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BRIEF REPORT

# Brief Report: Me, Reporting on Myself: Preliminary Evaluation of the Criterion-Related Validity of the Theory of Mind Inventory-2 when Completed by Autistic Young Adults

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## Abstract

There is a need for increased understanding of self-report measures for autistic individuals. In this preliminary study, we examine how a theory of mind self-report relates to other self-report measures for groups of autistic and neurotypical individuals, as well as eye tracking outcomes. Expected patterns of relatedness emerged between self-reports and the eye tracking findings, which lends validity to the theory of mind measure. Self-report measures are critical for autistic individuals to share their own experiences and this is the first step in establishing a theory of mind self-report tool.

**Keywords** Autism · Self-report · Theory of mind · Eye tracking

As the study of autism spectrum disorder (ASD) in adulthood continues to grow, we are faced with the challenge of developing measurement tools that enable autistic individuals[1] to report on their own experiences. Self-report measures are being used in ASD research to measure characteristics of ASD and internalizing symptoms such as anxiety (Baron-Cohen et al. 2001; Ozsivadjian et al. 2014). Self-assessment of theory of mind, however, remains a woefully understudied topic and research in this area is critical as more adults are seeking diagnostic evaluations, resulting in a need for tools that are accessible in situations when parent-report cannot (or will not) be available. Moreover, targeted and sensitive measurement of one's own theory of mind strengths and challenges would enable service providers to not only adapt social skills supports and monitor treatment progress in an ecologically valid way but may also provide the 'buy in' from clients crucial to intervention success. The goal of this pilot study was to investigate the criterion-related validity of the Theory of Mind Inventory-Second Edition (ToMI-2) as a self-report tool for autistic adults relative to pre-existing measures and to an objective behavioral measurement using eye tracking.

Theory of mind, or perspective-taking, is a pervasive mental activity implicated in a number of daily social functions (Birch et al. 2017). Theory of mind is a complex, developmental, and multifaceted construct which includes the ability to recognize emotions, attitudes, and intents and to make inferences about the inner mental states of one's self and others. Theory of mind plays a key role in social communication and is foundational to social and cultural learning (Astington 2003; Lenton-Brym et al. 2018). There is broad consensus among autism researchers that although not a formal diagnostic criterion (because theory of mind is situated at the cognitive as opposed to the behavioral

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[1] We will use "autistic individual" throughout this manuscript in response to statements from the autistic self-advocate community expressing a preference for this phrasing (Brown 2011).

level of analysis), theory of mind impairments are universal (although highly heterogeneous) among persons with autism (Baron-Cohen 2000). Traditional assessments of theory of mind, however, use standardized tasks (e.g., the Sally-Anne Task) that suffer from serious limitations including (but not limited to) a lack of content validity and the presence of ceiling effects when mentalizing is relatively good (Hutchins et al. 2012). For accurate diagnostic classification and meaningful treatment planning, a sensitive broadband self-report measurement of theory of mind would have great utility.

A unique aspect of the Theory of Mind Inventory-2-Self-Report (ToMI-2-SR) is that items were designed to characterize how autistic individuals experience perspective-taking opportunities, rather than relying on what is observable to caregivers. The original version of the ToMI-2 was developed and normed on a large representative sample of typically developing children ages 2–13 years (Hutchins et al. 2012; Lerner et al. 2011). In validation studies, the typically developing sample evidenced ceiling effects in late childhood but scores for the oldest and most able autistic children did not approach the ceiling. Subsequently, a similar pattern (i.e., no ceiling effect) was observed for highly verbal autistic adolescents (Lerner et al. 2011) suggesting that this tool might be appropriate for detecting even the most subtle theory of mind challenges in autistic adults. In the current study, we examined the criterion-related validity of the ToMI-2-SR as an adult self-report. Specifically, we investigated how ToMI-2-SR scores relate to another common autism self-report measure, the Social Responsiveness Scale-Adult Self Report (Constantino and Todd 2005) and to scales from broadband mental health measures (Adult Self Report; Achenbach and Rescorla 2003; Fresco et al. 2001). Additionally, we assessed how ToMI-2-SR responses related to objective measurement of social behavior using an eye tracking paradigm.

