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Short Communication

Theory of Mind experience sampling in typical adults

Lauren Bryant [a,*], Anna Coffey [a,1], Daniel J. Povinelli [b], John R. Pruett Jr. [c]

[a] Washington University in St. Louis, 1 Brookings Drive, St. Louis, MO 63130, USA
[b] Department of Biology, University of Louisiana, 104 University Circle, Lafayette, LA 70504, USA
[c] Department of Psychiatry, Washington University in St. Louis, School of Medicine, 660 S. Euclid Ave., St. Louis, MO 63110, USA

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ABSTRACT

We explored the frequency with which typical adults make Theory of Mind (ToM) attributions, and under what circumstances these attributions occur. We used an experience sampling method to query 30 typical adults about their everyday thoughts. Participants carried a Personal Data Assistant (PDA) that prompted them to categorize their thoughts as Action, Mental State, or Miscellaneous at approximately 30 pseudo-random times during a continuous 10-h period. Additionally, participants noted the direction of their thought (self versus other) and degree of socializing (with people versus alone) at the time of inquiry. We were interested in the relative frequency of ToM (mental state attributions) and how prominent they were in immediate social exchanges. Analyses of multiple choice answers suggest that typical adults: (1) spend more time thinking about actions than mental states and miscellaneous things, (2) exhibit a higher degree of own- versus other-directed thought when alone, and (3) make mental state attributions more frequently when not interacting (offline) than while interacting with others (online). A significant 3-way interaction between thought type, direction of thought, and socializing emerged because action but *not mental state* thoughts about others occurred more frequently when participants were interacting with people versus when alone; whereas there was an increase in the frequency of *both* action and mental state attributions about the self when participants were alone as opposed to socializing. A secondary analysis of coded free text responses supports findings 1–3. The results of this study help to create a more naturalistic picture of ToM use in everyday life and the method shows promise for future study of typical and atypical thought processes.

1. Introduction

Individuals capable of reasoning and making attributions about their own or another's beliefs, desires, or intentions are said to possess a Theory of Mind (ToM) (Premack & Woodruff, 1978; Wellman, Cross, & Watson, 2001). The development of this higher-order cognitive ability and its relationship to other areas of cognition has been the topic of much research. A great deal of the ToM literature has been devoted to its function and development, particularly focused on the age at which ToM abilities arise. The capacity to represent false beliefs—mental states containing content contrary to reality—has been widely considered a marker of ToM abilities in children (Wimmer & Perner, 1983). Proponents reason that to arrive at correct

* Corresponding author. Fax: +1 314 747 6777.
E-mail addresses: lauren.k.bryant@vanderbilt.edu (L. Bryant), meridian.coffey@gmail.com (A. Coffey), djp3463@louisiana.edu (D.J. Povinelli), pruettj@psychiatry.wustl.edu (J.R. Pruett Jr.).

[1] A. Coffey was enrolled at St. Olaf College, Northfield, MN, USA at the time of research.

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predictions or explanations of other people's behavior, it is necessary to understand that mental states are sometimes independent of reality and may misrepresent the state of the world. Wimmer and Perner's classic Sally-Anne task and others like it have demonstrated that the ability to understand false beliefs and thus the possession of ToM consolidates around the age of 5 years. However, experiments examining visual perspective taking and those utilizing anticipatory looking paradigms to test false beliefs suggest the possibility of ToM understanding in children as young as 15 months (Baillargeon, Scott, & Zijing, 2010; Brooks & Meltzoff, 2002).

ToM has been understood as a key component of humans' intricate social lives, contributing to the ability to understand irony, tell and detect lies, and participate in positive social interactions (Baron-Cohen, Tager-Flusberg, & Cohen, 1993). It is thought that such a skill is crucial for social adequacy and overall normal cognitive development. For this reason, deficits in ToM have been linked to social dysfunction seen in disorders such as schizophrenia and autism. Many individuals with schizophrenia display deficiencies in areas such as emotional perception and attribution that may be reflective of a ToM deficit. They also perform more poorly than non-affected subjects when trying to "read between the lines" (i.e., identifying what a given individual is thinking or feeling) (Penn, Sanna, & Roberts, 2008; Pickup & Frith, 2001). Children with autism often fail to develop proper social relationships and appropriately interpret social cues. Baron-Cohen, Leslie, and Frith (1985) hypothesized a link between the social deficits of individuals with autism and a deficit in ToM. Using the Sally-Anne task, Baron-Cohen et al. compared performance of subjects with autism to that of controls and children with Down's syndrome. Results revealed that even when the mental age of children with autism was higher than that of the controls, they failed to attribute beliefs to others. This has been replicated using variations of the Sally-Anne task (see Grant, Grayson, & Boucher, 2001 for review), including a non-verbal adaptation (Colle, Baron-Cohen, & Hill, 2007). While this is a well-replicated finding, ToM impairment likely does not cause autism, and some high-functioning individuals with autism pass ToM tasks (Boucher, 2012). Nonetheless, understanding why many with autism fail ToM tasks may reveal something fundamental about this disorder.

