Affectionate Contact and Theory of Mind Abilities of Parent-Child Dyads

By

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A thesis submitted to the Center of Neuroscience Studies
in conformity with the requirements for the
Degree of Master of Science

Queen’s University
Kingston, Ontario, Canada
August, 2013

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ABSTRACT

This study was conducted to investigate the extent to which affectionate physical contact (i.e., cuddling) affects preschoolers’ and parents’ abilities to engage in theory-of-mind reasoning. We explored the hypothesis that if affectionate contact affected theory-of-mind, then preschoolers and parents who cuddled would outperform those who did not. To test this hypothesis, we recruited 44 preschool aged children (3.8-4.6-year-olds) and their primary caregivers. We found that children who cuddled with their primary caregiver during a storybook reading task performed significantly better on theory-of-mind tasks compared to children who did not receive a cuddle. Importantly, our findings support the contention that affectionate contact affected children’s performance on theory-of-mind related tasks specifically, but not performance on executive functioning or non-mental representation tasks.

A secondary goal of this study was to explore whether any effects of affectionate contact would be mediated by functional polymorphisms of the oxytocin receptor gene (OXTR). Although we were unable to obtain a sample size that was sufficient to directly test this hypothesis, we found that parents homozygous for the G allele at rs2254298 were significantly better at decoding the affective mental states of others compared to those who carried at least one A allele. Thus, our results support the hypotheses that affectionate contact promotes children’s theory-of-mind reasoning abilities and that adult’s mental state decoding skills can be predicted by allelic variations on the OXTR gene. This study offers preliminary support for the role of affectionate contact and, separately, the oxytocinergic system on tasks related to theory-of-mind reasoning. These claims are discussed with respect to possible alternative explanations for our findings, as well as future directions to directly test the extent to which such experiential and psychobiological factors can affect theory-of-mind reasoning.
ACKNOWLEDGEMENTS

First, I would like to express my gratitude to my supervisor, Dr. Mark Sabbagh, for his invaluable guidance, support and feedback. I am extremely thankful for being provided with the opportunity to work under his supervision. His advice and encouragement allowed me to proceed through the Masters program and complete this thesis. I would also like to thank the Center for Neuroscience Studies and the Developmental Psychology department at Queen’s University for providing myself, and other graduate students, with supportive learning environments and knowledgeable faculty members to stimulate and promote critical thinking. In particular, I would like to extend my thanks to the members of my thesis committee, Dr. Janet Menard, Dr. Elizabeth Kelley, and Dr. Valerie Kuhlmeier. Their creativity, feedback and willingness to share their knowledge to further my understanding was much appreciated.

Thank you to the families who volunteered their time to participate in this study and thank you to my research assistants, Alexandra Cross, Kathryn Barton and Amanda Shelley. Thank you to the members of the Early Experience Lab and the Mood Research Lab for providing invaluable academic and personal support throughout my time as a graduate student. It is rare to find such supportive and genuine people in one place. Special thanks to Jeannette Benson for your advice and friendship – your resiliency and the love you have for those around you are truly admirable qualities.

I would also like to thank my family and friends for their continuous love and encouragement. Thank you to my parents, Ike and KaCi Christopher. I would not be where I am today without their support. I cannot thank them enough for their love, guidance and countless morale-boosting conversations over the past 2 years. Thank you for always supporting me and for truly believing that I can accomplish anything I set my mind to.
With a full heart, I also extend my gratitude to my fiancée and best friend, Scott Campbell. Words cannot describe how thankful I am for his unfailing love and support. From providing comic relief when I needed it most, to instilling me with the confidence and strength to persevere and meet critical deadlines, his love and encouragement allowed me to successfully complete this thesis. I will be forever grateful for his unconditional love and support.

Finally, I would like to dedicate this work to my “Grampa”, Fred Clark. He has always had a guiding voice in my life and has continuously supported and encouraged my personal and academic endeavors. Even though he is no longer with us, I feel his love and encouragement everyday. Thank you for being such an important person in my life, I hope that this work makes you proud!
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Goals of the Present Study</td>
<td>9</td>
</tr>
<tr>
<td>2. METHOD</td>
<td>12</td>
</tr>
<tr>
<td>Participants</td>
<td>12</td>
</tr>
<tr>
<td>Materials</td>
<td>13</td>
</tr>
<tr>
<td>Child Measures</td>
<td>13</td>
</tr>
<tr>
<td>False Belief Battery</td>
<td>13</td>
</tr>
<tr>
<td>Contents Change</td>
<td>13</td>
</tr>
<tr>
<td>Location Change</td>
<td>14</td>
</tr>
<tr>
<td>Deceptive Pointing</td>
<td>15</td>
</tr>
<tr>
<td>Knowledge Access</td>
<td>16</td>
</tr>
<tr>
<td>Executive Functioning Tasks</td>
<td>16</td>
</tr>
<tr>
<td>Grass/Snow</td>
<td>17</td>
</tr>
<tr>
<td>Card/Sort</td>
<td>17</td>
</tr>
<tr>
<td>Bear/Dragon</td>
<td>18</td>
</tr>
<tr>
<td>False Photograph Tasks</td>
<td>19</td>
</tr>
<tr>
<td>Identity Change</td>
<td>19</td>
</tr>
<tr>
<td>Location Change</td>
<td>20</td>
</tr>
<tr>
<td>Language Measure</td>
<td>21</td>
</tr>
<tr>
<td>Attachment Measure</td>
<td>22</td>
</tr>
</tbody>
</table>
Adult Measures…………………………………………………………..22

Mental State Decoding…………………………………………………22

Genetic Measures…………………………………………………………25

Procedure…………………………………………………………………26

Coding of Parent Child Interactions……………………………………29

3. RESULTS………………………………………………………………………30

Adult Preliminary Analyses……………………………………………30

Adult Focal Analyses……………………………………………………31

Child Preliminary Analyses……………………………………………32

Language Measure………………………………………………………..32

Parental Mental State Talk………………………………………………33

Attachment Style…………………………………………………………34

Relations Among Tasks and Scale Aggregates………………34

Executive Functioning Aggregate……………………………………34

False Belief Aggregate……………………………………………….34

False Photograph Aggregate………………………………………35

Child Focal Analyses……………………………………………………35

Genetic Data: OXTR………………………………………………………..38

OXTR rs53576……………………………………………………………39

Adults……………………………………………………………………….39

Children…………………………………………………………………….39

OXTR rs2254298……………………………………………………………40

Adults……………………………………………………………………….40
Children………………………………………………………….40
Gene by Condition Interactions………………………………..40

4. DISCUSSION……………………………………………………………….42
  Affectionate Contact and Adults’ Theory of Mind……………………….43
  Affectionate Contact and Childrens’ Theory of Mind…………………..44
  Future Directions…………………………………………………………..47
  Summary…………………………………………………………………..49

REFERENCES CITED…………………………………………………….51

APPENDICES

A. SAMPLE FALSE BELIEF BATTERY TASK SCRIPTS………………….58
B. SAMPLE EXECUTIVE FUNCTIONING BATTERY TASK SCRIPTS……62
C. SAMPLE FALSE PHOTOGRAPH TASK SCRIPTS……………………68
D. AFFECTIONATE CONTACT CODING SCALE………………………69
E. LIST OF MENTAL STATE TERMS FOR EACH ITEM ON RMET……70
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. List of Items for Easy and Difficult Items on RMET</td>
<td>32</td>
</tr>
<tr>
<td>2. Correlates Among Aggregate Behavioural Measures</td>
<td>35</td>
</tr>
<tr>
<td>3. Allele and Genotype Frequencies of OXTR SNPs</td>
<td>39</td>
</tr>
<tr>
<td>4. Allelic Variations on rs53576 and rs2254298 and Adult RMET Mean Scores by Condition</td>
<td>41</td>
</tr>
<tr>
<td>5. Allelic Variations on rs53576 and rs2245298 and Children’s False Belief Scores by Condition</td>
<td>41</td>
</tr>
</tbody>
</table>
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Contents Change False Belief</td>
<td>14</td>
</tr>
<tr>
<td>2. Location Change False Belief</td>
<td>15</td>
</tr>
<tr>
<td>3. Deceptive Pointing</td>
<td>16</td>
</tr>
<tr>
<td>4. Knowledge Access</td>
<td>16</td>
</tr>
<tr>
<td>5. Grass/Snow</td>
<td>17</td>
</tr>
<tr>
<td>6. Card Sort</td>
<td>18</td>
</tr>
<tr>
<td>7. Bear/Dragon</td>
<td>19</td>
</tr>
<tr>
<td>8. Identity Change False Photograph</td>
<td>20</td>
</tr>
<tr>
<td>9. Location Change False Photograph</td>
<td>21</td>
</tr>
<tr>
<td>10. Mental State Decoding “RMET”</td>
<td>24</td>
</tr>
<tr>
<td>11. Mental State Decoding “Animals”</td>
<td>24</td>
</tr>
<tr>
<td>12. Timeline of Study Procedures</td>
<td>28</td>
</tr>
<tr>
<td>13. Mean Group Adult Performance Scores on Animals Task and RMET</td>
<td>32</td>
</tr>
<tr>
<td>14. Children’s Standardized Group performance on False Belief, Executive Functioning and False Photograph Tasks</td>
<td>36</td>
</tr>
</tbody>
</table>
Chapter 1: Introduction

Theory-of-mind is the understanding that peoples’ observable actions are caused by internal mental states such as beliefs, desires and intentions (Wellman, 1991). As adults, we have a “representational” theory-of-mind whereby we understand that mental states are idiosyncratic representations of the world whose content depends on one’s unique experiences. During the preschool years, children’s representational theory-of-mind abilities change rapidly. These rapid changes in the ability to engage in a representational theory-of-mind reflect the development of domain-specific conceptual understandings. The goal of the present study is to understand how children’s performance on theory-of-mind tasks might be affected by affectionate contact.

Children’s representational theory-of-mind development is typically indexed by the false belief task. The standard false belief task involves asking children to reason about an unseen change of location: A child sees a character (e.g., Barney) put his ball in a basket and then leaves. While Barney is absent, his friend, Big Bird, moves the ball from the basket to a drawer. Barney returns, and the child is asked, “Where does Barney think the ball is?” Three-year-olds typically fail this task by reporting that the Barney will search for the ball in its current location (i.e., in the drawer). In contrast, most 4-and-5-year-olds correctly report that Barney will search for the ball in the original location (i.e., in the basket). Reasoning in this task relies on children’s understanding that mental states are idiosyncratic representations of reality, and as such, may not match children’s own beliefs or reflect the true state of the world (Wellman, Cross, & Watson, 2001). The rapid changes in preschoolers’ theory-of-mind development over the preschool years have been observed across various cultures (Callaghan
et al., 2005). Children from diverse backgrounds, with varying experiences, display roughly the same timetable of explicit representational theory-of-mind development.

Within this general developmental trajectory, several factors can affect the specific timing of false belief development. Some of these factors can be categorized as experiential. For example, research on socio-economic status and theory-of-mind development suggest that children of low-income, primarily African-American, families display the same patterning of theory-of-mind development as children from white middle-class families however, the rate of development is somewhat slower (Holmes, Black, & Miller, 1996). Other evidence for the role of experience comes from research on the influence of parental mental state talk. Mothers who use more mental state terms have children who demonstrate theory-of-mind understanding earlier than children of mothers who use less mental state terms (Ruffman, Slade, & Crowe, 2002). Others have shown that preschoolers from larger families (i.e., more siblings and extended family living in the home) are better able than preschools from smaller families to predict false-belief based actions (Perner, Ruffman, & Leekam, 1994). Finally, Meins et al., (1998) showed that children’s early attachment security predicts later theory-of-mind understanding whereby children who were classified as being securely attached in infancy were more likely to pass false beliefs tasks at age 4.

