Reading strategies in children with ASD while reading texts and answering questions that do, or do not, require inference generation: An eye movement study

Martina Micai, Holly Joseph, Mila Vulchanova, David Saldaña

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Profile of Readers with Autism Spectrum Disorder (ASD)

- Reading comprehension problems (-0.7 SDs)
  Brown & Oram-Cardy, 2013: Meta-Analysis

- Strength in word identification
- Hyperlexia (5-10%)
- IQ
- Vocabulary
- Working Memory
Practical Issues

Cognitive profile in the norm

Reading comprehension problems can cause difficulties in everyday life
Previous Studies on Inferences in ASD

- ASD activated the appropriate world knowledge primed by implicit inferences while reading, as TD (Saldaña & Frith, 2007)

- ASD spent more time fixating on text, made more overall fixations and regressions while reading than TD (Sansoti, Was, Rawson & Remaklus, 2013)

- Vocabulary is associated with inferencing ability (Lucas & Norbury, 2015)
Research Questions

• What cognitive functions are involved in responding to literal and inferential passage-dependent questions?

• Is there a different strategy in responding to questions in ASD and TD?

• Accuracy

• Eye movement measures
Participants

22 ASD
19 males
Autism Diagnostic Observation Schedule (ADOS)
Autism Spectrum Quotient (AQ)

Exclusion criteria:
• WISC-IV ≤ 70
• Other disorders in comorbidity

22 TD
15 males
Cognitive measures

• **WISC-IV**: Verbal Comprehension, Perceptual Reasoning, Working Memory, Processing Speed

• **TALE**: Reading Speed and Accuracy; Reading Comprehension

• **Peabody**: Vocabulary Size

• **TROG**: Grammatical Structures Comprehension

• **Theory of Mind**: False Belief Task
<table>
<thead>
<tr>
<th>Measure</th>
<th>Mean (SD)</th>
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</thead>
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<td></td>
<td>ASD</td>
<td>TD</td>
<td>p</td>
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<tr>
<td>Age</td>
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<td>13.43 (2.5)</td>
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<tr>
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<td>108.7 (12.5)</td>
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<td>107.2 (17.8)</td>
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<tr>
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<td>108.8 (13.1)</td>
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<tr>
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<td>106.8 (12.7)</td>
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<tr>
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<td>110.4 (11.4)</td>
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<tr>
<td>Peabody</td>
<td>107.9 (18.5)</td>
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<td>.96</td>
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<tr>
<td>TROG (Standardized Scores)</td>
<td>.1 (.6)</td>
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<td>Reading Speed (Standardized Scores)</td>
<td>-.2 (.9)</td>
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<td>Reading Comprehension</td>
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<tr>
<td>Theory of Mind</td>
<td>5.1 (1.5)</td>
<td>6.3 (1)</td>
<td>.01</td>
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</tbody>
</table>
Experimental design

2 conditions

Literal

TEXT
(containing the correct answer)

QUESTION
• CORRECT answer
• SEMANTIC distractor
• IN TEXT distractor

Inferential

TEXT

QUESTION
• CORRECT answer
• SEMANTIC distractor
• IN TEXT distractor

5 stories divided in 6 paragraphs
15 trial each condition
Era lunes por la mañana y hacia mucho sol. Don Francisco le dio la comida a su loro y luego se fue para ver si el gato Mico estaba bien. Dormía profundamente y parecía que estaba soñando. Las piernas de Mico se movían para adelante y para atrás como si estuviera imaginando a un ratón que perseguía velozmente, intentando atraparlo.

Que animal es Mico?

a. Un perro  
b. Un loro  
c. Un gato
It was Monday morning and was really warm. Mr. Francisco fed his parrot and then went over to check that the cat Mico was ok. He was in a deep sleep and appeared to be dreaming. Mico’s legs were moving back and forth as if he was imagining chasing a mouse very fast, trying to catch it.

What animal is Mico?

a. A dog
b. A parrot
c. A cat

Critical word
Inferential condition

It was Monday morning and was really warm. Mr. Francisco fed his parrot and then went over to check that the little Mico was ok. He was in a deep sleep and appeared to be dreaming. Mico’s legs were moving back and forth as if he was imagining chasing a mouse very fast, trying to catch it.

What animal is Mico?

a. A dog
b. A parrot

c. A cat

Critical word

Semantic distractor
In text distractor
Correct answer
Results

Accuracy

% Correct Responses

Literal

Inferential

ASD
TD

* $p < .05$
### Answering question during reading and cognitive functions

**Zero-order correlations between accuracy scores and standardizes tests for ASD and TD**

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<thead>
<tr>
<th>Measure</th>
<th>Literal Accuracy</th>
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<tr>
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<td>-.28/ .18</td>
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<td>.34/ .32</td>
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<tr>
<td>WISC-IV Verbal Comprehension</td>
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<td>.23/ .11</td>
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<td>.45/ .14</td>
<td><strong>.68</strong>*/ .53</td>
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<td>.12/ .07</td>
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<tr>
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<td>.30/ .12</td>
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<td>.05/ .57**</td>
<td>.26/ .35</td>
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<td>.24/ .49*</td>
<td>.11/ .42</td>
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<tr>
<td>Reading Comprehension</td>
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<td>.21/ .22</td>
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<tr>
<td><strong>Theory of Mind</strong></td>
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*Note.* *p < .05; **p < .01
Answering question during reading and cognitive functions

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¿Qué animal es Mico?

a. Un perro
b. Un loro
c. Un gato
ASD and TD showed overall the same behaviour during reading paragraphs

- Number and mean duration of fixations
- Number of regressions
Question explored before the critical word

¿Qué animal es Mico?

a. Un perro
b. Un loro
c. Un gato

Critical word

Question
Question explored after the critical word

Critical word

Question

a. Un perro
b. Un loro
c. Un gato

¿Qué animal es Mico?
INFERENTIAL

% CORRECT answers

* $p < .05$

QUESTION BEFORE  QUESTION AFTER

ASD  TD
Discussion

No differences in accuracy between groups:

• High functioning individuals
• No differences in reading comprehension scores in standardized tests between ASD and TD
• Computerized and structured task
• On-line task
Answering inferential questions and cognitive function in ASD

- **Vocabulary skills** are associated with inferencing generation during reading
  (Lucas & Norbury, 2015)

- **Nonverbal IQ**: organize and use strategies through problems

- **Theory of Mind**: imply high level inference generation
  (Kim, 2015)
Reading strategy

ASD found benefit in reading the question before to approach the text during inferencing generation
Acknowledgments

• Children, parents, and schools
• Students and my colleague Sobh Chahboun

Thank you for your attention