



Empathy, sex and fluid intelligence as predictors of theory of mind

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ABSTRACT

Individual differences in theory of mind (ToM) are affected by a variety of factors. We investigated the relationship between empathy, sex and fluid intelligence (FI) as predictors of ToM in a random probabilistic sample of secondary students. First, we explored whether sex, as well as high, average or low levels of empathy and FI affect ToM performance. Furthermore, we assessed the contribution of empathy, sex and FI in predicting ToM by using a path analysis. This method allows testing of causal models of directed dependencies among a set of variables. The causal dependencies of empathy, sex and fluid intelligence were confirmed and identified. In addition, the model confirmed the direct effect of empathy, sex and fluid intelligence on ToM; and the indirect effect of sex mediated by empathy. Thus, individual differences in ToM levels are partially attributable to sex, empathy and fluid intelligence variability, raising important considerations for clinical research as well as ToM's theoretical models of domain specificity.

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1. Introduction

Humans are expert interpreters of others' intentions and actions, demonstrating a domain-specific ability to "read others' minds". However, will a more empathetic person therefore have greater capacity to infer others' intentions? Is sex, mediated by empathy, another predictor of this capacity? Additionally, do abilities such as general cognitive skills affect this aptitude? This study investigates the relationship between empathy, sex and fluid intelligence (FI) in the capacity to infer the internal emotional states of others (theory of mind, ToM).

ToM allows us to understand the mental states (intentions, beliefs and emotional states) of ourselves and others and seems to be the core of social cognition (Ibanez & Manes, 2012). ToM is related to individual differences in executive functions (Sabbagh, Xu, Carlson, Moses, & Lee, 2006) and general skills (Pellicano, 2010), among other factors (Amodio & Frith, 2006). ToM is thus dependent on several different processes, which suggests that it is relatively domain nonspecific (Stone & Gerrans, 2006).

ToM evolves early in human development (Miller, 2009). ToM precursors such as joint attention (arising at 3 months; Scaife & Bruner, 1975) appear early in the development. Children at 3 years

or earlier provide mentalistic explanations for behavior (Clements, Rustin, & McCallum, 2000). The first order ToM (e.g., inferring the thoughts of another person) is fully achieved at 4–5 years old. The second order ToM [one person's (A's) belief about another person's (B's) mental state] is achieved at 5–6 years old (Korkmaz, 2011; Miller, 2009). Inferring complex emotions and thoughts of other persons from eye regions is considered an equivalent to second order ToM (Miller, 2009). More complex ToM inferences are accomplished at 7–9 and the full ToM achievement is granted during the young adolescence (10–11 years; Brune & Brune-Cohrs, 2006; Korkmaz, 2011; Miller, 2009). More complex interactions of ToM and pragmatic language processes (e.g., figurative language) appear later in the development but the evidence is scarce (Miller, 2009). Most of the research has been performed in children and young adolescence; and differences among children, adolescents and adults are now well known (Brune & Brune-Cohrs, 2006; Korkmaz, 2011). Thus, young adolescence is a good stage to test ToM individual differences due to the full achievement of mentalizing skills. In addition, results can be more generalizable to other reports.

Empathy involves sharing another's feelings (emotions and sensations, Singer, 2006). Although sometimes used synonymously, empathy and ToM are different processes that engage partially shared areas of the brain. For instance, sharing sensations and feelings (empathy without ToM) requires an emotional response to another person's state of mind (Baron-Cohen, 2009) whereas

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mentalizing (ToM without empathy) requires a cognitive inference about mental state (Singer, 2006). Despite a number of studies assessing both empathy and ToM, it is not known whether differing levels of empathy can predict ToM performance.

Social behaviors appear to be strongly influenced by sex differences (Baron-Cohen, 2009). It is assumed that sex differences also affect ToM; the higher levels of ToM observed in females may be explained by the female brain's capacity for empathy (Baron-Cohen, 2009). Note that this implies not only that sex would have a direct effect on levels of ToM, but also an indirect effect, mediated by empathy. Surprisingly few empirical studies have tested whether sex has this effect (Charman, Ruffman, & Clements, 2002; Cutting & Dunn, 1999; Walker, 2005). The widely used Reading the Mind in the Eyes Task (RMET), which involves the emotional inference of mental states, indexes one of the most basic mosaics of ToM (Baron-Cohen, 2009). To our knowledge, only one report has shown evidence of sex differences in RMTE in a small sample (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001).