In recent years, a number of researchers have stressed the importance of naturalistic – as opposed to laboratory-based – studies of social cognition. Ickes, Stinson, Bissonnette, and Garcia (1990) explored the overt behavior and covert thoughts and feelings of pairs of subjects during a period of unstructured interaction to examine "empathic accuracy". More recently, Malle and Pearce (2001) asked participants to report on their thoughts and speculate about those of their partner during a dyadic interaction. Importantly, both methods required subjects to make perceptual judgments based upon their memory of previous interactions and *not* within the moment. Frith, Happe, and Siddons (1994) explored the ecological validity of ToM tasks with respect to parent-teacher reports of the everyday social interactions of individuals with autism.

However, most ToM research to date involves studies in highly controlled laboratory settings. In the lab, tasks are explicitly designed to elicit ToM attributions. Tailoring tasks towards a mentalizing state of mind may lead to a greater number of mental state attributions. A lack of naturalistic social distractions may also allow more time to make ToM attributions given research which demonstrates that ToM is cognitively taxing (Apperly, Back, Samson, & France, 2008; Malle & Pearce, 2001). In addition, experimental settings that do not mirror life's complexities could lead to an inaccurate record of the type and target of thought attributions. Support for this notion comes from research conducted by Malle and Pearce (2001) hypothesizing that attentional bias motivated by the complex nature of social interactions leads a person to focus on and recall their own inner states over their actions and another's actions over that person's inner states.

The goal of the present study was to explore the extent to which typical adults make ToM (mental state) attributions and under what conditions in everyday life. One approach to doing so involves experience sampling variants such as those used to study the default mode network and the role of mind wandering (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009; Schooler et al., 2011). Therefore, to examine ToM attributions in a more ecologically valid manner, we adopted the experience sampling method to randomly query subjects about their thoughts throughout the day (Larson & Csikszentmihalyi, 1983). Similar to the Electronically Activiated Recorder (EAR) (Mehl & Robbins, 2012), this methodology allowed us to gather information from a day in the life of the participants as they choose to live it, filled with the intricacies of the human experience that are difficult to replicate in laboratory settings.

As a starting point, we hypothesized that ToM attributions might occur relatively infrequently outside the lab, and that ToM might not prominently figure into immediate social exchanges under most circumstances. This hypothesis is based largely on a conceptual consideration of the socio-cognitive abilities of humans and nonhuman primates. Non-human primates are capable of producing a variety of behaviors during social interactions that mimic those of humans, including deception, reconciliation, and gaze following (see Marrus et al., 2011; Povinelli, 2000; Watts, 2002). However, Povinelli and Giambrone (2001) argue that chimpanzees may not reason about the mental and perceptual states that appear to be fundamental for ToM attributions. If social interactions amongst chimpanzees occur despite lack of the higher-order representational ability Povinelli and colleagues claim is necessary for ToM (see Penn, Holyoak, & Povinelli, 2008; Penn & Povinelli, 2007), it is plausible that humans may also rely primarily on underlying cognitive and perceptual abilities to interpret and react to behaviors and only secondarily on ToM, lending to infrequent ToM attributions. Furthermore, given that everyday social interactions in humans draw on a multitude of cognitive resources, and such resources are more readily available in the absence of social "distractions", we predicted that when ToM attributions do occur, they will happen more frequently outside of social interactions.

2. Method

2.1. Participants

We recruited subjects and performed the experiment according to an IRB approved human-studies protocol. Participants included 30 adults (15 male, 15 female; mean age = 22.1, *SD* = 1.8) with no reported history of neurological or psychiatric disorders and no family history of an Autistic Spectrum Disorder (ASD) or Attention-Deficit/Hyperactivity Disorder (ADHD). Participants were recruited through word of mouth (snowball sampling), resulting in a sample comprised mostly of undergraduate and graduate students at Washington University in St. Louis. Assessments included the matrix reasoning and vocabulary subsets of the Wechsler Abbreviated Scale of Intelligence (WASI), full scale derived mean = 127, *SD* = 6. We also quantitatively assessed the burden of autistic traits in our subjects by using the Social Responsiveness Scale, (SRS: Constantino; Western Psychology Services), mean = 23, *SD* = 3. All subjects scored below 65, two standard deviations below the mean SRS score for Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS) in a population sample (Constantino et al., 2004). Ethnicity was not an important subject variable, however, participants self-identified as White, Black, Asian, and Hispanic. Participants were compensated hourly, based on length of participation.

2.2. Design

We were interested in measuring the frequency and type of thought attribution, especially with respect to social context. We adapted the Experience-Sampling Method to test our hypothesis. The Experience-Sampling Method is often used in personality and behavioral psychology and relies on self-reports to measure the frequency and the patterning of mental processes in everyday situations (Larson & Csikszentmihalyi, 1983). Barrett and Barrett (2001) computerized this method, enabling us to query participants using a handheld electronic device called a Personal Data Assistant (PDA) (see http://www.experience-sampling.org/ for software details). We used a PDA made by Palm, Inc. (model VIIx). Participants' responses were stored on the PDA, and after the sampling period, transferred to a computer for analysis.

