TD students, we found a positive correlation between inhibitory control and explicit message comprehension, and a negative correlation between working memory and inhibitory control and improved explicit message comprehension. Moreover, we found a positive correlation between cognitive flexibility and implicit message comprehension, and a negative correlation between cognitive flexibility and improved implicit message comprehension.

**Conclusions.** The current study has both scientific-literary contributions, and applicative-educational ones. It joins a series of recent studies concerning the use of strategies for third grade students with HFASD as a means for helping them comprehend full-length expository texts. The current findings reveal that the very use of a strategy helps improve the comprehension of expository texts for any child, with HFASF or TD. For children with HFASD, a visual- graphic organizer strategy that demonstrates the relationships between the information in the text is preferable to the main- idea extractor strategy.

Moreover, the current study found correlation between executive functions and reading comprehension of both implicit and explicit messages, as well as correlation between central coherence and executive functions and improved reading

comprehension following usage of learning strategies. These findings can benefit teachers and teaching staff at work, and point out that alongside reading skills, one must also develop the cognitive functions with which the student is struggling and provide them with a suitable strategy for overcoming this obstacle.