

Mindreading: The influence of introversion and extraversion

Angela King

Grenfell Campus, Memorial University of Newfoundland

Approval Page

The undersigned recommend
the acceptance of this thesis

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Angela S. King

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Abstract

Theory of mind (also called ‘mindreading’), is the ability to explain and predict others’ behaviour by inferring their mental states, such as their knowledge, beliefs, perceptions and desires. One largely unexplored question in theory of mind research is the relationship between personality and theory of mind abilities in adults. The current study investigated introverts’ and extraverts’ performance on two theory of mind tasks: one task involved judging emotional states from pictures of eyes (RMTE task), and the other involved making judgments about one’s own and others’ visual perspective (AVP task). In both tasks, the personal relevance of the situation was varied to examine whether this factor would differentially affect the performance of introverts and extraverts. There was a significant interaction between personality (introvert *vs.* extravert) and condition (personal *vs.* impersonal) in the AVP task, with extraverts performing better in the personal than in the impersonal condition but introverts performing the same in both conditions. In the RMTE task there was no interaction, as all participants performed better in the personal condition regardless of personality. There was also a main effect of personality in the RMTE, with introverts performing better overall than extraverts at judging emotions from eyes. Possible reasons behind these and other observed differences are discussed.

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Theory of mind, or “mindreading,” can be defined as the ability to explain others’ behaviour by inferring their mental states such as their knowledge, beliefs, and desires (Frith & Frith, 2005). Humans not only use this inferred information to explain behaviour, but we also use it to predict others’ behaviours (Liszkowski, 2013) and infer the perspectives of others. Perspective-taking involves knowing what another person can and cannot see (Knowles, 2014). Theory of mind also helps us to judge the emotional states of others (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001).

It is theorized that theory of mind evolved from our primate ancestors. Many primates live in groups in which all individuals are dependent on one another and engage in complex interactions (Brune & Brune-Cohrs, 2006). Due to this, it is important for all members of the group to cooperate and to discourage taking advantage of other group members. The benefit of helping others must outweigh the gains of not cooperating. Numerous studies with humans have consistently found that people tend to suffer costs to themselves in order to help others (Orbell, Tomonori, & Harwig, 2004).

In contrast, the Machiavellian Intelligence Hypothesis states that individuals tend to have motives more related to defection (de Waal, 1989). Although there are advantages to living within a group, such as protection and access to mates, there is also genetic competition. This means that the individuals with the best genes for within-group competition will have their genes evolutionarily selected. In order to do this, individuals must manipulate and exploit other group members while simultaneously protecting themselves from being exploited. To protect against exploitation, individuals have to infer the true intentions of others. Additionally, inferring the thoughts and intentions of others can actually aid in the manipulation of others. Theory of mind can help to

determine which individuals are easy to deceive and what others may believe about a particular situation. Therefore, the benefits gained for competition with others is a possible explanation as to why theory of mind evolved. Theory of mind is key for both cooperation and manipulation because both are important for survival and reproductive success. (Humphrey, 1976; Orbell et al., 2004).

In addition to evolving across many generations throughout the history of the human species, theory of mind also develops within individual humans. In developmental psychology there has been a large amount of research on theory of mind in humans. Most theory of mind research has focused on children and individuals with mental impairments. A less explored area has been theory of mind in normal adults. Even more so, the influence of personality traits on theory of mind performance has been rarely investigated.

I will begin my discussion of the research on theory of mind by giving a brief description of the developmental research on theory of mind. I will then discuss personality traits and their influence on theory of mind performance.

Theory of mind in children

Presently, the development of theory of mind in children is a popular area of research. A common way to measure theory of mind in children is the false belief task. Children begin to successfully pass false belief tasks around the age of four (Fodor, 1992). This task is designed to determine whether a child can recognize that people have beliefs about the world that are incongruent with the child's own beliefs, as well as different from the true state of affairs. One classic false belief test is called the Sally-Anne task. Children are shown a scenario involving dolls named Sally and Anne. Sally is

shown placing an object in a certain location. Then, while Sally is not looking, Anne changes the location of the object. This causes Sally to have a false belief about the object's location. Three-year-olds often assume that Sally knows what they know, even though she has not been exposed to the same information. However, most four-year-olds recognize that Sally will think the object is in the original location (Apperly, Samson, & Humphreys, 2009; Baron-Cohen, Leslie, & Frith, 1985; Wimmer & Perner, 1983).

Why children fail this test before the age of four is unknown. Perhaps they lack knowledge about what beliefs are, or maybe they do not understand that a belief can incorrectly represent the world (i.e., false belief). The development in theory of mind competency may be a result of maturation, learning, or a combination of the two (Fodor, 1992). This is what developmental psychologists aim to find out.

The importance of studying theory of mind in adults

Although theory of mind in children continues to be a heavily studied topic, theory of mind abilities in adults have been far less explored. Despite the lack of attention, knowledge about adult theory of mind has importance. Apperly et al. (2009) stated a number of reasons why psychologists should also focus on adult theory of mind research. They said that understanding the adult mind allows researchers to know if, and when, theory of mind development is complete. Although children are eventually able to pass the more advanced, sensitive theory of mind tasks, they are still likely to be slower and more rigid in their skills when compared to adults. The later improvements of these abilities will indicate further development of their communication and social cognition skills. Executive functions refer to the processes, such as working memory and planning,

involved in goal-directed behaviors in novel or ambiguous situations. The study also focuses on aspects of language such as grammar.

Additionally, Apperly et al. (2009) note that knowledge of adults' abilities provides explanations for why relationships between theory of mind and skills such as executive functioning and language are observed. They claim that the perceived sudden development in children's theory of mind performance may be due either to executive functions and language aiding in the development of theory of mind or that they play a role in the maturation of the child overall. They suggest that by studying adults, researchers will be able to uncover the true relationships between theory of mind and language and executive functioning.

