Intergenerational transmission of theory-of-mind

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Abstract

We examined whether individual differences in children's performance on a scaled battery of theory-of-mind tasks was predicted by parents' performance on an adult theory-of-mind task. Forty-six 3-year-old children and their parents participated in this study when children were aged 2;11 to 4;0. Thirty dyads returned 6 months later for a second assessment. After statistically controlling for relevant covariates, we detected a positive correlation between parents' and children's theory-of-mind scores. The correlation was significant at both time points, and was robust when data were aggregated across the two sessions. These results provide some evidence for intergenerational transmission of theory-of-mind abilities in a typically developing sample, and possible mechanisms underlying this relation are discussed.

Introduction

Everyday social understanding rests on having a theory-of-mind – an understanding of how others’ actions are motivated by internal mental states, such as beliefs, desires and intentions. Theory-of-mind is widely considered to be a foundational skill with important links to various areas of social-cognitive functioning including language development (Sabbagh & Baldwin, 2005), fantasy and pretend play (Taylor & Carlson, 1997), and prosocial behavior and emotional functioning (J. Dunn, 1999; Happé & Frith, 1996). The importance of theory-of-mind is underscored by individuals with autism – a lifelong neuro-developmental disorder characterized by impairments in various domains of social functioning (APA, 1995). Baron-Cohen (Baron-Cohen, 1995; Baron-Cohen, Leslie & Frith, 1985) was the first to suggest that these social functioning deficits might stem, at least in part, from a fundamental deficit in theory-of-mind reasoning. Since then, it has been well established that many individuals with autism, including high-functioning individuals and individuals with Asperger syndrome, have difficulties with theory-of-mind (Baron-Cohen, 2001).

Recent research has shown that sub-threshold autistic characteristics are manifest in family members of autistic individuals (e.g. Bailey, Palferman, Heavey & Le Couteur, 1998). These milder impairments have sometimes been referred to as constituting the ‘broader phenotype’ of autism (e.g. Piven, Palmer, Jacobi, Children & Arndt, 1997). Most relevant to the present discussion, first-degree relatives of individuals with Asperger’s syndrome show deficits in tasks that are designed to tap adult theory-of-mind skills (Baron-Cohen & Hammer, 1997). These findings are intriguing because they raise the possibility that theory-of-mind skills might be best thought of as ‘cognitive traits’. Like other such traits, the expression of theory-of-mind skills might vary naturally within a given population, and be subject to intergenerational transmission.

The aim of the present study was to gain evidence for intergenerational transmission of theory-of-mind skills in a typically developing population. To date, this question has been difficult to investigate because of limitations in how both adults’ and children's theory-of-mind is typically measured. With respect to adults, most theory-of-mind measures are designed to test for impairments in theory-of-mind reasoning due to localized brain damage or psychiatric condition (e.g. autism or schizophrenia). These tests are unsuitable for individual differences research with a typical population because unaffected adults usually show ceiling-level performance and little variability. Fortunately, these methodological limitations have been overcome in recent work by Baron-Cohen and colleagues (Baron-Cohen, Wheelwright, Hill, Raste & Plumb, 2001) who developed an adult theory-of-mind measure that assesses the ability to identify mental states from pictures of eyes. Healthy adults perform well, but not at ceiling (around 70% correct) and there are considerable individual differences in performance.

With respect to children, the gold standard of theory-of-mind measurement in preschoolers is the false-belief task (see Wellman, Cross & Watson, 2001). However, this measure is limited in two ways. The first is that it is difficult to administer multiple false belief tasks within a single session to obtain the kind of parametric variation that is necessary for analyses of individual differences. Second, the false-belief task only measures one step in...
the trajectory of theory-of-mind development. Yet, more recent research on theory-of-mind development has advocated a wider perspective including milestones that are first achieved in the late infancy period and extend to middle childhood (Wellman, Phillips, Dunphy-Lelii & LaLonde, 2004). Fortunately, Wellman and Liu (2004) developed a simple five-item scale that allows for the parametric measurement of theory-of-mind development during the early- to late-preschool period. This methodological advance enabled us to test whether parents’ scores on a theory-of-mind test predict children’s performance on a theory-of-mind scale.