While experience may play a role in setting the specific timing of theory-of-mind development, it is also likely that neurobiological factors constitute a critical rate-limiting factor. Some evidence for this comes from neurodevelopmental disorders, such as autism, in which performance on false belief tasks is impaired (Baron-Cohen, 2001). Most direct evidence that neuromaturational factors are important comes from recent studies of brain electrical activity. For instance, Sabbagh et al., (2009) revealed that individual differences in
baseline electroencephalogram (EEG) activity localized to the dorsal medial prefrontal cortex (dMPFC) and the right temporal parietal juncture (rTPJ) were positively associated with children’s theory-of-mind performance. Such findings build on previous research by suggesting that specific regions within the prefrontal cortex and the rTPJ are not only recruited while actively reasoning about others’ mental states (see Saxe & Kanwisher 2003), but that the maturation of these brain regions plays a critical role in the development of preschoolers’ theory-of-mind reasoning abilities. Similarly, Liu et al., (2009) used event-related brain potentials (ERPs) to show that a late, left-frontal, slow wave was associated with reasoning about beliefs in both children and adults. Taken together, these findings strongly suggest that development within the prefrontal cortex plays a rate-limiting role on preschoolers’ theory-of-mind development.

More recently, researchers have examined the neurodevelopmental correlates of theory-of-mind reasoning by investigating relevant neurochemical factors. For example, Lackner, Bowman, and Sabbagh (2010) examined differences in dopaminergic functioning and preschoolers’ theory-of-mind. Results showed that Eye Blink Rate (EBR), a reliable measure of functional dopamine activity within the prefrontal cortex, was a strong predictor of children’s theory-of-mind performance. Further evidence for the role of dopamine comes from research using molecular genetic techniques. Specifically, dopamine receptor D4 gene variation predicts preschoolers’ developing theory-of-mind such that preschoolers with shorter alleles outperform preschoolers with one or more longer alleles (Lackner et al., 2012). These findings suggest that dopamine binding may be particularly important for theory-of-mind development.
Although researchers have looked at the experiential and neurobiological correlates of theory-of-mind reasoning as distinct factors, there is reason to think that as in other domains, experience and biology interact in highly specific ways to render the developmental trajectory of theory-of-mind reasoning. For example, Lackner et al. (2010, 2012) noted that in animal models, dopamine signaling plays a critical role in learning about the structure of the world from errors (i.e., instances where predicted outcome does not match what really occurs) (see e.g., Schultz, 2007). Based upon these findings, Lackner et al. (2012) speculated that the relation between dopamine binding and theory-of-mind might be because of the role that dopamine plays in learning from experience. A second way in which experience and biology can interact is through the more direct psychobiological effects of experience. Many aspects of experience have affective valence (i.e., either positive or negative) which shape the cascades of neuroendocrine events that are associated with responding to experience. These neuroendocrine events shape both long-term aspects of brain development (when particular kinds of experiences are chronic), and near-term aspects of neurocognitive functioning (to process information in the immediate surround).

It is within the context of this second way in which experience and biology interact that we undertook our current research question of whether affectionate contact between a parent and a child (or cuddling) affects either the parent’s or the child’s theory-of-mind abilities. Affectionate contact refers to warm and gentle physical touches that do not serve a specific instrumental purpose, such as holding hands, hugging, massaging and cuddling. Affectionate contact is of primary interest in the present context for two reasons. First, parent-child affectionate contact has clear near-term and long-term effects on domain-general cognitive skills that are important for making good judgments about others’ mental states,
including attention and emotion regulation. For instance, Belsky & Fearon (2002) showed that children who experienced high-sensitive mothering and affectionate contact at 15 months significantly outperformed their low-sensitive mothered peers on a battery of measures assessing socio-emotional development. In fact, early high-sensitive mothering in intimate interactions predicted later social competence, expressive and receptive language abilities, and school readiness. Moreover, Scott & Watterberg (1995) showed that children deprived of maternal contact, such as premature infants, often suffered long-term disruptions to hormonal and brain systems that regulate stress – ultimately influencing later social cognitive skills.

Second, affectionate contact stimulates the release of oxytocin (Feldman, 2010), a neuropeptide, which acts like a neurohormone and seems to play some role in promoting social behaviour. For instance, massage has previously shown to evoke a strong neuroendocrine response. Research with nonhuman animals has reported peak plasma oxytocin levels approximately 15 minutes after the onset of sensory stimulation (Juszczak & Stempniak, 1997). Another study with humans detected an increase in plasma oxytocin after 5 minutes of massage (Turner et al., 1999). One study showed a spike in oxytocin levels in both mothers and fathers after a 15 minute “play-and-touch” interaction with their infants (see Feldman, 2010). Furthermore, Weisman et al., (2012) found parenting differences between fathers receiving an intranasal dose of oxytocin and fathers receiving placebo. Compared to placebo, oxytocin fathers displayed increased key parenting behaviours (e.g., touch and social reciprocity) that support parental-infant bonding. Intriguingly, parallel increases were also found in child engagement behaviour whereby the children of oxytocin fathers demonstrated superior social gaze and social reciprocity in comparison to their placebo counterparts. Likewise, maternal oxytocin levels in the first trimester of pregnancy predict maternal
postpartum behaviour (Feldman et al., 2007). In other words, mothers with high levels of oxytocin in the early stage of pregnancy display more “motherese” vocalizations, positive affect, and affectionate touches after the birth of their child compared to mothers with low levels of oxytocin in the early stage of pregnancy.

More relevant to the present research question, some research has suggested that oxytocin is important for human social cognition, broadly construed. For instance, oxytocin has been shown to improve recognition of faces, but not recognition of scenery or numbers (Rimmele et al., 2009). Perhaps more interesting for the current study, Guastella and colleagues (2008) revealed that administration of oxytocin increases eye-to-eye gaze in healthy adults. In this study, oxytocin participants evidenced an increased number of fixations, and total gaze time, toward the eye region of others. These findings provide evidence for oxytocin’s role in social communication as the eye region represents the primary source for detection of interpersonal interest and emotion in others (Haxby et al., 2002). Supporting this broad view, an imaging study (Kirsch et al., 2005) revealed that oxytocin decreases amygdala activation in response to manifestations of fearful faces. As a function of oxytocin attenuating activation in this region, it might in return facilitate social interactions by decreasing potentially negative, anxiety-provoking associations thereby allowing one to engage with others in an optimal manner by increasing eye-to-eye gaze.

Domes et al. (2007) present perhaps even more compelling evidence for a suggestive role of oxytocin in facilitating theory-of-mind. These researchers showed that a single dose of 24 IU intranasal oxytocin enhanced participants’ performance in inferring mental states from the eye region of others, measured with the Reading the Mind in the Eyes Test (RMET; Baron-Cohen et al., 2001). Specifically, oxytocin improved performance on those images that
represented highly subtle social cues (i.e., difficult items). These findings further suggest a role for oxytocin in facilitating social communication by assisting in the interpretation of affective mental states via the eye region of others.

Not only has oxytocin been linked to social cognitive behaviours in typically developing adults, but recent research suggests its role in improving social cognition in special populations that experience deficits in a variety of social cognitive abilities. Individuals with autism spectrum disorders display abnormalities in emotion perception and experience difficulties in responding appropriately to social cues. These are all specific impairments related to social cognition, and more specifically to theory-of-mind reasoning. Guastella and colleagues (2010) demonstrated that oxytocin improves emotion recognition in young adults with autism. Others have shown that oxytocin facilitates processing of social information, strengthens individuals’ social interactions and even increases eye-to-eye gaze in autistic individuals (Green & Hollander, 2010).

Furthermore, advances in social neuroscience and genetics have associated oxytocin receptor (OXTR) genotypes with autism spectrum disorder (Wermter et al., 2010). Importantly, specific variants on the same single nucleotide polymorphisms (SNPs) of OXTR (i.e., rs2268498 and rs53576) that have been associated with autism have also been linked to performance on the RMET (Lucht et al., 2012) in typically developed adults. These findings have not yet been accurately replicated, and so it is still unknown exactly how oxytocin is working on a mechanistic level to assist adults in interpreting others’ feelings and intentions. However, the implications for such findings are intriguing in their own right, as the capability of oxytocin to ease inference of the affective mental states of others might reduce ambiguity.
in social situations and in this way encourage social approach, affiliation, and trusting behaviours.

Kosfeld et al. (2005) found that intranasal administration of oxytocin causes a substantial increase in trusting behaviour between adult strangers. These researchers reported that participants given oxytocin are better able to overcome trust obstacles, such as betrayal aversion, in social interactions. They followed up their initial investigation to strengthen their ‘social trusting hypothesis’ by conducting a risk experiment in which participants were asked to play the same trust game with a computer system. This design ensured that monetary transfer decisions were not embedded in a social interaction as participants were explicitly told they were playing a game with a randomized computer system (i.e., not another person). Interestingly, in this modified risk experiment, participants’ behaviour did not differ between the oxytocin and placebo groups, suggesting that oxytocin specifically affects trust in interpersonal social interactions. Some researchers have linked trusting behaviours to theory-of-mind reasoning abilities. For example, Coricelli et al., (2000) propose a “mind-reading” system that attributes mental states to social partners in order to achieve greater expected gains from exchange. Thus, by engaging in theory-of-mind reasoning, perhaps individuals in the trust experiment reasoned that their social partner had intentions similar to their own (e.g., to gain money). However, when shared intentions were not relevant (e.g., in the computerized risk experiment) this “mind-reading” system became inactive. As such, trusting behaviours were no longer influenced by the administration of oxytocin because individuals’ theory-of-mind reasoning had been disengaged.

Finally, as mentioned above, dopamine plays a role in learning from experience and functional dopamine activity within the PFC is a strong predictor for theory-of-mind. In fact,
mammalian research suggests that oxytocin influences reward via the dopamine-dependent mesolimbic reward pathways (Donaldson & Young, 2008). Young and Wang (2004) show that blockage of either dopaminergic or oxytocinergic signaling within the reward-and-reinforcement associated accumbens prevents the development of partner preference in prairie voles. As such, oxytocin may play a role in regulating dopaminergic functioning in respect to theory-of-mind abilities as well.

*Goals of the Present Study*

The primary goal of our research was to explore whether affectionate contact enhances preschoolers’ performance on false belief tasks and promotes adults’ mental state decoding abilities. To accomplish this, we conducted a between-subjects study with two experimental conditions. In particular, parent-child dyads either cuddled or did not cuddle as they read a wordless storybook. Following the storybook reading session, the dyads were separated and each went to complete a small battery of theory-of-mind tasks. We predicted that if affectionate contact affected theory-of-mind, then preschoolers and parents who cuddled would outperform those who did not.

Although we have framed our hypotheses with respect to the specific influences that affectionate contact might have on theory-of-mind performance, there are other mechanisms by which we might see the same benefits. For instance, it is possible that cuddling with a parent for some time simply puts children more at ease in the unfamiliar testing environment and allows them to perform at higher capacity. We reasoned that if this were true, then children should show cuddle-related improvements on other age-appropriate experimental tasks in addition to the false belief task. To test this, we administered a small battery of measures that are known to be ontogenetically associated with theory-of-mind reasoning,
including executive functioning tasks, a language measure, and a measure of children’s reasoning about non-mental representations. In addition to allowing us to address the question of whether affectionate contact effects were specific to theory-of-mind, they also allow us to address the question of whether any improvements in theory-of-mind are mediated by improvements in these arguably more general cognitive abilities.

Another possibility is that cuddling might fundamentally change the way in which parent-child dyads read the storybook together. For instance, one of our hypotheses was that parents who cuddle with their children would show better theory-of-mind skills. It is possible that these theory-of-mind effects would be realized within the storybook reading task itself. If this were the case, parents who cuddled might be more likely than parents who did not cuddle to talk about the mental states of the story characters. If this were true, then it could be that any benefits that children received from being in the cuddle condition could be attributed to their exposure to more mental state talk during the storybook reading session. To test this possibility, we transcribed and coded all of the parent-child conversations that occurred throughout the storybook reading task with the goal of determining whether parents’ reading styles did in fact differ between conditions.