Deficits in theory of mind

Humans are diverse regarding their abilities and theory of mind is no exception. People have many individual differences which make us unique, and these individual differences result in differing theory of mind abilities. Mental deficits can also result in differences in these abilities. Research on individuals with Autism and Asperger Syndrome indicates these disorders may involve a deficit in theory of mind abilities. In a study by Baron-Cohen et al. (2001), it was found that participants with high-functioning Autism and Asperger Syndrome were significantly impaired when inferring emotional states from images of pairs of eyes. These results suggest deficits in social intelligence within these individuals. Kleinman, Marciano, and Ault (2001) also conducted a study on Autistic individuals and found that they performed significantly worse than controls on theory of mind tasks. Not only did they have trouble inferring mental states from images,

but they also demonstrated impairment when making inferences about mental states from recordings of voices.

The literature on people with certain types of brain damage suggests that they have difficulties reading certain emotional expressions, which is important for theory of mind. People with amygdala damage have great difficulty recognizing fear in others and some trouble recognizing disgust (Calder et al., 1996). People with Huntington's disease also have problems recognizing facial expressions of disgust (Sprengelmeyer et al., 1996) and even have some impairments in their own vocal expressions of disgust (Sprengelmeyer et al., 1997).

Aside from research on the effects of mental impairments, the effects of the aging process on theory of mind performance has also been investigated. Bernstein (2011) found evidence that theory of mind declines in middle-aged and older adults. In that study, young adults performed better on a false belief task than middle-aged and older adults. Additionally, Bernstein found that these results occur independently of other age-related differences such as executive function, memory, and processing speed.

Personality and theory of mind

People have individual differences that are not attributed to pathology or age. You do not need to be a social scientist to recognize this fact. Laypeople can easily recognize that humans have differences in personality and that these differences influence aspects of our life, such as our social skills. In terms of theory of mind, the relationship between personality traits and theory of mind performance is minimally explored. Within this area of research, the most researched personality trait is empathy. Singer (2006) stresses the importance of differentiating between empathy and theory of mind. They are often

considered synonymous; however, they are different abilities which require functioning of different brain areas. Theory of mind is the ability to infer others' mental states and is associated with activity in the temporal lobe and pre-frontal cortex. Empathy is the ability to actually *share* the emotional states of others and is associated with activity in the sensorimotor cortices as well as the limbic and para-limbic structures.

The effect of agreeableness on theory of mind performance has also been studied. Nettle and Liddle (2008) noted that agreeableness is related to warmth, friendliness, and altruism. People with high agreeableness also try to promote harmonious relationships with others. In their study, they investigated the relationship between agreeableness and theory of mind. Specifically, the study looked at the influence of agreeableness on social-cognitive and social-perceptual theory of mind. Social-cognitive theory of mind involves reasoning about another's mental states by means other than bodily cues, such as by hearing a story spoken by another person, and using this information to make predictions about their actions and behaviour. Social-cognitive theory of mind is related to linguistic abilities. Social-perceptual theory of mind is the detection of others' mental states via physical cues such as facial expression and bodily movements. Nettle and Liddle (2008) found that agreeableness correlated with social-cognitive theory of mind performance but there was no correlation with social-perceptual theory of mind.

A study on children conducted by Stellwagen and Kerig (2013) investigated the role of the "dark triad" personality traits (narcissism, callous-unemotional traits, and Machiavellianism) in theory of mind. The results demonstrated that narcissism is positively correlated with theory of mind and most callous-unemotional traits are

negatively correlated with theory of mind. Machiavellianism and the callous-unemotional trait of impulsivity were not related to theory of mind performance.

Extraversion and introversion

While there is minimal research on the relationship between personality and theory of mind, there is even less research specifically on extraversion and introversion and their role in theory of mind. I will begin by outlining basic characteristics of extraversion and then describe specific characteristics of each that could influence theory of mind. Smillie (2013) mentioned that extraversion is linked to reward-processing and positive affect. Extraverts engage in social and outgoing behaviours, both of which normally involve advancement towards a reward. Interaction with rewarding situations may cause increased feelings of positive affect.

Guilford (1934) described extraverts as active seekers of interaction with the environment. Due to this need for stimulation from their surroundings, he says that extraverts are likely more easily distracted from tasks but they do tend to perform better on tasks that are personal. A personal task, as described by South (1927), relates to a person's interests and own experiences. Research has also shown that extraverts maintain eye contact longer than introverts during social interactions (Larsen & Shackelford, 1996), perhaps because they are more comfortable with direct eye contact.

In contrast, introverts tend to concentrate on activity within their own mind as opposed to their environment (Lieberman & Rosenthal, 2001). Introversion also tends to be correlated with social anxiety (Edelmann & McCusker, 1986). This social anxiety may be related to introverts fearing insult by others, often causing them to avoid social interactions or endure them with discomfort (Stein & Stein, 2008). Finally, introverts

perform better on tasks that are impersonal (Guilford, 1934). This can be described as the opposite of a personal task, thus not relating to one's own experiences and interests.

There are predictions as to why extraversion and introversion evolved. Nettle (2005) suggests that extraversion may have evolved because it contributed to reproductive fitness. People who are extraverted tend to have more sexual partners and they more easily leave a relationship for a new one. This behaviour helps to achieve a high-quality reproductive partner. Additionally, extraverts seek stimulation from their environment and thus gain social support from those around them. However, extraversion can lead to negative consequences such as physical harm due to stimulation seeking. As well, extraverts are more prone to family instability because of their frequent termination of relationships and this causes problems for offspring (Nettle, 2006).