2.3. Procedure

Participants carried a PDA loaded with a questionnaire for a continuous 10-h period. At approximately 30 pseudo-random time points, they were prompted to answer a brief questionnaire without assistance. The randomized times were based on an algorithm written for the ESP software. Participants may have been alerted to answer a questionnaire within minutes after completing the previous one, but no more than an hour passed in between each query. Participants were instructed to categorize the thought immediately preceding the beep as Action, Mental State (MS) or Neither (Miscellaneous). Before the PDA was assigned, participants were instructed on how to categorize their thoughts according to strict definitions and examples (see Appendix for Instructions and General Information). Action thought content was defined as "what you or another is doing, has done or will do", a mental state was defined as a thought that "exists in your own or someone else's head", and the content of miscellaneous thought was neither mentalistic nor an action. If categorized as an action or mental state, participants also noted the direction of that thought (own versus other). Participants were also asked about the degree to which they were socializing (alone or interacting with others). Lastly, participants responded in free text form to two questions, "What are you doing?" and "What are you thinking about?" in order to give context for their self-categorized thoughts. We verbally instructed subjects that all queries applied to thought they reported having immediately prior to the beep in order to minimize confusion. Participants were allotted 10 min to respond to the questionnaire for safety reasons (i.e., if they were driving) and were not penalized for missing queries. Yet on average, participants took 11.94 (*SEM* = 5.94) seconds to respond to each survey. This allows us to be relatively confident that participants were responding in most cases promptly after the beep. The PDA automatically turned off at the end of each questionnaire.

3. Analyses

3.1. Primary analyses

We explored relationships between the frequencies of thought type (Action, MS, and Miscellaneous), direction (own versus other) and degree of socializing (alone versus interacting with others) and subject variables with SPSS 18.0 (SPSS, Inc.). Tests included an Analysis of Variance (ANOVA), paired sample *t*-tests, and bivariate correlations between thought type frequencies and IQ and SRS scores. Primary analyses were performed solely on the quantitative (button press) results, excluding responses to the free text response questions "What are you doing?" and "What are you thinking about?".

3.2. Secondary analyses

To examine validity of participants' button press responses and their interpretation of their thoughts based on the instructions provided, we recalculated the frequencies of thought type, direction, and degree of socializing according to

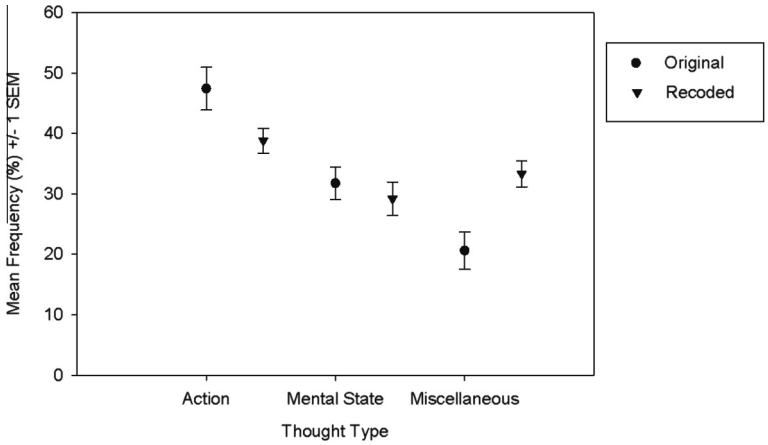

Fig. 1. Mean frequency of thought type. This figure illustrates the mean frequency of Action, Mental State and Miscellaneous thought type. Data from subjects' button press responses are shown (original) compared to the recoded data.

participants' qualitative responses. Categorization was based on the independent coding of two raters following the instructions of a strict coding scheme (see Section 3.2.1). Coding disagreements were completely resolved, and raters' responses were then compared to the subjects' button press responses. One subject was excluded due to insufficient qualitative data necessary for coding.

3.2.1. Coding scheme

A coding scheme was modeled after various experiments that examined children's utterances of mental terms (see Bartsch & Wellman, 1995; Shatz, Wellman, & Sibler, 1983; Tager-Flusberg, 1992). Two coders (authors LB and AC) were trained on this scheme. They practiced analyzing literature rich in dialogue and containing mental state references, such as a psychiatry training book and online romance novels (Miller & Rollnick, 2002; Reeves, 2008). Training continued until an acceptable inter-rater reliability was reached, percent agreement ($M = 75.23$, $SEM = 1.08$, *kappa* = 0.63). Blind of participants' original button press responses, raters then categorized participants' thoughts using the qualitative responses based upon these strict coding instructions (see Appendix for coding instructions).