**Method**

**Participants**

Fifty parent–child dyads initially participated in this study as part of a larger longitudinal study; however, two dyads were removed from the present study because the children were adopted. Two additional dyads were removed because the children did not complete the theory-of-mind scale. Therefore the final sample at Time 1 consisted of 46 children who were 3 years old (29 boys, 17 girls; \( M = 42.13 \) months, \( SD = 3.60 \) months, range: 35–48 months). Three children participated with their fathers and the rest with their mothers \( (M = 34 \) years, \( SD = 4.50 \) years, range: 24–43 years). Thirty-four of these dyads returned for Time 2 testing approximately 6 months later \( (M = 6.0 \) months, \( SD = .52 \) months, range: 6–8 months). Of these, 28 children completed the necessary protocol. Therefore, the Time 2 sample consisted of 28 children (17 boys, 11 girls; \( M = 47.97 \) months, \( SD = 3.91 \) months, range: 41–56 months) and their parents. Participants were recruited from a predominately white, middle-class university and military community in Southeastern Ontario, Canada.

**Tasks**

Parents’ ‘Reading the Mind in the Eyes’ task (Baron-Cohen et al., 2001)

The test consists of 36 black-and-white photographs of the eye region taken from magazine photographs. Each pair of eyes is edited so that the eye region is visible from just above the eyebrow down to midway along the bridge of the nose. Each pair of eyes is a standardized size \( (15 \text{ cm} \times 6 \text{ cm}) \). At each of the four corners of the picture, there is a mental state adjective. Participants are asked to choose the adjective that best corresponds with the mental state on display in the picture.

This task was adapted from its original format for computerized presentation and response recording. The original eye stimuli were digitized using a flat bed scanner \( (150 \text{ dpi}) \) and the screen image measured approximately \( 14.5 \times 5.5 \text{ cm} \). The four descriptive adjectives were placed in the four corners surrounding the picture and were equidistant from the center of the screen (see Figure 1 for a sample item). The location of the correct answers was counterbalanced across items. Participants indicated their selection by pressing a key on the keyboard \( (S, X, K, M) \) that was spatially analogous to their corresponding adjective on the screen. Raw scores in this task were percent correct responses. This procedure has been used effectively in previous research (e.g. Harkness, Sabbagh, Jacobson, Chowdrey & Chen, 2005).

The task also involves two control tasks (see Figure 1). In one, participants are presented with 12 trials in which a black-and-white picture of an animal is surrounded by four adjectives in a format identical to the main task. Again, participants were asked to select the adjective that best matched the picture. The purpose of this task is to control for variance in task performance that is due to the task demand of matching a picture to one of four related adjectives in the computerized format. In the second control task, participants were given 12 trials in which they had to identify the gender of a picture used in the main task. The gender terms \( (i.e. \text{Male}/\text{Female}) \) were placed in the lower corners of the picture and participants responded by pressing X or M. The purpose of this task was to ensure that participants could obtain at least one kind of systematic information from the pictures of eyes.
Items from the main and control tasks were mixed and randomly presented in a single block of 60 trials. The entire procedure took approximately 7–10 minutes.

Children’s theory-of-mind scale

Developed by Wellman and Liu (2004), this is a five-item scale that assesses children’s level of developmental progression through preschool theory-of-mind milestones. The scale consists of a diverse desire task, diverse belief task, knowledge access task, contents false belief task and a real–apparent emotion task (see Table 1 for a brief description of the tasks). The strength of this scale is that all items are similar with respect to the props, question format and materials used. Thus, performance on increasingly difficult items is likely attributable to genuine developments in theory-of-mind understanding. Children were administered the scale beginning with the easiest task and testing was halted after children failed two consecutive items. Children were scored on the total number of tasks passed.1 The entire task took approximately 7–10 minutes.

Peabody Picture Vocabulary Test (PPVT-R)

This is a standardized test of children’s receptive vocabulary development, and a reliable indicator of children’s verbal mental age. In the test trials, children are asked to point to the picture corresponding to a given word. The target picture is located in a 2 × 2 grid in which the other three cells contain distracters. Children begin the test at an age-appropriate level and then proceed through progressively more difficult sets of 12 pictures each. The test is discontinued after children fail eight items within a set. Raw scores are assigned on the basis of how many blocks children complete, adjusting for errors they may have made along the way.

