Guess What?
Comparing Ad-hoc and Scalar Implicatures in Children with Autism Spectrum Disorder

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Pragmatic abilities of people with Autism Spectrum Disorder (ASD) have been the subject of extensive research, often considering their communicative problems as derived from their deficit in Theory of Mind (ToM). On the other hand, recent studies on the derivation of scalar implicatures (SIs)– such as *some but not all* that are built on certain lexical items ordered in an entailment scale based on their informativeness, e.g. <some, all> − found no differences between typical population and people with ASD (Chevallier et al., 2010; Pijnacker et al., 2009; Su & Su, 2015). Verbal intelligence (VIQ) and ToM development have been claimed to play a role; despite this, ToM was not included in any of these studies. Moreover, testing SIs as the only case of pragmatic inferencing might be problematic, if we consider that scales like <some, all> need to be lexicalized for the SI to be derived, and that a failure in this case might arise from difficulties in retrieving the lexical alternatives (Barner et al., 2011; Foppolo et al., 2012), thus it might not reflect a truly pragmatic problem.

In our experimental study, 28 Italian speaking children were tested, of whom 14 were high-functioning ASD children (mean age = 7;4 mos, range, 55-124 mos) and 14 were age matched typically developing (TD) children (mean age = 7;2 mos, 57-111 mos); t(26) = .214; p = .833. Participants were administered a Picture Selection Task (PST) to assess the computing of scalar and *ad-hoc* (context- based) implicatures (c.f., Surian & Job,1987; Stiller, Goodman & Frank, 2015). Participants were asked to detect the correct target (among 4 pictures) by exploiting a sentential cue provided by a character. In the SI condition, participants were presented with 4 statements containing the quantifier *some*. For instance, in Figure 1a, the picture shows two possibly correct answers to the implicature statement (1) the cake in which *all* the candles are lit (logic answer) and (2) the cake in which *only some* of the candles are lit (pragmatic answer). Figure 1b shows the ad-hoc condition in which choosing the character with only glasses is a pragmatic answer and choosing the character with both glasses and a hat is a logic answer. Note that in this condition the pragmatic inference is derived contextually. There also was a control condition, consisting of 6 statements, 2 with the quantifier *all* and 4 with no quantifier.

The PST is informative because the relevant alternatives are verbally and visually provided; this can offer a valid solution for the debate regarding SI computation. In addition, both ASD and TD participants received an IQ test (Raven, 1998), a lexical and syntactic language tests (BVL: Marini et al., 2015) and seven ToM tasks (c.f., Wellman & Liu, 2004). ASD and TD children did not differ neither for IQ abilities (unpaired $t(26) = 1.359$; p = .186) nor for syntactic ($t(26) = 1.053$; p = .302) abilities. However, the two groups differed in term of lexical abilities (U = 150; p = .01) and ToM abilities (TD ToM mean correct = 75%, ASD ToM = 44%; U = .142; p = .04).

The average percent correct in the control condition is 98% for the ASD and 96% for the TD. Figure 2 shows the results of the picture selection task for the underinformative items. The TD's average percent correct in the ad-hoc implicature condition was significantly higher than the ASD's (TD ad-hoc = 95% vs ASD ad-hoc = 70%; Kruskal-Walliss H: χ^2 (1) = 4.989; p = .03). However, there was no difference between the two groups' percent correct in the SIs condition (TD SIs = 79% vs ASD SIs = 61%; χ^2 (1) = 0.569; p = .45).

There was no correlation between SIs performance and ad-hoc performance for either group. For the TD group, there was a significant positive correlation between Age and percent correct in

both the ad-hoc and SIs condition (r = .690; p = .006 & .562; p = .04 respectively). The TD group showed no correlation between ToM performance and the percent correct in the two conditions. In contrast, the ASD group's correlations between Age and percent correct in the ad-hoc and SIs condition were r = .645; p = .01 & .412; p = .14, respectively.
For further analysis, we decided to conduct Pearson Partial Correlation, controlling for Age. Data on ASD children show:

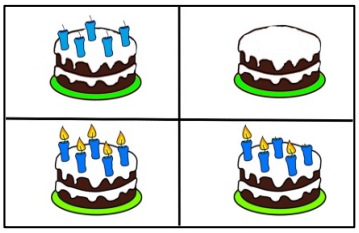
(i) a correlation of ToM with SIs (r = .647; p =.02) but not with ad-hoc implicatures (r = .108; p = .73)

(ii) a correlation between SIs and syntactic competences (r = .676; p =.01). Moreover, ToM abilities correlate with syntactic competence (r = .727; p = .005).