4. Results

4.1. Subjects button press responses

We analyzed the frequencies of Action ($M = 47.40$, $SEM = 3.53$), MS ($M = 31.76$, $SEM = 2.69$), and Miscellaneous ($M = 20.63$, $SEM = 3.07$) thoughts as seen in Fig. 1. Frequency counts were established based upon the number of events per category over total number of events during the 10 h sampling period. Paired sample *t*-tests demonstrated a significant difference in the frequency of Action versus MS thoughts, $t(29) = 2.85$, $p = .008$, Action versus Miscellaneous thoughts, $t(29) = 4.43$, $p < .001$, and MS versus Miscellaneous thoughts, $t(29) = 2.44$, $p = .021$ (uncorrected *p* values are reported). Collapsing across thought type, we performed a 2-way repeatedmeasures analysis of variance (ANOVA) between direction of thought (own or other) and degree of socializing (alone or interacting), and found a significant interaction effect between direction of thought and socializing, $F(1,29) = 52.64$, $p < .001$, where the difference in frequency of own-directed thought when alone ($M = 41.94$, $SEM = 3.00$) compared to thoughts about others when alone ($M = 9.04$, $SEM = 1.57$) was much greater than the difference in frequency of own-directed thought when interacting ($M = 16.97$, $SEM = 1.77$) compared to thoughts about others ($M = 11.41$, $SEM = 1.65$) when interacting, as seen in Fig. 2. There was also a significant main effect of direction, $F(1,29) = 76.69$, $p < .001$, with a higher frequency of own-directed thoughts ($M = 73.76$, $SEM = 2.49$) compared to other-directed thoughts ($M = 26.25$, $SEM = 2.50$), and a significant main effect of socializing, $F(1,29) = 19.42$, $p < .001$, with a higher frequency of overall thought attribution (MS, Action, and Miscellaneous) ($M = 64.29$, $SEM = 3.03$) occurring when subjects were not interacting with others than when socializing ($M = 35.80$, $SEM = 3.01$). The frequency of MS thought attributions was isolated and examined with respect to degree of socializing (alone or interacting with others). A paired sample *t*-test revealed a significant difference between the proportion of MS attributions when participants were interacting with others ($M = 10.39$, $SEM = 1.53$) versus when they were alone ($M = 20.96$, $SEM = 2.07$), $t(29) = 4.30$, $p < .001$.

We also performed a repeated measures ANOVA across the 3 categories of thought type, socializing, and direction. Results produced a significant 3-way interaction, $F(1,29) = 4.25$, $p = .048$. There was a numerically higher frequency of action thoughts about others while interacting with others ($M = 7.34$, $SEM = 1.17$) than when alone ($M = 4.85$, $SEM = 1.09$), whereas there was no increase in frequency of MS attributions about others while interacting ($M = 4.06$, $SEM = 0.96$) than when alone

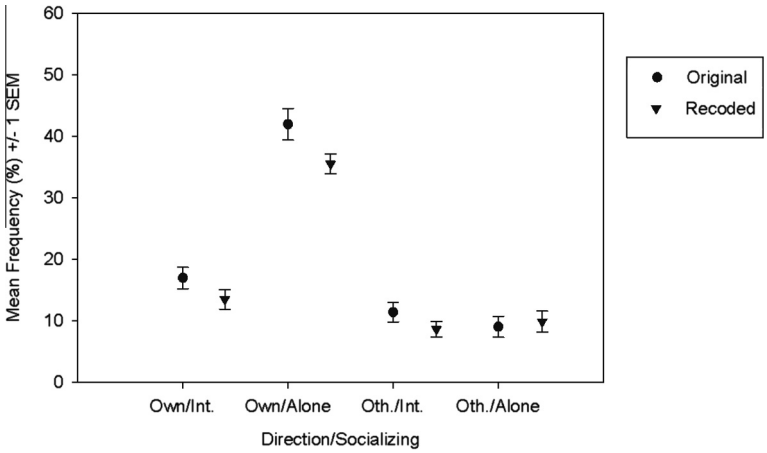

Fig. 2. Direction × Socializing. This graph illustrates the mean frequency of own-directed and other-directed thoughts with respect to socializing (Int. = Interacting), collapsed across Action and Mental State thoughts. Data from subjects' button press responses are shown (original) compared to the recoded data. Error bars corrected for repeated-measures design.

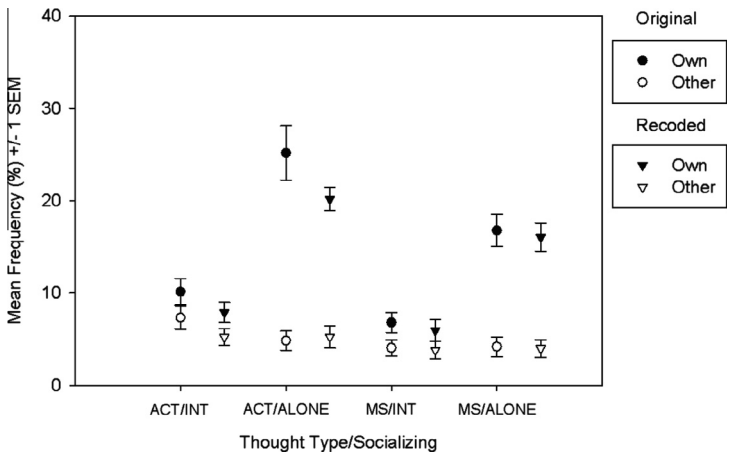

Fig. 3. This graph illustrates the mean frequency of Action (ACT) and Mental State (MS) thought types with respect to direction (own and other) and socializing (Interacting (INT) and alone). Data from subject's button press responses are shown (original) compared to the recoded data. Error bars corrected for repeated-measures design.