Procedure

The procedure and materials used were exactly the same during both testing sessions. At both Time 1 and Time 2, after consent was obtained from the parent, the dyads ‘read’ a commercially available wordless picture book as part of the protocol for another study. When this task was completed parents were familiarized with the ‘Reading the Eyes in the Mind’ task. The parent completed the task in a quiet room in the laboratory while their child completed the theory-of-mind scale and then the PPVT with the experimenter.

Results

Time 1 analyses

As expected given their ages, children’s performance on the theory-of-mind scale fell into the lower range of the measure ($M = 1.54$, $SD = 1.15$). The distribution of scores is presented in Table 2. Although a large number of children scored zero, children’s performance as a group was not at floor and there was a good range of variability to detect relations with parents’ mental state decoding skills. Also, although there was a fairly wide age range, age-in-months was not a significant predictor of children’s performance on their theory-of-mind measure, $r(44) = .21$, $p = .154$. Thus, raw scores of children's performance on the theory-of-mind scale would be appropriate for use in subsequent analyses.

Parents’ performance on the mental state decoding task was well within the range expected given a typical population of mostly women participants ($M = 71.79\%$ correct, $SD = 9.70$) (Baron-Cohen et al., 2001). Performance on

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### Table 1

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Task</th>
</tr>
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<tbody>
<tr>
<td>Children must make a judgment about whether their desires can differ from those of a story character.</td>
<td>1. Diverse Desires</td>
</tr>
<tr>
<td>Children are asked whether their beliefs about the location of an object can differ from that of a story character. Neither belief is shown to be correct.</td>
<td>2. Diverse Belief</td>
</tr>
<tr>
<td>Children have knowledge of what is concealed inside a box, and are asked to judge the knowledge/ignorance of a story character who has not seen inside the box.</td>
<td>3. Knowledge Access</td>
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<tr>
<td>Children are asked what a naïve story character will believe is inside a box that is filled with unexpected contents.</td>
<td>4. False Belief (Contents)</td>
</tr>
<tr>
<td>Children are asked to judge that a person can feel one way (e.g. sad) while appearing to feel differently (e.g. happy).</td>
<td>5. Real–Apparent Emotion</td>
</tr>
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</table>

### Table 2

<table>
<thead>
<tr>
<th>Assessment</th>
<th>$n$</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 1</td>
<td>46</td>
<td>11 (23.9%)</td>
<td>10 (21.7%)</td>
<td>16 (34.8%)</td>
<td>7 (15.2%)</td>
<td>2 (4.3%)</td>
</tr>
<tr>
<td>Time 2</td>
<td>28</td>
<td>2 (7.1%)</td>
<td>4 (14.3%)</td>
<td>10 (35.7%)</td>
<td>6 (21.4%)</td>
<td>6 (21.4%)</td>
</tr>
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</table>
the animals control task \((M = 79.89\%, SD = 14.56)\) was significantly better than that on the mental state decoding task, paired-\(t(45) = 3.80, p < .001\). Finally, performance on the gender task was near ceiling \((M = 92.63\%, SD = 7.25)\), though comparison with the other two tasks was not possible because the gender task had a higher rate of being correct by chance \((p = .5)\) relative to the mental state decoding and animal tasks \((both p = .25)\).

Preliminary analyses showed that parents' performance on the mental state decoding task was related to their performance on the animals control task, \(r(44) = .344, p = .019\), but not the gender task, \(r(44) = .188, p = .210\). We reasoned that the relation between the mental state decoding and the animal trait recognition task was likely due to their common task characteristics (e.g. use of a laptop computer, selecting target adjective out of a four-item array). Thus, to gain a clearer picture of parents' mental state decoding abilities per se, we residualized parents' scores on the mental state decoding task controlling for their performance in the animal trait identification task.

