

The atypical pattern of irony comprehension in children with high-functioning autism

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Irony comprehension is a complex task that typically developing (TD) children reach around the age of six. Some scholars (Sullivan et al., 1995 a.o.) claimed that 2nd order Theory of Mind (ToM) skills are required to understand irony, but also linguistic abilities (which predict ToM development: Milligan, Astington & Dack, 2007) play a role (Filippova & Astington, 2008; Bosco & Gabbatore, 2017). Conversational experiences as well might account for the asymmetry in the recognition of ironic criticisms, the most common form of irony, and ironic compliments (Dews & Winner, 1997). Children with high-functioning autism (HFA) have intact linguistic abilities, but impaired social relations. Some children with ASD pass even 2nd order ToM tasks, even if they could be using compensatory verbalizing strategies (Fisher, Happé & Dunn, 2005; Happé, 1995; Tager-Flusberg, 2000).

We tested irony comprehension in HFA children with the aim to assess the contribution of the factors that may facilitate it and disentangle their relationships. In this study, we tested 26 HFA children (mean age = 7;2, range 45-123 mos) and 26 age-matched TD children ($p = .98$). All participants were tested for non-verbal IQ (Raven Coloured Progressive Matrices: Belacchi et al., 2008), ToM (5 tasks up to 2nd order ToM: Wellman & Liu, 2004; Sullivan et al., 1994) and linguistic abilities (lexical and syntactic tasks of the *Batteria di Valutazione del Linguaggio*: Marini et al., 2005). To assess irony comprehension we created a new task that consists of 10 short stories with a concluding remark that can be either literal (4) or ironic (3 ironic compliments and 3 ironic criticisms); all stories were recorded controlling for prosody. Participants had to answer 3 questions: i) detection of speaker's meaning ii) context recognition (control) and iii) understanding of speaker's attitude.

The two groups did not differ in non-verbal IQ ($t(50) = 9.66, p = .51$) and BVL-lex scores ($t(50) = 1.24, p = .22$), whereas TD children had higher scores on the BVL-synt ($t(50) = 3.23, p = .002$) and on the ToM tasks ($t(50) = 7.61, p < .001$). We analyzed responses to the key question to understand irony, i.e. questions on speaker's meaning and attitude. Considering literal stories, accuracy was at ceiling in both groups (HFA: 99%; TD: 99.5%). Group results on the ironic stories are reported in Table 1, individual results are shown in Figure 1. We performed a mixed-effect logistic regression, with accuracy on the meaning and attitude questions as dependent variable, and group (HFA vs TD), type of irony (compliments vs criticisms) and their interaction as fixed factors. Subjects and items were added as random factors. The group by type of irony interaction was not significant and it was removed from the model. The two main fixed factors were significant: in both types of irony, accuracy was higher in TD children compared to ASD children ($\beta = 8.25, SE = 2.52, z = 3.27, p = .001$) and, in both groups, accuracy was higher on criticisms than on compliments ($\beta = 0.90, SE = 0.32, z = 2.83, p = .005$). Pearson

correlations revealed that in the HFA group only ToM abilities were significantly correlated with irony comprehension ($p < .001$), whereas in the TD group we initially found a correlation with age, non-verbal IQ, language (all $ps < .001$) and ToM, and specifically a correlation between ToM and ironic criticisms ($p = .003$); after controlling for age, only syntactic abilities continued to correlate ($p = .03$).

HFA children showed a peculiar pattern: their accuracy on literal stories was at ceiling, demonstrating that they understood the task, but in irony comprehension they lag behind their TD peers matched for age and non-verbal IQ. Even if this result was not unexpected, given the impairment in social communication associated to HFA, our group of 26 HFA showed a somehow surprising bimodal distribution. As featured in Figure 1, most children (16) exhibited an extremely low performance (LP: $< 25\%$ accuracy) in ironic stories, whereas some (6) demonstrated a full comprehension of all ironic stories, reaching 100% accuracy (HP: High Performance). Moreover, differently from the TD group, accuracy on ironic stories did not depend neither on age nor on (non-)verbal IQ in HFA participants. And conversely ToM skills played a significant role in irony understanding only for HFA children, and not for TD children.