Finally, our hypotheses regarding the effects of affectionate contact were developed with the knowledge that affectionate contact stimulates the release of oxytocin, which itself appears to promote a broad range of social cognitive skills. Unfortunately, getting direct evidence for this specific neurobiological mechanism was not possible within the current project, as it requires obtaining a blood sample. However, we did attempt to get some indirect evidence for this mechanism by investigating whether the effects of affectionate contact are mediated by allelic variations within the oxytocin receptor (OXTR) gene. Functional single
nucleotide polymorphisms (SNPs) within OXTR have been associated with aspects of social cognition more broadly (see e.g., Rodrigues et al., 2009), and disorders of social cognition, such as autism (Jacob et al., 2007; Wu et al., 2005; Green et al., 2001). As such, we examined the possible associations between the two most replicated SNPs from OXTR (rs2254298 and rs53576) and social-cognitive abilities in children and adults. We reasoned that if oxytocin were the main reason that children who cuddled showed better theory-of-mind reasoning, then the benefits of cuddling would be more strongly realized in children who had allelic variations that made them more sensitive to oxytocin signaling. Also, collecting genetic data allowed us to conduct exploratory investigations of how theory-of-mind in children and adults might be associated with allelic variation in OXTR more generally.
Chapter 2: Method

Participants

Participants were recruited from the Child and Adolescent Development Group’s database at Queen’s University. This database is comprised of a primarily Caucasian, middle-class community in Southeastern Ontario who are interested in participating in developmental psychology research. Forty-four parent-child dyads participated in this study. Twenty-two dyads were tested in the no-cuddle condition and twenty-two dyads were tested in the cuddle condition.

Adults

Adult participants were forty-four primary caregivers (42 females, 2 males). Adults ranged in age from 28 years to 45 years. Three adults were excluded from the adult focal analyses because of experimenter error (n=1), interruptions from siblings brought into the lab (n=1), and verbally expressed extreme exhaustion due to nearing the end of a pregnancy (n=1).

Children

Child participants were forty-four preschool-aged children (19 females, 25 males). At the time of the testing session, children ranged in age from 3 years, 8 months to 4 years, 6 months. Five children were excluded in the focal analyses because of experimenter error (n=1), failing control questions (n=1), and providing insufficient data (i.e., refused to complete tasks to be administered) (n=3).

Four additional parent-child dyads were excluded from the final sample because they did not complete the storybook task (n=1), were not a true representation of their assigned condition (i.e., did not engage in affectionate contact in the cuddle condition or engaged in too
much affectionate contact in the no-cuddle condition) \((n=2)\), or spoke a different language aside from English during the storybook task \((n=1)\).

Thus, the final sample consisted of thirty-seven adults and thirty-five children. Adults ranged in age from 28 to 45 years \((M = 37.12, SD = 4.51)\) and there were 2 males and 35 females. Children ranged in age from 44 to 54 months \((M = 50.23, SD = 3.26)\) and there were 20 males and 15 females.

**Materials**

Both children and their primary caregiver were tested on a variety of measures. Children were tested on a battery of false belief and executive functioning tasks, 2 false photograph tasks, a language test, and a rating of attachment style. Parents were tested on their ability to infer the mental states of others. Finally, both children and their parent provided a saliva sample for genetic analysis of the OXTR. Each measure is described in detail below:

**Child Measures**

*False Belief Battery*

The scripts for each false belief task \((4)\) are presented in Appendix A. The tasks included in this battery assess children’s understanding of others’ mental states. These tasks evaluate children’s ability to reason about others’ beliefs and understand that they may differ from their own. All tasks were presented to children using stuffed animals, puppets and picture props.

*Contents Change.* Children were shown a Smarties box and asked to state what it contains. Following this exercise, the experimenter reveals the actual contents of the Smarties box (e.g., stickers). Children were then introduced to a puppet (e.g., Mickey Mouse). Children
were asked to proclaim what Mickey, who has never seen inside the Smarties box before, will think it contains (see figure 1): “What does Mickey think is inside this box? Smarties? Or stickers?” In order to answer this question correctly, the child must understand that Mickey does not have the same knowledge about the contents of the box that they themselves have, thereby recognizing the puppet’s false belief.

![Mickey plush toy](image)

*Figure 1. Contents change*

*Location Change.* The experimenter set up a scene with 2 boxes (1 blue and 1 green) and introduced the children to 2 characters (e.g., Barney and Big Bird) that were playing with a yellow ball (see Figure 2). Barney then left the scene to eat his lunch. Before leaving, he put the yellow ball inside the blue box. After Barney’s departure, Big Bird retrieved the ball from the blue box and continued to play. After a short period of time, Big Bird left the room to take a nap. Before leaving, Big Bird put the yellow ball in a different location than where Barney left it; he hid the ball inside the green box instead of the blue box. Barney, the first character, returned to the scene and children were asked where Barney would look for the ball: “Where does Barney think the ball is?” To be correct, children needed to understand that Barney did not have access to the same knowledge about the balls’ whereabouts that they themselves possessed and so should act according to Barney’s own knowledge state (i.e., the ball still remained in the location where it was originally hidden; the blue box).
Deceptive Pointing. Children saw the experimenter place a toy car inside 1 of 2 covered boxes. They were then taught that the cars’ location could be indicated by pointing to the box in which the car was located. The children were instructed to further demonstrate their understanding of this concept by placing the car in a box and pointing to it themselves. Following this exercise, children were introduced to a puppet named Samantha and were told that they were going to put the car inside one of the boxes and see if Samantha could find it (see figure 3). The experimenter placed Samantha behind a curtain where she was reported to be unable to see. While Samantha was absent, the child was asked to hide the car in one of the boxes. The experimenter then told the child to play a trick on Samantha by pointing to make her look in the wrong box. In order to succeed at this task, children had to provide misleading clues (i.e., point to the empty box) upon Samantha’s return to the scene. This would demonstrate that the child tried to make someone believe something that was not true, thereby indicating that they have an implicit understanding of false beliefs. Children participated in 2 trials of this task. The second trial involved playing the same trick on a different character (e.g., puppy). Children were awarded a score of 1 if they successfully used deception. Thus, a score of 2 indicated their use of deception on both trials of this task.
Knowledge Access. Children were shown a dresser and asked what they thought was inside a particular drawer on the dresser. After they responded with an answer, or stated that they did not know, the box was opened to reveal a small plastic pig (see figure 4a). The drawer was then closed again and children were introduced to a character named Audrey (see figure 4b). They were told that Audrey had never *ever* seen inside that drawer before, and then asked whether Audrey knew its contents: “Does Audrey *know* what’s inside the drawer?” In order to answer the test question correctly, children had to understand that Audrey did not have the same knowledge about the drawer’s contents that they themselves had.

Executive Functioning Tasks

The complete scripts and scoring protocol for these tasks are provided in Appendix B. These tasks required children to inhibit their initial impulses in order to respond in alternate ways. Again, puppets and picture props were used to illustrate the task scenarios.
**Pointing Stroop Task (i.e., Grass/Snow).** A black board (20” x 14”) with a green card (6” x 4”) attached to the upper left-hand corner and a white card (6” x 4”) attached to the upper right-hand corner was placed in front of the children (see figure 5). To establish that children knew the corresponding colours for grass and snow, children were asked to point to the colour of grass and then to the colour of snow. The experimenter then explained that they were going to play a “very silly game” by pointing to the white square anytime she said the word “grass,” and to the green square anytime she said the word “snow.” Children completed as many practice trials, with feedback, as necessary until they correctly responded to 1 grass trial and 1 snow trial. Subsequently, children completed 16 trials where no feedback was provided. Children were awarded a score of 1 for initially pointing to the correct square on each and every test trial. Children received a score of 0 on any given trial if they pointed to the incorrect square, or pointed to both squares simultaneously. Therefore, a maximum of 16 points were possible to obtain in this task. This task measured children’s ability to inhibit the impulse to point to the colour that corresponded to the spoken word in order to provide the correct response.

**Figure 5. Grass/snow**

*Card Sort.* The experimenter placed two baskets, side by side, in front of the children. A picture of a red rabbit was attached to the basket located to the right of the children and a picture of a blue boat was attached to the basket located to the left of the children (see figure 6). Children were then presented with cards, one at a time, depicting 1 of 2 different shapes
(e.g., a rabbit or a boat) that could be 1 of 2 different colours (e.g., red or blue). In a series of 5 pre-switch trials, the children were asked to sort the cards into 1 of the 2 baskets according to shape only (i.e., rabbit cards go into the rabbit basket and boat cards go into the boat basket). Subsequently, only after this rule had been established and the children correctly sorted 5 cards by shape, the children were told that they were no longer going to play the shape game. The experimenter explained that they were now going to play the colour game. Thus, the next 5 post-switch trials required children to sort the same cards according to colour only (i.e., red cards go into the red basket and blue cards go into the blue basket), ignoring shape as a defining characteristic. In order to succeed at this task, children had to inhibit the previously learned rule (i.e., sort only by shape) and focus exclusively on the new rule (i.e., sort only by colour). A maximum of 5 points were allotted on this task, one for every number of correct post-switch trials.

Figure 6. Card sort

* Bear/Dragon. Prior to playing this game, the experimenter asked children to perform 10 simple actions (e.g., touch your tummy, clap your hands, touch your ears, etc.). Children were then introduced to a “nice bear” puppet and a “mean dragon” puppet (see figure 7). The puppets were both controlled by the same experimenter. Children were instructed to do what they were told (e.g., touch your nose) by the "nice bear" puppet, but not what they were told by the "mean dragon" puppet. After children demonstrated their understanding of the rules through practice trials with feedback, the puppets took turns telling children to act out the
actions that were performed earlier in the game (e.g., touch your tummy, etc.). A total of 10 test trials were administered (i.e., 5 demands from the nice bear and 5 demands from the mean dragon). This task measured executive functioning by examining the extent to which children were successful at not following the “mean dragon’s” instructions to complete specific actions. Responses on the dragon test trials were coded on a scale from 0 to 4: 0 = full correct movement, 1 = partial correct movement, 2 = incorrect movement (e.g., touches eyes when instructed to touch teeth), 3 = strategic movement (e.g., shakes head no, or sits on hands), and 4 = no movement. Thus, children with a cumulative score of 20 successfully inhibited the urge to follow direction from the “mean dragon”.

![Bear/dragon](image)

*Figure 7. Bear/dragon*

**False Photograph Tasks**

The scripts for the 2 false photograph tasks are provided in appendix C. These tasks required children to focus on making judgments about photographic representations rather than mental states. Prior to administration of the false photograph tasks children were given the opportunity to familiarize themselves with a digital camera. Together with the experimenter children took a picture of various cartoon animals (e.g., giraffe, elephant, etc.) displayed on the wall in the testing room. Children were then shown how to view the picture they had taken on the digital screen.

*Identity Change False Photograph.* The experimenter revealed a park scene and introduced the children to a small stuffed animal (e.g., Mr. Bunny) playing in the park (see
With the experimenter, the children took a picture of Mr. Bunny sitting in the park using the same digital camera they used in the warm up phase of this task. The children were then told that Mr. Bunny left the park to start out on an adventure. Following Mr. Bunny’s departure, a new stuffed animal (e.g., Mr. Penguin) entered the park looking for Mr. Bunny to play. The children were asked the test question, “in the picture we took, who was sitting in the park, Mr. Bunny or Mr. Penguin?” Children received a score of 1 for correctly reasoning about the photographic representation and proclaiming that Mr. Bunny was sitting in the park when they took the picture.

![Figure 8](image.png)

Figure 8. Identity change, false photograph

**Location Change False Photograph.** First, the experimenter set up a bedroom display. A small chair and bed were placed approximately 8 inches apart in front of the child. Children were then introduced to a small stuffed animal (e.g., Teddy). The experimenter proceeded to explain that Teddy loves sitting in his chair and asked the children if they wanted to take a picture of Teddy sitting in his chair (see figure 9). With the experimenter, children took a picture of Tedding sitting in his chair. The experimenter then explained that Teddy decided to walk over and lay down on his bed. After Teddy was settled on his bed the children were asked the test question “in the picture we took, where is Teddy, on his chair or on his bed?” In order to answer this question correctly and obtain a score of 1, children had to reason about representations that did not accurately reflect the current state of reality and proclaim that Teddy was on his chair when they took the picture.
All of the above mentioned tasks were administered to children in the following order: (1) knowledge access, (2) grass/snow, (3) identity change false photograph, (4) card sort, (5) location change false belief, (6) deceptive pointing, (7) location change false photograph, (8) bear/dragon and (9) contents change false belief. In addition to these tasks, all children completed a language measure. We also obtained an appraisal of attachment based on the primary caregiver’s assessment of their own child. These two measures are described in detail below.

