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Exploring the Relationship Amongst Sex, Personality Traits, and Cognitive Task Performance

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EXPLORING THE RELATIONSHIP AMONGST SEX, PERSONALITY TRAITS, AND COGNTIVE TASK PERFORMANCE

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Abstract

The results of many research studies support the hypothesis that men possess better spatial abilities than women, particularly on versions of the mental rotation task (MRT). However, while this sex difference may hold true for any given sample of men and women from the general population, people within each of these sex categorizations differ on such characteristics as personality traits. These differences in personality can be seen on the Myers-Briggs Type Indicator (MBTI), the Bem Sex Role Inventory, and the Big Five Aspect Scales (BFAS). The current study explored whether these personality traits, as returned by the aforementioned inventories, were better predictors of mental rotation task performance than sex, with a particular emphasis on determining whether women with traditionally "male" personality traits performed equally to men and better than women with stereotypically "female" personality traits on a version of the mental rotation task. Analyses on a sample of men and women ($N=101$) indicate that while men significantly outperform women on the MRT ($p<.001$), women with the greatest number of "male" traits perform no differently from men, though they do not outperform women with fewer "male" traits on the MRT. Furthermore, certain personality traits yielded a significant model for predicting MRT performance—Openness/Intellect was a stronger predictor of MRT performance than sex. These results suggest that personality factors, not sex alone, may be a factor in determining spatial ability as measured by the MRT.

Exploring the Relationship Amongst Sex, Personality Traits, and Cognitive Task Performance

In most Western societies, citizens believe that differences exist between males and females beyond primary and secondary sex characteristics. Certain personality traits are stereotypically associated with men, while other, generally opposite, traits are more frequently associated with women. Likewise, certain abilities are characterized as either masculine or feminine and some careers are considered better suited for one sex over the other. In spite of this trend, some scientists assert that no true sex differences beyond the physical exist—the differences witnessed are merely the result of differential social reinforcement. While their opinion may be correct, the majority of scientists support an interactionist viewpoint of sex differences, meaning that they believe both the underlying biological influences and the socialization of a child result in the currently observable sex differences.

Although researchers have explained most reported sex differences as due to differential social reinforcement despite the widely accepted interactionist view, some sex differences are consistently found throughout the literature and seem partially attributable to biology or other environmental factors besides socialization. One well known review of the sex difference literature (i.e., Jacklin & Maccoby, 1972) proposed that those sex differences attributable to a cause beyond social reinforcement are those witnessed concerning verbal and spatial abilities. Specifically, girls are known to learn language earlier, and this advantage may continue throughout their lifetime (Jacklin & Maccoby, 1972). Also, by the fourth grade, boys tend to outperform girls in spatial abilities—this difference increases throughout high school (Jacklin & Maccoby, 1972).

Although Jacklin and Maccoby's 1972 review is over forty years old, later research has reflected their findings, particularly in support of males' superior spatial skills. However, a meta-analysis of 165 language studies found that only 27% of the studies reported that females outperformed males, 66% found no significant gender differences, and 7% found that males outperformed females—suggesting that females' supposed superior verbal ability may be limited (Hyde & Linn, 1988).

As mentioned, researchers have demonstrated males' superior spatial reasoning using a number of different tasks since Jacklin and Maccoby (1972). Men offered more abstract and Euclidian directions and utilized a map more effectively (Dabs, Chang, Strong, & Milun, 1998), solved geometry and word problems more quickly and accurately (Geary, 1996), better recalled the distance between objects and the size of a layout (Iachini, Sergi, Ruggiero, & Gnisci, 2005), and demonstrated more skillful performance on paper versions of mental rotation tasks (Parsons et al., 2004). Researchers have also reported female superiority on some tasks beyond those of their tenuously superior verbal ability. For example, a factor analysis demonstrated that female medical school applicants in West Germany outperformed men on the memory factor of the admissions test (Stumpf & Jackson, 1994)— though men outperformed female applicants on the reasoning factor. Regardless, most studies support no sex differences in cognition or differences favoring males.

The aforementioned male superiority on spatial tasks may be mediated by factors beyond their sex. One such factor could be preference for certain academic majors and related tasks. Quaiser-Pohl and Lehmann (2002) analyzed the performance on a version of the Vandenburg and Kuse Mental Rotations Test (MRT) by men and women from various academic majors. They discovered that MRT performance was affected by program and gender (with men outperforming women), though the effect size of the gender differences varied; the sex difference was largest with students majoring in arts and humanities and smallest with those majoring in computational visualistics. A reason for this difference could be stereotype threat, as explained by Hausmann (2014). Stereotype threat, first described by Steele and Aronson (1995), is the phenomenon that occurs when a member of a negatively stereotyped group performs less than optimally on a stereotype-salient task due to anxiety about confirming the stereotype. Hausmann (2014) discovered that stereotype threat could be activated during the MRT by priming either gender identity or academic major (science or arts) identity. When females' gender identity or arts major identity was primed, they performed worse on the MRT than a control group of women. Interestingly, women whose science major identity was primed performed equally as well as men on the MRT, though worse than men when their gender identity was primed (Hausmann, 2014).

Biological Associates of Cognitive (or MRT) Performance

Male superiority on spatial tasks has been linked not only to psychological factors such as stereotype threat, but also to several biological factors. For example, sex differences in MRT performance may be due to their increased parietal lobe size (Windmaier, Raff, & Strang, 2014), an increased number of projections of aromatase-expressing neurons (Wu et al., 2009), and levels of testosterone. Aleman, Bronk, Kessels, Koppeschaar, and van Honk (2004) supported the testosterone hypothesis in their experiment in which they had twenty-sex young women take a pre-test and then a post-test of visuospatial ability following an injection of either testosterone or an inert substance. Those who received the testosterone demonstrated significantly improved visuospatial ability on the post-test after controlling for testing effects (Aleman et al., 2004). Gouchie and Kimura (1991) also found that women with higher salivary concentrations of testosterone performed better than women with low concentrations on measures of spatial and mathematical ability. Furthermore, it was found that males' cognitive ability to successfully perform the Morris water task and the MRT decreased with lower levels of circulating testosterone (Driscoll, Hamilton, Yeo, Brooks, & Sutherland, 2005).

Related to these findings regarding testosterone was the discovery by Burton, Henninger, and Hafetz (2005) utilizing finger length ratios as hormonal indexes. They determined that better cognitive performance on those tasks in which one's gender generally lags was associated with a less gender-typical finger length ratio—higher ratios between the second and third, fourth, and fifth fingers for men and lower ratios for women. However, Burton et al.'s (2005) study still found men outperformed women on the mental rotation task, unlike a study by Rilea, Roskos-Ewoldsen, and Boles (2004) that reported no differences between men and women on the MRT or a paper folding task. Whether the cause of males' superior spatial ability on the MRT is due to psychological or biological phenomena, all the potential causes should be examined to provide a more satisfying answer to why this sex difference exists.

Personality Associations with Cognitive (or MRT) Performance

Because sex differences in spatial ability may result from differential hormone levels or other sexual dimorphisms in the brain as described above, these biological factors may covary with specific personality traits as well. Certain personality traits have already been correlated with particular patterns of brain activity while completing cognitive tasks like the MRT (Stenberg, Wendt, & Risberg, 1993) and with the volumes of certain brain areas (Bjornebekk, Fjell, Walhovd, Grydeland, Torgersen, & Westlye, 2013; De Young, Hirsh, Shane, Papademetris, Rajeevan, & Gray, 2010; Sampaio, Soares, Coutinho, Sousa, & Goncalves, 2014). The findings of following studies allude to the idea that there may be a link between the underlying biology, personality traits, and certain cognitive abilities.