The disadvantages of extraversion could have influenced the evolution of introversion as a means of avoiding the negative consequences of being extraverted. Being introverted protects one from physical harm due to stimulation seeking. Introverts are also better able to maintain family stability because they are less likely to end relationships. However, this protection of the self and kin also come at a price. It can be inferred that by having secure relationships, introverts reduce the chances of obtaining a higher quality reproductive partner. Additionally, reducing the amount of environmental exploration avoids physical harm but makes it difficult for introverts to establish a social support system with those around them (Nettle, 2006). Conversely, introverts' faithfulness may be considered admirable, thus allowing introverts to have long-term beneficial relationships. Since there are benefits and disadvantages to both introversion

and extraversion, both personality types are strategic for survival. This means that both types will evolve and be maintained in the human population.

Extraversion, introversion, and theory of mind

The aforementioned differences between extraversion and introversion could be linked to predicted performance on theory of mind tasks. Because introverts are more preoccupied with their own thoughts than extraverts, it could be assumed that they may struggle more when required to infer the thoughts of others. For example, it is likely that introverts would have difficulty inhibiting their own visual perspective in favour of someone else's. Additionally, this focus on the self, coupled with the preference for reduced eye contact with others in comparison to extraverts, could possibly make reading the emotional states of others problematic.

This is similar to patients with amygdala damage. These patients have difficulty recognizing complex emotions from images of whole faces and images of pairs of eyes. This may be because they fail to attend to the eyes when looking at a face and spend most of the time looking at other aspects of the face (Adolphs, Baron-Cohen, & Tranel, 2002). The eyes are key for expressing one's emotion, so lack of attention can cause difficulty in interpreting emotions of others. Taking the perspective of others and inferring their emotional states is important for theory of mind ability, so these inferences may suggest that introverts are not as successful with theory of mind when compared to extraverts. If a theory of mind task is personally relevant to an introvert, there may be additional impairments since the literature notes introverts' greater success at *impersonal* tasks.

Tasks that measure theory of mind in adults

There are a number of approaches that can be used to study and measure theory of mind in adults. Because adults are more developed in their theory of mind skills than children, more complex tasks must be used to accurately measure adult ability. The most common area of study for children is false belief, and adult theory of mind research is reflective of this. One type of false belief task, as used by Birch and Bloom (2007), is the “contamination task.” It is referred to in this way because the participant’s own beliefs influence, or contaminate, what they think someone else believes. For example, if the participant knows the location of a hidden object, he or she is more likely to make errors when required to quickly judge where another person falsely believes the object to be.

Although popular, false belief tasks are not the only type of task used to assess adult theory of mind. Apperly et al. (2009) suggest that theory of mind tasks for adults can be made more challenging by requiring participants to complete simple theory of mind tasks simultaneously with another task, such as judging someone’s mental state while simultaneously differentiating between music tones. Additionally, sometimes adults are assessed on how quickly they can complete a task, and how many errors they make on a theory of mind task.

Some theory of mind tests have been designed to test adults’ ability to take another’s visual perspective. These tests may also involve some contamination from the participant’s own perspective. A perspective-taking task, as used by Samson, Apperly, Braithwaite, Andrews, and Bodley Scott (2010) and Surtees and Apperly (2012), involved participants being shown images of an avatar (a computer-generated representation of a person) in an empty room with circles on the walls. Participants were

asked to answer either how many circles they themselves could see from their perspective, or how many the avatar could see from its perspective. In some of the trials, the number of circles that the participant could see and the number the avatar could see were consistent. In the remaining trials, the number of circles that the participant could see and the number the avatar could see were different, and therefore inconsistent. Response time and number of errors were recorded using computer software. Both studies found that participants showed greater difficulty in taking the avatar's perspective when it was different from their own, as indicated by slower reaction times and more errors. Surtees and Apperly (2012) even found that participants had more difficulty judging their *own* perspective when the avatar's perspective was inconsistent with their own.

Theory of mind research in adults has also examined adults' ability to infer emotional states. This type of theory of mind research in adults has thus far focused primarily on individuals with psychological impairments. For example, Simon Baron-Cohen and colleagues created the "Reading the Mind in the Eyes" test, which they revised in 2001 (Baron-Cohen et al., 2001). The test was used to assess theory of mind in adults with high-functioning Autism and Asperger Syndrome, in comparison to normal adults. The task involved judging what expression a black and white photo of a pair of eyes was displaying, and the participant chose their response from four possible options. The pairs of eyes were either facing the camera or looking away and displayed either a positive or negative emotion. They found that participants with high-functioning Autism and Asperger Syndrome were significantly impaired on this test, relative to normal controls, indicating deficits in social intelligence.

The current study

The current study intends to explore theory of mind performance in normally functioning adults. It will focus on the relationship between theory of mind and personality because little previous work has been done in this area. More specifically, the study will look at the relationship between the personality variable of extraversion and introversion and theory of mind performance. There are characteristics of both extraversion and introversion that may relate to individual differences in performance on theory of mind tasks.

The current study will explore how introverts and extraverts perform on two theory of mind tasks. One of the tasks will test participants' visual perspective taking and will be adapted from the avatar tests developed by Apperly et al. (2010) and Surtees and Apperly (2012) discussed earlier. The other task will test participants' ability to infer emotions and will be a modified version of the "Reading the Mind in the Eyes" revised test (Baron-Cohen et al., 2001). Each of the tests will include a personal and an impersonal condition (i.e. one condition will be made personally relevant to the participant while the other condition will not).

Proposed hypotheses

Based on the differences between introverts and extraverts noted earlier, the current study offers three hypotheses: 1) Because introverts are more preoccupied with their own thoughts than extraverts, they will perform less well overall than extraverts on both theory of mind tasks; 2) Within each test, introverts will perform less well than extraverts in the personal condition, but will perform similarly or better than extraverts in the impersonal condition. This prediction is based on past findings that extraverts do

better with personal tasks and introverts do better with impersonal tasks (Guilford, 1934).