**Language Measure**

To assess children’s receptive language abilities, the experimenter administered version B of the Peabody Picture Vocabulary Test, Fourth Edition (PPVT-IV, Dunn & Dunn, 2007). This measure was included to control for general language skills when examining individual differences in children’s performance on the study tasks. In each trial, children were shown a page with four colour pictures. Children were asked to point to the drawing that corresponded to a specific vocabulary word (e.g., washing). Children continued through progressively more difficult items until they incorrectly answered 8 or more in a set of 12. Children’s scores were calculated by subtracting the total number of errors made from the highest overall item reached.
Attachment Measure

To assess children’s attachment style, parents were asked to complete the Attachment Q-Set, Version 3.0 (Waters, 1995). Parents were instructed to sort 90 index cards into 9 card piles with an equal 10 items in each pile. Each index card was inscribed with a different behavioural description such as “my child asks for and enjoys having me hold, hug, and cuddle him.” Parents were instructed to sort the items as behaviours they observe everyday that are very much unlike (1) to very much like (9) the typical behaviour of their child. To simplify the sorting task, all parents were advised to first sort the cards into 3 broad categories (i.e., one pile containing behaviours that were very much like their child, another pile containing behaviours that were very much unlike their child, and a third pile containing behaviours that were somewhere in between). Following this initial categorization, parents were then instructed to further subdivide each of the 3 categories into 3 more categories with an even 10 items in each pile. Parents were provided with 9 small numbered (1-9) boxes in which they were asked to place the final categorization of the items. Each sort was later correlated to a criterion sort of the hypothetical ‘most secure child’ in accordance with Version 3 of the Attachment Q-Set. Thus, children received a score within the range of -1 (insecure) to +1 (secure) based on their caregivers’ assessment.

In addition to collecting false belief measures for children, we obtained an adult measure of Theory of Mind. This measure is described in detail below.

Adult Measures

Mental State Decoding

To assess Theory of Mind abilities using mental state decoding, parents’ were asked to complete the Reading the Mind in the Eyes Test (Baron-Cohen, et al., 2001). From this point
on, we will refer to this task as the RMET. Parents were instructed to sit comfortably on the couch (70” x 34” x 34”) in the testing room with a wireless keyboard placed in their lap. Parent’s attention was then directed to the 50-inch big screen TV located 6 feet in front of them. Once parents expressed that they were comfortable, the research assistant proceeded to explain the RMET. Parents were told they were going to view images of eyes displayed on the TV screen. These images were surrounded by 4 adjectives (i.e., one in each corner of the image; 1 in the top left corner, 1 in the top right corner, 1 in the bottom left corner and 1 in the bottom right corner) (see figure 10). Parents were told to use the keyboard to indicate the word they thought best described the image they were shown. The keyboard was labeled with bright stickers to indicate the key that corresponded to the location of each adjective on the TV screen (e.g., “A” corresponded to the top left adjective, “K” corresponded to the top right adjective, “Z” corresponded to the bottom left adjective, and “M” corresponded to the bottom right adjective). Parents completed 2 practice trials followed by 36 randomized test trials. This test was used as an empirical assessment of adult theory-of-mind abilities.

To ensure that adult group differences between the cuddle and no cuddle conditions on the RMET could be attributed to differences in mental state decoding, parents were also asked to complete The Animals Task (Harkness et al., 2005). This task is similar to the RMET however, parents were asked to select 1 of 4 adjectives that best described the image of an animal that was displayed on the TV screen (see figure 11). Just like the RMET, this task required parents to match a picture with a target word presented with three distracters. Thus, the response demands were similar to those of the RMET, however participants were not asked to reason about mental states. Parents completed a total of 12 randomized test trials of
this task. Images from both tasks (i.e., RMET and the Animals task) were combined and randomized for a total of 48 test trials.

*Figure 10. Mental state decoding “RMET” Figure 11. Mental state decoding “Animals”*
Genetic Measures

Genetic Testing.

Both parents and children were asked to provide a saliva sample for later genetic analysis by spitting into a medical grade sterile tube. The majority of the children (96%) were unable to spit into the tube so sterile sponges were used to absorb saliva from the cheek pouches. OXTR genotypes were determined by Dr. Xudong Liu, located at Ongwanada Research Centre. DNA was extracted from the saliva samples following the manufacturer’s instructions (Oragene, DNA Genotek). The Oragene Saliva Extraction kits were used following the 3mL Oragene extraction protocol. Samples were quantified using a spectrophotometer (95uL TE and 5uL sample) and DNA quality was checked using a 1% agarose gel run for 30 minutes at 165volts (3uL loading dye and 5uL DNA). Samples were then genotyped using TaqMan Assays from Life Technology on an ABI ViiA7 instrument for the following oxytocin markers; rs2254298 and rs53576. A portion of the extracted stock DNA was diluted into 10ng/ul, which was used as a DNA working solution. At this time, 4uL of the DNA working solution was loaded into 384 well plates. The DNA was then heat dried and 1.5uL of the mixed cocktail consisting of 85.5uL dH2O, 90uL TaqManMaster Mix (2x) and 4.5uL SNP Marker was added to each reaction. All samples were then amplified.
**Procedure**

All parent-child dyads were tested in the Queen’s Biological Communication Centre at Queen’s University. One of 2 trained research assistants engaged the children in casual play (e.g., colouring) in the waiting area while the experimenter explained the information and consent forms to the parents. Following the completion of all forms, the experimenter directed the children into one of the testing rooms to show them where they would be playing some games with puppets and stuffed animals. The experimenter then explained that before the children played the games with the experimenter they got to read a story book displayed on a big screen TV with their primary caregiver. At this point in time, the experimenter directed both the child and their caregiver into the other testing room which contained a big screen TV, a couch and a small desk and chair. The initial lab tour was incorporated into the study design after piloting to ensure that both the parent and child were comfortable and familiar with the testing environment.

In a between-subjects experimental design, dyads were randomly assigned to either cuddle while completing the storybook task or sit separately on opposite ends of the couch to complete the task. The experimenter provided the following instructions for those dyads assigned to the cuddle condition: “Hop up on the couch and get nice and cozy like you would if you were at home watching a movie or reading a book.” The instructions provided to those dyads assigned to the no-cuddle condition were as follows: “Hop up on the couch to read the story, the only thing is that you (looking at the child) have to sit on this side of the couch (pointing to the right) and mom/dad has to sit on this side of the couch (pointing to the left side).” After provided with these instructions, parents were told to use the computer mouse to advance to each subsequent page of the storybook. Parents were notified that the mouse
would only advance pages if they clicked after a green arrow appeared in the bottom right hand corner of the screen. This restriction was incorporated into the study design to control for the length of the storybook session. The storybook task was programmed using E-Prime 1.0 (Psychology Software Tools, Pittsburgh, PA, USA) to facilitate a minimum of 12 minutes of parent-child interaction. A 15 minute massage has previously shown to evoke a strong neuroendocrine response in infants and adult women. One study showed a spike in oxytocin levels in both mothers and fathers after a 15 minute “play-and-touch” interaction with their infants (see Feldman, 2010). As such, we reasoned that by placing a 12 minute minimum on the storybook reading session parent-child dyads in our study would experience a similar neuroendocrine response. Following the brief explanation of the storybook task, parent-child dyads were left alone in the testing room to complete the task. All sessions were videotaped.

Immediately following the storybook reading task, the experimenter brought children into a separate testing room to administer the study tasks. All tasks were administered in the above mentioned order and took approximately 23 minutes to complete. During the administration of these tasks, the primary caregiver remained in the storybook room and completed the RMET task following instructions that were provided by a research assistant. This task took approximately 5 minutes to complete. The literature suggests that active levels of oxytocin have a half-life of approximately 20 minutes. Generally speaking, this means that circulating levels of oxytocin are 50% of peak 20 minutes after peak. With this in mind, we administered all study tasks within 23 minutes of completing the storybook session.

Following the completion of the tasks mentioned above, parents and children were asked to provide a saliva sample. Children were then provided with a short, 5-minute break in which they were offered fruit snacks. The break was followed by the administration of the
PPVT which took between 15 to 20 minutes. Parents remained in the storybook room and completed the Attachment Q-Set. On average, parents completed the Attachment Q-Set within 35 minutes. See figure 12 for a detailed visual depiction of the study’s procedures.

Figure 12. Study procedures
Coding of Parent-Child Interactions

Interactions were micro-coded to evaluate second-by-second postural changes within each parent child dyad. Patterns of touch were evaluated on both the parent and child level by reporting affectionate touches (e.g., caress, kiss, pat, light pokes), and functional proprioceptive touches (e.g., moving the child in space, changing the child’s position, or touching social partner for attention).

The Postural Affectionate Contact Score was created by summing the proportions of time the parent-child dyad held one of eight specific positions outlined in the Affectionate Contact Coding Scale. See Appendix D for a detailed description of each postural category. This coding system was developed using archival data from our research lab. Even though the two experimental conditions were designed to either discourage affectionate touch between parent and child (i.e., no-cuddle condition), or to promote affectionate contact styles within dyads (i.e., cuddle condition), this coding system allowed us to statistically differentiate between high and low affectionate contact groups. Importantly, as aforementioned, three dyads were removed from the sample because they were not a true representation of their experimental condition. Dyads in the no-cuddle condition (n = 22) engaged in affectionate contact for less than 12% of the time and had an average postural score of 1385 (range = 730 – 2760). Dyads in the cuddle condition (n = 19) engaged in affectionate contact for more than 54% of the time and had an average postural score of 5241 (range = 1675 – 8734). Inter-rater reliability was computed for 8 interactions and Cohen’s kappas averaged .91 (range = .76 – 1.00).
Chapter 3: Results

The primary goal of this study was to determine whether affectionate contact would influence theory-of-mind performance in both children and their primary caregivers. A secondary goal of this study was to explore whether any effects of affectionate contact would be mediated by functional polymorphisms of the oxytocin receptor gene (OXTR). We will begin by reporting findings from the behavioral measures. First, we will discuss findings from the adult data, and then we will report results from the child data. Finally, we will discuss the genetic findings.

Adult Preliminary Analyses

Preliminary analyses were carried out to examine the reliability of the RMET. Inspection of the internal reliability of the 36-item measure revealed that is was relatively low (alpha = .405). Internal reliability assesses the consistency of results across items within a given test. In the present study, we wanted to ensure that all items retained in the RMET were a reliable measure of the same latent construct (i.e., mental state decoding abilities). As such, we conducted an analysis by item, which showed that removal of items 1, 25, and 30 resulted in a slight increase in the reliability of the measure (alpha = .499). Upon further inspection, removal of items 12 and 16 resulted in a further, yet not substantial, increase (alpha = .544). Despite the low internal reliability, the mean and general distribution of performance on the 36-item scale in our sample ($M = .76, SD = .08$) closely resembles that of previous research (see Baron-Cohen et al., 2001) ($M = .74, SD = .09$). Thus, we elected to retain all 36 items in the measure. Additionally, eliminating the items listed above from the analyses does not significantly change any of the reported results. Internal reliability of the 12-item animals
control task proved to be acceptable (alpha = .566), thus all 12-items were retained on this measure.

**Adult Focal Analyses**

Mean performance on the “RMET” and the “Animals” task for each condition are illustrated in Figure 13. As expected, there was no significant difference between the no-cuddle (M = .83, SD = .13) and cuddle (M = .83, SD = .14) groups on the Animals control task, \( t(35) = .02, p = .500, d = .01 \). Contrary to our hypothesis, there was no significant difference between the no-cuddle (M = .75, SD = .09) and cuddle (M = .78, SD = .08) conditions on the RMET, \( t(35) = 1.17, p = .250, d = .39 \).