For example, one study using Eysenck's Questionnaire as well as the Karolinska Scales of Personality published that global cerebral blood flow correlated with extraversion in women and that introverts demonstrated greater right-hemisphere activation than extroverts while completing a mental rotation task (Stenberg, Wendt, & Risberg, 1993). Furthermore, researchers such as De Young and colleagues have tested their hypothesis about neuronal correlates to Big Five traits within their emerging field of personality neuroscience. Specifically, De Young et al. (2010) found that Extraversion covaried with the volume of the medial orbitofrontal cortex associated with processing rewards; Neuroticism covaried with the volume of brain regions associated with threat, punishment, and negative affect; Agreeableness covaried with the volume of regions that process intentions and mental states of others; and Conscientiousness covaried with the volume of the lateral prefrontal cortex involved in the planning and voluntary control of behavior. In contrast, another study failed to obtain reliable associations between brain structure and Agreeableness, but did find structural differences that correlated with Neuroticism, Extraversion, and Conscientiousness, with Neuroticism being the trait most clearly linked to brain structure (Bjornebekk et al., 2013). Furthermore, Sampaio, Soares, Coutinho, Sousa, and Goncalves (2014) investigated correlates between the Big Five personality dimensions and the default mode network (DMN)—a network of interconnected brain structures that show lower levels of activation when we are engaged in a specified mental task, but higher levels of activity when we are "at rest." Extroversion and Agreeableness were related to activity in the midline core of the DMN, while Neuroticism, Openness, and Concientiousness were correlated with activity in the parietal cortex system (Sampaio et al., 2014).

These correlations between the Big Five and brain structure and reactivity differences are important because as mentioned previously, the same mechanism could be associated with both personality and sex differences. Nevertheless, certain personality traits are more prevalent among one gender than the other. Gender differences in the occurrences of certain personality traits are particularly clear among those measured by the Myers-Briggs Type Indicator, especially the Thinking vs. Feeling subscale. Thinking versus feeling describes how one makes decisions, with Thinking types focusing on basic truths and principles to be applied and impersonal logic, and Feeling types analyzing their own and others' feelings and points of view to make the most harmonious decision (Martin, 1997). Further, 40.2% of the general population is Thinking, while 56.5% of the male population is Thinking (43.5% are Feeling) and only 24.5% of the female population is Thinking (75.5% of women are Feeling; Statistic Brain Research Institute, 2016). Interestingly, Murray (2001) discovered that among U.S. Naval Academy female midshipmen applicants, those who were Extroverted-Sensing-Thinking-Judging types were most likely to graduate; an intriguing observation as Thinking is on average a trait more often associated with men, and the Navy is male-dominated.

Despite the MBTI's utilization as the personality measure in a large number of studies, it is not without critique. While Salter, Forney, and Evans (2005) used TMO procedures to evaluate the stability of Myers-Briggs scores and found positive results for the stability of MBTI scores, other evaluations have had mixed results on the stability of scores, demonstrating that a person's type can change. Salter et al. (2005) stated these earlier studies examined limited data points and utilized less sophisticated analyses, but studies such as that by Arnau, Thompson, and Rosen (1999) offer relevant criticism concerning the reliability and validity of the MBTI as a measure including: the MBTI yields dichotomized types rather than continuous scores, does not acknowledge that some people may have relatively neutral or undifferentiated preferences on some dimensions, and invokes a forced-choice, ipsative response format which inherently yields spurious negative correlations among items. However, Arnau et al. (1999) did discover that certain Jungian constructs, as measured by the MBTI, are reliable and correlate with certain Big Five traits as measured by the NEO PI-R, which has continuous scores and no forced choice responses, which is considered more reliable and valid. Similar correlates between Big Five traits and Jungian constructs were found in a non-U.S. population in Poland (Tobacyk, Livingston, & Robbins, 2008). Four of the five significant relationships between MBTI and NEO-FFI scales reported in the American sample were also recorded in the Polish sample: MBTI Extraversion-Introversion with NEO Extraversion, MBTI Sensing-Intuition and MBTI Judging-Perceiving with NEO-Openness, and MBTI Judging-Perceiving with NEO Conscientiousness (Tobacyk et al., 2008).

Gender differences have also been observed using the NEO PI-R on its domains of Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism, which researchers have been trying to link to neuronal correlates (Weisberg, DeYoung, & Hirsh, 2011). On this inventory, women typically score higher in Agreeableness, Extraversion, and Neuroticism than men, along with other gender differences on the various subscales of these domains (Weisberg et al., 2011). These subscales are known as aspects, and refer to the two distinct factors that were discovered to be necessary to account for the shared genetic variance among the facets within each domain (DeYoung, Quilty, & Peterson, 2007). These aspects include Withdrawal and Volatility for Neuroticism, Compassion and Politeness for Agreeableness, Industriousness and Orderliness for Concientiousness, Enthusiasm and Assertiveness for Extraversion, and Openness and Intellect for Openness (DeYoung et al., 2007). Measuring the aspect scores, Weisberg et al. (2011) observed that women scored higher than men on Enthusiasm, Compassion, Politeness, Orderliness, Volatility, Withdrawal, and Openness, while men scored higher than women on

Assertiveness and Intellect. Notably, the aspect of Intellect on which men tended score higher is characterized by the ability and interest in attending to and processing complex stimuli (Weisberg et al., 2011), which relates to the Myers-Briggs Thinking type, though their relationship has not been previously examined, as with the domains of the Big Five and the Jungian constructs.

The noted and potential correlations between Big Five and Myers-Briggs traits are useful for the current project because certain Big Five domain traits have been correlated with spatial ability using the Santa Barbara Sense of Direction Scale (SBSOD; Condona, Wiltb, Cohena, Revellea, Hegartyc, & Utttala, 2015). A considerable portion of the variance in SBSOD scores in Condona et al.'s (2015) study was explained by Big Five personality traits, including Conscientiousness ($r = 0.33$), Intellect ($r = 0.27$), Emotional Stability ($r = 0.26$), and Extraversion ($r = 0.23$). A different personality inventory than the two previously discussed—the MBTI and the NEO PI-R—has been more closely related to the measure of spatial ability utilized in the current study, that of the MRT. That inventory is the Bem Sex Role Inventory (BSRI), which measures how closely one relates to traditional gender stereotypes, with the possible outcomes of masculine, feminine, androgynous (high in both masculine and feminine traits), or undifferentiated (low in both masculine and feminine traits; Holt & Ellis, 1998). Though the BSRI was created in 1974, Holt and Ellis (1998) demonstrated using statistical means that the inventory is still a valid measure of perceptions of gender roles, though the perceptions are not as dramatically different for men and women as they were in 1974.

Results on the BSRI were linked to MRT performance in an experiment completed by Ritter (2004). This experiment negated the idea that people tend to perform better on cognitive tasks when their gender-related self-concept is consistent with the stereotyping of the tasks.

Women of the various Bem designations demonstrated no significant differences in performance across a verbal task and the MRT, but men with androgynous or feminine designations performed significantly better on the verbal task (on which females tend to outperform males) than men of other designations (Ritter, 2004). With a larger sample (Ritter only had 79 participants, with 37 females), differences may be found between women of different BSRI designations on the MRT as well. One aim of the present study was to improve on Ritter by increasing the number of women in the sample to determine if this was the case.

The Study's Purpose and Hypotheses

The variables of interest in this study were personality type on the MBTI Thinking vs. Feeling subscale, degree of identification with Big Five domains and aspects (high or low scores), and gender role identification on the BSRI and how these related to sex and performance on the MRT. The purpose of the current study was to explore the value of using a composite personality profile in the prediction of MRT performance and to directly compare the value of the profile with the self-reported gender of the participant in this prediction. Thus, it was hypothesized that women who demonstrated a personality profile that is more frequently associated with males would perform no differently from self-categorized males on the MRT and would outperform self-categorized females who demonstrate a personality profile that is more frequently associated with females. That is, women who exhibit a more male-associated personality profile (i.e., Thinking on the MBTI; low in the Big Five Domains of Agreeableness, Extraversion, and Neuroticism; high on the Big Five aspects of Assertiveness and Intellect; and masculine or androgynous on the BSRI) will perform no differently from men on the MRT but will outperform other women, especially those with a more female-associated personality profile. Following this line of reasoning, the researcher further hypothesized that those traits stereotypically considered masculine would be better predictors of, and would explain more variance in, MRT performance than categorical, self-reported gender variable as traditionally assumed.