In order to account for these data, we can hypothesize that – in general – HFA children show an impairment in pragmatic inference abilities and in ToM abilities (see Loukusa & Moilanen, 2009 and Baron-Cohen, 2000 for a review), as found also in our sample of LP children. The HP children, on the other hand, might adopt a strategy, different from TD children, to respond correctly to ironic stories, as suggested by Wang et al. (2006). Interestingly, Pexman et al. (2011) found that HFA children, who did not differ in accuracy with respect to TD controls, applied a different processing strategy for irony comprehension, and hypothesized that they resort to a more rule-based strategy, with an intellectual-style approach to compensate their social deficits. Our bimodal distribution could then identify two classes of HFA participants: the LP ones correspond to the pragmatic-impaired profile of HFA, the HP ones on the other hand could be using a compensatory strategy, since they could have been trained to recognize irony and/or other persons' states of mind (ToM) during speech therapy sessions, as reported in Persicke et al. (2013). Future research should investigate this hypothesis more in depth, with a longitudinal study of HFA participants after a training in irony comprehension, in ToM metarepresentational abilities, and without training.

Group	Ironic criticisms	Ironic compliments	Irony total
ASD	34.0 (47.5)	26.9 (44.5)	30.4 (46.1)
TD	85.2 (35.6)	80.1 (40.0)	82.7 (37.9)

Table 1. Mean percentage of accuracy (and SD) by group and type of irony

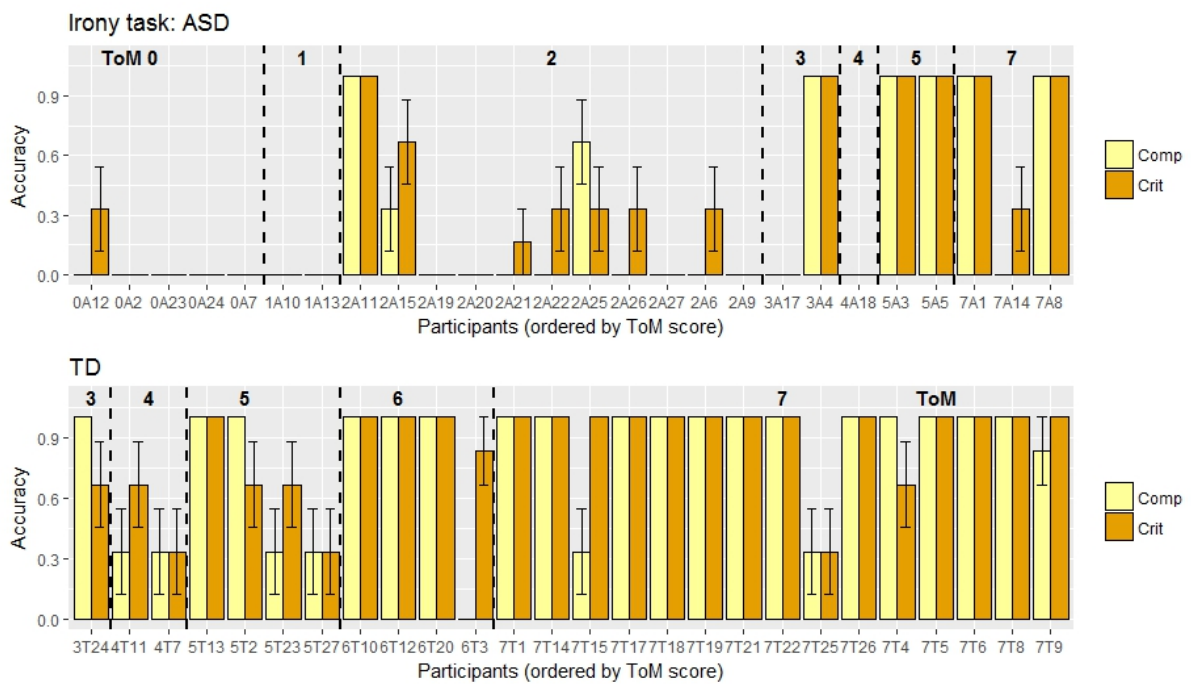


Figure 1. Mean accuracy (and SE) in ironic criticisms and ironic compliments

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