The results showed that TD group's performance was significantly better in the ad-hoc condition than the ASD's, and both groups' performance was related to Age. With respect to the SIs condition, the TD group's performance was numerically better than the ASD group, but the difference was not significant, which may be due to a lack of power. Moreover, there is again a positive relationship between Age and SI performance, but only for the TD group. For the ASD group, there are positive relationships between SI performance and ToM as well as the linguistic syntactic measure. These relationships suggest that there is something different underlying the two groups' performance in the SI condition. In computing SIs, ASD children seem to rely mainly on their syntactic linguistic abilities, which in turn are strongly connected with ToM skills; this connection can be related with the syntactic complexity of ToM's clauses that involve subordination e.g. *You believe that I believe that you believe*. On the other hand, given that the best predictor for ad-hoc implicatures computation in ASD children is Age, we may suggest that indeed there is a delay in the development of pragmatic abilities in ASD children, also confirmed by the lower ToM scores in the ASD group. In conclusion, it seems that the computation of SIs and ad-hoc implicatures rests on different computational mechanisms and future research should take this insight into consideration.

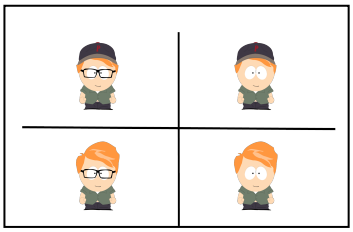
Figure 1. Picture Selection Task. A: Example of SI condition; B: Example of ad-hoc condition.

A)



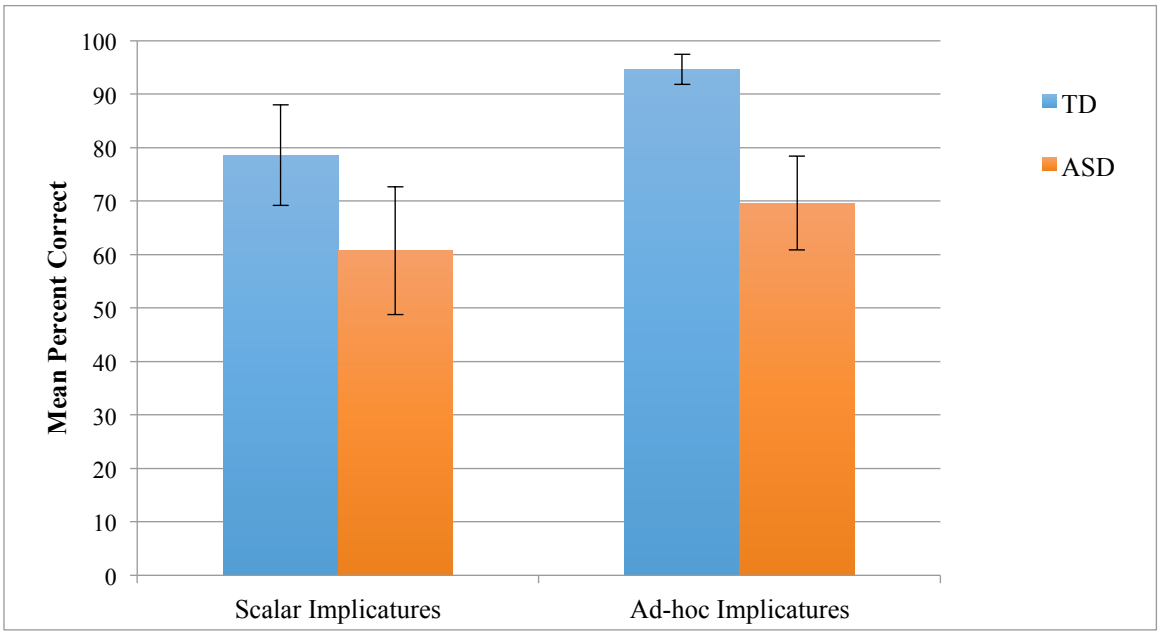
Lead-in sentence
Guess which one is my birthday cake, I give you a cue.
Target sentence
On my birthday cake, some of the candles are burning.

B)



Lead-in sentence
Guess who is my friend, I give you a cue.
Target sentence
My friend wears glasses.

Figure 2. Mean percent correct (std error) for the two groups in the PST



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