However, because handedness is associated with spatial ability, this variable was also considered. The right hemisphere of the brain has been associated with spatial ability, and it is known that the right hemisphere of the brain controls the left half of the body, while the left hemisphere controls the right half of the body. For this reason, handedness has been associated with hemispheric dominance. Therefore, before beginning other analyses, the researcher planned to determine if it was necessary to control for handedness.

Method

Participants

Participants from this study (27 men, 74 women) include students from several Midwestern and Kentucky universities along with adults from these regions. The average age of participants was 21 (age range: 18—58 years), with those attending college most often classified as sophomores (freshmen=23, sophomores=33, juniors=13, seniors=26, other=6). Participants reported various academic majors including Biology, Biochemistry, Psychology, Nursing, Anthropology, Accounting, Engineering, Chemistry, Communications, Exercise Science, Education, Sociology, Theology, English, Business Administration, Math, Music, and Computer Science (STEM=47, social science=27, other=27). Most participants were right-handed (right-handed=91, left-handed=10). The researcher invited subjects to participate via word-of-mouth, classroom and email announcements from several faculty members, a post on the researcher's social media page, and an advertisement in an online campus bulletin.

Materials

The materials utilized for this study included several personality inventories and a version of the mental rotation task. The researcher incorporated the mental rotation task, the three personality inventories, and demographic questions into a Google Form whose link was distributed to participants.

Mental Rotation Task. The researcher created the mental rotation task from a library (Peters & Laeng, 2008) of sixteen Shepard and Metzler type figures (Shepard & Metzler, 1971) and their mirror images rotated around the x and y-axes in five-degree increments. Using the Revised Vandenberg & Kuse Mental Rotation Test (Vandenburg, 1978) as a model, the researcher selected the un-rotated version of each figure as the target figure, then chose two identical figures (one rotated around the x-axis and the other around the y-axis) and two mirror images (one rotated around the x-axis and the other around the y-axis)—with the degree of rotation determined by a random number generator—for each of the sixteen questions on the task. For each question of the test, participants were instructed to select the two shapes from four that were identical to the target figure, thus indicating their spatial ability.

Personality Assessments. The personality inventories included the Myers-Briggs Type Indicator (Ross & Stricker, 1962), the Big Five Aspect Scales (DeYoung et al., 2007), and the Bem Sex Role Inventory (Bem, 1974). All were included to measure different personality traits with known gender variance.

Myers-Briggs Type Indicator (MBTI). The MBTI measured personality based upon four scales, Introversion versus Extraversion, Intuition versus Sensing, Thinking versus Feeling, and Judging versus Perceiving. The particular scale of interest for this study was Thinking versus Feeling and the researcher measured this as a continuous variable by using a version of the test with 64 questions that measures the percentage to which a person demonstrates one trait of each

MBTI dichotomy over the other. Each question presented the participant with a certain trait and asked them to rate how characteristic this trait was of themselves on a 5-point scale.

Big Five Aspect Scales (BFAS). Also using a 5-point scale with the anchors being 1 (Strongly disagree) and 5 (Strongly agree) upon which participants rated their expression of particular traits, the BFAS measured personality along the standard five continuums—Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism—along with each of the two aspects of each of these domains as previously described. Of the 100 traits presented, ten corresponded with each aspect; ergo, twenty corresponded to each domain.

Bem Sex Role Inventory (BSRI). The BSRI analyzed the extent to which a person's personality aligned with traditional gender roles, or to what extent they demonstrate socially desirable traits for a particular gender (Bem, 1974). The possible results were masculine, feminine, androgynous (high in both masculine and feminine traits), or undifferentiated (low in both masculine and feminine traits). In this measure, participants rated how frequently they displayed particular traits utilizing a 7-point scale with the anchors being 1(Never or almost never true) and 7 (Always or almost always true).

Procedure

Once participants accessed the link sent to them via email by their professor or available on social media, they viewed an informed consent screen that outlined the procedures of the study and their rights as a research participant and invited them to participate. If they chose to continue past this screen highlighting the voluntary nature of their participation and the ability to end their participation at any time, their informed consent was implied. The next section contained the mental rotation task, followed by the MBTI, the BFAS, and the BSRI. Following the assessments was a section containing demographic questions assessing handedness, gender, and academic major (to determine STEM or non-STEM) as the researcher planned to use these variables in the analyses. Subjects had unlimited time to complete the various measures on the Google Form and submit this online. The Google Form was available during the fall semester of 2016 (September 30-November 14) for data collection.

Data Reduction Procedures

Following the completion of data collection, in order to prepare for analyses, participants' average scores for each aspect and domain of the BFAS and difference score (used to determine a subject's categorization) for the BSRI were calculated. In interpreting the BSRI difference score, the researcher used the following scale: Masculine categorization for scores -20 and under, Nearly Masculine for -19 to -10, Androgynous for -9 to +9, Nearly Feminine for +9 to +19, and Feminine for +20 and over. Participants' majors were coded as STEM (Biology, Engineering, Chemistry, etc.), Social Science (Psychology, Sociology, Anthropology), or other (Business Administration, Finance, etc.). Furthermore, the researcher translated participants' MBTI percentage results into scores on a continuum with one as the anchor. Using one as the anchor, with all scores interpreted on a diverging scale of 1 to 200, the result "You have a slight preference for Thinking (9%) over Feeling" would be 91 (all Thinking scores were 100 minus their percentage; all Feeling scores were the percentage number added to 100). Thus, scores in the 1-100 range indicated a "Thinking" designation, while scores in the 100-200 range indicated a "Feeling" designation. The determination concerning which portion of the traditional dichotomy to place on the low end (beyond the traditional placing of introversion as low extroversion) was made based upon the results of Arnau et al. (1999). They found that MBTI Intuition was related to NEO-PI Openness (r= .72), MBTI Feeling was related to Agreeableness (r= .44), and MBTI Perceiving was negatively related to Conscientiousness (r= -.49). The MBTI trait positively related to a NEO-PI, or Big Five Trait, became the high end for the continuous measure of the MBTI trait. For the Thinking vs. Feeling subscale, the percentage score was also coded as the traditional, dichotomous, discrete T and F.

Lastly, the researcher created a personality profile of "male-traitedness" among female subjects using their (1) MBTI classification as T vs. F, (2) BSRI Categorization, and (3) high or low score (either above or below the median) on the domains and aspects of the BFAS traditionally showing sex differences (Neuroticism, Withdrawal, Volatility, Agreeableness, Compassion, Politeness, Orderliness, Extraversion, Enthusiasm, Assertiveness, Intellect, and Openness) along with those that showed a sex difference for the sample (Openness/Intellect domain). On each of these variables, female participants could have either the expected "male" (T; Androgynous, Nearly Masculine, or Masculine; high on Assertiveness, Openness/Intellect, Intellect, and Openness, low on remaining aspects) or "female" profile (F; Nearly Feminine or Feminine; low on Assertiveness, Openness/Intellect, Intellect, and Openness, high on remaining aspects). The number of "male" traits each female participant demonstrated was calculated, and then each woman was sorted into one of five groups (0-4 traits, 5-6 traits, 7-8 traits, 9-10 traits, and 11-14 traits) based on how many "male" traits she had.

Results

Descriptive Statistics

The descriptive statistics (Table 1) and frequencies (Table 2) of the variables of interest in this study are summarized following the References. In order to validate the dataset, independent sample *t*-tests were computed comparing men and women to determine whether the sample supported the findings in known literature. In terms of personality traits, as expected, a significant difference was found between men and women on the MBTI Thinking vs. Feeling subscale, $t(99) = -2.61$, $p = .005$ (1-tailed), $d = .56$, with women ($M = 116.54$, $SD = 29.84$) rating themselves significantly higher on the subscale than men ($M = 98.00$, $SD = 36.10$).