As we will discuss in more detail later, a more detailed investigation of the literature that has reported an association between oxytocin and performance on the RMET revealed that the association is typically weak; findings are usually reported as significant at the one-tailed level. Indeed, in one study, an association appeared when considering performance on the most difficult items (see Domes et al., 2007). To see whether the same was true in the present study, we returned to the paper that originally published norming data (n=225) by item on the RMET (Baron-Cohen et al., 2001). We then arranged the item means into a distribution and we classified items into groups of the easiest 20% (i.e., items that people got correct most often) and the most difficult 20% (i.e., items that people got incorrect most often). The items for each group are listed in Table 1 and their item reference can be found in Appendix E. Yet, we found no evidence that the distinction between easy and hard eyes was informative with respect to condition effects – the condition effect was not significant for either easy, \( t(35) = 1.18, p = .245, d = .39 \), or difficult, \( t(35) = .27, p = .788, d = .09 \), items.
Thus we gained no evidence that parents’ performance on the RMET was affected by cuddling with their preschoolers.

Table 1. List of items for easy and difficult items on the RMET

<table>
<thead>
<tr>
<th>Group</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>2, 3, 9, 12, 14, 20, 22, 30</td>
</tr>
<tr>
<td>Difficult</td>
<td>17, 19, 25, 27, 28, 31, 32, 33</td>
</tr>
</tbody>
</table>

![Figure 13](image.png)

*Figure 13.* Mean adult performance scores on the control “Animals” task and the test “Eyes” task (RMET) for the no-cuddle and cuddle conditions. The x-axis shows the tasks completed and the y-axis represents the range of scores on the measure.

*Child Preliminary Analyses*

Preliminary analyses were carried out to establish that the two experimental groups did not differ with respect to demographic and control variables that could affect theory-of-mind performance. Boys and girls were equally represented in both conditions, and the two groups did not differ in age (cuddle: $M = 50.28$ months, no-cuddle: $M = 50.18$ months). As such, all further analyses were conducted collapsing across sex and age. Moreover, no
significant group differences were found in children’s receptive language abilities, parental mental state talk, or parent rated child attachment style, $p’s > .05$. These measures and their descriptive statistics are listed and described below.

Language Measure

Raw scores on the PPVT IV ranged from 54 to 124 ($M = 95.51$, $SD = 16.61$). Performance within this range is expected of typical children in this age group. An independent samples $t$-test revealed no significant difference in scores between the no-cuddle ($M = 95.28$, $SD = 17.36$) and cuddle ($M = 95.76$, $SD = 16.29$) groups, $t(33) = .09$, $p = .932$, $d = .03$.

Parental Mental State Talk

Parents’ use of mental state terms while engaged in the storybook task ranged from 4 to 57 tokens ($M = 20.34$, $SD = 11.73$). An independent samples $t$-test revealed no significant difference in the number of mental state words used by parents in the no-cuddle ($M = 17.17$, $SD = 7.05$) and cuddle ($M = 23.71$, $SD = 14.70$) conditions during the storybook task, $t(33) = 1.69$, $p = .100$, $d = .57$. Moreover there was no significant group difference on the amount of time that non-cuddlers ($M = 16.00$, $SD = 3.93$) and cuddlers ($M = 17.41$, $SD = 5.68$) spent in the storybook reading session, $t(33) = .86$, $p = .396$, $d = .29$. However, because the duration of the storybook task varied between parent-child dyads (range: 12-29 minutes) and, subsequently, parental total talk varied between dyads (range: 1006-3320 words), we elected to compare group differences on parental mental state talk controlling for total talk. Again, no significant group difference between the no-cuddle ($M = 1.02$, $SD = .43$) and cuddle ($M = 1.20$, $SD = .53$) conditions were found, $t(33) = 1.14$, $p = .264$, $d = .39$. 
Attachment Style

Attachment scores obtained from parental report of the Attachment Q-Sort ranged from -0.18 to 0.69 ($M = 0.40, SD = 0.18$). As mentioned above, scores on this measure range from -1 (i.e., most insecurely attached) to +1 (i.e., most securely attached). Thus, our findings highlight the overall secure attachment of our sample. An independent samples $t$-test revealed no significant difference in parent-rated attachment styles between children in the no-cuddle ($M = 0.36, SD = 0.19$) and cuddle ($M = 0.43, SD = 0.18$) conditions, $t(33) = 1.13, p = .269, d = .38$.

Relations Among Tasks and Scale Aggregating

Executive Functioning Aggregate

The executive functioning battery was comprised of 3 tasks: Grass/Snow, Card Sort, and Bear/Dragon. Grass/Snow scores were calculated by summing the number of correct trials. There were a total of sixteen trials on this task and scores ranged from 0 to 16 ($M = 12.40, SD = 4.45$). Card Sort scores were calculated by summing performance on the three incompatible post switch trials. Scores ranged from 0 to 3 ($M = 2.14, SD = 1.33$). Bear/Dragon scores were calculated by summing the number of correct responses on the dragon trials. There were a total of 5 dragon trials and scores ranged from 0 to 20 ($M = 18.4, SD = 3.71$). Internal reliability of the standardized 3-item scale revealed that it was sufficient (alpha = .632). Thus, we combined standardized scores of the three measures to form one reliable 3-item aggregate illustrating childrens’ executive functioning skills.

False Belief Aggregate

The false belief battery was comprised of 4 tasks: Knowledge Access, Contents Change False Belief, Location Change False Belief, and Deceptive Pointing. Children
received either 1 (i.e., pass) or 0 (i.e., fail) on the first three tasks listed above. Deceptive pointing scores were calculated by summing performance on 2 trials, ranging from 0 to 1 on each trial. The internal reliability of the 4-item scale was acceptable for an experimental measure (alpha = .515), and so we combined the z-scores of the four measures to form one 4-item aggregate indicating childrens’ false belief performance.

**False Photograph Aggregate**

The false photograph battery was comprised of 2 tasks: False Photograph Location Change and False Photograph Identity Change. Children received a score of 1 on each task if they correctly answered the test question. The two tasks were strongly correlated, \( r(33) = .40, \ p = .018 \). Thus, we proceeded with a 2-item aggregate, which was comprised of the standardized scores for each false photograph task.

Correlations of the above aggregate measures are summarized in Table 2.

<table>
<thead>
<tr>
<th>False Belief</th>
<th>Executive Functioning</th>
<th>False Photograph</th>
</tr>
</thead>
<tbody>
<tr>
<td>False Belief</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Executive Functioning</td>
<td>.540**</td>
<td>-</td>
</tr>
<tr>
<td>False Photograph</td>
<td>.190</td>
<td>.455**</td>
</tr>
</tbody>
</table>

** p < 0.01 level.

**Child Focal Analyses**

An independent samples \( t \)-test was conducted to compare children’s theory-of-mind abilities as indexed by their false belief understanding between the two experimental conditions: no-cuddle and cuddle. In line with our hypothesis, children who cuddled with their primary caregiver during the storybook reading task performed significantly better on the false belief battery compared to children who did not receive a cuddle, \( t(33) = 2.08, \ p = \)
.046, $d = .70$. No significant group differences were found in respect to childrens’ executive functioning skills, $t(33) = 1.01, p = .320, d = .34$, or in their ability to reason about non-mental representations, $t(33) = .36, p = .720, d = .12$. Childrens’ mean performance on the false belief, executive functioning and false photograph tasks are illustrated in Figure 14.

Figure 14. Childrens’ standardized group performance on False Belief (FB), Executive Functioning (EF), and False Photograph (FP) tasks

As noted above (see Coding of Parent Child Interactions), there were fairly wide individual differences in the degree to which parents showed affectionate contact in both the cuddle and no-cuddle conditions. One question from this is whether individual differences in affectionate contact as indexed by the cuddle scores were associated with performance on our experimental measures of interest. Of particular interest is whether parents who showed higher degrees of affectionate contact had children who showed very good performance on the theory-of-mind tasks. Results from correlation analyses provided no evidence that this was the case. The degree of affectionate contact as measured by the cuddle score was not
significantly correlated to false belief understanding in either the no-cuddle, \( r(16) = .32, p = .193 \), or cuddle condition, \( r(15) = .17, p = .504 \). These findings suggest that whatever benefits were conferred by the cuddling manipulation were realized fully with moderate levels of affectionate contact.

One of our main interests was to address whether the cuddling manipulation was associated specifically with increases in theory-of-mind reasoning. One alternative possibility was that the period of affectionate contact simply put children at ease in the novel testing environment and thus allowed them to perform well on a range of laboratory measures. Our initial analyses did not suggest support for this alternative – there was a significant effect of the cuddle manipulation on theory-of-mind performance but not on either executive functioning performance or on tasks that required reasoning about non-mental representations. Yet, inspection of the means suggests that though not significant, the differences between groups were in an expected direction for both the executive functioning and the non-mental representation tasks.

To gain further evidence on the specificity of the association between the cuddle manipulation and children’s performance on theory-of-mind tasks, we conducted a series of multiple regressions. In the first, children’s theory-of-mind performance was considered the dependent measure while experimental condition and executive functioning performance were considered predictors. Results showed that, as expected and reported above, there is a robust association between executive functioning and theory-of-mind, \( b = .49, t(31) = 3.44, p = .002, d = 1.20 \). More interesting, the association between experimental condition and theory-of-mind remained moderate, though it fell just short of standard levels of statistical significance, \( b = .25, t(31) = 1.76, p = .087, d = .62 \).
For comparison, we conducted a similar analysis though this time, executive functioning was the dependent measure while experimental condition and theory-of-mind performance were considered as predictors. We reasoned that if cuddling affected both theory-of-mind and executive functioning in equal measure, then we would see a pattern of results similar to those seen when false belief performance was the dependent measure. However, this pattern we observed here was much different; beyond the robust association between theory-of-mind and executive functioning, there was no evidence of a condition effect on executive functioning performance, $b = .01, t(31) = .08 p = .940, d = .03$. A similar analyses showed that there was no evidence of a condition effect on children’s reasoning about non-mental representations in the false photograph task, $b = .00, t(31) = .01, p = .992, d < .01$. Taken together, these findings support the contention that the affectionate contact manipulation affected children’s performance on false belief tasks, but not performance on executive functioning or non-mental representation tasks.

**Genetic Data: OXTR**

A secondary goal of this study was to examine possible associations between the most replicated functional SNPs from OXTR (rs53576 and rs2254298) and theory-of-mind abilities in adults and children. Only 33 of the 35 children included in the behavioural analyses provided a saliva sample. Thus, the genotyping analyses were conducted on the 33 children that were able to do so. All parents provided samples, however, one was lost during the extraction process, and so the adult analyses were conducted on 36 samples. Genotype frequencies of both SNPs for children and adults are summarized in Table 3. The allele frequencies in our samples are consistent with those reported in the human genome database (see hapmap.org) (Jacob et al., 2007; Wu et al., 2005). Due to the low overall frequency of
AA carriers on both SNPs in our sample (seven AA carriers (10%) for rs53576, and only one AA carrier (1%) for rs2254298), we used a dominant genetic model, combining the AA and AG carriers. This model created a single group defined by having at least one A allele. In line with past research, we hypothesized that individuals homozygous for the G allele (GG) would have higher scores on our theory-of-mind measures compared to individuals with one or two copies of the A allele (AA and AG).

Table 3. *Allele and genotype frequencies of OXTR SNPs*

<table>
<thead>
<tr>
<th></th>
<th>Genotype Distribution</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>RS53576</strong></td>
<td></td>
<td>GG</td>
<td>AG</td>
<td>AA</td>
</tr>
<tr>
<td>Adults</td>
<td>20 (56%)</td>
<td>14 (39%)</td>
<td>2 (5%)</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td>18 (54%)</td>
<td>10 (30%)</td>
<td>5 (15%)</td>
<td></td>
</tr>
<tr>
<td><strong>RS2254298</strong></td>
<td></td>
<td>GG</td>
<td>AG</td>
<td>AA</td>
</tr>
<tr>
<td>Adults</td>
<td>27 (75%)</td>
<td>9 (25%)</td>
<td>0 (0%)</td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td>26 (79%)</td>
<td>6 (18%)</td>
<td>1 (3%)</td>
<td></td>
</tr>
</tbody>
</table>

*OXTR rs53576*

*Adults.* After grouping participants according to a dominant genetic model, we found no association between variants of rs53576 and mental state decoding abilities, *t*(34) = .84, *p* = .409, *d* = .28. Individuals homozygous for the G allele of rs53576 performed the RMET roughly as well as individuals who carried at least one A allele (*Ms* = .75, .77, *SD*s = .09, .09, respectively).

