Intervention in typical language development and autism: A common metric
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Models of syntactic comprehension from formal syntax based on Relativized Minimality (1) as well as recent psychological models of memory (2) both grant a special status to intervention in long-distance dependencies involving movement, and to similarity-based interference (3-4). Research on language development has recently underscored the role of movement on the one hand (5) and feature-based similarity interference on the other (6-7). The aim of the present study is to systematize the observations into a global picture of the complexity metric, which involves three cumulative factors: movement, intervention and similarity (see Table). If such a complexity metric is at play in children’s sentence comprehension, four levels should characterize performance: the highest Level 1 is expected in structures involving no movement, Level 2 in structures involving movement without intervention, Level 3 in structures involving movement and intervention from a featurally different element, and Level 4 in structures involving movement and intervention from a similar element. Moreover, if this metric reflects major principles of the grammar/parser, it should manifest across both typically and atypically developing children.

Our participants included 45 typically developing children (TD) from three school levels (mean ages 4;9, 6;8 and 8;8) and a group of 15 atypically developing children with Autistic Spectrum Disorder (ASD) aged 6 to 16 (mean age 9;4). Eight syntactic structures distributed in the four levels of the metric were tested (see examples below). Level 1: (a) Wh- Object questions in situ with a -NP object and (b) Wh- Object questions in situ with a +NP object; Level 2: (c) Wh- Subject questions with a -NP subject, (d) Wh- Subject questions with a +NP subject, and (e) Subject relatives with a +NP subject; Level 3: (f) Wh- Object questions ex situ with a -NP object; Level 4: (g) Wh- Object questions ex situ with a +NP object and (h) Object relative clauses with a +NP object. All structures were studied within-subjects with a procedure of sentence picture matching based on materials from (7). Children with ASD performed similarly to TD children aged 4;9, except for Level 3 for which they performed significantly worse (p < .05). Nevertheless, comparisons across the 4 levels of the complexity metric showed an identical profile: both mean TD and ASD performance was significantly better in Level 1 than Level 2 and in Level 2 than Level 3 (ps < .05). Although a trend is observed towards better performance in Level 3 than Level 4, this trend failed to reach significance level in both groups.

Overall, observations across a wide range of syntactic structures support the hypothesis that movement and intervention play a significant, cumulative role in children’s sentence comprehension. However, similarity, implemented by the lexical +NP restriction of the subject and object in Wh- questions, did not appear to play a role. Further research is necessary to determine the cause for this absence of effect. One possibility is that lexical restriction requires sentences to be put in context in order to be fully operational. Finally, the data provide interesting evidence with respect to syntax in ASD, which has only seldom been explored to date (8-9). Importantly, despite their strong deficit in syntactic comprehension, children with ASD were found to be sensitive to the same factors of movement and intervention as TD children, providing evidence for the core, principled role of these factors in sentence comprehension.
Examples
(a) (Montre-moi) Le lapin poursuit qui?
(Show-me) The rabbit is chasing who?
(b) (Montre-moi) Le lapin poursuit quel chat?
(Show-me) The rabbit is chasing which cat?
(c) (Montre-moi) Qui poursuit le chat?
(Show-me) Who is chasing the cat?
(d) (Montre-moi) Quel lapin poursuit le chat?
(Show-me) Which rabbit is chasing the cat?
(e) (Montre-moi) Le lapin qui poursuit le chat.
(Show-me) The rabbit who is chasing the cat.
(f) (Montre-moi) Qui le lapin poursuit?
(Show-me) Who the rabbit is chasing?
(g) (Montre-moi) Quel chat le lapin poursuit?
(Show-me) Which cat the rabbit is chasing?
(h) (Montre-moi) Le chat que le lapin poursuit.
(Show-me) The cat that the rabbit is chasing.

Table
Percentage of correct responses in TD and ASD children across the four levels of complexity as characterized by 3 cumulative theoretical factors: movement, intervention and similarity.

<table>
<thead>
<tr>
<th>Level</th>
<th>Movement</th>
<th>Intervention</th>
<th>Similarity</th>
<th>TD 4:9</th>
<th>TD 6:8</th>
<th>TD 8:8</th>
<th>TD Mean</th>
<th>ASD 9:4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>86.1</td>
<td>97.8</td>
<td>100</td>
<td>94.6</td>
<td>83.8</td>
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<tr>
<td>Level 2</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>86.8</td>
<td>95</td>
<td>95.9</td>
<td>92.6</td>
<td>75</td>
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<tr>
<td>Level 3</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>70</td>
<td>73.3</td>
<td>90</td>
<td>77.8</td>
<td>60.8</td>
</tr>
<tr>
<td>Level 4</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>52.8</td>
<td>80.8</td>
<td>87.8</td>
<td>73.6</td>
<td>56.6</td>
</tr>
</tbody>
</table>

References
(2) Van Dyke, J.A. (2012). Memory Interference as a Determinant of Language Comprehension. Language and Linguistics Compass, 6, 193-211.