Likewise, to validate the Big Five domains, a significant difference in Neuroticism and Agreeableness were found, with women rating themselves higher in Neuroticism than men and also rating themselves higher in Agreeableness than men. Validating the Big Five aspects, and as expected, a significant difference was found in Intellect, with men rating themselves significantly higher than women. Because it was noticed that men rated themselves more highly on average on Openness—an aspect the literature states that is rated more highly in women, an independent samples *t*-test was calculated comparing the ratings of men and women on the overall domain of Openness/Intellect, which has shown no sex differences in prior literature (all other domains and aspects followed the expected trends). A significant difference was found, with men rating themselves higher in Openness/Intellect than women. Because of this, for this study, Openness/Intellect was considered a “male” trait when determining “male-traitedness” as previously described. For a summary of all means, standard deviations, *t*-scores, *p*-values, and effect sizes for these BFAS results, see Table 3.

Three other independent *t*-tests were calculated (1) to determine whether men did outperform women as a whole on the mental rotation task (MRT), (2) to see if it was necessary to control for handedness in subsequent calculations, and (3) to examine whether one’s traditional dichotomous Thinking vs. Feeling score affected MRT performance. First, as expected, a significant difference was found between men and women on the MRT, $t(99) = 4.47$, $p < .001$ (1-tailed), $d = 1.01$, with men ($M = 10.89$, $SD = 4.89$) scoring significantly higher than women ($M = 5.86$, $SD = 5.04$) (see Figure 1). Next, the *t*-test comparing MRT performance for the left- and right-handed participants showed no significant differences between the two groups yielded no significant results (left-handed, *M*=8.50, *SD*=5.10; right-handed, *M*=7.07, *SD*= 5.50). Lastly, using the hypothesis that MBTI Thinking is a “male” trait and “male” traits lead to better MRT performance, it would be expected that those with the traditional dichotomous MBTI Thinking designation would score higher on the MRT. A significant difference was found between those who were Thinking compared to those who were Feeling on MRT score, $t(99)=1.73$, $p=.04$ (1-tailed), $d= .36$, with those classified as Thinking (*M*=8.49, *SD*=5.24) scoring higher than those classified as Feeling (*M*=6.53, *SD*= 5.48) (see Figure 2).

Furthermore, one-way ANOVAs were calculated to compare the MRT scores of participants based upon their BSRI categorization, school year (freshman, sophomore, junior, senior, other), and type of major (STEM, non-STEM, and social science) to determine whether participants’ gender perception of themselves, level of education, or type of education (and perhaps greater exposure to mental rotation tasks) affected their performance. No significant differences were found between any of the conditions, though Nearly Feminine individuals scored the highest on average of any BSRI categorization, seniors and others scored higher than any other education level, and STEM majors scored higher on average than any other major type.

Bivariate Correlations between Study Variables. When all the various quantitative variables of interest (MBTI Thinking vs. Feeling, Bem Sex Role Score, all Big Five domains and aspects, and MRT score) in this study were analyzed to determine their intercorrelations, as depicted in Table 4, many significant relations emerged. Among the expected correlations are the positive correlations between each aspect of the same domain and their domain, such as Withdrawal and Volatility being positively related to Neuroticism. Also expected were the positive correlations between traits sharing the same gender in which it is commonly expressed, such as higher MBTI T vs. F scores (higher scores correspond to the Feeling side, which is more prevalent in women) and Neuroticism (more common in women), and the negative correlations between traits in which the gender expression prevalence of each differed, such as BSRI score (higher scores correspond to nearly feminine and feminine scores more common in women) and assertiveness (expressed more often in men).

Some unexpected positive relationships observed were the associations between MBTI T vs. F score and Conscientiousness, MBTI T vs. F score and Industriousness, BSRI score and Conscientiousness, and BSRI score and Industriousness as Conscientiousness and Industriousness have not shown sex differences in prior literature (and therefore any correlations, positive or negative, with these two variables outside of their domain was unexpected). Furthermore, some unexpected negative associations occurred between Neuroticism and Extroversion and Withdrawal and Enthusiasm, as in both these pairings the traits in question are more highly reported in women. Interestingly, MBTI T vs. F score was negatively correlated with Intellect scores, meaning that lower T vs. F, or Thinking scores, were related to higher Intellect scores—providing support for the MBTI construct of Thinking as it is shown to be significantly related with a measure considered more reliable. Most excitingly, the two aspects of the domain Openness/Intellect, Openness and Intellect, along with the domain itself (see Figure 4), were shown to be positively related with MRT score.

Hypothesis Testing

It was hypothesized that women who demonstrated a personality profile that is more frequently associated with males would perform no differently from self-categorized males on the MRT and would outperform self-categorized females who demonstrate a personality profile that is more frequently associated with females. Following the separation of women into the groups of "male-traitedness" as described previously (i.e., women with 0-4, 5-6, 7-8, 9-10, or 11-

14 “male” traits), MRT scores of male and female participants classified by varying levels of the male-traitedness profile were compared using a one-way ANOVA. A significant difference was found between the six conditions, $F(5,95)=3.91$, $p=.003$, $\eta^2= .17$. Tukey’s HSD was used to determine the location of the differences between the various conditions. This analysis revealed that men (M=10.89, SD= 4.89) scored significantly higher than women with 0-4 “male” traits (M=6.00, SD= 5.09), women with 5-6 “male” traits (M=5.59, SD= 5.31), women with 7-8 “male” traits (M=6.11, SD= 5.51), women with 9-10 “male” traits (M=5.50, SD= 4.48), but not significantly differently from women with 11-14 “male” traits (M= 6.75, SD= 5.12).

However, while women with 11-14 “male” traits did not perform significantly different from men, they did not score significantly differently from other women either—no group of women scored significantly differently from any other female group (see Figure 3). Interestingly, a one-way ANOVA calculated comparing the same groups (0-4 “male” traits, 5-6 “male” traits, etc.) on MRT performance, but with men incorporated into the groups according to their number of “male” traits, found no significant differences. Furthermore, one-way ANOVAs calculated using different ways of determining “male-traitedness,” such as omitting the MBTI Thinking vs. Feeling data and/ or the BSRI categorization as traits to consider or using only the traits supported as “male” traits in the literature (i.e., not including Openness/Intellect as a “male” trait), also yielded no significant results.

It was also hypothesized that those traits stereotypically considered masculine would be better predictors of, and would explain more variance in, MRT performance than the categorical, self-reported gender variable as traditionally assumed. To test this hypothesis, a stepwise regression analysis was performed to compare the value of using self-categorized sex, openness, intellect, and openness/intellect in the prediction of MRT performance. No other personality traits were included in this analysis as the bivariate correlations between the variables demonstrated that these were the only traits correlated with MRT performance. Because this was an exploratory study, the researcher desired for all possible predictors to be considered in the model and for SPSS to determine the strongest predictor from among these, hence the use of step-wise regression over other analyses like hierarchical regression. In the first step, openness/intellect was selected as the strongest predictor of MRT performance, $F(1,99) = 35.55$, $p < .001$, $f^2 = .35$, adjusted $R^2 = .26$. In the second step, sex was selected as the second strongest predictor of MRT performance, $F(2,98) = 27.42$, $p < .001$, $f^2 = .54$, adjusted $R^2 = .35$. This second step reflects the final model as no other input variables were selected as valuable predictors of MRT performance after openness/intellect and sex were included (see Table 5 and Figure 5).