*Children.* After grouping children according to the dominant genetic model, we found no association between variants of rs53576 and theory-of-mind abilities as measured by false belief understanding, *r*(31) = 1.04, *p* = .309, *d* = .36. Participants homozygous for the G allele performed similarly to those with at least one A allele (*Ms* = -.13, .22, *SD*s = 1.08, .799, respectively).
OXTR rs2254298

**Adults.** After grouping adults according to the dominant genetic model, we found an association between variants of rs2254298 and mental state decoding abilities, $t(34) = 2.15$, $p = .039$, $d = .72$. Participants homozygous for the G allele performed significantly better on the RMET compared to participants who carried at least one A allele ($M_s = .78, .71$, $SDs = .08, .09$, respectively).

**Children.** After grouping children according to the dominant genetic model, we found no association between variants of the rs2254298 and theory-of-mind abilities as measured by false belief understanding, $t(31) = 1.54$, $p = .133$, $d = .53$. Children homozygous for the G allele performed similarly to those with at least one A allele ($M_s = .16, -.46$, $SDs = .86, 1.24$ respectively).

**Gene by Condition Interactions**

Perhaps a more focal reason for including a genotyping analysis was in hopes of gaining evidence regarding the potential biological mechanism underlying any effects of affectionate contact. In particular, we reasoned that if children in the cuddle condition showed better theory-of-mind reasoning because cuddling stimulates oxytocin release, then the benefits of cuddling would be more strongly realized in children who had allelic variations that made them more sensitive to oxytocin signaling. Unfortunately, we were unable to obtain a sample size that was sufficient to test this hypothesis. Nonetheless, the relevant means are summarized in Tables 4 and 5. Broadly and descriptively speaking, there is no obvious hint that the cuddle effect is more substantial for adults or children who are homozygous for the G allele relative to those who carry at least one A allele. However, it may be noteworthy that in
both adults and children, the group that performed the most poorly were participants in the no-cuddle condition who had at least one A allele.

Table 4. Allelic variations on rs53576 and rs2254298 and adult RMET mean scores by condition

<table>
<thead>
<tr>
<th>Allelic Variation</th>
<th>rs53576</th>
<th>rs2254298</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Cuddle</td>
<td>Cuddle</td>
</tr>
<tr>
<td>GG</td>
<td>.72 (.10) n = 11</td>
<td>.79 (.04) n = 9</td>
</tr>
<tr>
<td>AG/AA</td>
<td>.78 (.08) n = 8</td>
<td>.77 (.11) n = 8</td>
</tr>
</tbody>
</table>

Table 5. Allelic variations on rs53576 and rs2254298 and children’s false belief scores by condition

<table>
<thead>
<tr>
<th>Allelic Variation</th>
<th>rs53576</th>
<th>rs2254298</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Cuddle</td>
<td>Cuddle</td>
</tr>
<tr>
<td>GG</td>
<td>-.32 (1.21) n = 12</td>
<td>.22 (.72) n = 6</td>
</tr>
<tr>
<td>AG/AA</td>
<td>-.08 (1.08) n = 12</td>
<td>.37 (.58) n = 14</td>
</tr>
</tbody>
</table>
Chapter 4: Discussion

The main goal of this study was to provide an initial investigation of the extent to which affectionate contact within parent-child dyads affects parents’ and children’s ability to reason about the mental states of others. Results showed that affectionate contact was related to false-belief task performance in children such that children who cuddled with a parent prior to completing a battery of false-beliefs tasks performed significantly better than those children who did not. However, we do not have evidence that the same was true for parents – parents who cuddled with their children did not outperform those who did not cuddle on an adult theory-of-mind task.

A secondary goal of this study was to investigate whether particular polymorphisms of the OXTR gene – a gene that affects oxytocin functioning – would be related to theory-of-mind in either adults or preschoolers. Here, we found that for adults, those who were homozygous for the G allele at rs2254298 were significantly better at decoding the affective mental states of others compared to those with one or two copies of the A allele. In contrast, we did not have evidence for a similar pattern in children. Moreover, we found no evidence for a predicted gene-by-condition interaction in which individuals with allelic variations that promote sensitivity to oxytocin signaling benefited most from affectionate contact.

In the next sections we will discuss our pattern of findings in the present study in light of previous research and will consider several possible mechanisms responsible for the observed behavioural effects of affectionate contact on theory-of-mind abilities in adults and preschoolers.
As mentioned above, we failed to find a significant effect of condition on the RMET. Our hypotheses regarding the effects of affectionate contact on this task were developed with the knowledge that affectionate contact stimulates the release of oxytocin (see Feldman, 2010). In past research, intranasal administration of oxytocin has been shown to improve performance on the RMET in healthy adults (Domes et al., 2007) and in youth with autism spectrum disorders (Guastella et al., 2010). We reasoned that affectionate contact might have similar benefits for performance on the RMET.

There are several reasons that our predictions regarding the connection between theory-of-mind and affectionate contact did not obtain. One important one concerns the extent to which affectionate contact truly stimulated the release of oxytocin. In the previous research, specific quantities of oxytocin (24 IU) were administered prior to participants engaging in theory-of-mind tasks (e.g., Domes et al., 2007; Guastella et al., 2010). It is possible that affectionate contact in the present study did not trigger comparable levels of oxytocin as those directly administered to participants in the studies mentioned above. More research is required to use direct measures to test both the extent to which everyday affectionate contact truly stimulates release of oxytocin, and whether the extent of oxytocin release is sufficient to affect social cognitive performance in the short term.

Of course, broadly speaking there is a considerable amount of research supporting the idea that affectionate contact stimulates the release of oxytocin (see Turner et al., 1999; Seltzer et al., 2010; Grewen et al., 2005; Feldman et al., 2010; Fries et al., 2005). Thus, a second possibility is that the prior findings that have found a connection between oxytocin and performance on the RMET are weaker than we originally thought. A closer investigation
of that prior literature suggested that this may be the case. For instance, the prior associations between oxytocin and the RMET were supported by one-tailed tests of significance. Although there may be some situations in which one tailed-test of significance are appropriate for use in scientific literature, it is a weak basis for establishing new findings (see e.g., Lombardi & Hurlbert, 2009). Second, Domes et al., (2007) found that oxytocin improved performance on a subset of the RMET that were labeled as “difficult.” Unfortunately, it was unclear how items were classified as difficult, which raises the possibility that the classifications were idiosyncratic to their study. Finally, these findings regarding the role of oxytocin in improving performance on the RMET have not been replicated, either in a general sense or for the specifically difficult items. With these concerns in mind, it is perhaps not surprising that we did not find evidence that affectionate contact was associated with parents’ performance on the RMET.

_Affectionate Contact and Children’s Theory-of-Mind_

In the present study we gained evidence that affectionate contact affects preschoolers theory-of-mind abilities. One possibility for why this occurred is because affectionate contact stimulated the release of oxytocin, which in turn boosted children’s social cognitive skills. However, before discussing this intriguing possibility, it is important to address alternative explanations.

One plausible explanation for how affectionate contact might have influenced preschoolers’ theory-of-mind abilities is that cuddling with a parent may have put children more at ease in the unfamiliar testing environment. Insofar as the stress of the novel testing environment can negatively affect children’s performance (Cohen, 1980) it seems reasonable to suggest that affectionate contact may have soothed children, reduced their stress and thus
allowed them to perform at a higher level than children who did not get affectionate contact. Such an explanation would dovetail well with animal findings showing that affectionate contact is typically associated with lower levels of stress hormones (e.g., cortisol) (Heinrichs et al., 2003). Though such a mechanism may be at work, we do not believe that it provides a good explanation for our pattern of findings. Specifically, if cuddling simply reduced stress, we would have expected to see improvements in performance across all task batteries for children in the cuddle condition. However, we only obtained evidence that affectionate contact affected performance on false belief tasks, not performance on executive functioning or non-mental representation tasks. Thus, our findings of a domain specific effect of affectionate contact on false-belief reasoning abilities suggests that the mechanism by which affectionate contact conferred benefits was not a general one of reducing the stress of the testing environment.

A second alternative explanation – one better suited to accounting for the domain-specific nature of the findings – is that cuddling may have affected parent-child storybook reading interaction in a way that promoted children’s reasoning about false beliefs. It is very difficult to rule out this possibility entirely as there are many dimensions on which the storybook reading task can be measured, and it is unknown which of those dimensions could plausibly promote false-belief reasoning. However, we were able to address one such possibility with our data. Specifically, we addressed the possibility that parents who cuddled with their children would be more likely than parents who did not cuddle to talk about the mental states of the story characters. We focused on this particular behaviour for two reasons. First, it is well established that individual differences in parents’ tendencies to talk about mental states is associated with children’s theory-of-mind development (see Ruffman et al.,
2002). Second, and somewhat more speculatively, it seems reasonable to suggest that more talk about mental states could “prime” children’s theory of mind reasoning, which could then improve their performance on false belief tasks. Our data, however, showed that parents in both groups used, on average, the same number of mental state words during the storybook task. These findings thereby rule out the possibility that any benefits that children received from being in the cuddle condition could be attributed to their exposure to more mental state talk.

Finally, our findings raise an interesting issue concerning the direction of the cuddle effect. The results from the present study suggest that children who cuddled with their primary caregiver prior to completing a battery of false belief tasks outperformed children who did not cuddle with their primary caregiver. Such findings support the idea that children who cuddled experienced a ‘boost’ in their ability to reason about the mental states of others. Alternatively, one may interpret these findings as though children who did not receive a cuddle from their primary caregiver displayed a deficit in their theory-of-mind reasoning abilities. Given the nature of the experimental design in the present study we are encouraged to favour the first explanation (i.e., cuddling enhances children’s ability to reason about the mental states of others). Both conditions (i.e., cuddle and no-cuddle) proved to be a positive experience for parent-child dyads. In other words, the no-cuddle condition was not a depriving experience for children. Participants across both conditions displayed positive affect while reading the storybook and expressed their enjoyment after completing the task.

Our preferred hypothesis, then, is that affectionate contact boosted preschoolers’ theory-of-mind abilities by stimulating oxytocin release which itself promotes social cognitive reasoning. At this point, however, there are two serious challenges that prevent us
from fully endorsing this hypothesis. The first is that it is highly speculative because we did not take measures of oxytocin (either from plasma or saliva) following cuddling and so we cannot be sure whether, and to what extent, cuddling affected oxytocin. We hoped that we might get indirect evidence by investigating the extent to which allelic variation on OXTR affected the extent to which cuddling affected theory-of-mind performance in both adults and children. However, given the relatively infrequent occurrence of “risk alleles” (i.e., alleles that make receptors less sensitive to oxytocin signaling), we were unable to use these data in a convincing manner. A second, equally serious concern is that it is not clear how, specifically, oxytocin could promote false belief reasoning. As many researchers have noted, false belief reasoning relies on a suite of cognitive skills that include the ability to form representations about others’ mental states and the abilities to reason about those representations in real-world contexts. More work is required to better understand what particular aspects of false belief reasoning are benefited by oxytocin before a convincing case can truly be made.

**Future Directions**

Our specific experimental manipulation was modeled on studies that used direct administration of oxytocin to benefit performance on social-cognitive reasoning tasks in the short term. An open question concerns whether chronic exposure to affectionate contact might benefit the development of theory-of-mind on a developmental timescale. Meaney (2001) showed that high levels of maternal touch and contact in rats have long-term effects on infant brain development in terms of both structure (e.g., oxytocin receptor density) and function (e.g., HPA functioning). Insofar as these factors promote growth and maintain optimal functioning in brain areas that are associated with social cognitive tasks like reasoning about
false beliefs, it may be that chronic exposure to affectionate contact could itself be associated with advanced trajectory of theory-of-mind development.