Our critical analysis, then, concerned whether parents' mental state decoding abilities predicted children's theory-of-mind skills. Scores were inspected for outliers \((\pm 2.5 SD)\) and there were two outliers on the parent measure. After removing these two outliers, we detected a significant relation between mental state decoding and children's performance on the theory-of-mind scale, \(r(42) = .39, p = .009\). Thus, at Time 1, the better parents were at mental state decoding, the better their 3-year-old children performed on the theory-of-mind scale.

**Time 2 analyses**

At Time 2 \((n = 28)\), children's performance on the theory-of-mind scale \((M = 2.36, SD = 1.19)\) had improved significantly relative to Time 1, paired-\(t(26) = 3.16, p = .004\). The distribution of scores is given in Table 2. In contrast to the Time 1 analyses, children's age at Time 2 was significantly correlated with children's theory-of-mind scale performance, \(r(26) = .45, p = .017\). It is not clear why age was related to theory-of-mind performance at Time 2, but not at Time 1. One possibility is that the relatively poor performance on the scale at Time 1 made children's theory-of-mind measure less sensitive to relations with age. Nonetheless, because we sought to characterize individual differences in children's theory-of-mind performance per se, we residualized children's Time 2 theory-of-mind performance controlling for age. The age-controlled scores were then used in subsequent analyses.

For the parents who returned and are included in the analyses, performance on the mental state decoding task did not change significantly from Time 1 \((M = 73.51\%, SD = 11.21)\) to Time 2 \((M = 75.19\%, SD = 10.83)\), paired-\(t(27) = 0.90, p = .377\). Similarly, parents did not significantly improve on the animals control task from Time 1 \((M = 83.63\%, SD = 12.93)\) to Time 2 \((M = 85.72\%, SD = 10.37,\) paired-\(t(27) = 0.83, p = .415\)). Also, at Time 2, parent's performance on the mental state decoding task was not significantly related to their performance on the animals control task, \(r(26) = .301, p = .12\), perhaps because they had become more familiar with the mechanics of the task than they were at Time 1. Performance on the mental state decoding task was also not related to performance on the gender task, \(r(28) = .111, p = .573\). Thus, raw mental state decoding scores were deemed a good measure of individual differences in parents' skill at the task.

Children's age-controlled theory-of-mind scale scores and parents' mental state decoding scores were inspected for outliers \((\pm 2.5 SD)\), but there were none. Parents' mental state decoding scores correlated with children's age-controlled scores on the theory-of-mind scale, \(r(26) = .38, p = .047\). Thus, as was the case at Time 1, the better parents were at mental state decoding, the higher children scored on the theory-of-mind scale.

**Combined time analyses**

The inclusion of two time points in the present study afforded the opportunity to aggregate performance and attain a more reliable measure of both parents' and children's performance on the target tasks. One of the children who contributed data to the Time 2 analyses did not complete the theory-of-mind battery at Time 1. Thus, there were 27 dyads eligible for the combined time analyses. Preliminary analyses revealed that children's performance on the theory-of-mind scale at Time 1 was correlated with performance at Time 2, \(r(25) = .43, p = .025\). A Time 1 to Time 2 correlation was also found for parents' performance on the mental state decoding task, \(r(25) = .598, p = .001\). The interrelations between Time 1 and Time 2 measures provided confidence that parents' and children's performance could be averaged across time into a single measure.

As above, we performed a preliminary analysis to test the relation between children's age and their performance on the theory-of-mind scale. Because there was some variability in the length of delay between Time 1 and Time 2 testing, children's age was averaged across the two different testing times for use as a variable in the analyses. Using these average measures, children's age was strongly related to their performance on the theory-of-mind scale, \(r(25) = .55, p = .003\). Following the same logic as above, we residualized children's performance on the theory-of-mind scale to control for age.

A second preliminary analysis showed that there was a significant relation between parents' average performance on the mental state decoding task and their average performance on the animals control task, \(r(25) = .512, p = .006\). Again, following the same logic as above, we obtained the residuals from the regression predicting parents' performance on the mental state decoding task to control for performance on the control task.