Discussion

The purpose of this study was to explore the relationship between sex, personality traits, and cognitive task performance, specifically, on the mental rotation task. The researcher explored this relationship to determine if the sex differences in cognitive performance within the existing literature, particularly in spatial ability, are more complex than one sex simply outperforming the other by nature of their sex alone. This study wanted to begin to determine what mechanisms lay at the heart of this sex difference and what traits make a person successful at this task beyond their sex. The results obtained partially support this study's initial hypotheses that females who exhibited more masculine personality traits (Thinking on the MBTI; low in the Big Five Domains of Agreeableness, Extraversion, and Neuroticism and high on the Big Five aspects of Assertiveness and Intellect; and masculine or androgynous on the BSRI) would perform no differently from males on the MRT while outperforming other females, especially those with typically feminine traits. While it was found that women with the most “male” traits, or the highest degree of “male-traitedness,” did not perform differently than men on the MRT, they also did not outperform other women. Those with the lowest degree of “male-traitedness” could also be considered as those having typically female traits, and they were not outperformed by the women with the most “male” traits as expected. However, this could be partially explained by there being so few women in this study with the highest degree of masculine traits, as it was the smallest group in the ANOVA.

It also was hypothesized that those traits more commonly expressed in males are better predictors of MRT performance than gender as traditionally assumed. This hypothesis was supported by the result that Openness/Intellect, a male trait (at least for the males of this study), was the strongest predictor of mental rotation performance, followed by gender. Gender still contributed unique variation, but within the second step of the best predictive model. However, no other of the male traits were shown to be correlated with MRT score, and the Openness aspect, more common in the literature in females but showing no gender differences in this study, was positively correlated with MRT performance.

Connections to the Literature

Perhaps most perplexingly is: why Openness/Intellect? However, the answer could be partially explained by the findings of Sampaio et al. (2014). They discovered that Neuroticism, Openness/Intellect, and Conscientiousness were each correlated with different areas of the parietal cortex system. The parietal lobe, particularly in the left hemisphere, is associated with mental rotation (Alivisatos & Petrides, 1997) and is larger in men (Frederikse, Lu, Aylward, Barta, & Pearlson, 1999). Perhaps this area is responsible for both males’ superior spatial ability and the correlation between Openness/Intellect and spatial ability as measured by the MRT. This area could also explain the greater occurrence of higher levels of Openness/Intellect in males. This system of relationships is supported by Condona et al. (2015) who discovered that a considerable portion of the variance in their participants' spatial reasoning scores was explained by the Intellect aspect of Openness/Intellect. Their study once again draws a connection between the Opennss/Intellect domain of personality and its aspects and a cognitive ability related to the functioning of the parietal lobe.

In addition to brain structures, another biological basis for the relationships between MRT performance and various traits could be hormone levels, as alluded to in the introduction. Aleman, Bronk, Kessels, Koppeschaar, and van Honk (2004) demonstrated that testosterone could be causally related to visuospatial ability in young women, as their ability improved following one injection of testosterone (in comparison to a placebo group) and Driscoll, Hamilton, Yeo, Brooks, and Sutherland (2005) found that men's visuospatial ability declined with decreasing testosterone levels. However, the relationship between hormones and visuospatial ability may be more complex than simply higher testosterone levels predicting better visuospatial performance, especially as Burton, Henninger, and Hafetz (2005) found that better cognitive performance—on verbal and mental rotation tasks—was associated with a less gender-typical finger-length ratio (related to hormone patterns) for both men and women. In measuring testosterone specifically, Gouchie and Kimura (1991) found that men with lower testosterone levels while women with higher testosterone levels scored higher on spatial tasks—again, those showing atypical hormone patterns for their gender performed better. There were not enough males in this study to divide them into levels of male-traitedness; however, when all participants were included together in the groups of male-traitedness, no significant differences between the groups were found. Perhaps this is because the women with the most male traits had the most testosterone, aiding their MRT performance, but the men with the most male traits also had the most testosterone, hampering their performance. If the highest male-traited group had the best scoring women with the worst scoring men, their average with be expected to be similar to the group with the best scoring men and lowest scoring women. However, though there were no significant differences between the groups when all participants were divided into groups based on male-traitedness regardless of gender, the group with the most male-traitedness still scored the highest on the MRT on average. This makes the speculated hormonal hypothesis tenuous.

Regardless, the fact that male-traitedness did lead to a certain group of women performing no differently than males expands on the results found by Ritter (2004). In his study, he discovered that androgyny and femininity in males predicted their verbal ability. He did not find that androgyny or masculinity had an effect on mental rotation ability in females, however, he did not have many females. The current study had many females, and while it did not find that androgyny or masculinity alone had an effect on MRT ability, it did find that combining these designations with other male traits in females identified a group of women with more masculine self-concepts that performed better on the MRT.

In this study, it was also found that a trait outside of the Big Five was related to MRT score, specifically Thinking on the Myers-Briggs Type Indicator when analyzed in its traditional dichotomy with Feeling. Those participants classified as Thinking, a trait more commonly expressed in men, performed significantly better on the MRT than those who were Feeling. These results relate to a study by Murray (2001) which found Thinking to be related to SAT Math scores. Furthermore, the current study found Intellect scores to be significantly correlated to Thinking vs. Feeling scores (once translated onto the continuum used for this study).

Therefore, both Thinking and Intellect could be registering the same personality factors that may be influenced by biological underpinnings and impact MRT performance.

The current study showed no differences between left-handed individuals and right-handed individuals on MRT performance despite widespread findings relating handedness to spatial ability in the literature. In the current study, there were very few left-handed participants (*n* =10) compared to right-handed participants (*n* = 91). However, a primary concern in such a comparison with unequal group sizes is homogeneity of variance assumption. That is, do the two groups have equivalent variances even though there is such a large difference in sample size? For the current study, the answer is yes; the left- and right-handed groups of participants yielded equal variance (i.e., Levene's Test for Equality of Variance, $F = .31$, $p = .58$). This finding lends support to the validity of the null finding when comparing left- and right-handed participants on MRT performance regardless of the unequal group sizes. However, an inspection of the means did suggest that left-handed individuals (M=8.50, SD=5.10) tended to perform slightly better than right-handed individuals (M=7.07, SD=5.50) on the MRT despite the lack of statistical significance. Perhaps future studies could include a larger, or equivalent, number of left-handed participants to adequately control for this variable.

Limitations

As already touched upon, some variables, such as handedness, were not controlled for in this study. This could have been a concern, because as described in the introduction, handedness is related to spatial ability. Studies like those of Reio and Czarnolewski (2004) support this as they found that left-handed persons performed significantly better over right-handed persons in total and secondary (two-handed) scale scores on 3-D rotation, a speeded visual exploration task, and a flexibility of closure task. In looking at interactions between handedness and gender, Singh and Singh (2003) found no significant interactions between these two variables for the MRT, though both were predictors of spatial ability when examined individually and the interaction between the two was significant for a “drawing an angle” task.

Other confounding variables may include the amount of sleep participants received the night before participating or the time females were at in their menstrual cycle. Sleep deprivation significantly decreases college students’ cognitive ability (Pilcher & Walters, 1997). Likewise, the period a women is at in her menstrual cycle has been demonstrated to affect her performance on various tasks, especially verbal (Rosenberg & Park, 2002), but some spatial tests (Hampson, 1990). Future replication of this study may wish to include questions evaluating these variables in order to control for them.

Furthermore, the potential effects of the rival hypothesis of stereotype threat were not taken into account. Though the researcher carefully named the study, mentioning only that it involved “cognitive task performance” rather than mathematical or spatial ability to try to not prime stereotype threat in women, for which the stereotype exists that their mathematical and spatial ability is inferior, this could have had an effect, especially as the researcher mentioned gender as a variable and the first measure was the mental rotation task. The researcher also placed questions about the students’ major after the MRT measure, as Hausmann (2014) showed that major and gender both could prime negative stereotypes about spatial ability. In order to control for this, or at least determine if it was playing a role, this study could have been conducted in person and included physiological measures, such as vagal withdrawal or blood pressure, both associated with the activation of stereotype threat (Allen & Friedman, 2016; Blascovich, Spencer, Quinn, & Steele, 2001).