We attempted to address this question in a small way in the present study by including a parent-report measure of parent-child attachment. We reasoned that dyads that are more securely attached might engage in more regular bouts of affectionate contact relative to dyads that were insecurely attached. Using our parent-report measure, however, we found no evidence that such was the case. In some sense, this was not terribly surprising given that we had a relatively small sample (n = 34) and most of whom scored as being securely attached. Also, half the participants participated in the affectionate contact condition, which may have overshadowed any baseline effects that could have been attributed to attachment styles. For these reasons, we believe that a more extensive and targeted study that directly investigates the role of long-term exposure to affectionate contact is warranted.

A second future direction stems from a consideration of the differences between the tasks that were used to assess theory-of-mind abilities. Adults were tested on their ability to infer the affective mental states of others (i.e., mental state decoding) while children were tested on their ability to reason about false beliefs (i.e., mental state reasoning). The RMET tests one’s ability to make inferences on the internal state of another based upon immediately available (though, arguably, subtle) information that is present in the stimulus itself. Importantly, one does not need to know anything about the history, experience or contextual background of the individual in order to make these judgments. In this way, the mental state decoding task differs markedly from the false belief task. In the case of the false belief task, no information is immediately available in the expression of the story character that would give a clue about his or her ignorance. Instead, imputing the false belief requires one to
integrate time-varying contextual information about whether the target had or did not have access to the critical information. Thus, these two tasks have distinct conceptual underpinnings. Moreover, research from our lab showed that the neural circuitry that underlies the ability to decode mental states from the RMET differs from that underlying the ability to reason about those mental states (Sabbagh, 2004). Insofar as affectionate contact influenced the oxytocinergic system, it follows that oxytocin may have affected regions of the brain that are especially important for reasoning about mental states (e.g., left medial frontal regions), and not those regions important for decoding mental states (e.g., orbitofrontal cortex). Thus, future research may benefit from investigating theory-of-mind abilities in adults and children using tasks that rely on the same kinds of social-information processing skills, and subsequently the same neural circuitry.

Finally, the format of task administration for adults and children differed as well. Adults completed the RMET while sitting on a couch alone in a testing whereas children interacted with the experimenter and periodically answered target questions about the short stories that were acted out in front of them with puppets. Although not likely, it is possible that such discrepancies in environment and task administration accounted for part of the differences seen in task performance as well.

**Summary**

Our findings show that affectionate contact promotes children’s theory-of-mind reasoning abilities and that adult’s mental state decoding skills can be predicted by allelic variations on the OXTR gene. While these results offer preliminary support for the role of affectionate contact and, separately, the oxytocinergic system on tasks related to theory-of-mind reasoning, future research is necessary to replicate these findings in a larger sample and
to directly test the extent to which such experiential and psychobiological factors can affect theory-of-mind reasoning.

Another important avenue for future research involves directly testing the involvement of oxytocin as a mechanism driving the relationship between affectionate contact and theory-of-mind understanding. Such studies would require the resources to obtain plasma oxytocin and could focus on research questions such as: Does affectionate contact actually produce a phasic boost of oxytocin within the system or do affectionate contact styles contribute to more natural developmental trajectories of false belief knowledge such that children who are cuddled more throughout their childhood index false belief understanding earlier than those children who do not get cuddled? Answering such questions would provide further evidence suggesting that affectionate contact influences theory-of-mind abilities.
References


Lucht, M. J., Barnow, S., Sonnenfeld, C., Ulrich, I., Grabe, H. J., Schroeder, W., … &


Appendix A: Theory of Mind Battery

1. Knowledge Access

*Show drawer, with pig inside and drawer closed.*

Here’s a drawer. What do you think is inside the drawer? Open drawer show contents. Let’s see. Gasp! It’s a PIG! *Close the drawer.*

Okay, so what is in the drawer? *Show Audrey.*

Here’s Audrey. Now Audrey has *never ever* seen inside the drawer before. So, does Audrey know what is in the drawer? (*target question*)

Did Audrey see inside the drawer? (*memory question*)

To be correct child must answer “no” to the target question and the memory question.

FALSE BELIEF BATTERY

1. Contents Change False Belief

Here’s a Smarties box. What do you think is inside the Smarties box?

*(Next, the Smarties Box is opened.)* Well let’s see….it’s really pens inside. *Close Smarties box.*

Okay, what is in the Smarties box?

(Show Mickey.)

Here’s Mickey. Mickey’s never seen inside this Smarties Box before. So, did Mickey see inside the box? (*memory question*)

If NO:

That’s right! He didn’t see inside the box.

If YES:

Actually, Mickey’s never seen inside this Smarties Box before.

So, did Mickey see inside the box?

*Once they answer correctly:*

So, what does Mickey think is in the box, Smarties or pens (*target question*?)

To be correct the child must answer “Smarties” to the target question and “no” to the memory question.

2. Location Change False Belief

(Place blue box (B) on child's left and green box (A) on child's right)

Now let me show you what else I have. Here are two puppets. This one is Barney (make Barney say hello). And this one is Big Bird (make Big Bird say hello).
Barney and Big Bird are playing with this ball. (Make puppets play together). Barney is going to go eat lunch now. He'll put the ball in here (place ball in blue box; Barney hidden away). Big Bird wants to play some more. (Big Bird takes out ball from the blue box and plays). Now Big Bird is going to go eat lunch. He'll put the ball in this box (places the ball in green box; Bird hidden away). Here comes Barney again. He wants to play with the ball some more.

Test: Where does Barney think the ball is?

B-Blue(1)   A-Green(0)   Other ____________
(Prevent S from opening box)

Control: Where is it really?

B-Blue(0)   A-Green(1)   Other ____________

You can go ahead and show Barney where the ball is. Ok! That was fun!

Overall Score: Fail(0) Pass(1)
(S must answer both questions correctly to pass)

3. Deceptive Pointing

Warm-up trial (pointing = location)
We're gonna play a game with Samantha. See this car? And see these boxes over here? I'm gonna put the car inside one of the boxes like this (E puts car in green box). I can point to the box with my finger like this (points) so we'll know which box the car is in.

Now you try. Take the car out of the box. Go ahead and put the horse in that box (red box). Ok, now, point to that box so we'll know where the car is.

Good job! See, now we can tell where the car is by pointing to it.

Test Trial # 1
Now let's put a car in a box and see if Samantha can find it. But first Samantha is going to leave and go in here (drawer) so she can't see. Ok. Go ahead and put the car in one of the boxes.

Car placed in: GREEN RED

Hey, I have a great idea! Let's play a funny trick on Samantha. Let's play a trick so she can't find the horse. Maybe we could trick her so she'll look in the wrong box. OK? Now, remember, we're going to play a funny trick on Samantha. We can play a trick by pointing so she won't find the car.
Here comes Samantha. “Where’s the car?”

Prompt 1: Samantha is asking where the car is. Where do you want to point?
Prompt 2: (if no response): Which box do you want to point to?
Prompt 3: (if still no response): Do you want to point to this box (green) or this box (red)?

Child points to: GREEN   RED

OK Samantha. You can look now.

(If child uses deception, Samantha looks in the wrong box and E1 says)
Oh, she didn't find it! I guess we tricked her! We’re so tricky. Go ahead and show her where it really is.
(If no deception, Samantha looks in the correct location and E1 says)
Oh, she found it! I guess we didn't trick her that time.
(E1 says) That was fun. (PUT AWAY SAMANTHA)
Now it’s time for Puppy to come play with us. (Bring out puppy)

Test Trial # 2
Let's put the car in a box and see if PUPPY can find it. First Puppy’s going to leave and go in here (drawer) so he can't see. (Puppy put away)
Ok. Now go ahead and put the car in one of the boxes.

Car placed in: GREEN RED

Hey, I have another great idea! Let's play a funny trick on PUPPY. Let's play a trick so he can't find the car. Maybe we could trick him so he'll look in the wrong box. OK?
Now, remember, we're going to play a funny trick on Puppy. We can play a trick by pointing so he won't find the car.

Here comes Puppy. “Where’s the car?”

Prompt 1: Puppy is asking where the car is. Where do you want to point?
Prompt 2: (if no response): Which box do you want to point to?
Prompt 3: (if still no response): Do you want to point to this box (green) or this box (red)?

Child points to: GREEN   RED

OK Monkey. You can look now.

(If child uses deception, E1 looks in the wrong box and E2 says)
Oh, he didn't find it! I guess we tricked him! We are so tricky. Go ahead and show him where it really is.
(If no deception, E1 looks in the correct location and E2 says)
Oh, he/she found it! I guess we didn't trick him/her that time.
That was fun. We're all done with that game. You did a great job!
Now remember, it's fun to play tricks sometimes, but we should always tell the truth, OK?

# Deceptive Trials: _____

% Deception: _____

(# Deceptive trials /total trials)
Appendix B: Executive Functioning Tasks

1. Bear/Dragon Task

Warm-up
(Make sure P can follow all of the directions by having P do the following; E models the movements during warm-up)
OK, I'm going to ask you to do some silly things before we start our next game. Stick out your tongue. (E remember to model)

Touch your ears.
Touch your teeth.
Touch your eyes.
Clap your hands.
Touch your feet.
Touch your head.
Touch your tummy.
Touch your nose.
Wave your hand.

OK. Good job!

Instructions
(E takes out the bear and dragon puppets)
I have a game we can play with these puppets. This puppet (show the bear) is a nice bear. When he talks to us, we will do what he tells us to do. This puppet (show the dragon) is not very nice. This puppet is a dragon. So when he talks to us, we won't listen to him. If he tells us to do something, we won't do it.

Practice Trials

OK. Let's practice one time.
BEAR: This is the good bear. He says, "Touch your nose." (in a mellow, nice voice)

Touch no touch # tries _____

(If S does not touch nose)
Remember, we listen to the nice bear and do what he says because that's how we play the game.

(E repeats the command and may model the action until S succeeds)
(If S touches nose)

That's right! Now let's practice with the naughty dragon. In this game, we won't do what the dragon asks us to do because he's not so nice.
DRAGON: Touch your tummy. (in a low, gruff voice)

Touch no touch # tries _____

(If S touches stomach)
Remember how we play this game. We’re not going to listen to the mean dragon. We won’t do what he tells us to do because that’s how we play the game.

(Repeat until S gets it right, holding S's hands down if necessary on the 6th try)
Do we do what the dragon tells us to do? Nooooo! Ok, let’s try again. “Touch your tummy!”

(When S succeeds at both practice trials)
Yeah! That was fun.

Rule Check

So, when the Bear tells you to do something, do you do it? Yes No
(Correct if necessary) # tries _____

And when the Dragon tells you to do something, do you do it? Yes No
(Correct if necessary) # tries _____

OK, let's play some more.

Test Trials
(E does not model or give feedback on test trials) Coder 1 Coder 2

1. BEAR: Stick out your tongue. _____ _____
2. DRAGON: Touch your ears. _____ _____
3. BEAR: Touch your teeth. _____ _____
4. DRAGON: Touch your eyes. _____ _____
5. BEAR: Clap your hands. _____ _____

(Reminder given regardless of performance)

Remember the way we play this game. We do what the bear tells us to do because he’s nice, but we won't do what the dragon tells us to do because he’s not so nice.

6. DRAGON: Touch your feet. _____ _____
7. BEAR: Touch your head. _____ _____
8. DRAGON: Touch your tummy. _____ _____
9. BEAR: Touch your nose. _____ _____
10. DRAGON: Wave your hand. _____ _____
Coding Instructions

Bear trials: Bear Total (add trials 1, 3, 5, 7, and 9): _____
0 = failure to move
1 = a wrong movement
2 = a partial correct movement
3 = a full correct movement

Dragon trials: Dragon Total (add trials 2, 4, 6, 8, and 10): _____
0 = a full correct movement
1 = a partial movement
2 = incorrect movement
3 = strategic movement
4 = no movement

Strategies used on Dragon trials: (check all that apply, add comments below)

_____ Says “no”
_____ Shakes head
_____ Sits on hands
_____ Other, describe:

2. Pointing Stroop: Grass-Snow

(Bring out a board that has a solid white card attached to the upper left corner, a solid green card attached to the upper right corner (both cards are 15 x 10 cm), and two fabric cut-outs shaped like a child’s hands centered below the cards.)

