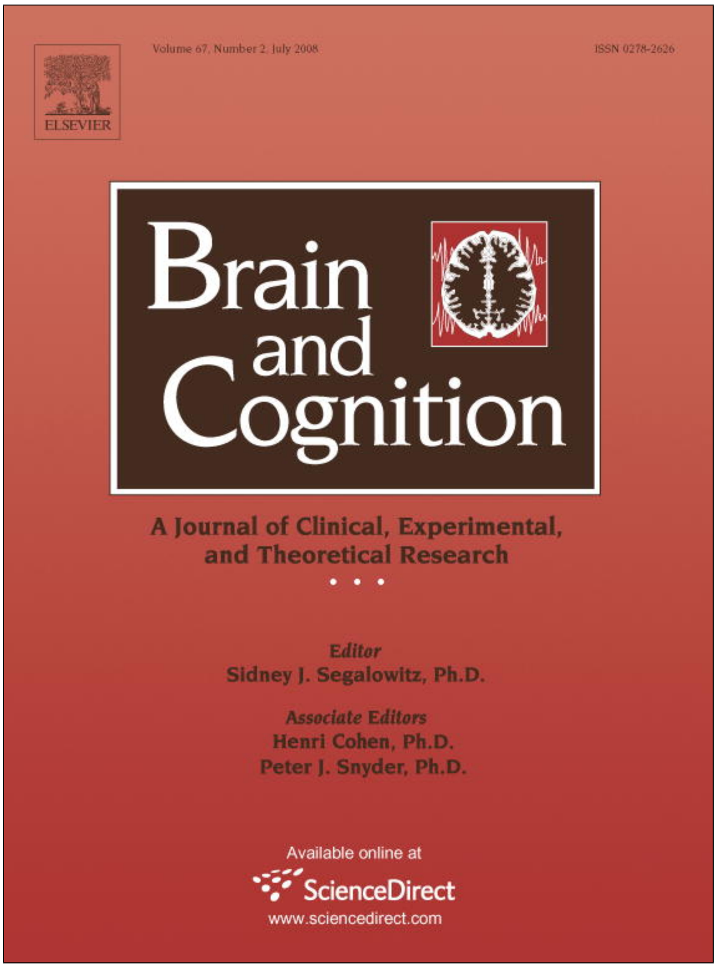
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Gender differences in empathy: The role of the right hemisphere

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Abstract

The relationship between activation of the right cerebral hemisphere (RH) and empathy was investigated. Twenty-two men and 73 women participated by completing a chimeric face task and empathy questionnaire. For the face task, participants were asked to pick which of the two chimeric faces looked happier. Both men and women were significantly more likely to say the chimera with the smile to their left was happier, suggesting activation of the RH. As expected, men scored significantly lower than women on the empathy questionnaire, $p = .003$. A correlation was found between RH activation on the face task and empathy for women only, $p = .037$, suggesting a possible neural basis for gender differences in empathy.

Keywords: Empathy; Asymmetry; Gender differences; Laterality; Social cognition

1. Introduction

The neurological basis of empathy has been a popular subject matter in recent years (e.g. Decety & Jackson, 2004, 2006; Eslinger, 1998). According to the *Random House Dictionary* (Flexner, 1980), empathy is "identification with or vicarious experiencing of the feelings or thoughts of another person". Many authors have differentiated between different types of empathy. The most common distinction is between "emotional" and "cognitive" empathy (Davis, 1980, 1983; Decety & Jackson, 2004; Mehrabian & Epstein, 1972). Cognitive empathy involves the ability to know what another person is thinking or feeling and is similar to the concept of "theory of mind". Emotional empathy, on the other hand, involves actually experiencing a similar emotion.

Empathy is believed to be important for developing prosocial behavior and for appropriate moral development. It is also seen as important for psychotherapists (Chessick, 1998; Ickes, 1993; Rogers, 1959), parents, and anyone who works with young children (Mehrabian, Young, & Sato, 1988). Deficits in empathy have been found in children with autism and Asperger's syndrome (Charman et al., 1997; Dapretto et al., 2006; Romanowski-Bashe & Kirby, 2005), in adults with multiple sclerosis (Benedict, Priore, Miller, Munschauer, & Jacobs, 2001), and in psychopaths (Mullins-Nelson, Salekin, & Leistico, 2006).

