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Exploring the Relationship Amongst Sex, Personality Traits, and Cognitive 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 two 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.

Keywords: Sex Differences, Mental Rotation Task, Big Five Aspect Scales

1. Introduction

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 completed by Jacklin and Maccoby proposed that those sex differences attributable to a cause beyond social reinforcement are those witnessed concerning verbal and spatial abilities.[1] Specifically, girls are known to learn language earlier, and this advantage may continue throughout their lifetime.[1] Also, by the fourth grade, boys tend to outperform girls in spatial abilities—this difference increases throughout high school.[1]

Although Jacklin and Maccoby's 1972 review is over forty years old, later research has supported their findings, particularly in regard to males' superior spatial skills. Men offered more abstract and Euclidian directions and utilized a map more effectively,[2] solved geometry and word problems more quickly and accurately,[3] better recalled the distance between objects and the size of a layout,[4] and demonstrated more skillful performance on paper versions of mental rotation tasks.[5]

2. Background

2.1 Socialization Associates Of Mental Rotation Task Performance

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 analyzed the performance on a version of the Vandenburg and Kuse Mental Rotation Test (MRT) by men and women from various academic majors.[6] 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.[7] Stereotype threat, first described by Steele and Aronson, 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.[8] Hausmann discovered that stereotype threat could be activated during the MRT by priming either gender identity or academic major (science or arts) identity.[7] 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.[7]

2.2 Biological Associates Of 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,[9] an increased number of projections of aromatase-expressing neurons,[10] and levels of testosterone. Aleman, Bronk, Kessels, Koppeschaar, and van Honk 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.[11] Those who received the testosterone demonstrated significantly improved visuospatial ability on the post-test after controlling for testing effects.[11] Gouchie and Kimura also found that women with higher salivary concentrations of testosterone performed better than women with low concentrations on measures of spatial and mathematical ability.[12] 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.[13]

2.3 Personality Associations With MRT Performance

Certain personality traits have been correlated with particular patterns of brain activity while completing cognitive tasks like the MRT[14] and with the volumes of certain brain areas.[15,16,17] 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.

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. 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.[16]

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.[18] 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).[19]

Gender differences have also been observed using the NEO PI-R on its domains of Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism.[20] 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.[20] 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.[21] 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.[21] Measuring the aspect scores, Weisberg et al. 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.[20]

Certain Big Five domain traits have been correlated with spatial ability using the Santa Barbara Sense of Direction Scale (SBSOD).[22] 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).[22] 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).[23]

Results on the BSRI were linked to MRT performance in an experiment completed by Ritter.[24] 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.[24] 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.

3. 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.

4. Methods

4.1 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. Participants reported various academic majors (STEM=47, social science=27, other=27). 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.

4.2 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.

The researcher created the mental rotation task from a library[25] of sixteen Shepard and Metzler type figures[26] and their mirror images rotated around the x and y-axes in five-degree increments. Using the Revised Vandenberg & Kuse Mental Rotation Test[27] 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.

The personality inventories included the Myers-Briggs Type Indicator,[28] the Big Five Aspect Scales,[21] and the Bem Sex Role Inventory.[29] All were included to measure different personality traits with known gender variance.

4.3 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.

4.4 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.[30] 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).[30] 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.

5. Results

5.1 Descriptive Statistics

The descriptive statistics (Table 1) and frequencies (Table 2) of the variables of interest in this study are summarized below.

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

[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

Three independent t-tests were calculated to determine whether men did outperform women as a whole on the mental rotation task (MRT) and 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 ($M=5.86$, $SD=5.04$). Next, 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 ($M=6.53$, $SD= 5.48$).

5.2 Hypothesis Testing

It was hypothesized that women who demonstrated a personality profile 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.

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 bivariate correlations between the variables demonstrated that these were the only traits correlated with MRT performance. In the first step, openness/intellect was selected as the strongest predictor of MRT performance, $F(1,99) = 35.55$, $p < .001$, $f2 = .35$, adjusted $R2 = .26$. In the second step, sex was selected as the second strongest predictor of MRT performance, $F(2,98) = 27.42$, $p < .001$, $f2 = .54$, adjusted $R2 = .35$. 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 3 and Figure 1).

Table 3: 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

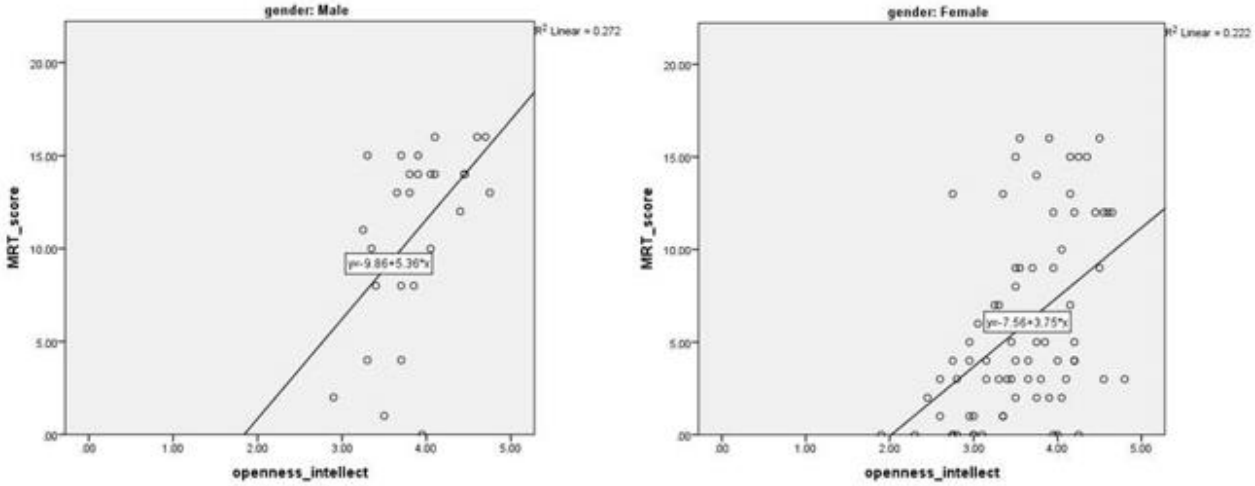

Figure 1. Mental Rotation Task Score as predicted by Openness/Intellect in each sex. Openness/Intellect is positively related to MRT performance and the strongest predictor of score, but males have a higher mean performance than females.

6. 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.

6.1 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.[17] 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[31] and is larger in men.[32] 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. who discovered that a considerable portion of the variance in their participants' spatial reasoning scores was explained by the Intellect aspect of Openness/Intellect.[22] Their study once again draws a connection between the Openness/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 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)[11] and Driscoll, Hamilton, Yeo, Brooks, and Sutherland found that men's visuospatial ability declined with decreasing testosterone levels.[13] 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 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.[33] In measuring testosterone specifically, Gouchie and Kimura 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.[12] 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.[24] 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.

6.2 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 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 the 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." Last, future research should examine how female-traitedness impacts verbal ability, as Ritter 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.[24]

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 similarly to 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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