

BAR-ILAN UNIVERSITY

Cognitive Functions Related to Reading
Comprehension for Typically-Developing
Students and for Students with High
Functioning Autism Spectrum Disorder

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Abstract

Background. Children diagnosed with High Functioning Autism Spectrum Disorder (HFASD) often struggle with reading comprehension (Heumer & Mann, 2010; McIntyre1 Solari1, Gonzales, Solomon, Lerro, Novotny, Oswald & Mundy, 2017; Nation, Clarke, Wright, & Williams, 2006; O'Connor & Klein, 2004), particularly of narrative texts (Volkmar, Paul, Klin, & Cohen, 2005). Reading comprehension is considered a highly complex cognitive process. In many cases, children with HFASD present difficulties when academic demands of reading comprehension shift from concrete tasks of explicit message comprehension to abstract tasks that include the comprehension of implicit messages (Smith-Myles, Hilgenfeld, Barnhill, Griswold, Hagiwara & Simpson, 2002). Recent studies explored three key cognitive theories in an attempt to understand the correlation between the style of cognitive processing and academic struggles exhibited in HFASD individuals (Hill, 2004). It appears that some reading comprehension difficulties can be explained by theory of mind (Associating mental states such as beliefs and intentions to the person himself or others) (Asberg & Sandberg, 2010; Mar, 2011), central coherence (Comprehension of the subject's essence) (Asberg & Sandberg, 2010; Happe & Frith, 2006) and executive functions (High-order cognitive skills such as working memory, planning, inhibitory control and cognitive flexibility) (Asberg & Sandberg, 2010).

Research objectives. The current study has several objectives: The first is to expand research in the field of cognitive functions among children with HFASD. The second is to examine reading comprehension (explicit and implicit messages) of narrative texts among third grade students with HFASD, compared to students with neurotypical development. The third is to explore the contribution of each cognitive theory to explain reading comprehension among children with HFASD. The final objective is to explore the correlations between each cognitive theory to reading comprehension (explicit and implicit messages) of narrative texts among children with HFASD, compared to students with neurotypical development.

Research hypotheses. Concerning differences between the research groups, we hypothesized that neurotypical children will exhibit better results in tasks that examine cognitive functions –

the second order theory of mind task, the central coherence task and executive function tasks (working memory, planning, inhibitory control and cognitive flexibility) – compared to children with HFASD. We also hypothesized that children with neurotypical development will display greater reading comprehension skills, particularly of questions pertaining to implicit messages, compared to third grade students with HFASD. In terms of correlation between the research variables, we hypothesized that we would find a positive correlation between children's capabilities in the theory of mind task and comprehension of implicit message-related tasks. In addition, we expected to find that the HFASD group will exhibit a positive correlation between weak central coherence and explicit message comprehension of the long narrative text, and negative correlation between weak central coherence and implicit message comprehension. Lastly, in line with the literature review and to the best of our knowledge, the correlation between working memory, planning, inhibitory control and cognitive flexibility and the comprehension of a long narrative text (implicit and explicit messages) among these two groups was never explored; for that reason, we could not hypothesize on the correlation and its nature between the components of executive functions and reading comprehension among the two groups.

Research questions. In regards to the study variables, we wanted to find out whether there will be a positive correlation between cognitive capabilities (theory of mind, central coherence and executive functions) and reading comprehension (implicit and explicit messages) in narrative texts beyond the groups. We also wondered whether we would find difference in correlation between cognitive functions (theory of mind, central coherence and executive functions) and reading comprehension between the two groups.

Method. The sample included 28 participants with neurotypical development, and 28 children with HFASD, all in the third grade. The neurotypical 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 a school in central Israel and attend the same language class as the neurotypical students. The groups were distributed according to linguistic ability and mothers' education. Verbal IQ was measured using the PPVT-III linguistic assessment (Dunn & Dunn, 1997). In addition to acting as a baseline for

comparison between the groups, this test was also used to establish the HFASD diagnosis ($VIQ \geq 75$). First, a teacher/parent report was received, confirming that their child's level of interpretive reading is standard. Next, participants were asked to read out loud two lines of informative 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 read a two-page long narrative text based on a text from an assessment test (part I of the standardized second-grade level test kit for students in Israel, 2013). After reading, participants were asked to answer seven comprehension questions (three pertaining to explicit messages – locating and identifying information – and four pertaining to implicit messages – interpretation and deduction. To assess cognitive functioning, participants performed the following tasks over the two sessions: one task for examining the theory of mind from a second order belief perspective (Baron-Cohen, O'Riordan, Stone, Jones & Plaisted, 1999), another for assessing central coherence using the Children's Embedded Figures Test (CEFT) (Witkin, Oltman, Raskin, Karp, 1971), and additional tasks 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, Kaplan, & Kramer, 2001).

Results. The results of the study partially affirmed our first hypothesis concerning difference between groups in terms of cognitive functioning. We found differences in capabilities in favor of neurotypical children, compared to children with HFASD, in theory of mind and executive functioning in the working memory and cognitive flexibility indices. As for the other indices, no distinct differences were found between the groups. The results of the study disproved our second hypothesis – in examining the differences between the groups in terms of reading comprehension, to our surprise and contrary to previous studies (e.g., Smith- Myles et al., 2002), we did not find significant comprehension difficulties among students with HFASD and their neurotypical peers, even in implicit message comprehension. For questions pertaining to the correlation between the study's variables, a series of multiple regressions was performed. Results pertaining to the question of whether we would find correlation between cognitive functions (theory of mind, central

coherence and executive functions) and reading comprehension (explicit and implicit messages) in narrative texts beyond each group, we found that greater achievements in theory of mind capabilities for both groups pointed to a better understanding of implicit information. To our surprise and contrary to prior studies (Frith & Happe, 1994; Jolliffe & Baron-Cohen, 1999; Randi, Newman, & Grigorenko, 2010), no positive correlation was found in either group between central coherence and explicit message comprehension. Since no direct correlation between cognitive functions (working memory, planning, inhibitory control and cognitive flexibility) and reading comprehension (explicit and implicit messages) of narrative text has been explored for both groups, the results of the current study present innovative information concerning this correlation and its adjustment between executive functions and reading comprehension. In other words, greater achievements in planning, inhibitory control and cognitive flexibility point to a better understanding of implicit information. No distinct group effect was found for reading comprehension indices for any of the analyses. Lastly, concerning the question of whether we would find differences in correlation between cognitive capabilities (theory of mind, central coherence and executive functions) and reading comprehension between the two groups, we found effects of interaction between the HFASD group and planning and central coherence. When children with HFASD displayed greater capabilities in these cognitive functions, we found a tendency to perform better in reading comprehension.

Conclusions. The current study has both scientific and academic contributions to the study of children with HFASD. It expands the scope of knowledge attained through studies that explored the academic capabilities of children with HFASD in regards to reading comprehension of long narrative texts. Furthermore, the current joins a small number of recent studies that examine cognitive functions which contribute to reading comprehension of narrative texts. Its innovation is in examining the total cognitive functions explored in this study. Findings provide educators with information on how certain cognitive function capabilities can contribute to narrative text reading comprehension of children with HFASD. Awareness to the role of these variables in reading comprehension can help make decisions pertaining to assessment, intervention and the improvement of cognitive functions in children with autism.