A number of brain regions have been suggested to be involved in empathy. The strongest evidence suggests involvement of the medial frontal lobes. Patients with lesions to this area have been reported to show deficits in empathy (Eslinger, 1998; Grattan & Eslinger, 1992; Shamay-Tsoory, Tomer, Berger, & Aharon-Peretz, 2003; Varney & Menefee, 1993). A role for the medial frontal lobes has also been suggested by neuroimaging studies of normal subjects. Farrow et al. (2001) used fMRI to study healthy individuals who were asked to judge another's state of emotion when encountering a social scenario. Activation occurred in the left superior frontal gyrus and orbitofrontal cortex. Vollm et al. (2006) also used fMRI and found activation in numerous regions, including medial prefrontal cortex, the temporoparietal junction, temporal pole, cingulate and amygdala, in men asked to judge the intentions and emotions of characters presented in a cartoon story. Shamay-Tsoory et al. (2005), using PET, found activation of the medial and superior frontal gyrus, occiptotemporal

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cortices, thalamus and cerebellum in participants undergoing an interview designed to elicit an empathic response about a story character in distress. Ruby and Decety (2003, 2004) also used PET and asked subjects to answer questions based on their own perspective, or on the imagined perspective of another person. Imagining another's perspective resulted in activation in frontopolar cortex and right inferior parietal lobe.

In addition to Ruby and Decety's (2003, 2004) finding of right parietal involvement, other studies have suggested that the right hemisphere (RH) may be more involved in empathy than the left hemisphere (LH). Perry et al. (2001) looked at individuals with anterior temporal lobe atrophy and found evidence suggesting greater empathy deficits in those whose lesions involved the RH. Shamay-Tsoory et al. (2003) also found greater empathy deficits in patients with frontal or posterior lesions involving the RH. Rankin et al. (2006) examined patients with various forms of neurodegenerative disease and found that empathy deficits correlated with a decrease in volume in the right temporal pole, right fusiform gyrus, right caudate and right subcallosal gyrus.

Spinella (2002) studied empathy in healthy individuals by using an odor identification task. He found that right-nostril smell identification showed a higher correlation with empathy than left-nostril smell identification. Since the sense of smell relies on ipsilateral pathways, it was suggested that the RH is more involved in empathy than the LH. To measure empathy Spinella used the Mehrabian and Epstein (1972) Empathy Questionnaire (MEEQ). This empathy questionnaire has been validated in a number of previous studies and shown to correlate with empathy-related behaviors such as helping and aggression (for a review, see Mehrabian et al., 1988).

The role of the RH in empathy is congruent with its role in the ability to interpret emotional expression in faces (Adolphs, Damasio, Tranel, Cooper, & Damasio, 2000; Etcoff, 1984; Fried, Mateer, Ojemann, Wohns, & Fedio, 1982; Gur, Skolnick, & Gur, 1994; Warrington & James, 1967) and other social behaviors (Adolphs, 2001; Happe, Brownell, & Winner, 1999; Rueckert & Pawlak, 2000).