Outside of the threats to internal validity, the current study is also limited in its generalizability. Though the researcher cannot be sure of the origin of all the participants, most all were college students, and likely students originating from one small Midwestern region and/or attending university in that region. These students, and the few adults, from these regions may differ from populations in other regions of the United States and the globe. Likewise, because the various measures did take some time to complete and visiting the link for the Myers-Briggs led to the Google form restarting when participants tried to re-access it, some potential participants may have chosen to not complete the study. Those participants who did not complete the form may differ from those who persevered through the entirety of the measures. Furthermore, twenty participants were eliminated from the study because they did not follow instructions; either they did not report the percentages for their MBTI data or they did not give two responses for each MRT question as requested. These participants may have increased the diversity of the sample.

Lastly, an article currently in press by Boone and Hegarty (2017) outlines some final potential limitations. Their study examined whether there are sex differences in mental rotation tasks that are beyond that of a sex difference in mental rotation. Some versions of the Revised Vandenburg and Kuse Mental Rotation Task (Vandeburg, 1978) and the similar Shepard and Metzler task (Shepard & Metzler, 1971) include trials in which the incorrect shapes are not mirror images, but are entirely different shapes or have different numbers of blocks, but are still rotated to various angles from the target figure. In these trials without mirror images, alternate strategies, including counting the blocks and the arm direction strategy can be used and frequently are used for higher angles of rotation instead of mental rotation. These tasks, therefore, do not purely measure mental rotation ability, or sex differences within it. However, Boone and Hegarty (2017) discovered that men seem to be better at noticing and implementing these alternative strategies, though women can apply them equally as well and bridge the gap with males in performance when instructed on these alternate strategies. From their research results, they state that if a researcher desires to measure mental rotation ability purely, then the researcher must eliminate trials that allow for nonrotation strategies. Mirror trials, which were all that were used in the current study, require mental rotation, so participants could not use known alternative strategies. However, Boone and Hegarty (2017) also suggest that the angle or rotation be standardized across trials, which the current study did not do.

Future Directions

Because this study discovered that women with the most male traits performed no differently from men on the mental rotation task and that a male personality trait is the strongest predictor of MRT performance, future research should examine why this is the case. Since there are many potential biological correlates, perhaps the most fruitful future research would relate both mental rotation ability and openness intellect to parietal lobe size or activation levels and/or hormone levels, particularly testosterone. Regardless of the biological connections that could be found to relate personality and mental rotation ability beyond gender, the the role of socialization should also be explored further, and in conjunction with the biological research, to determine any interactions.

Research including more men should also be conducted to determine whether their personality traits, or level of female or male-traitedness, impacts their performance in the same or opposite direction as women. Basically, do men with more female traits, as opposed to male traits, perform better on the MRT? This study's results and the literature imply that they could likely show this opposite trend to women, but this hypothesis cannot be supported or disproved until this research is conducted. To improve further on the limits of the current study, future research could also load the various "male" personality traits differently—those traits more related to masculinity, or biological maleness (i.e., higher testosterone) could receive more points in the categorization of "male-traitedness." Lastly, future research should examine how female-traitedness impacts verbal ability as Ritter (2004) found that this could have an effect on verbal tasks for males and include tasks of spatial ability beyond the mental rotation task to see if these results generalize to overall visuospatial ability.

Though this study does not offer direct applications to a particular psychological construct, it does have implications for how we interpret the mental rotation literature and how we view the differences between men and women. This study demonstrates that the relationship between sex and cognitive task performance, particularly on the mental rotation task, is more complex than traditionally reported—personality plays a role. Though women in general tend to perform worse than men, those women with more male personality traits perform no statistically differently from men on the mental rotation task. This study offers suggestions as to why this may be—it could be due to underlying biological factors that the results of this study imply are worth examining, especially as a male trait, Openness/intellect, associated with the parietal lobe, is a stronger predictor than gender in predicting mental rotation performance. One major contribution of this study stems from its examining variables not previously examined together and showing that they do have a relationship, albeit one that requires further investigation to explain. Most importantly, though, this study demonstrated that there are some women that perform no differently from men on the mental rotation task—sex alone does not determine mental rotation ability, nor does it predict it best.

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Table 1

Descriptive Statistics for Continuous Variables

Variable[a]	Minimum	Maximum	*M*	*SD*
MBTI E vs. I	16.00	191.00	91.55	38.61
MBTI N vs. S	53.00	175.00	110.29	25.61
MBTI F vs. T	9.00	169.00	111.58	32.51
MBTI J vs. P	45.00	169.00	109.50	25.71
Neuroticism	1.40	4.75	3.07	.71
Withdrawal	1.50	4.60	3.18	.78
Volatility	1.10	4.90	2.95	.82
Agreeableness	2.15	5.00	3.96	.55
Compassion	1.50	5.00	4.04	.68
Politeness	2.50	5.00	3.89	.55
Conscientiousness	1.85	4.55	3.38	.57
Industriousness	1.60	4.80	3.22	.69
Orderliness	1.80	5.00	3.54	.67
Extraversion	2.15	4.85	3.35	.60
Enthusiasm	1.60	5.00	3.47	.71
Assertiveness	1.80	4.90	3.23	.70
Openness/Intellect	1.90	4.80	3.66	.61
Intellect	2.10	5.00	3.61	.67
Openness	1.50	5.00	3.71	.77
BSRI score	-27.00	43.00	9.38	13.91
MRT score	0.00	16.00	7.21	5.45

Note. MBTI E vs. I= Myers-Briggs Type Indicator Extroversion vs. Introversion, MBTI N vs. S= Intuiting vs. Sensing, MBTI F vs. T= Feeling vs. Thinking, MBTI J vs. P= Judging vs. Perceiving, BSRI score= Bem Sex Role Inventory score, and MRT score= Mental Rotation Task score.

[a]N=101

Table 2

Frequencies for Categorical Variables

Variable	N	Percentage
Gender		
Male	27	26.7
Female	74	73.3
MBTI F vs. T		
Feeling	66	65.3
Thinking	35	34.7
BSRI Categorization		
Masculine	2	2.0
Nearly Masculine	4	4.0
Androgynous	47	46.5
Nearly Feminine	28	27.7
Feminine	20	19.8

Note. MBTI=Myers-Briggs Type Indicator and BSRI=Bem Sex Role Inventory

Table 3

A Summary of the BFAS t-test Comparisons between Men and Women

BFAS Trait	*M*	*SD*	*t*(99)	*p*	*d*
Neuroticism			-3.51	<.001 (one-tailed)	.79
Men	2.67	.69			
Women	3.21	.68			
Agreeableness			-2.51	.007 (one-tailed)	.52
Men	3.74	.64			
Women	4.04	.49			
Intellect			2.84	.003 (one-tailed)	.65
Men	3.91	.61			
Women	3.50	.66			
Openness/Intellect			2.47	.02 (two-tailed)	.52
Men	3.87	.48			
Women	3.58	.63			

Table 4

Correlations Among the MBTI Thinking v. Feeling Scale, Bem Sex Role Inventory, Big Five Aspect Scales, and Mental Rotation Task Performance

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. MB TF	—																	
2. BSRI	.52**	—																
3. Ntcm	.30**	.13	—															
4. Wdrwl	.32**	.32**	.89**	—														
5. Vlty	.22*	-.07	.90**	.61**	—													
6. Agrbl	.57**	.69**	.11	.30**	-.09	—												
7. Cmpsn	.69**	.62**	.15	.27**	.002	.91**	—											
8. Pltns	.28**	.60**	.04	.26**	-.17	.86**	.57**	—										
9. Cnscts	-.29**	-.21*	.01	-.04	.06	-.08	-.16	.05	—									
10. Indst	-.34**	-.33**	-.28**	-.32**	-.19	-.13	-.22*	.01	.83**	—								
11. Ordrl	-.15	-.03	.30**	.25*	.30**	.009	-.05	.08	.83**	.38**	—							
12. Extrvn	.19	-.17	-.24*	-.32**	-.11	.15	.21*	.04	.21*	.36**	-.02	—						
13. Enthm	.38**	.13	-.19	-.22*	-.12	.37**	.41**	.23*	.02	.09	-.06	.85**	—					
14. Assrtv	-.07	-.42**	-.21*	-.32**	-.06	-.12	-.05	-.17	.34**	.52**	.04	.85**	.45**	—				
15. On/Int	-.07	-.13	-.14	-.07	-.17	.11	.18	.003	-.03	-.03	-.03	.11	-.01	.20*	—			
16. Intlct	-.35**	-.30**	-.39**	-.33**	-.36	-.09	-.07	-.10	.13	.27**	-.05	.21*	.02	.35**	.82**	—		
17. Opns	.20*	.05	.12	.17	.04	.26**	.35**	.09	-.17	-.27**	-.004	-.01	-.03	.01	.87**	.42**	—	
18. MRT	-.10	-.03	-.08	-.04	-.11	-.01	.06	-.10	-.09	-.14	-.01	-.14	-.12	-.13	.51**	.40**	.46**	—