## Method

### Participants

Participants ages 18 and older without an intellectual disability were recruited into two main groups: an ASD group (N = 15) and a neurotypical (NT) group (N = 17). Individuals with a diagnosis of autism, Asperger's, or Pervasive Developmental Disorder (PDD), confirmed by the study team's review of documentation from a medical professional such as a psychiatrist or psychologist, were in the ASD group. Recruitment took place just after the publication of DSM-5 and thus diagnostic histories for these young adults reflected the language of DSM-IV. Medical documentation, at a minimum, needed to include a thorough developmental history, observation summary (such as the Autism Diagnostic Observation Schedule), and a summary of social communication. Participants were primarily recruited from a local program of autistic college students from the surrounding area, as well as through child psychiatry clinics. For the NT group, inclusion criteria included no known diagnosis of autism, Asperger's, or PDD. All participants completed a one-time study visit, described below. Prior to data analysis, one participant in the ASD group was not included in the participant pool, as their medical documentation did not provide a conclusive diagnostic determination of ASD. The lack of intellectual disability criteria was confirmed by IQ testing results in medical reports as available, self-report when initially recruited if no medical report was available, and confirmed by the administration of a brief cognitive screener during the study visit (IQ $\geq$ 70).

Of the 36 participants, 41.6% had a diagnosis of autism, Asperger's, or PDD. Overall, 41.7% of the participants were female. Average age of the group was 20.5 years (2.2) and average brief IQ was 113.0 (*13.5*) as assessed using two scales from the Wechsler Abbreviated Scales of Intelligence (Vocabulary and Matric Reasoning).

### Study Visit

This study was approved by *redacted*. After a complete review of study procedures, written informed consent was obtained from all individual participants included in the study. Participants were recruited as part of a larger eye tracking study. A one-time study visit consisted of completing questionnaires, being administered a brief cognitive assessment, and observing eye tracking paradigms. For this report, the results from three of the behavioral measures and one of the eye tracking paradigms (stare-in-the-crowd effect) are presented.

### Measures

#### Theory of Mind Inventory-Second Edition, Self-Report

The "Theory of Mind Inventory-Second Edition, Self-Report" (ToMI-2-SR; Hutchins et al. 2012) is a 48-item inventory intended as a broadband assessment of social cognition. Use of this measure allowed for parsing out theory of mind effects over and above social responsiveness across the NT and autistic adults. The adult version of the measure is identical to the parent-report ToMI-2 except the sentence frame for each item adopts first person language (e.g., instead of "My child understands the difference between lies and jokes" the adult version reads "I understand the difference between lies and jokes"). The original parent-informant version of the ToMI-2 has demonstrated excellent psychometric properties (i.e., test–retest reliability for short and long lags, excellent internal consistency, and strong evidence