A number of studies have suggested that women may be more empathetic than men. In a literature review and meta-analysis, Eisenberg and Lennon (1983) found that gender differences, favoring women, were highly reliable in a large number of studies utilizing self-report, but less reliable in studies using alternative measures of empathy, such as facial expression or physiological arousal. They suggested that the gender difference may be due to demand characteristics; women may think they are expected to be more caring towards other people, and so are more likely to endorse those items. However, this explanation is called in to question by recent studies that have found evidence of a biological basis for gender differences in empathy. Knickmeyer, Baron-Cohen, Raggatt, Taylor, and Hackett (2006) found a correlation between prenatal testosterone levels and empathy-related behaviors at age four in normal children. Fukushima and Hiraki (2006), using EEG, found a medial-frontal negative component in both men and women 300 ms after they experienced a negative outcome in a gambling game. But only women showed that component after observing a similar negative outcome for their opponent in the game. In addition, Singer et al. (2006) used functional MRI to measure brain activity while participants received mild electric shocks or witnessed a confederate receiving a similar shock. They manipulated participants' liking of the confederates by having them watch two confederates play a "prisoner dilemma" type of game. In each case, one of the confederates played the game fairly and the other played unfairly. They found that both men and women showed bilateral activation in pain-related areas of the brain (anterior insula and anterior cingulate) when they received a shock, and when they witnessed a "fair" confederate receive a shock. However, only women showed this activation when the "unfair" confederate received a shock. The men, on the other hand, showed activation in reward-related areas (left ventral striatum/nucleus accumbens and orbitofrontal cortex) when they saw the "unfair" confederate shocked.

While some previous studies have suggested a special role for the RH in empathy, others have not found this asymmetry. Given the fact that many studies have reported gender differences in empathy, it is quite possible that the relative role of the RH could differ by gender. Although gender differences in regional activation have generally not been reported in the neuroimaging literature, those studies have typically involved relatively small sample sizes, which may preclude comparisons across gender. The purpose of the present study was to further examine individual differences in RH activation and empathy in a large sample, and to test for potential gender differences. It was hypothesized that there would be a correlation between empathy and the activation of the RH. To measure RH activation, we chose the Levy Chimeric Faces Task (LCFT; Levy, Heller, Banich, & Burton, 1983). This task requires participants to choose the happier of two chimeric faces (faces with one side smiling and the other side showing a neutral expression). Numerous previous studies have demonstrated that right-handed participants (regardless of gender) tend to chose the chimeric face with the smile to their left more often than the chimeric face with the smile to their right (Banich, Elledge, & Stolar, 1992; Levy et al., 1983; Luh, Rueckert, & Levy, 1991; Rueckert, 2005). This is most likely due to the fact that, in right-handers, the RH is dominant for the perception of faces and emotional expression. So when asked to judge the emotional expression of faces, the RH becomes more active. This causes a bias in attention to the left-side of space (Levy et al., 1983). Since the LCFT specifically measures RH involvement in *emotion*, a stronger correlation with empathy might be expected than that found by Spinella (2002), using lateralized odor identification. As in the study by Spinella, empathy will be measured using the MEEQ, which has shown gender differences in past research (Mehrabian et al., 1988). Although Spinella did not find gender differences, that could have been due to his small sample size.

2. Method

2.1. Participants

Twenty-two men and 73 women undergraduate students from Northeastern Illinois University (NEIU) voluntarily participated. All participants were between 18 and 57 years of age (mean age = 26 years). All participants also met the following set of criteria: (1) normal or corrected eyesight, (2) no history of a neurological disorder, (3) no episode of a head injury that included loss of consciousness for longer than 5 min and (4) reported that they wrote with their right-hand. All participants gave written informed consent.

2.2. Materials

2.2.1. Levy Chimeric Faces Task (LCFT; Levy et al., 1983)

The same stimuli used by Levy et al. (1983) were used. This task was given using both the traditional paper and pencil format and via an overhead projector. This task consisted of viewing 36 pairs of chimeric faces. A chimeric face was formed by joining two pictures of the same person together. The first picture was taken of a person smiling and the second picture was taken of the same person, but with a neutral expression on his face. Each picture was then cut into equal vertical halves. To make the chimeric face, a left-side smiling face was paired with a right-side neutral face or a left-side neutral face was paired with a right-side smiling face. A pair consisted of the original and its mirror image. Each pair of chimeric faces was placed vertically on the page. Half of the pairs of chimeric faces had the smile-left chimera on the top and half of the pairs had the smile-right chimera on the top, and these were randomly intermixed. The entire set of stimuli can be viewed or downloaded at http://www.neiu.edu/~lruecker/chimericfaces.htm.