With regard to the “Reading the Mind in the Eyes” test, it also based on the fact that introverts seem to be less comfortable with direct eye contact than extraverts (Larsen & Shackelford, 1996); 3) Introverts should especially struggle when asked “other person” questions than “you” questions in the avatar perspective-taking test, because participants need to inhibit their own perspective to accurately judge what the avatar can/cannot see. Additionally, extraverts are expected to perform equally well when asked “other person” and “you” questions.

Method

Participants

Participants were recruited from classes at Grenfell Campus, Memorial University of Newfoundland, upon receiving permission from the professors. All students were asked if they would like to participate in a study on perspective-taking. All students were informed that their participation was completely voluntary and anonymous, and that all results would remain confidential. Data was collected during class time if the instructor consented, and the remaining data was collected outside of class time. For classes that did not participate in the study during class time, a form was passed around the class requesting names and school emails of prospective participants. After receiving names and emails, each person was contacted by the researcher via email to arrange a time and place to participate in the study. Participants completed the study in the same room as other participants, but independently.

One hundred sixty-three participants’ data were useable for the study. Five participants’ data were omitted due to an inability to score their BFI. Data was missing on

their pages, thus their BFI score could not be calculated. The average participant age was 21 and ranged from 18 to 45. One hundred seventeen participants identified as female, 44 identified as male, and 2 identified as other.

Materials

The Big Five Inventory (BFI)

The BFI is a publicly available personality inventory for non-commercial research that measures five personality factors: extraversion, openness, conscientiousness, agreeableness, and neuroticism. It was used in this study to determine the participants' level of extraversion or introversion. All 8 items that measured introversion-extraversion remained on the questionnaire. All but two items from each of the other traits were removed to conceal the fact that introversion-extraversion was being measured specifically. See Appendix A for a copy of the modified BFI. The original BFI by John & Srivastava (1999) can be seen in Appendix B.

Avatar Visual Perspective-Taking Task (AVP)

This task was based on those by Samson et al. (2010) and Surtees & Apperly (2012). The present task was a modification of the aforementioned tasks. There were two versions of the AVP and participants received one of the two conditions: personal or impersonal. The personal condition consisted of a scenario that involved imagining the participant's own private space (i.e., their home) and the impersonal condition was a scenario that involved imagining a public location (i.e., a pizzeria). After reading the given scenario, all participants were shown the same series of images depicting a human-like avatar standing in an empty room with rectangles representing pictures on the walls. The avatar varied in the direction it was facing (left or right) and could be in one of five

locations in the room. The location and number of rectangles displayed also varied. The number of rectangles to be counted ranged from 5 to 9. See Appendix F for examples of the images that were presented to the participant and see Appendix G for detailed descriptions of each scenario.

“Reading the Mind in the Eyes” Revised Task (RMTE)

The RMTE task used in this study is a modified version of Simon Baron-Cohen’s test (Baron-Cohen et al., 2001). All participants completed the same modified RMTE task. The participants were shown a series of 24 black and white photos of male and female eyes. The pairs of eyes were either looking directly at or away from the camera (i.e., direct versus indirect gaze, corresponding to the personal versus impersonal conditions, respectively). The modification made was that eight of the original photos have been removed to ensure there were an equal number of positive and negative emotions displayed for both direct and indirect gazes. Each photo was accompanied by four emotion terms, indicating four possible choices of what the displayed emotion may be. See Appendix C for examples of questions in this task. Participants were also given a paper which defined less common emotion terms on the test to look at for a brief period of time to reduce the possibility of a person choosing an incorrect option because they did not know the definition of a particular emotion term. See Appendix D for the list of terms which were given to participants.

Experimental Design

		Personality	
		Extraverted	Introverted
Condition	Personal	Ext. P.	Int. P.
	Impersonal	Ext. Imp.	Int. Imp.

Figure 1. Experimental design

The experimental design for the current study involved two variables: personality and condition. The personality variable included introversion and extraversion and the condition variable included personal and impersonal. All participants received the BFI first, then all were given both conditions of the RMTE (personal and impersonal). Lastly, all participants completed the AVP; however, as noted earlier, half of the participants were in the personal condition of the AVP and half were in the impersonal condition. See Figure 1 for a summary matrix of the experimental design.

Experimental Procedure

Participants participated in the study in groups and the tasks were administered in a classroom setting. Participants completed the study individually, but completed the study simultaneously in the same room as other participants. All participants did not interact with each other. Prior to beginning the study, the participants completed an informed consent form. They were notified that their participation was entirely voluntary,

anonymous, and confidential and that they could discontinue testing at any time. For participants who chose to continue, the completed informed consent forms were collected at the end of the session, put into an envelope, sealed, and placed in a secure cabinet by the researcher at the researcher's home. The participants were given a copy of the informed consent form for their records. Participants also received a research package containing all answer sheets for the study and a list of emotional terms for reference during the RMTE task. Participants who did not wish to participate were told to leave their papers blank and submit them at the end of the study to remain anonymous.