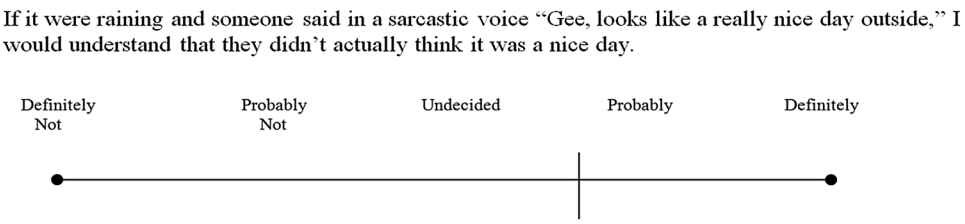


**Fig. 1** Example item from the ToMI-2-SR; the vertical line illustrates how participants would respond to the item

for construct validity in the form of criterion-related validity and contrasting groups validity; Hutchins et al. 2012) and the use of the parent-informant measure for adolescent children has strong evidence of validity (Lerner et al. 2011). The ToMI-2 yields a total score and three subscales scores (Early, Basic, and Advanced) that were derived on the basis of principle components analysis (see specific scale details elsewhere (Hutchins et al. 2012). The Early subscale includes concepts such as shared affect and joint attention and the Basic subscale assesses metarepresentation, which includes skills such as appearance-reality distinction, deception behavior, and false belief tasks (Hutchins et al. 2014). Findings pertaining to the Advanced subscale, which assesses theory of mind achievements that emerge in the school years and adolescence (e.g., white lie understanding, humor appreciation, self-conscious emotion recognition, verbal irony comprehension, mixed emotions), were of particular interest given the recruited population but Early and Basic subscales were also analyzed as possible drivers of significant findings on the Advanced subscale. See Fig. 1 for a sample item and an example of the response arrangement used on the ToMI-2 (note: items are scored via ruler with scores ranging from 0 to 20 with higher values reflecting greater degrees of confidence that the individual possesses a particular theory of mind knowledge or skill set).

#### Social Responsiveness Scale-Adult Self-Report

The "Social Responsiveness Scale-Adult Self-Report" (SRS-A; is a 65-item measure designed to assess the frequency of social response. The SRS-A has a Cronbach's alpha of .71 in typically developing populations (Bölte 2012). A total and five subscale (Receptive, Social, Expressive Language, Cognitive, Preoccupations) scores are calculated. Although not a diagnostic tool, high total scores on this measure are often reflective of an ASD diagnosis and can be used to characterize a social responsiveness profile.

#### Adult Self Report

The "Adult Self Report" (ASR; is a 126-item survey that assesses internalizing symptoms, externalizing symptoms, substance use, and adaptive functioning of an adult. T-scores are calculated using age- and gender-based norms on empirically derived subscales. Ooi et al. (2011) found that three of the clinical subscales (Withdrawn/Depressed, Social problems, Thought problems) on the child version of the ASR (the CBCL) significantly differentiated children with and without autism. The ASR does not have a Social Problems scale but the other two corresponding scales were included here to assess how they relate to the ToMI-2-SR in a population of adults.

### Eye Tracking

The stare-in-the-crowd effect paradigm was administered using an EyeLink 1000. For specific details about the paradigm, see Crehan and Althoff (2015) and Fig. 2. Broadly, this paradigm assesses how self-directed gaze and changes to that gaze are detected to simulate shifting gaze during social interactions. The EyeLink1000 collects over 100 measures of gaze behavior and preset areas of interest, called interest areas (IA), allow for comparisons of time spent looking at different regions of an image, for instance the eyes versus non-eye facial regions. In previous work, IA dwell time (to assess looking at social information) and IA second fixation duration (to assess response to shifting social information) were useful in indicating interest in social stimuli and are therefore used here (Table 1).

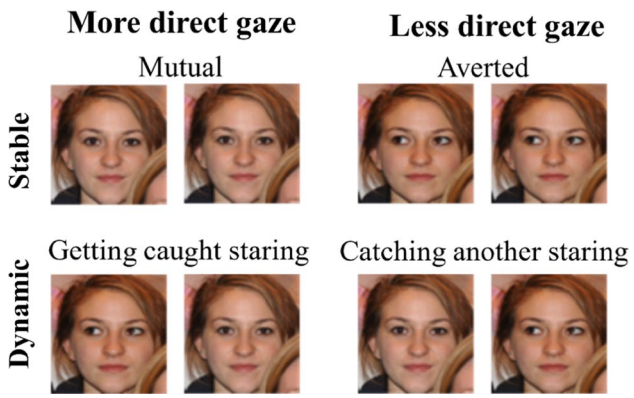


**Fig. 2** Stimuli were images of groups of people with one "target" person's gaze shifting over the course of the presentation of the image. An example of this target person is shown here. Other individuals in these images would either exhibit mutual or averted gaze throughout the presentation of the stimuus image