Note. *N*=101 for all variables. MB TF= MBTI Thinking vs. Feeling, BSRI= Bem Sex Role Inventory, Ntcm= Neuroticism domain, Wdrwl= Withdrawal aspect, Vlty= Volatility aspect, Agrbl= Agreeableness domain, Cmpsn=Compassion aspect, Pltns=Politeness aspect, Cnscts= Conscientiousness domain, Indst= Industriousness aspect, Ordrl= Orderliness aspect, Extrvn= Extraversion domain, Enthm= Enthusiasm aspect, Assrtv= Assertiveness aspect, On/Int= Openness domain, Intlct= Intellect aspect, Opns= Openness aspect, and MRT= mental rotation task.

*p<0.05 (two-tailed). **p<0.01 (two-tailed).

Table 5

Results of a Stepwise Regression Analysis Comparing the Value of Sex and Personality as Predictors of Mental Rotation Task Performance

Variable	B	SE(B)	β	t	Sig. (p)
Step 1					
Openness/Intellect	4.62	.77	.514	5.96	< .001
Step 2					
Openness/Intellect	4.02	.74	.45	5.40	< .001
Sex	-3.86	1.02	-.32	-3.80	<.001

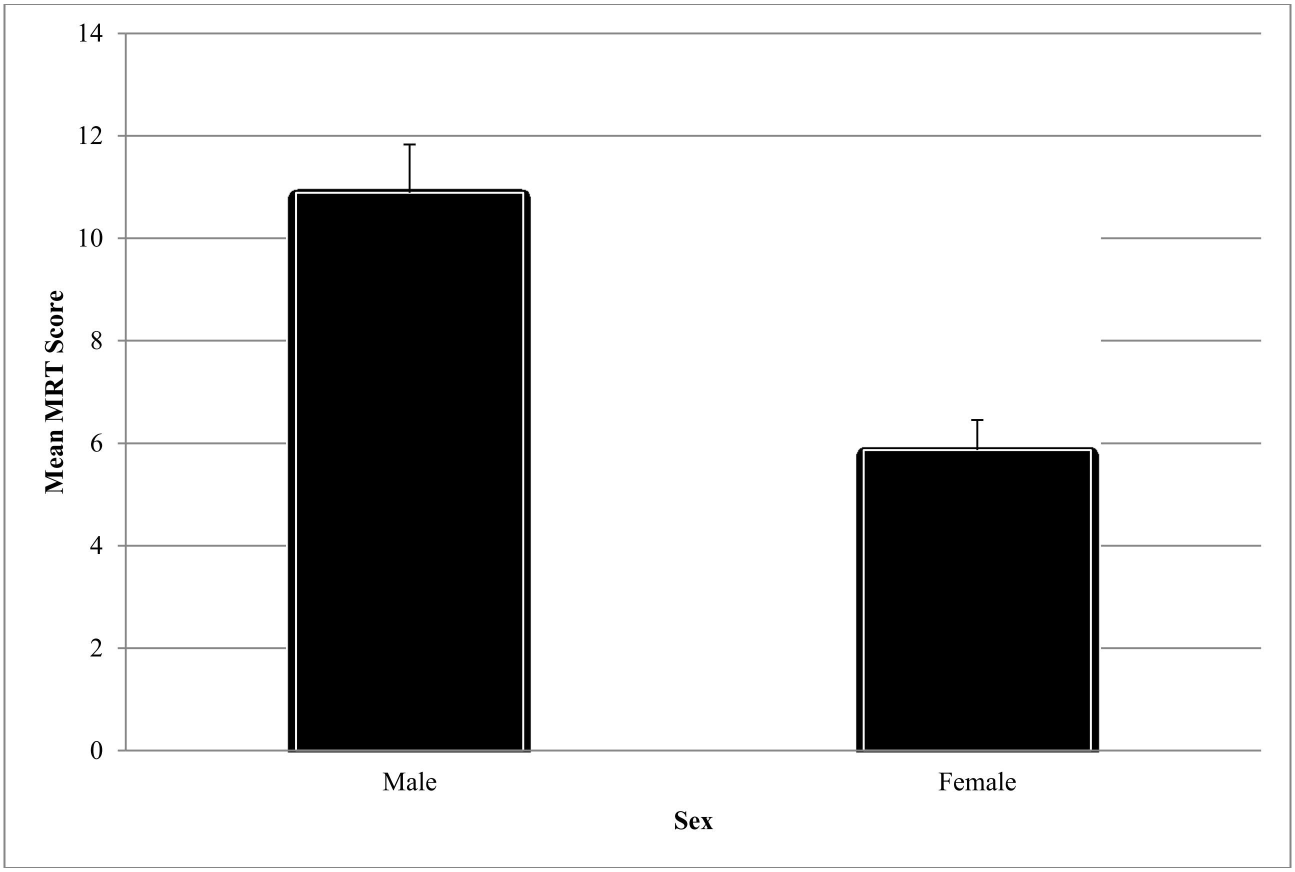

Figure 1. Mean Mental Rotation Task score by sex. Males significantly outperformed females. Standard errors are represented in the figure by the error bars attached to each column.