Before beginning the theory of mind tasks, the researcher asked the participants to fill out the first sheet in the booklet, which was the BFI. Once everyone was finished, the researcher instructed the participants to turn to page two of their booklet. This page was the list of emotion terms and their definitions for the RMTE task. Prior to beginning the RMTE task, the researcher asked participants to take a moment to review the terms that they were given and familiarize themselves with any words they did not previously know the definition of. The researcher explained to the participants that they should not look up a term during the task because they did not need to think too deeply about their answers and should instead choose the option that first came to mind. Before showing the images, the researcher explained that the participants would see images of pairs of eyes and four emotion terms and that they had to determine which of the four emotions the eyes were displaying. Participants were also told that each image would remain visible for a maximum of 15 seconds before the next image was shown. When the task began, the participants then determined which emotion each displayed pair of eyes was expressing from four possible choices. Each pair of eyes was shown individually with the four

possible options for that image via projector and the participants circled the letter of the desired answer on their answer sheet on the next page. See Appendix E for a copy of the RMTE answer sheet. Each picture and their respective options remained visible for 10 seconds. Before starting, a trial image was given to ensure participants understood the nature of the task.

Once the RMTE task was completed, the participants finished the study by completing the AVP task. As noted previously, half of the participants were given the personal scenario and half were given the impersonal scenario. To begin, a sample image was shown and the researcher explained to the participants that the rectangles in the image represented pictures on the wall and the avatar represented the other person mentioned in the scenario. The researcher then asked the participants to carefully read the scenario on their page and to imagine themselves in the scenario. The researcher explained that the following images would only be shown for a couple of seconds so it was important that they were attentive. Participants were then shown pictures via a projector one at a time for 0.5 seconds per picture, with a delay between photos of a couple seconds for participants to write their answer. In each trial, the participants' task was to determine how many rectangles--which represented pictures--were either in the field of view of the depicted avatar or in their own field of view, as prompted by the researcher. That is, before each image was shown, the researcher either asked, "How many pictures can *you* see in the following image?" or, "How many pictures can *the other person* see in the following image?" Prior to testing, two practice trials were given so the participants understood the nature of the task.

When the study was completed, the researcher collected all research booklets and informed consent forms. The researcher asked all participants to put filled out copies of the informed consent form in the designated folder and all remaining papers in another folder. For those who did not participate, they were similarly asked to put all blank forms in the same designated folders to remain anonymous. The researcher thanked all participants for their time and participation in the study.

Results

Firstly, the raw data from the BFI was scored by hand. All scores for the extraversion scale were totalled and averaged to give a score between 1 and 5 for each participant. The median of all scores was 3.12. All scores in the top 25% of the range were considered high on the introversion/extraversion continuum (and therefore classified as extraverts) and those in the bottom 25% of the range were considered low on the introversion/extraversion continuum (and therefore classified as introverts). All remaining scores were not used in these analyses. Another set of analyses were conducted using all scores above and below the median, but these analyses yielded similar results. Results given in this section are based on those obtained from the analyses on the top and bottom 25% of scores from the continuum. The dependent measure for this study was the percentage of items answered correctly for each task.

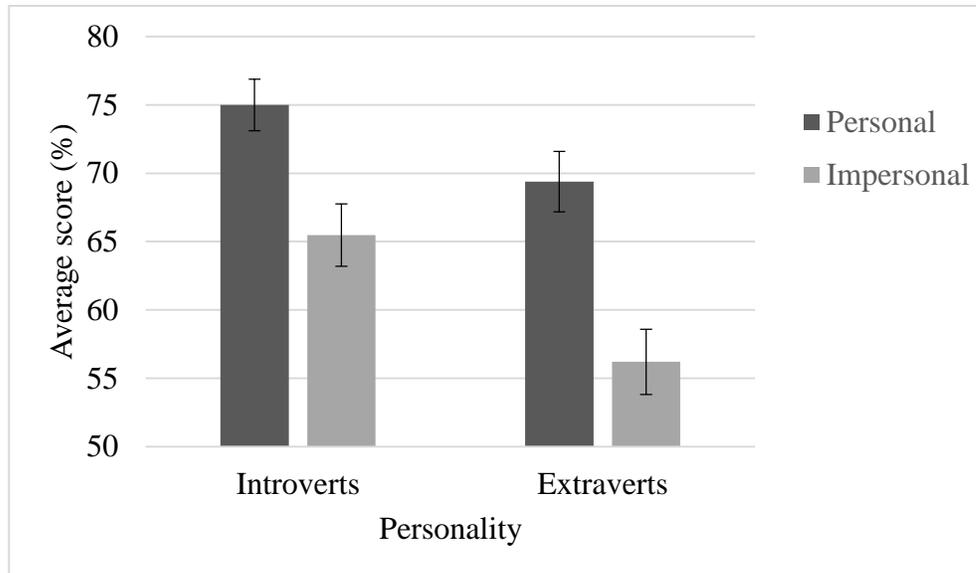


Figure 2. Performance on the RMTE task

A 2(personality) x 2(condition type) mixed analyses of variance (ANOVA) was used for analyzing the data from the RMTE task. The results are displayed in Figure 2. There was no significant interaction between personality and condition type, $F(1, 83) = .918, p = .341, \eta_p^2 = .01$. However, there was a main effect for condition type, $F(1, 83) = 35.41, p < .001, \eta_p^2 = .30$, in that participants in general correctly determined the emotion in the image significantly more often when the eyes were looking directly at the camera (personal condition: $M = 72.19\%$) as opposed to looking away (impersonal condition: $M = 60.84\%$). There was also a main effect for personality, $F(1, 83) = 9.15, p = .003, \eta_p^2 = .10$, indicating that introverts ($M = 70.24\%$) performed significantly better overall than extraverts ($M = 62.79\%$) when judging emotions from the images.