($M = 4.19$, $SEM = 1.1.4$). Concurrently, there was a similar increase in frequency of both Action ($M = 25.17$, $SEM = 2.75$) and MS ($M = 16.77$, $SEM = 1.70$) thought attributions about one's self when alone, than when interacting with others (Action, $M = 10.14$, $SEM = 1.40$ and MS, $M = 6.83$, $SEM = 1.09$). There was also significant 2-way interaction effect of direction by socializing, $F(1,29) = 52.63$, $p < .001$; and significant main effects of thought type, $F(1,29) = 8.21$, $p = .008$, direction, $F(1,29) = 76.69$, $p < .001$, and socializing, $F(1,29) = 19.42$, $p < .001$, as seen in Fig. 3.

We found no significant correlation between frequencies of MS, Action, and Miscellaneous thought and IQ assessments (vocabulary scaled scores and matrix reasoning scaled scores) and SRS scores. However, there was one subject that was 2.55 standard deviations above the mean SRS score of 22.67. This subject's score was not greater than 2 standard deviations below the PDD-NOS mean from a population sample; it would not have triggered an autism work-up, per protocol, in our other research studies (e.g., Pruett, LaMacchia, Hoertel, Squire, McVey et al., 2011); and it was not more than 1.5 interquartile ranges above the third quartile. However, the subject reported the highest frequency of Action thoughts, $M = 93.1$, $SD = 2.36$, leading us to consider the data without the subject. Previous statistical tests of thought type, direction, and degree of socializing remained significant at $p < .05$, however the 3-way interaction (Thought Type × Direction × Socializing) dropped to trend level, $F(1,28) = 3.09$, $p = .09$.

4.2. Recoding

To validate our results further, we coded and re-categorized the subjects' responses based upon their free text responses to the questions "What are you doing?" and "What are you thinking?" One subject was excluded from subsequent

analyses due to insufficiently descriptive responses. We analyzed the frequencies of Action ($M = 38.78$, $SEM = 2.06$), MS ($M = 29.17$, $SEM = 2.78$), and Miscellaneous ($M = 33.32$, $SEM = 2.15$). A paired sample t-test demonstrated a significant difference in the frequency of Action versus MS thoughts, $t(28) = 2.24$, $p = .034$. Differences in Action versus Miscellaneous thoughts, $t(28) = 1.79$, $p = .084$, and MS versus Miscellaneous thoughts, $t(28) = -0.91$, $p = .371$ were insignificant, depicted in Fig. 1. A 2-way repeated measures ANOVA between direction of thought and degree of socializing revealed a significant interaction effect between direction of thought and socializing, $F(1,28) = 39.07$, $p < .001$, where the difference in frequency of own-directed thought when alone ($M = 35.65$, $SEM = 1.71$) compared to thoughts about others whenalone ($M = 10.15$, $SEM = 1.90$) is much greater than the difference in frequency of own-directed thought when interacting ($M = 13.78$, $SEM = 1.63$) compared to thoughts about others ($M = 8.95$, $SEM = 1.41$) when interacting, as seen in Fig. 2. There was also a significant main effect of direction, $F(1,28) = 75.60$, $p < .001$, with a higher frequency of own-directed thoughts ($M = 73.54$, $SEM = 2.63$) compared to other-directed thoughts ($M = 26.52$, $SEM = 2.62$), and a significant main effect of socializing, $F(1,28) = 34.54$, $p < .001$, with a higher frequency of overall thought attribution (MS, Action, and Miscellaneous) ($M = 63.66$, $SEM = 3.11$) occurring when subjects were not interacting with others, than when socializing ($M = 36.55$, $SEM = 3.09$). A paired sample t-test revealed a significant difference between the proportion of MS attributions when participants were alone ($M = 19.42$, $SEM = 1.65$) versus when they were interacting with others ($M = 9.76$, $SEM = 1.71$), $t(28) = 4.76$, $p < .001$.

A repeated measures ANOVA across the 3 categories of thought type, socializing, and direction produced a significant 2-way interaction effect of direction by socializing, $F(1,28) = 49.78$, $p < .001$, and significant main effects of thought type, $F(1,28) = 4.84$, $p < .038$, direction, $F(1,28) = 93.78$, $p < .036$, and socializing, $F(1,28) = 33.62$, $p < .001$, as seen in Fig. 3. The 3-way interaction was insignificant, $F(1,28) = 0.42$, $p = .520$.