**Table 1** Descriptive and inferential results for all comparisons

| | Neurotypical group (N = 17) | | Autistic group (N = 15) | |
|---|---|---|---|---|
| | M | SD | M | SD |
| Age | 20.05 | 1.16 | 21.20 | 3.10 |
| Sex | 48% female | | 33% female | |
| IQ | 109.71 | 14.05 | 117.00 | 11.73 |
| Theory of Mind Inventory- total* | 19.09 | .76 | 17.63 | 2.07 |
| ToMI early | 18.15 | 1.50 | 16.74 | 2.80 |
| ToMI basic | 19.22 | .78 | 18.57 | 2.41 |
| ToMI advanced**** | 19.35 | .69 | 16.89 | 2.36 |
| Social Responsiveness Scale total**** | 35.90 | 12.24 | 78.13 | 35.57 |
| SRS awareness* | 6.67 | 1.39 | 8.67 | 3.31 |
| SRS cognition**** | 4.76 | 2.53 | 12.07 | 7.19 |
| SRS communication**** | 11.29 | 5.44 | 25.73 | 12.76 |
| SRS motivation**** | 8.62 | 4.34 | 16.13 | 6.88 |
| SRS autistic mannerisms**** | 4.57 | 2.77 | 15.53 | 8.45 |
| Adult self-report | 36.05 | 15.29 | 53.20 | 26.01 |
| Withdrawn/depressed | 18.48 | 6.88 | 27.80 | 12.68 |
| Thought problems | 17.57 | 9.19 | 25.40 | 15.39 |

*Indicates significant difference between diagnostic groups at $p < .05$ level

**$p < .01$

***$p < .005$

****$p < .001$

## Results

A significant group difference emerged between the ASD and the NT group, $t(30) = 3.64$, $p = .001$, on the ToMI-2-SR-Advanced scale with the ASD group scoring significantly lower. Although means tended in the expected direction, the Early and Basic subscales did not differ significantly between groups. Similarly, the ASD group rated themselves as having more difficulties with social responsiveness than the NT group for each SRS subscale.

Even after correcting for multiple comparisons, the ToMI-2-SR-Advanced scale was significantly correlated with each of the SRS-A subscales (Social Awareness, Social Cognition, Social Communication, Social Motivation, and Restricted Interests and Repetitive Behavior) with Pearson's *r* ranging from − .51 to − .72, as well as the Withdrawn/Depressed and Thought problems scales from the ASR, with Pearson's *r* ranging from − .50 to − .52. Thus, participants reporting difficulties with social cognition were also noticing challenges with social responsiveness and depressive symptoms which are highly theoretically and clinically demonstrable links.

Of the four eye tracking conditions, two initially displayed a target person "looking" directly at the participant, e.g. mutual gaze. In these conditions, dwell time in the interest area around the target person's eye region and length of the second fixation in the interest area (e.g., to confirm detection of self-directed gaze) were significantly correlated with ToMI-2-SR Advanced (but not Early or Basic) subscale scores. In the condition with initial averted gaze and delayed mutual gaze, dwell time in the interest area around the target person's eye region was significantly correlated with ToMI-2-SR ratings (see Table 2). These findings indicate that the more limited a person reported their theory of mind to be, the less looking they did at salient social information, as captured by the eye tracker. This brings important objective grounding to the utility of the ToMI-2-SR.