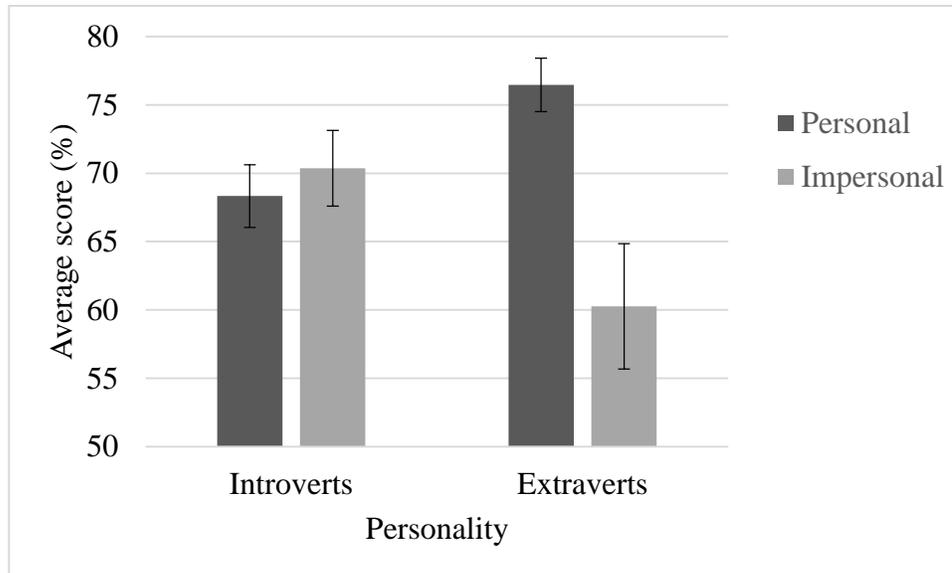


Figure 3. Performance on the AVP task

A 2(personality) x 2(condition type) x 2(question type) mixed analyses of variance (ANOVA) was used for analyzing the data from the AVP task. There was no 3-way interaction between the variables, and the only significant interaction was between personality and condition type, $F(1, 81) = 9.42, p = .003, \eta_p^2 = .10$. The results for this interaction are displayed in Figure 3. Extraverts performed significantly better in the personal condition than the impersonal condition, $MD = -16.20, t(24.46) = -3.25, p = .003$. Conversely, there was no significant difference in introverts' performance in the personal and impersonal conditions, $MD = 2.02, t(40) = .56, p = .576$. Additional t-tests were conducted to find any other differences. After applying the Bonferroni correction, it was also found that extraverts performed significantly better in the personal condition than the introverts, $MD = -8.13, t(43) = -2.72, p = .009$. A trend was shown where introverts almost performed significantly better than extraverts when the condition was impersonal, $MD = 10.09, t(38) = 1.93, p = .062$.

There was no main effect for personality, $F(1, 81) = .12, p = .732, \eta_p^2 = .001$. On the other hand, there was a main effect for condition, $F(1, 81) = 5.75, p = .019, \eta_p^2 = .07$, with participants performing significantly better overall when the condition was personal ($M = 72.34\%$) as opposed to impersonal ($M = 65.29\%$). However, we have to be aware that this effect is driven entirely by the data from the extraverts, as introverts performed similarly across both conditions. Finally, there was also a main effect for question type, $F(1, 81) = 24.97, p < .001, \eta_p^2 = .24$. Overall, participants performed significantly better when asked “you” questions ($M = 73.30\%$) as opposed to “other person” questions ($M = 64.3\%$).

Discussion

The current study investigated the relationship between theory of mind and personality. More specifically, the relationship between theory of mind performance and the personality variable of extraversion and introversion was explored. The study examined how introverts and extraverts performed on two theory of mind tasks. One of the tasks tested participants’ visual perspective taking and the other task tested participants’ ability to infer emotions. Each of the tasks included a personal and an impersonal condition (i.e. one condition was personally relevant to the participant while the other condition was not).

The findings of this study partially confirm the proposed hypotheses. One finding which was not as predicted was in relation to the first hypothesis; because introverts are more preoccupied with their own thoughts than extraverts, they are predicted to perform less well overall than extraverts on both theory of mind tasks. For the RMTE task, introverts performed better than extraverts at judging emotions from the images.

Although this was not as predicted, the extraverts may have been more easily distracted from the task at hand. It may also be possible that extraverts become more distracted when judging emotions in general, so they had greater difficulty recognizing the emotional cues presented in the images. Conversely, for the AVP task, extraverts performed significantly better in the personal condition in comparison to introverts' performance. This was as predicted. This finding is likely because extraverts tend to excel on personal tasks, whereas introverts succeed best at impersonal tasks, as previous research suggests.

The second hypothesis, which predicted that within each test, introverts will perform less well than extraverts in the personal condition, but will perform similarly or better than extraverts in the impersonal condition, was also partially confirmed by the findings. As previously mentioned, extraverts performed significantly better in the personal condition of the AVP task in comparison to introverts' performance. Again, this was as expected. Additionally, there was also a trend towards introverts performing better than extraverts in the impersonal condition. Even though it was not significant, this was still as predicted, since introverts tend to excel at impersonal tasks. Further research is required to determine whether this finding demonstrates an actual difference between introverts and extraverts on an impersonal task.

The findings pertaining to the last hypothesis were not exactly as predicted. It was hypothesized that introverts should especially struggle when asked "other person" questions than "you" questions in the avatar perspective-taking test. Participants, regardless of personality type, performed best when they had to give their own perspective versus someone else's. Consistent with past research, it is probably because

participants had to try to inhibit their own perspective in order to give the other person's perspective. Introverts and extraverts likely performed the same because they both have characteristics which may be handicapping in this task. Introverts focus more on their own thoughts, which may cause them to have difficulty switching their attention to someone else's perspective. Likewise, extraverts' tendency to get distracted with tasks may cause them to lose focus when they have to inhibit their perspective in order to take someone else's.