5. Discussion

5.1. Summary of findings

Subjects' button press responses reflected a higher frequency of thoughts about actions than mental states and miscellaneous things. This relationship was validated upon recoding their free text responses. Action thoughts were the most frequent, which is what we predicted given how much of our thought is devoted to planning behavioral responses. After isolating MS attributions with respect to direction and degree of socializing, the results revealed that MS attributions occurred more offline (i.e. when alone) than online, and that these thoughts were most frequently oriented towards the self. Further, a significant 3-way interaction between thought type, degree of socializing, and direction of thought arose, signifying that action but *not* mental state thoughts about others occurred more frequently when participants were interacting with people versus when they were alone, while self-directed action and mental state attributions were both less frequent when participants were interacting with people, than when in isolation. Although this 3-way relationship was not statistically significant in our secondary recoding, the remaining effects are encouraging for future studies involving the use of ToM during social exchanges.

5.2. Closer examination of ToM attributions

An examination of MS responses revealed interesting details about the circumstances and orientation of such attributions. The higher frequency of own-directed thoughts as compared to other-directed thoughts (across both action and MS thought types) may not be too surprising given humans' demonstrated disposition towards egocentricity (Greenwald, 1980; Krueger, Windschitl, Burrus, Fessel, & Chambers, 2008). Even more intriguing is the frequency of own-directed MS thoughts ($M = 75.19$, $SEM = 4.03$), compared to other-directed MS thoughts ($M = 24.81$, $SEM = 4.03$). Examining these statistics with respect to social context, there were more MS thoughts reported outside of social interactions, and a majority of those thoughts were self-directed. These results allude to the reflective nature of ToM and seem to echo prior research conducted by Andersen and colleagues that suggest that, in constructing self-knowledge, people give greater weight to their internal subjective experiences than to overt behavioral expressions (Andersen & Ross, 1984). Although it may be premature to draw conclusions about the frequency of MS attributions with respect to current views on ToM, our implementation of the experience sampling method has produced novel results which may represent caveats to Theory of Mind. Nevertheless, such results invite further examination of how ToM is used within a naturalistic setting before making any resounding claims on its utility.

5.3. Limitations

The experience sampling method has high ecological validity, yet methodological weaknesses do exist. It is impracticable to query participants on their thoughts without bringing them to conscious awareness of those thoughts. It is possible that the method of randomly alerting participants may have prompted an increase in MS attributions simply because we were asking them to critically analyze thoughts that, under normal circumstances, may not contain much mentalistic substance. There were also a few rare instances in which participants responded that they were thinking about why they or someone

else was doing something, thinking, or appeared some way. This raises the question as to whether participants are able to distinguish between the things they had questions about (often behaviors or observations) and the potential answers to those questions (typically mental states). In review of participants' free-text responses about what they were thinking about, statements revolving around "why" were flagged. For sake of parsimony, these infrequent (16 events in total across all subjects) types of thoughts were not included in the analyses for sake of parsimony and did not have a significant impact on the results. Interestingly, in a review by Higgins and Pittman (2008) regarding people's concerns with comprehending, managing, and sharing the inner states of self and others, it is stated that people try to make sense of another person's actions by analyzing the feelings or attitudes that provide reasons for or caused his or her actions. However, one is not similarly motivated to consider one's own inner states produced the action because people tend to comprehend their own action from a situational standpoint and believe their action was the natural, objective response to seeing the world. This might explain why the majority of the "why" thoughts we flagged consisted of others' thoughts and behaviors, rather than the participant's own thoughts and behaviors. Future studies will investigate the relationship between this type of metacognition and ToM. Additionally, there were some participants who reported thinking about "nothing." Further considering the procedure, we instructed participants to refer to the thought immediately preceding the auditory signal at the start of each questionnaire. Some participants reported that the beep interrupted their current thought, and this interruption might have led to confusion and possible miscategorization. Future studies may utilize Mehl's EAR system, which provides audio recordings of selected interactions. This might allow more accurate recall about such things as thought contents (Mehl & Robbins, 2012).

The type of participants recruited may have also introduced an influential subject variable, as most of the participants were undergraduate and graduate students. Immersion in an analytical environment where many students are striving towards degrees in areas that involve reasoning about mental states (i.e. psychology, marketing) could have led to an overestimation of MS attributions. Nevertheless, comparisons of subjects' button press and recoded responses show subjects' introspection was relatively accurate when determining mental state thoughts. Of the thoughts the raters categorized as mental states, subjects' button press responses coincided 71% of the time. Many of the discrepancies between subjects' button press responses and the coders' categorizations can be partially attributed to misinterpretation of the instructions if subjects were not focusing on the object of their thought. Specifically concerning action and miscellaneous thought types, a participant might respond that she was thinking, "What am I going to eat for dinner" and categorize the thought as an action, referring to eating, when the object of the thought is actually the type of food she will eat. Because the object of her thought is neither mental or an action, it would be re-categorized as miscellaneous. Although there is no way to know exactly what her thought was referring to, coders were explicitly instructed to focus on the object of the subject's thought. In the future, we will take measures to ensure that this concept is clear to the subjects as well. Ideally, a future study would also make use of coders who are not only blind to the subjects' original button press responses but also naïve to both the theory and the hypotheses in order to achieve the most impartial analysis and interpretation.