There was one outlier on the parent measure and one outlier on the child measure. Once these outliers were...
removed, there was a strong significant relation between parents’ mental state decoding skills and children’s performance on the theory-of-mind scale, \(r(23) = .448\), \(p = .025\) (see Figure 2). Thus, collapsed across time, parents’ performance on the mental state decoding task correlated with children’s performance on the theory-of-mind scale.

**Control analyses**

An important question concerns the specificity of the relation between parents’ performance on the adult theory-of-mind task and children’s performance on the theory-of-mind scale. For instance, it is possible that parents who perform well on the theory-of-mind task may simply have generally enhanced cognitive capabilities, which in turn might be transmitted to their children (Devlin, Daniels & Roder, 1997). If the mechanism of transmission was a more general one, rather than specifically related to theory-of-mind skills, we might expect that parents’ performance on the theory-of-mind task would correlate with other measures of children’s cognitive development. To explore this possibility we performed a series of control analyses to determine whether parents’ theory-of-mind skills were related to children’s vocabulary development, as measured by the PPVT. For these analyses, we used all of the children who provided usable PPVT data, regardless of whether they also provided usable theory-of-mind data. This was done because there were some children who provided one type of data, but not the other, and eliminating all of them resulted in a reduction of sample size that we reasoned might affect the power of the focal analyses. Thus, to maintain power, we used the maximum available samples.

At Time 1, children’s PPVT scores ranged from 11 to 82 (\(M = 44.64\); \(SD = 17.80\)), and were strongly correlated with age, \(r(43) = .56\), \(p < .001\). When Time 1 PPVT scores were residualized to control for age, we found no evidence of a relation between PPVT and parents’ theory-of-mind scores, \(r(43) = -.02\), \(ns\).

At Time 2, children’s PPVT scores were significantly higher than they were at Time 1 (range = 25–87, \(M = 55.88\); \(SD = 18.92\)), paired-\(r(31) = 3.32\), \(p = .002\). Time 2 PPVT scores were correlated with age, \(r(30) = .57\), \(p < .001\). Age-controlled PPVT scores were not, however, significantly correlated with parents’ theory-of-mind performance, \(r(30) = .08\), \(ns\).

Time 1 and Time 2 PPVT scores were strongly correlated, \(r(30) = .68\), \(p < .001\). In the aggregate, as in the individual tests, we detected no significant relation between PPVT and parents’ theory-of-mind scores (excluding outliers), \(r(28) = .08\), \(ns\). Thus, in contrast to the findings regarding children’s performance on the theory-of-mind scale, we found no evidence to suggest that parents’ theory-of-mind skills correlate with a measure of children’s vocabulary development.

**Discussion**

This study provides the first demonstration of a direct link between parents’ and their typically developing children’s theory-of-mind skills. This link was apparent when children were on average 3.5 years old, and then replicated in the same sample approximately 6 months later. The link was strongest when parents’ and their children’s data were aggregated across the two time periods.

These findings are particularly intriguing because the tasks that were used for parents versus children arguably tap different aspects of theory-of-mind reasoning. Recent work suggests that theory-of-mind skills might be fractionated into dissociable components (e.g. Sabbagh, 2004; Saxe, Carey & Kanwisher, 2004). One distinction relevant to the present study concerns inductive versus deductive processes in mental state reasoning. Mental state induction describes the process by which probabilistic judgments about others’ mental states are made based upon immediately available information such as facial expression, gaze direction, body posture or tone of voice. These inferences are made in a more data-driven or ‘bottom-up’ manner. Mental state deduction, by comparison, involves making putatively reliable theory-based inferences about others’ mental states in a more ‘top-down’ manner, based upon prior knowledge of either the person (e.g. the person’s idiosyncratic history) or knowledge about the world. Within this framework, our parents’ task is likely described best as a mental state induction task; parents were asked to make judgments based solely upon the perceptual information present in pictures of others’ eyes. In particular, no background information about the person depicted in the photograph was required (or given) to assist in the judgment. In contrast, children’s tasks were best described as mental state deduction tasks; in each, children were required to access their knowledge...
about how mental states are formed, and how they motivate behavior, to predict how the protagonist would ultimately act in the particular scenario.