There were also some additional findings. For the RMTE task, participants performed better when the eyes in the images were looking directly at the camera (personal condition). Perhaps people are better at inferring emotions of others when the situation is made personally relevant. People may feel they need to judge the emotions of others when it may be directed at themselves. For the AVP, extraverts performed better in the personal condition than the impersonal condition. This is not surprising since extraverts tend to excel at personal tasks. Similarly, participants overall performed better when the condition was personal, which is similar to what was found for the RMTE task. It may be that participants were concerned about the potential opinions of the other person in regards to their personal space, so they focused more closely on what the other person is looking at.

Due to the minimal research in this area, I recommend that future research attempt to confirm the results of this study and to offer further explanation of the results. The results are somewhat complex and the limited past literature makes interpreting them difficult. However, the results of this study demonstrate that this area may be promising

for research, so it would be interesting to see other researchers investigate further into this area.

Studies such as this may help us understand how people interact with each other. Knowing how introverts and extraverts communicate with others may allow for the development of methods to help excel in interpersonal interactions. Additionally, it could just help people become more accepting when interacting if there's a misunderstanding between both parties. How personality influences theory of mind abilities can potentially explain one part of humans' complex nature of social interaction.

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Appendix A

The Big Five Inventory (BFI) - Modified

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who *likes to spend time with others*? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

1. Disagree strongly

2. Disagree a little

3. Neither agree nor disagree

4. Agree a little

5. Agree strongly

Age: _____**Gender:** _____*I See Myself as Someone Who...*

___ 1. Is talkative

___ 9. Is a reliable worker

___ 2. Tends to find fault with others

___ 10. Generates a lot of enthusiasm

___ 3. Is reserved

___ 11. Has a forgiving nature

___ 4. Can be somewhat careless

___ 12. Is outgoing, sociable

___ 5. Is sometimes shy, inhibited

___ 13. Worries a lot

___ 6. Is relaxed, handles stress well

___ 14. Has an assertive personality

___ 7. Is curious about many different things

___ 15. Has an active imagination

___ 8. Is full of energy

___ 16. Tends to be quiet

Appendix B**The Big Five Inventory (BFI) - Original**

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who *likes to spend time with others*? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

- | | | |
|--|-----|--|
| 1. Disagree strongly | ___ | *20. Has an active imagination |
| 2. Disagree a little | ___ | 21. Tends to be quiet |
| 3. Neither agree nor disagree | ___ | *22. Is generally trusting |
| 4. Agree a little | ___ | *23. Tends to be lazy |
| 5. Agree strongly | ___ | *24. Is emotionally stable, not easily upset |
| | ___ | 25. Is inventive |
| <i>I See Myself as Someone Who...</i> | ___ | 26. Has an assertive personality |
| ___ 1. Is talkative | ___ | *27. Can be cold and aloof |
| ___ 2. Tends to find fault with others | ___ | *28. Perseveres until the task is finished |
| ___ *3. Does a thorough job | ___ | *29. Can be moody |
| ___ *4. Is depressed, blue | ___ | *30. Values artistic, aesthetic experiences |
| ___ *5. Is original, comes up with new ideas | ___ | 31. Is sometimes shy, inhibited |
| ___ 6. Is reserved | ___ | *32. Is considerate and kind to almost everyone |
| ___ *7. Is helpful and unselfish with others | ___ | *33. Does things efficiently |
| ___ 8. Can be somewhat careless | ___ | *34. Remains calm in tense situations |
| ___ 9. Is relaxed, handles stress well | ___ | *35. Prefers work that is routine |
| ___ 10. Is curious about many different things | ___ | 36. Is outgoing, sociable |
| ___ 11. Is full of energy | ___ | *37. Is sometimes rude to others |
| ___ *12. Starts quarrels with others | ___ | *38. Makes plans and follows through with them |
| ___ 13. Is a reliable worker | ___ | *39. Gets nervous easily |
| ___ *14. Can be tense | ___ | *40. Likes to reflect, plays with ideas |
| ___ *15. Is ingenious, a deep thinker | ___ | *41. Has few artistic interests |
| ___ 16. Generates a lot of enthusiasm | ___ | *42. Likes to cooperate with others |
| ___ 17. Has a forgiving nature | ___ | *43. Is easily distracted |
| ___ *18. Tends to be disorganized | ___ | *44. Is sophisticated in art, literature, or music |
| ___ 19. Worries a lot | | |

An * indicates that this question has been removed in the modified version.

Appendix C

“Reading the Mind in the Eyes” Test: Revised Version - Modified

Sample item 1



Presented with this photo, the participant is asked to select the correct answer (distrustful) from four options: aghast, baffled, distrustful, and terrified.

Sample item 2



Presented with this photo, the participant is asked to select the correct answer (thoughtful) from four options: irritated, thoughtful, encouraging, and sympathetic.

Appendix D

Glossary terms

AGHAST horrified, astonished, alarmed

Jane was *aghast* when she discovered her house had been burgled.

ANTICIPATING expecting

At the start of the football match, the fans were *anticipating* a quick goal.

ARROGANT conceited, self-important, having a big opinion of oneself

The *arrogant* man thought he knew more about politics than everyone else in the room.

BAFFLED confused, puzzled, dumfounded

The detectives were completely *baffled* by the murder case.

CONTEMPLATIVE reflective, thoughtful, considering

John was in a *contemplative* mood on the eve of his 60th birthday.

DESPONDENT gloomy, despairing, without hope

Gary was *despondent* when he did not get the job he wanted.

DISPIRITED glum, miserable, low

Adam was *dispirited* when he failed his exams.

DOMINANT commanding, bossy

The sergeant major looked *dominant* as he inspected the new recruits.

FLUSTERED confused, nervous and upset

Sarah felt a bit *flustered* when she realised how late she was for the meeting and that she had forgotten an important document.

IMPLORING begging, pleading

Nicola looked *imploring* as she tried to persuade her dad to lend her the car.