5.4. Future directions

Our hypothesis was that ToM attributions would occur relatively infrequently outside the lab. A challenge with the current study involves exactly how to determine a baseline for the frequency measure. In this study, we used the frequency of action thoughts as an anchor for comparison. However, future studies might use frequencies recorded within a laboratory setting where social context or thought type is controlled and compare it to that of an experience sampling or similarly ecologically valid method. Such studies may help to reveal previously unknown facets of ToM.

The Experience Sampling method has the potential to become a viable avenue of research in understanding the social deficits seen in psychiatric disorders such as autism and schizophrenia and also in the study of dyadic situations. There has already been precedent set by Hurlburt, Happe, and Frith (1994), who used experience sampling and interview techniques in order to examine the form of thought in three adults with Asperger's Disorder, and more recently by Hintzen, Delespaul, van Os, and Myin-Germeys (2010) to explore social needs in the daily lives of people with PDD-NOS. Implementation of the present experience sampling approach in atypical populations would require successive approximation, starting first with the highest functioning individuals and adapting the method to subjects with increasingly more severe social-communicative impairments. If we were to successfully repeat this experiment in individuals with high functioning ASD or schizophrenia, would we see different frequencies of MS thought attributions versus those seen in matched control subjects? Based on the claim that these individuals experience deficits in ToM, we might expect to see a decrease in MS attributions. Research conducted on the ecological validity of ToM tasks demonstrated that regardless of performance on in-lab ToM tasks, children who were normally developing and handicapped showed significant evidence of ToM in their everyday lives as measured by an adapted Vinland Adaptive Behavior Scale. However, most subjects with autism, even those who passed in-lab ToM tasks, showed impairment in ToM use in everyday life (Frith et al., 1994). If we were to conduct the current study with subjects with autism, we may also see a different pattern in the direction of thought, given research that suggests that individuals with autism also have more difficulties representing their own beliefs than the beliefs of other people (Williams & Happe, 2009). However, one would have to pay careful attention to potential deficiencies in introspective and communicative capabilities when analyzing and interpreting the results.

Interestingly, the participant who was excluded before recoding received the highest SRS score and had the highest frequency of action thought attributions at 93.1%. Although the excluded subject's SRS score was not high enough to trigger more formal evaluations for a research categorization of an ASD diagnosis, this anomaly further serves as motivation to

explore relationships between the frequency of Action, MS, and miscellaneous thought attributions in atypical populations using the experience sampling method.

While other studies have looked at the effects of personality, motivation, and emotional factors on thought attributions (Kozak, Marsh, & Wegner, 2006; Sheldon & Johnson, 1993), our research did not parse out these factors. In addition, a study conducted by Andersen, Glassman, and Gold (1998) emphasized how emotional connectedness between two people may affect thought attribution. Although we are motivated to study thought attribution in the most naturalistic manner, future studies might manipulate social context where subjects are surrounded by significant others and see if spontaneous thoughts about others are more frequent and whether they are more mentalistic than behavioral in content. We also did not probe whether subjects' thoughts were reflective of the past or present. Research conducted by Pronin, Olivola, and Kennedy (2008) examined the hypothesis that people's decisions for future selves differ from their decisions for present selves and instead more closely resemble decisions for other people. It would be interesting to see if there were a unique delineation between thought type, direction, and socializing with respect to the tense of the thought. A number of social cognitive research studies have relied heavily on participants describing their response to hypothetical scenarios. Our methods might also be adapted to address these sorts of questions.

Despite reported and hypothesized relationships between ToM and measures of general intelligence, we did not find significant correlations between scores on verbal ($r = .149$) or matrix reasoning ($r = .164$) and the frequency of ToM (MS) attributions (de Villiers, 2007; Muller, Liebermann-Finestone, Carpendale, Hammond, & Bibok, 2012; Pellicano, 2007). However, since all subjects were above average in intelligence and adults who possess higher-order relational reasoning, a ceiling effect is unsurprising. Future studies may involve subjects with diverse relational reasoning abilities (e.g., children and those with intellectual disability and language disorders) and may include specific measures of executive functioning (e.g., working memory and inhibition) in order to tease apart potential relationships.

6. Conclusion

The purpose of this study was to explore the use of ToM in the real world. To the best of our knowledge, there has been no previous experience sampling account of how frequently and under what circumstances people make ToM attributions in everyday life. We have demonstrated that experience sampling presents an ecologically valid way to address this question. This study opens up new avenues for research and discourse surrounding typical and atypical thought processes, and sets the stage for future studies in younger children and in individuals with autism and/or intellectual disability.