Though each of these types of tasks is likely to be supported by distinct domain-general cognitive mechanisms, they are similar in that each requires sensitivity to information regarding others' mental states. The fact that we found a relation between the parents' and children's theory-of-mind using such dissimilar tasks raises the possibility that we have tapped individual differences in this shared task demand. If we had tested both parents and children in, say, similar vignette-based tasks, it would be possible to argue that the relation we detected may be due in part to the similarity of the peripheral cognitive demands imposed by these tasks (i.e. executive functioning, language, etc.). Such an argument is difficult to make here because the only demand that is obviously shared by the adults' (more inductive) and children's (more deductive) tasks is that both tasks require judgments about mental states.

The possibility that we have identified a specific relation between parents' and their children's abilities to accurately impute mental states to others is strengthened by the fact that we did not detect a correlation between parents' theory-of-mind and children's language development. Of course, it is difficult to interpret a null effect. However, it is noteworthy that our failure to detect a correlation is not likely due to psychometric characteristics of the vocabulary measure relative to the theory-of-mind measure. Both the PPVT and the theory-of-mind scale had respectable and similar correlations between Time 1 and Time 2, thereby suggesting the tasks have similar internal reliability. Further, both tasks had respectable and similar correlations with children's age, thereby suggesting similar levels of external validity. Thus, to the extent that we can interpret these differential patterns of correlations, we have some initial evidence that the relation between parents' and children's theory-of-mind is a specific one.

Given that the relation seems attributable to some core sensitivity to others' mental states per se, an important question concerns the mechanism by which intergenerational transmission of this sensitivity might take place. One clear candidate mechanism is genetics. There are currently two lines of empirical research supporting the possibility that theory-of-mind skills might be heritable through genetics. The first concerns the study of autism. In autism, theory-of-mind reasoning is especially impaired, and there is now agreement that autism is largely heritable (Cook, 2001). Moreover, as noted previously, the fact that first-degree family members of autistic probands show difficulty with theory-of-mind is generally thought to reflect the presence of genetic risk factors in those family members. The second line of evidence for genetic influence on theory-of-mind development comes from behavioral genetics. Specifically, Hughes and colleagues have reported a strong heritable influence on individual differences in 4-year-olds' theory-of-mind skills (Hughes & Cutting, 1999; Hughes & Plomin, 2000). The present finding of a link between parents' and their children's performance on theory-of-mind measures may suggest another way in which the heritability of theory-of-mind is manifest in a typically developing population.

A second plausible mechanism for intergenerational transmission of theory-of-mind skills is socialization. A number of studies have shown that parents' everyday talk about mental states predicts the timetable of preschoolers' theory-of-mind development (e.g. Ruffman, Slade & Crowe, 2002). Similarly, parents who appropriately use mental state terms to describe their infants (i.e. parents' 'mind-mindedness') tend to have children who develop theory-of-mind skills more quickly (Meins, Fernyhough, Wainwright, Clark-Carter, Gupta, Fradley & Tuckey, 2003). These effects are generally thought to reflect the influence that experience has on theory-of-mind development (Carpendale & Lewis, 2004). That is, through appropriate discussion of mental states in everyday conversations, parents make explicit the entailments of otherwise abstract mental state concepts. Through repeated participation in these conversations, children gain information that helps them to construct increasingly adult-like conceptualizations of mental states.

Given the extant evidence, most researchers would agree that the timeline of theory-of-mind development is shaped by both genetic and experiential factors (de Rosnay & Hughes, 2006). Nonetheless, it is important to recognize that in current research, the relevant contributions of these two factors are difficult to separate. For instance, parents who might be genetically predisposed to strong theory-of-mind skills might be the very parents who discuss mental states often and appropriately in everyday conversations with their children. When these children show accelerated theory-of-mind development, then, it is difficult to tease apart the mechanisms of genetics and socialization. Of course, it is not known whether there is a relation between parents’ skill at theory-of-mind and their tendency to talk about mental states with their children. Nonetheless, a study that included a sample of parents and adopted children to compare with a sample of parents and their biological children on the same measures utilized here might constitute an important next step in partialing the variance attributable to genetic and socialization factors in children's theory-of-mind development.

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