We’re going to play a game with this board.
Do you know what colour grass is? Can you point to the colour that grass is? _______

Do you know what colour snow is? Can you point to the colour that snow is? _______

(Praise right answers; correct wrong answers)

Well, now we’re going play a silly game.

In this game, when I say the word “grass”, I want you to point with your finger to the white card like this (E points to white card).

Can you point to the white card? Pointed Did not point
(Praise if pointed correctly, prompt if not)

When I say the word “snow”, I want you to point with your finger to the green card like this (E points to green card).
Can you point to the green card?  
(Praise if pointed correctly, prompt if not)

### Practice Trials
(Say: “Grass” and wait for response)
(If S hesitates) What card do you point to for this one?  
Green(0) White(1)  #tries

(Praise if correct)
(If incorrect: “Remember this is a silly game. When I say ‘grass’ I want you to point over here to the write card. When I say snow, ‘that’s’ when you point to the green card”)

Say: “Snow” and wait for response
(If S hesitates) What card do you point to for this one?  
Green(1) White(0)  #tries

(Praise if correct)
(If incorrect, say: “Remember this is a silly game. When I say snow I want you to point over here to the green card. When I say grass, that’s when you point to the white card”)

### Test Trials
(Whenever S hesitates, ask "What card do you point to for this one?" but do not use words "white" or green"; do not give feedback on test trials)

<table>
<thead>
<tr>
<th></th>
<th>Grass</th>
<th>Snow</th>
<th>Snow</th>
<th>Grass</th>
<th>Snow</th>
<th>Grass</th>
<th>Grass</th>
<th>Snow</th>
<th>Snow</th>
<th>Grass</th>
<th>Grass</th>
<th>Grass</th>
<th>Snow</th>
<th>Grass</th>
<th>Grass</th>
<th>Snow</th>
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<tbody>
<tr>
<td>1.</td>
<td></td>
<td>green(0) white(1)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2.</td>
<td></td>
<td>green(0) white(1)</td>
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<tr>
<td>3.</td>
<td></td>
<td>green(0) white(1)</td>
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<td>4.</td>
<td></td>
<td>green(0) white(1)</td>
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<td>5.</td>
<td></td>
<td>green(0) white(1)</td>
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<td>6.</td>
<td></td>
<td>green(0) white(1)</td>
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<td>7.</td>
<td></td>
<td>green(0) white(1)</td>
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<td>8.</td>
<td></td>
<td>green(0) white(1)</td>
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<td>9.</td>
<td></td>
<td>green(0) white(1)</td>
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<td>10.</td>
<td></td>
<td>green(0) white(1)</td>
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<tr>
<td>11.</td>
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<td>green(0) white(1)</td>
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<tr>
<td>12.</td>
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<td>green(0) white(1)</td>
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<tr>
<td>13.</td>
<td></td>
<td>green(0) white(1)</td>
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<tr>
<td>14.</td>
<td></td>
<td>green(0) white(1)</td>
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<tr>
<td>15.</td>
<td></td>
<td>green(0) white(1)</td>
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<tr>
<td>16.</td>
<td></td>
<td>green(0) white(1)</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Total Correct: _____
3. Card Sort

(E places two trays on table. Tray on left has a red rabbit card pasted on back wall. Tray on right has a blue boat card pasted on back wall.)

We are going to play a game. This is the SHAPE game. All the rabbits go in this box (pointing to left tray) and all the boats go in that box (pointing to right tray). We don't put any rabbits in that box. No way (shaking head). We put all the rabbits over here and only boats go over there. If it is a rabbit, then it goes here. If it is a boat, then it goes there. This is the SHAPE game.

OK. I'll go first. Rabbits go here. (E places a blue rabbit card in slot on left)
Boats go here. (E places a red boat card in slot on right)

Pre-switch Trials

OK. Now it's your turn.
1. If it is a rabbit, then put it here, but if it is a boat, put it there.
Here is a blue rabbit. Where does this go? rabbit tray* boat tray ______

2. If it is a rabbit, then put it here, but if it is a boat, put it there.
Here is a red boat. Where does this go? rabbit tray* boat tray* ______

3. If it is a rabbit, then put it here, but if it is a boat, put it there.
Here is a blue boat. Where does this go? rabbit tray boat tray* ______

4. If it is a rabbit, then put it here, but if it is a boat, put it there.
Here is a red rabbit. Where does this go? rabbit tray* boat tray ______

5. If it is a rabbit, then put it here, but if it is a boat, put it there.
Here is a blue rabbit. Where does this go? rabbit tray* boat tray ______

(When S is correct) Yes, that's right.
(When S is wrong) No, that's not right. Remember the rules. (Proceed to next trial)

(S must correctly sort 5 consecutive cards according to shape before proceeding to post-switch trials; remove cards from tray if needed)

Total Number Pre-switch Trials: ______

Number of Pre-Switch Errors: ______

Post-switch Trials

Now we are going to switch. We are not going to play the shape game any more. We are going to play the COLOR game. When it is red, you have to put it in this box (indicating left
tray), but whenever it is blue, then it goes in that box (indicating right tray). We don't put red things in that box. No way (shaking head). We put red things over here and only when it's blue does it go over there. If it's blue, then it goes there. If it's red, then it goes here.

(E does not give feedback on post-switch trials)

1. If it is red, then put it here, but if it is blue, put it there.
Here is a red boat. Where does this go? red tray(1) blue tray(0) ___
OK. Let's do another.

2. If it is red, then put it here, but if it is blue, put it there.
Here is a red rabbit. Where does this go? red tray(1) blue tray(0) ___
OK. Let's do another.

3. If it is red, then put it here, but if it is blue, put it there.
Here is a blue boat. Where does this go? red tray(0) blue tray(1) ___
OK. Let's do another.

4. If it is red, then put it here, but if it is blue, put it there.
Here is a red boat. Where does this go? red tray(1) blue tray(0) ___
OK. Let's do another.

5. If it is red, then put it here, but if it is blue, put it there.
Here is a blue rabbit. Where does this go? red tray(0) blue tray(1) ___

Compatible Trial Total (2 and 3): ___

Incompatible Trial Total (1, 4, and 5): ___

Post-switch Total: ___
APPENDIX C: False Photograph Tasks

1. False Photograph: Location Change

(Familiarize P with Polaroid camera by taking a picture of some toy. Allow P to take a picture themselves. Set camera down.)

This is Teddy. And this is Teddy’s chair. Lets take a picture of Teddy on his chair. (Show Teddy sitting in his chair and help P take picture of Teddy sitting in his chair – take the camera and set it face down on the table.)

Teddy is getting sleepy now so goes to lay down on his bed. (E moves Teddy over to his bed).

Control Questions:
When we took the picture, where was Teddy? On his chair or on his bed? Where is Teddy now? On his chair or on his bed?

Test Question:
In the picture (tap black camera screen) where is Teddy? On his chair or on his bed?

Score: ____

2. False Photograph: Identity Change

This is Mr. Bunny and he’s sitting in the park. Lets take a picture of him in the park! (E helps P take pictures of Mr. Bunny sitting the park – take the camera and set it face down on the table.)

Now, Mr. Bunny leaves the park to go for a walk – he starts out on an adventure. Mr. Penguin walks into the park looking for Mr. Bunny to play with.

Control Questions:
Who was sitting in the park when we took the picture? Mr. Bunny or Mr. Penguin? Who is sitting in the park now? Mr. Bunny or Mr. Penguin?

Test Question:
In the picture (tap black camera screen) who is sitting in the park? Mr. Bunny or Mr. Penguin?

Score: ____
## APPENDIX D: Affectionate Contact Coding Scale

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(1) Far Away</td>
<td>![Image of far away contact]</td>
</tr>
<tr>
<td></td>
<td>• End of couch or off couch (cannot easily touch even if wanted to)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(2) Close together</td>
<td>![Image of close together contact]</td>
</tr>
<tr>
<td></td>
<td>• On or off couch, close enough to touch, but not actually touching</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>(3) Partial Body Touch</td>
<td>![Image of partial body touch]</td>
</tr>
<tr>
<td></td>
<td>• Some part of body (e.g., hands, legs, feet) is touching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Or child is laying head on parent’s lap</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>(4) Sitting Together</td>
<td>![Image of sitting together contact]</td>
</tr>
<tr>
<td></td>
<td>• Sides Touching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Full upper (or lower) body in contact</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>(5) Sitting Together plus Extra Touch</td>
<td>![Image of sitting together plus extra touch]</td>
</tr>
<tr>
<td></td>
<td>• Full upper (or lower) body in contact AND there is an extra touch (e.g.,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• hand on lap, arm etc.)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>(6) Sitting Together plus Arm Around</td>
<td>![Image of sitting together plus arm around]</td>
</tr>
<tr>
<td></td>
<td>• Full upper (or lower) body in contact AND an arm is around other person</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>(7) Sitting Together plus Arm Around plus Extra Touch</td>
<td>![Image of sitting together plus arm around plus extra touch]</td>
</tr>
<tr>
<td></td>
<td>• Full upper (or lower) body in contact AND an arm is around other person</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• AND hand is on body</td>
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</tr>
<tr>
<td>8</td>
<td>(8) Child sitting in parent’s lap</td>
<td>![Image of child sitting in parent’s lap]</td>
</tr>
</tbody>
</table>
## APPENDIX E: List of Mental State Terms for Each Item in the RMET

### List of Target Mental State Terms for Each Item and Their Distractors in the RMET

<table>
<thead>
<tr>
<th>Practice</th>
<th>Jealous</th>
<th>Panicked</th>
<th>Arrogant</th>
<th>Hateful</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Playful</td>
<td>Comforting</td>
<td>Irritated</td>
<td>Bored</td>
</tr>
<tr>
<td>2</td>
<td>Terrified</td>
<td>Upset</td>
<td>Arrogant</td>
<td>Annoyed</td>
</tr>
<tr>
<td>3</td>
<td>Joking</td>
<td>Flustered</td>
<td>Desire</td>
<td>Convinced</td>
</tr>
<tr>
<td>4</td>
<td>Joking</td>
<td>Insisting</td>
<td>Amused</td>
<td>Relaxed</td>
</tr>
<tr>
<td>5</td>
<td>Irritated</td>
<td>Sarcastic</td>
<td>Worried</td>
<td>Friendly</td>
</tr>
<tr>
<td>6</td>
<td>Aghast</td>
<td>Fantasizing</td>
<td>Impatient</td>
<td>Alarmed</td>
</tr>
<tr>
<td>7</td>
<td>Apologetic</td>
<td>Friendly</td>
<td>Uneasy</td>
<td>Dispirited</td>
</tr>
<tr>
<td>8</td>
<td>Despondent</td>
<td>Relieved</td>
<td>Shy</td>
<td>Excited</td>
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<tr>
<td>9</td>
<td>Annoyed</td>
<td>Hostile</td>
<td>Horrified</td>
<td>Preoccupied</td>
</tr>
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<td>10</td>
<td>Cautious</td>
<td>Insisting</td>
<td>Bored</td>
<td>Aghast</td>
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<td>11</td>
<td>Terrified</td>
<td>Amused</td>
<td>Regretful</td>
<td>Flirtatious</td>
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<td>12</td>
<td>Indifferent</td>
<td>Embarrassed</td>
<td>Skeptical</td>
<td>Dispirited</td>
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<td>13</td>
<td>Decisive</td>
<td>Anticipating</td>
<td>Threatening</td>
<td>Shy</td>
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<td>Disappointed</td>
<td>Depressed</td>
<td>Accusing</td>
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<td>Reassuring</td>
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<td>Suspicious</td>
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