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Sridhar Kandala, Eric Feczko, Sarah Hoertel.

Appendix A.

A.1. Instructions

You will be completing a series of questionnaires over a period of ten hours on the device provided. Each questionnaire should take no longer than five minutes to complete. You must complete the questionnaire individually when the alarm sounds, without assistance or input from anyone else. The PDA will automatically shut off at the end of each questionnaire. Two of the questions require a short written response. Using the stylus located on the back of the PDA, tap the "abc" icon in the bottom left corner of the screen. This will bring up an onscreen keyboard with which you can respond. **Please be thorough in your responses; one to two sentences should be sufficient.** You will be compensated based on the length of participation in this study (see consent form). Participation requires answering each question throughout this study. Before participating, please ensure that you can fulfill these requirements. We will accommodate your needs in order to arrange a day where you do not have any conflicts.

You will not have access to anything but the questionnaire on the PDA. Do NOT remove the batteries to the PDA.

Name (print): _____	Date: _____
Signature: _____	Subject number: _____

A.2. General information

In this study we are asking you to report on your own thoughts throughout the day.
Please refer to the thought occurring right before the alarm sounds.
We ask about mental states and actions, which are explained as follows:

- A mental state exists in your own or someone else's head.
- An action is what you or another is doing, has done or will do.

A.3. Examples

Mental State

- Bill thinks Jane is in the house.
- I believe in UFOs.
- Jane wants a candy bar.
- I want to eat something I shouldn't.

Action

- Bill is running down the street.
- I will drive to work at 9.
- They are dancing the hokey-pokey.
- That driver just cut me off.

Neither

- There are flowers in the garden.
- It is 3:15 p.m.
- The music is loud.
- It's raining.
- It's hot.

What if I can't respond immediately (e.g. using the restroom, showering, driving)? You will have a window of 10 min to respond to the questionnaire. Please do not endanger your health in order to complete a questionnaire. If you must miss one or two questionnaires, you won't be penalized.

It says "Fatal alert," what do I do? Do not panic. Tap "reset" and it should return to a home screen. Then press the home symbol (a small house) below the touch screen and this should take you back to the ESP screen.

If you run into any major problems regarding your PDA, please contact (*contact information excluded*).

Appendix B.

B.1. Coding instructions

Use the subject's response to the prompts "What are you doing" and "What are you thinking" to categorize the object of the subject's thought.

In the columns provided, code each response based on whether the object of the subject's thought is a mental state, action, or something else (other):

Mental State→Code as 1.
Action→Code as 2.
Miscellaneous→Code as 3.
Indeterminate→Code as 4.
No thought→Code as 5.

B.1.1. Mental state

"Mental state" should be coded if the subject reported thinking about their own or someone else's beliefs, thoughts, desires, memories, emotions, or states of knowledge.

- For example, the subject may report thinking of wants, fears, hopes, or beliefs.

DO NOT code "mental state" for responses that use mental terms in a conversational manner where the mental state term is not the object of the subject's thought. For example, if someone writes "I think I will go to the park after lunch," the use of

the word "think" is a mental term but is not what the subject is thinking about. (This example would be categorized as Action). Alternately, if someone responds, "I was thinking about the significance of Charles asking Danielle out for lunch when he has a wife," you could categorize it as a mental state. Another example is "the light seemed welcoming," where the meaning of "seemed" simply means "looked" (This example would be categorized as Miscellaneous).

Thoughts about emotions should also be categorized as mental states. For example, the statement "I wonder if he is upset that I did not call" ("upset" is an emotion). Likewise, if the subject reported that they were thinking about "I love that box!" this would be coded as "mental state" because the object of the thought the subject's love for the box.

The subjects should be coded as thinking about mental states even if the subject is not human or animate (e.g., "I was thinking about how much I hate my computer", "I was thinking that the dog doesn't know where his bone is buried.").

B.1.2. Action

"Action" should be coded when the subject reports thinking about what someone or something is doing, has done or will do. For example, "I will drive to work at 9" and "That driver just cut me off" are action thoughts. This also includes planning, e.g. "What I need to get done before work tomorrow".

Cost–benefit (e.g., "Whether or not I should. . .") should be categorized as action, unless explicitly referencing a mental state.

B.1.3. Miscellaneous

When the object of the subject's thought is neither a mental state nor an action, categorize the thought as "miscellaneous". This includes observation such as "It is hot", "The music is loud" and "There are flowers in the garden". This would also include less descriptive responses such as "Dinner" or "Tomorrow afternoon".

B.1.4. Indeterminate

If the meaning is still unclear, judge the statement to be indeterminate, especially given instances where more than one interpretation could be equally appropriate. ALL "why" statements or questions (e.g. "Why did she go to work today?") should be categorized as indeterminate <u>but flagged using an asterisk</u> (i.e., 4*).

B.1.5. No thought

Statements in which the subject reports he or she is thinking of "nothing" should be coded as "No thought". This category does not include responses that are left blank.

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