FI has been defined as the ability to think logically and solve problems in novel situations, independent of acquired knowledge (Duncan, 2005). Although originally associated with "cold" cognitive skills, FI may also relate to social cognition. Psychosocial adaptation is related to FI (Huepe et al., 2011), suggesting the latter as part of a general capacity for adaptation to social contexts. Moreover, indirect reports suggest that intelligence is partially associated with facial processing (Wilhelm et al., 2010) and RMET (Roca et al., 2010). Thus, as in the case of executive functions, FI may be an important modulator of ToM.

In brief, the evidence presented above suggests that empathy, sex and FI could be important predictors of individual differences in ToM. This is the first study exploring the relationship between ToM and empathy, FI and sex in a random-probabilistic sample of secondary school students. First, we explored whether sex, along with high, average or low levels of empathy/FI, differentially affect ToM performance (assessed using the RMET). We hypothesized that females and individuals with higher levels of empathy/FI should present higher levels of ToM. Additionally, this study uses a path analysis to investigate the unique contribution of empathy, sex and FI in predicting ToM. This method allows the causal modeling of directed dependencies among a set of variables (Shipley, 2002). We hypothesized that each of the three factors would predict a significant portion of ToM variance. Additionally, we tested the indirect effect of sex on ToM, mediated by empathy.

2. Materials and methods

2.1. Participants

This sample was composed of 424 secondary school students (age, $M = 12.5$ years, $SD = 0.68$; range = 12.0–13.2; 47.6% female) recruited from a random-probabilistic sample (maximum variance of 95% confidence with $\pm 5\%$ sample error) from 27 schools ($M = 15.7$ students, $SD = 8.44$ per institution). All educational institutions in which the study was performed approved the research performed in Chile (Santiago) as part of a national research program on education. All participants and their parents or legal guardians gave signed, voluntary consent in accordance with the Declaration of Helsinki.

2.2. Measures

2.2.1. ToM

The RMET (Baron-Cohen et al., 2001) consists of a set of 25 photographs of the area of the face involving the eyes. Participants are given four options and are asked to choose the one that best

describes what the person in the photograph is thinking or feeling based on the expression in his or her eyes.

2.2.2. Fluid intelligence (IF)

A standard version of the Raven progressive matrices (RPM) was used as a measure of FI (or g factor; Raven, 2000). RPM included 60 spatial tasks divided into five blocks of 12 trials (from easiest to most difficult). In each trial, participants were asked to complete a series of drawings.

2.2.3. Empathy

The Interpersonal Reactivity Index (IRI; Davis, 1983) is a measure of dispositional facets of empathy (perspective taking, empathic concern, personal distress, and fantasy). In the present study, the global score of the IRI was used as an indicator of empathy.

2.3. Statistical analysis

2.3.1. Exploratory analysis

Groups of high, average, and low scorers on the FI and empathy measures were identified (high = >1 SD; low = <1 SD; average = ± 1 SD) to explore the relationship between FI, empathy, and ToM performance. Comparisons between these groups as well as between sexes were made using the Kruskal–Wallis test. z' pairwise comparisons were performed.

2.3.2. Path analysis

To test the relationship between empathy, FI, sex and ToM, we used a path analysis (Shipley, 2002). This method involves developing a theoretical model to specify relationships (usually represented using a path diagram) and testing these hypotheses by comparing the pattern of correlations found in the data with that implied by the model (see S1 in Supplemental material).

3. Results

3.1. Exploratory analysis

Regarding empathy scores, the Kruskal–Wallis test showed significant results ($H(2, N = 424) = 21.32, p < 0.001$) in relation to ToM. The resulting z' pairwise comparisons displayed significant differences both between high and average ($z = 4.08$) and high and low ($z = 4.20$) performance levels.

The same set of analyses was carried out for the relation of FI scores with ToM. The results of a Kruskal–Wallis test were also significant ($H(2, N = 424) = 13.7551, p < 0.001$), and the z' pairwise comparisons identified differences between high and average ($z = 2.54$) and between high and low ($z = 3.68$) scorings.

In regard to sex differences, the Kruskal–Wallis test H produced significant results ($(1, N = 424) = 24.0797, p < 0.001$), and the z' pairwise comparisons also showed significant differences between males and females ($z = 3.42$). See Table 1 and Fig. 1.

Table 1
Descriptive statistics.

	High ($n = 68$)	Average ($n = 292$)	Low ($n = 64$)
FI	20.24 (0.45)	18.14 (0.22)	17.17 (0.47)
Empathy	19.61 (0.51)	18.37 (0.21)	16.88 (0.51)
	<i>Female</i>	<i>Male</i>	
Sex	19.24 (0.26)	17.50 (0.25)	

High, average and low levels of empathy and FI, as well as sex differences in ToM.

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