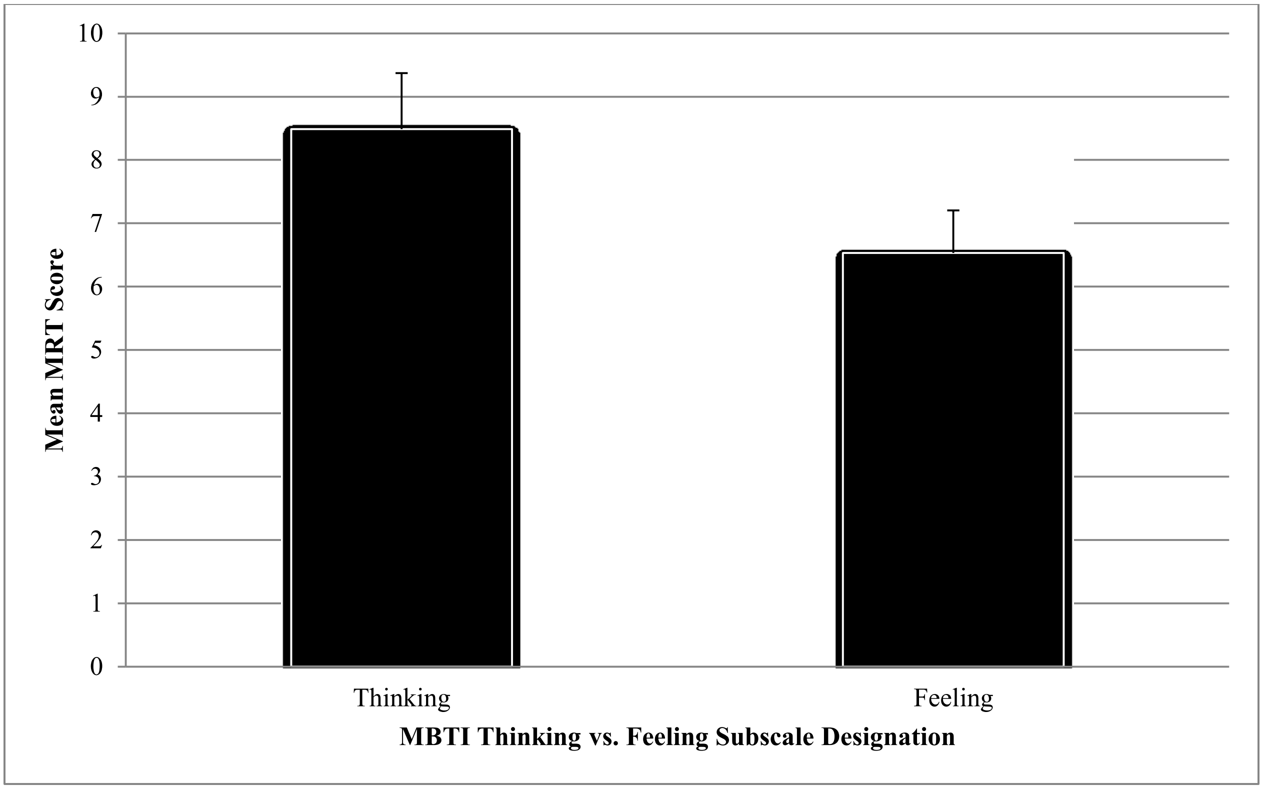

Figure 2. Mean Mental Rotation Task Score by Myers-Briggs Type Indicator Thinking vs. Feeling designation. Participants classified as Thinking significantly outperformed those classified as Feeling. Standard errors are represented in the figure by the error bars attached to each column.

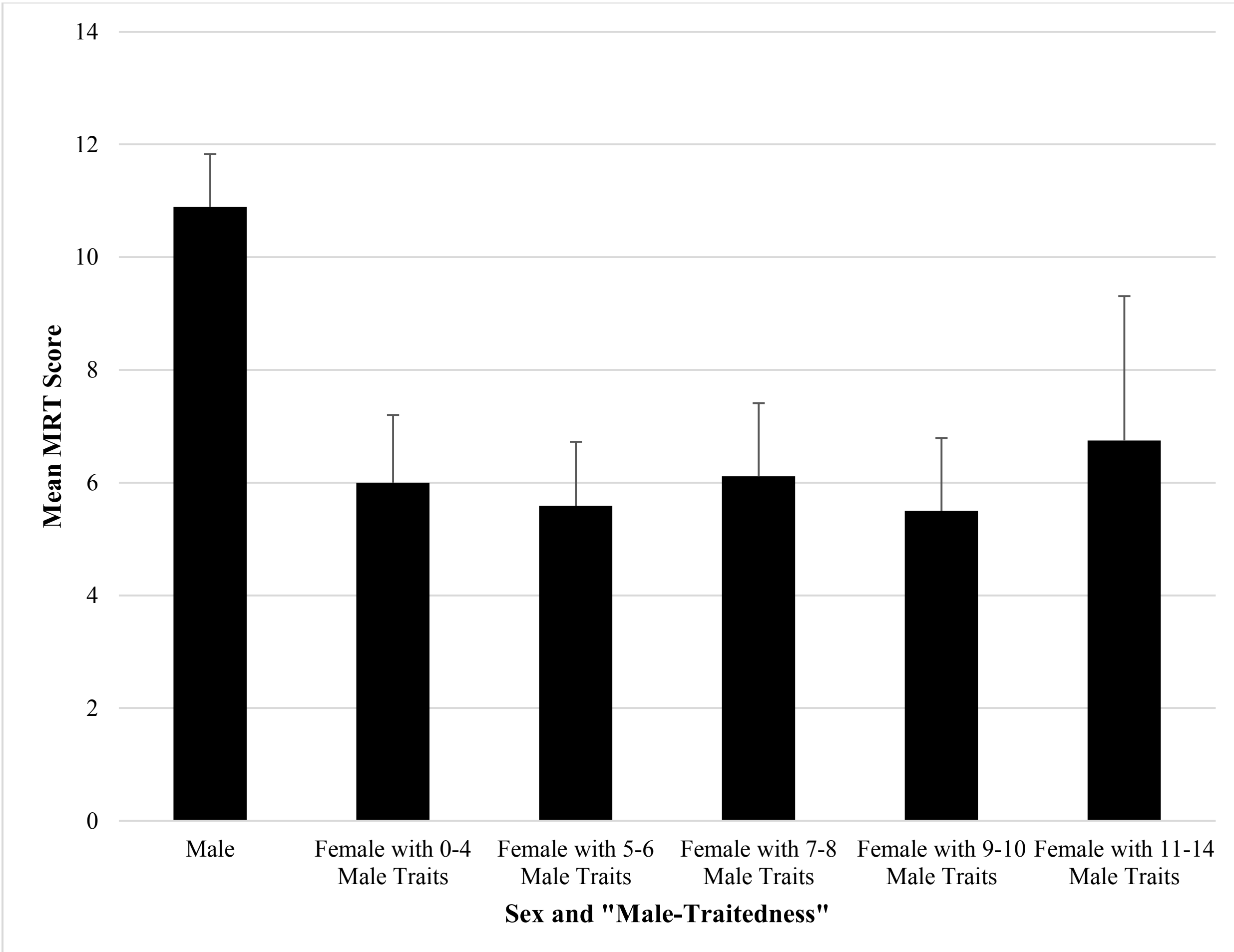

Figure 3. Mean Mental Rotation Task Score by sex (males versus classified females) and "male-traitedness." Males significantly outperformed all female groups besides females with 11-14 male traits, though females with 11-14 did not differ significantly from any female group. Standard errors are represented in the figure by the error bars attached to each column.

Figure 4. Mental Rotation Task Score as predicted by rating of the Big Five Domain Openness/Intellect.

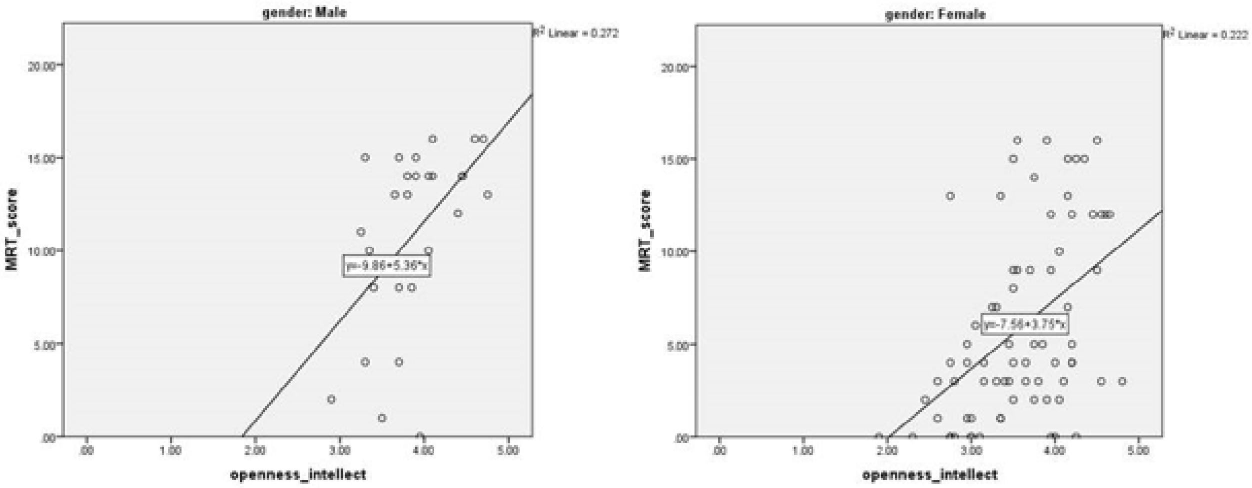

Figure 5. Mental Rotation Task Score as predicted by Openness/Intellect in each sex. Openness/Intellect is positively related to MRT performance and the strongest predictor of score, but males have a higher mean performance than females.