During the task, participants were shown two vertically-aligned chimeric faces at a time and were asked to choose which face appeared happier, the top or bottom face. They were not allowed to make an "equally happy" response. Scoring was done by counting, for each participant, the number of times he/she chose the face with the smile to his/her (the viewer's) left, and the number of times he/she chose the face with the smile to his/her right. A "laterality quotient" (LQ) was computed by subtracting the number of smile-left choices from the number of smile-right choices, and dividing by the total: (R-L)/36. A negative number indicates a leftward bias, and a positive number indicates a rightward bias. A more negative score indicates greater RH activation.

The LCFT has been used in numerous previous studies and has been shown to yield a very reliable leftward bias in right-handers, indicating RH activation. In addition, this task has given the same results, regardless of whether presented in a paper format or shown with a slide projector (Levy et al., 1983).

2.2.2. Mehrabian and Epstein Empathy Questionnaire (MEEQ; Mehrabian & Epstein, 1972)

The questionnaire was labeled as "personality scale" in order to avoid subject bias and demand characteristics. It consisted of 33 statements that apply to situational events. An example of an item is "Seeing people cry upsets me." Participants were asked to rate each statement on a scale from −4 to 4. A rating of −4 meant the participant disagreed with the statement while a rating of 4 meant the participant agreed. Some items were worded in the opposite way (e.g. "I often find public displays of affection annoying"), and scoring was reversed for these items. Total empathy scores can range from −132 to 132, with a higher score indicating a greater level of empathy.

The MEEQ has been used in numerous previous studies and has been shown to give reliable results and to correlate with a number of empathy-related behaviors (Mehrabian et al., 1988).

2.3. Procedure

Participants were recruited for this study by an advertisement placed on NEIU's psychology bulletin board. Seventy participants were tested individually using a pencil and paper version of the LCFT, and 25 were tested in a large classroom with the LCFT presented via projector. In both conditions, approximately half of the participants were given the LCFT followed by the MEEQ, and the other half were given the tasks in the opposite order.

In the classroom setting, the experimenter projected the 36 pairs of chimeric faces in a PowerPoint presentation, one by one, using an overhead projector while participants wrote their answers on the answer sheet. Each pair of chimeric faces was displayed for approximately 30 s.

3. Results

The overall mean LQ on the LCFT (−.306) was significantly less than zero, $t(94) = -6.543$, $p = .000$, showing that there was a reliable leftward bias. Men showed a mean LQ score of −.279 and women showed a mean LQ score of −.314. The difference was not significant, $t(93) = .312$, $p = .756$.

MEEQ scores can range from −132 to 132, with a higher score indicating a greater level of empathy. Men had a mean score of 21.95 and women had a mean score of 40.4795. The difference was significant, $t(93) = -3.059$, $p = .003$, $r^2_{pb} = .09$, showing that men reported lower empathy than women.

To test whether a relationship existed between empathy and the activation of the RH, Pearson's correlation coefficient was computed between LQ and MEEQ scores. The correlation computed for all participants was not significant, $r(93) = -.158$, $p = .126$. The correlation for men only was not significant either, $r(20) = .096$, $p = .671$. However the correlation for women was significant, $r(71) = -.245$, $p = .037$. The negative correlation shows that a more negative LQ (indicating greater RH activation) is associated with greater empathy.

Testing format was investigated to determine if it affected LQ scores. Participants that completed the LCFT using a paper and pencil format had a mean LQ score of −.376. Participants that completed the LCFT via an overhead projector gave a mean LQ score of −.109. The difference was significant, $t(93) = -2.593$, $p = .011$, $r^2_{pb} = .07$, showing that participants that completed the LCFT using a paper and pencil format had a stronger leftward bias.

Due to the significant difference in LQ as a result of testing format, all previously reported analyses involving LQ were re-calculated with testing format as a covariate. This did not change any of the results. However, further analyses using data only from the paper and pencil format showed a somewhat greater difference between men and women in the correlation between LQ and MEEQ; the correlation was still significantly negative for women ($r(50) = -.31$, $p = .027$), and became more *positive* for men ($r(16) = .23$, $p = .361$).