**Table 2** Correlations between ToMI-2-SR-Advanced scale and eye tracking outcomes, listed by condition, for full sample

| Condition | Visual attention to social stimuli: dependent variables | |
|---|---|---|
| | IA dwell time | IA second fixation duration |
| Mutual | .48** | − .46** |
| Averted | *Ns* | *Ns* |
| Getting caught staring | .53** | .36* |
| Catching another staring | .48** | *Ns* |

*$p < .05$

**$p < .005$

## Discussion

Previous studies have found that theory of mind is related to social responsiveness and functioning (Berenguer et al. 2018; Bishop-Fitzpatrick et al. 2017; Pruett et al. 2015), indices of psychological well-being, and more typical visual attention patterns to social stimuli (Baron-Cohen et al. 1995). We expected that scores for a construct-valid self-report measure of theory of mind would demonstrate these relations and indeed they did. However, it is noteworthy that significant results were only achieved for the Advanced subscale. This makes sense, considering the nature of the sample. This study surveyed autistic adults without intellectual disability and it has been well-documented that while autistic individuals can 'pass' basic theory of mind tasks (e.g., Sally-Anne type tasks), it is the advanced aspects of theory of mind that remain sensitive for identifying social cognitive impairments (Brewer et al. 2017).

Assessing one's own ability to perspective-taking is a potentially self-confounding concept. If you have less developed theory of mind, would you not rate yourself higher on a theory of mind measure, as you would have limited insight in this area? However, the group differences and relations to other measures reported here illustrate that autistic adults have insight into their social cognition and behavior, which confirms previous findings of similar constructs (Baron-Cohen et al. 2001; Hull et al. 2017; Schriber et al. 2014), indicating that theory of mind strengths and challenges can be self-assessed in autism. Further, connecting a behavioral self-report to objective eye movement measurements adds an additional dimension of validity to interpreting the ToMI-2 as a self-report.

One limitation of this study was that self-reported theory of mind was not compared to parent-report of theory of mind, which would help to root these findings in the existing literature. On the other hand, relying on self-report is incredibly useful for providing unique information that can only be relayed by the one experiencing the topic in question. For instance, a study of externalizing problems in adolescents showed similar elevations on symptoms reports across parent- and self-report but the self-report included additional details (Robinson et al. 2018). This demonstrates the importance of surveying the people of interest directly and the utility of multiple sources of information whether or not scores from different informants neatly align (Mazefsky et al. 2011). In fact, Lerner et al. (2012) demonstrated that discrepancies between parent- and self-report were more predictive of outcomes than either report alone. Thus, even discrepant findings are theoretically and clinically useful. Still, lacking a direct comparison between parent- and self-report is a limitation of the current study and work has already begun two compare these indices. Exploring these two means of data collection for unique behavioral, emotional, and cognitive domains is important to develop best practices. Within the developmental disabilities and autism specifically, inclusion of the voices of those with a diagnosis has not been prioritized historically.

The generalizability of this study is also a limitation due to the characteristics of the recruited participants. The average IQ of the ASD group was significantly higher than average and had strong verbal skills (across total sample, most were currently enrolled at a 4 year university). As noted earlier, this profile likely explains why the advanced subscale was the only scale resulting in significant findings. Replication of this study in populations with more diverse cognitive and verbal abilities would contribute to a more comprehensive understanding of the ToMI-2-SR. At present, this study offers an important first step and demonstration of the utility of the ToMI-2 in a self-report form.

## Conclusion

This study provides context for self-report measures in ASD. Self-report measures are much needed in the study of ASD both to better understand the diagnosis across the lifespan and for assessment purposes. Future work must continue to examine what we can learn from ASD self-report measures and how this fits with measures initially designed as parent-report.

**Author Contributions** E.C. and R.A. conceived of the study design which included the use of the TOMI-2-SR. T.H. and P.P. developed the TOMI-2-SR and discussed the use of TOMI-2-SR in this study. E.C. carried out the study and analyzed the data. All authors discussed the results. E.C. wrote the manuscript in consultation with all authors.

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### Compliance with Ethical Standards

**Conflict of interest** Drs. Crehan & Althoff and Ms. Riehl report no conflicts of interest. Drs. Prelock is an associate editor for JADD. Drs. Prelock and Hutchins are co-developers of the Theory of Mind Inventory. Dr. Hutchins is the owner of Theory of Mind Inventory LLC and Dr. Prelock receives royalties from Theory of Mind Inventory LLC.

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (include name of committee + reference number) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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