INCRECULOUS not believing

Simon was *incredulous* when he heard that he had won the lottery.

INDIFFERENT disinterested, unresponsive, don't care

Terry was completely *indifferent* as to whether they went to the cinema or the pub.

INSISTING demanding, persisting, maintaining

After a work outing, Frank was *insisting* he paid the bill for everyone.

REASSURING supporting, encouraging, giving someone confidence

Andy tried to look *reassuring* as he told his wife that her new dress did suit her.

REFLECTIVE contemplative, thoughtful

George was in a *reflective* mood as he thought about what he'd done with his life.

SCEPTICAL doubtful, suspicious, mistrusting

Patrick looked *sceptical* as someone read out his horoscope to him.

TENTATIVE hesitant, uncertain, cautious

Andrew felt a bit *tentative* as he went into the room full of strangers.

UNEASY unsettled, apprehensive, troubled

Karen felt slightly *uneasy* about accepting a lift from the man she had only met that day.

Appendix E

RMTE answer sheet

Instructions:

Please circle the letter which indicates your answer for each image as they are shown.

P: A B C D

1: A B C D

2: A B C D

3: A B C D

4: A B C D

5: A B C D

6: A B C D

7: A B C D

8: A B C D

9: A B C D

10: A B C D

11: A B C D

12: A B C D

13: A B C D

14: A B C D

15: A B C D

16: A B C D

17: A B C D

18: A B C D

19: A B C D

20: A B C D

21: A B C D

22: A B C D

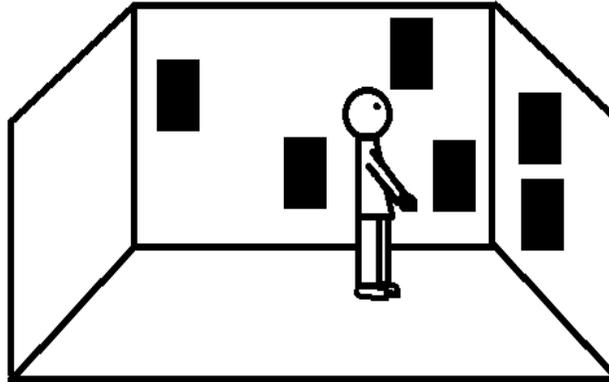
23: A B C D

24: A B C D

Appendix F

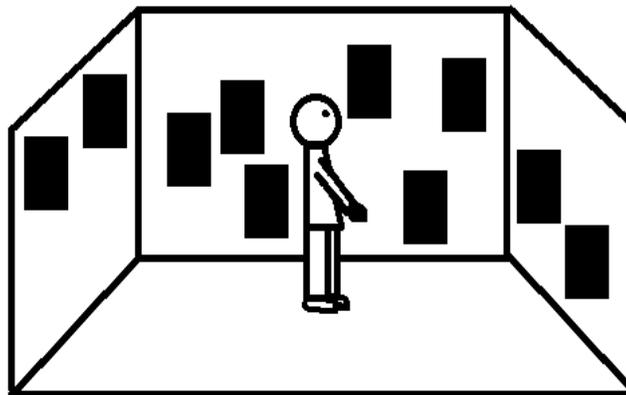
Avatar Perspective-Taking Task

Sample Item 1



The participant is asked to determine how many pictures (rectangles) they themselves can see. The correct answer in this question is six.

Sample Item 2



The participant is asked to determine how many pictures (rectangles) the avatar can see. The correct answer in this question is five.

Appendix G

AVP scenarios

Impersonal scenario

Imagine this scenario:

Please imagine that you are at a local pizzeria and you have ordered a pizza. You get your wallet to pay while the cashier checks in your order. While you are getting your money out of your wallet you notice another customer looking at the pictures of scenery displayed on the walls of the pizzeria.

Personal scenario

Imagine this scenario:

Please imagine that you are in your home and you have ordered pizza. When the delivery person arrives with your food, you tell them to step inside to wait while you get your wallet to pay. While you are getting your money out of your wallet you notice they are looking at your family photos on the wall.

Appendix H

AVP answer sheet

Instructions: For the following images that will appear on the screen, the researcher will ask you to answer how many pictures either you or the other person can see. Please circle the number which indicates your answer for each image as they are shown.

P1: 5 6 7 8 9**P2:** 5 6 7 8 9**A:** 5 6 7 8 9**U:** 5 6 7 8 9**B:** 5 6 7 8 9**V:** 5 6 7 8 9**C:** 5 6 7 8 9**W:** 5 6 7 8 9**D:** 5 6 7 8 9**X:** 5 6 7 8 9**E:** 5 6 7 8 9**Y:** 5 6 7 8 9**F:** 5 6 7 8 9**Z:** 5 6 7 8 9**G:** 5 6 7 8 9**AA:** 5 6 7 8 9**H:** 5 6 7 8 9**BB:** 5 6 7 8 9**I:** 5 6 7 8 9**CC:** 5 6 7 8 9**J:** 5 6 7 8 9**DD:** 5 6 7 8 9**K:** 5 6 7 8 9**EE:** 5 6 7 8 9**L:** 5 6 7 8 9**FF:** 5 6 7 8 9**M:** 5 6 7 8 9**GG:** 5 6 7 8 9**N:** 5 6 7 8 9**HH:** 5 6 7 8 9**O:** 5 6 7 8 9**II:** 5 6 7 8 9**P:** 5 6 7 8 9**JJ:** 5 6 7 8 9**Q:** 5 6 7 8 9**KK:** 5 6 7 8 9**R:** 5 6 7 8 9**LL:** 5 6 7 8 9**S:** 5 6 7 8 9**MM:** 5 6 7 8 9**T:** 5 6 7 8 9**NN:** 5 6 7 8 9