The order in which the two tasks were administered did not have any effect.

4. Discussion

The results of the present study replicated those of previous studies that reported that participants, regardless of gender, tend to pay more attention to the left-side of chimeric faces (Banich et al., 1992; Levy et al., 1983; Luh et al., 1991; Rueckert, 2005). The expected gender difference in empathy was also found, with women scoring higher than men. This also replicates numerous previous studies that have found that women score higher on the MEEQ (e.g. Eisenberg & Lennon, 1983; Mehrabian et al., 1988).

An unexpected result of this study was that a significant effect was found for the testing format—participants tested in the paper and pencil format showed a stronger leftward bias than those completing the task with the faces projected on to a screen. It is important to note, however, that a leftward bias was elicited for both formats. The LCFT has been administered with a slide projector in previous studies (e.g. Levy et al., 1983), and has yielded results equal to the paper and pencil format. While the format difference found in this study could be spurious, the additional control gained in the pencil and paper version make it the preferred format for future studies.

The original hypothesis of a correlation between empathy and the activation of the RH was partially supported. Specifically, only women showed this correlation. This partially replicates the results of Spinella (2002), who identified a relationship between right-nostril smell identification and empathy as measured by the MEEQ. Spinella did not report that the correlation differed for men and women. This may be due to his small sample size (20 women and 8 men) or it may be due to differences in the measure of RH activation. Whereas the odor identification task used in the Spinella study likely involves the orbitofrontal cortex (Di Nardo et al., 2000; Savic, Bookheimer, Fried, & Engel, 1997), the judgment of emotional expression in faces would be expected to involve more posterior regions (Adolphs et al., 2000; Haxby, Hoffman, & Gobbini, 2000).

It is important to note that there is no evidence that men and women differ in the involvement of the RH in the perception of emotional expression, as measured by the LCFT. Men and women did not differ in LQ in this study, or in previous studies utilizing the LCFT (e.g. Levy et al., 1983; Luh et al., 1991; Rueckert, 2005). They differ only in the correlation between that task and empathy, as measured by the MEEQ. It is possible that the statements on the MEEQ were more likely to elicit an emotional reaction in women than in men, and therefore tapped in to the same RH areas involved in the perception of emotional expression on the LCFT. We must also point out that the LCFT likely measures individual differences in RH activation superimposed upon a RH specialization for the processing of emotional expression (Kim, Levine, & Kertesz, 1990). The results of the present study cannot differentiate which of these two factors correlate with empathy.

The MEEQ was chosen for this study because it appears to assess mainly "emotional" empathy, which might be expected to correlate with RH activation to a greater extent than "cognitive" empathy (for example, it includes items such as "I tend to get emotionally involved with a friend's problems"). However, this is purely conjecture, and in future studies a greater understanding of gender differences may be gained by examining other forms of empathy. For example, Decety and Jackson (2004, 2006) have postulated that empathy involves an affective component, a cognitive component, and the ability to distinguish self from other, and suggest that the RH may be especially involved in self-other awareness. Davis (1980, 1983) has designed a questionnaire that measures four types of empathy: "perspective taking" (similar to theory of mind, or cognitive empathy), "empathic concern" (emotional empathy), "fantasy" and "personal distress". Obviously, empathy is not a uni-dimensional construct, and different types of empathy are likely to involve different regions of the brain. (For an extensive discussion of the various aspects of empathy, and possible neural bases, see Preston and de Waal (2002).)

The few existing studies that have reported gender differences in the brain during tasks designed to elicit empathy have suggested than men and women may not differ in overall empathic capacity so much as the types of situations under which empathy is elicited (Fukushima & Hiraki, 2006; Singer et al., 2006). Specifically, women may exhibit more empathy than men toward some one that is perceived to be a competitor or enemy.

Clearly, the nature of gender differences in empathy is a topic that needs further study, and that has great potential to benefit from the field of social neuroscience.

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