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Cognitive and Personality Characteristics of Masculinity and Femininity Predict Wayfinding Competence and Strategies of Men and Women

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Abstract Bem (1974) reconceptualized masculinity and femininity as independent and orthogonal constructs that both men and women possess to varying degrees. This perspective was used as a starting point to investigate whether the contributions of gender-typed characteristics can help to account for commonly observed gender differences in wayfinding (the ability to identify one's current location and successfully navigate to an unseen location in the environment) favoring men. We further divided gender-typed characteristics into cognitive and personality characteristics to assess their separate influence on wayfinding and explored whether gender-typed characteristics predicted self-reported use of masculine wayfinding strategies (i.e., orientation strategies) and self-reported wayfinding competence. Participants were 452 college women and men in a southern U.S. public university. They completed the Gender-Stereotypic Characteristics questionnaire (Diekmann and Eagly 2000), a social comparison questionnaire (created by the authors), a wayfinding strategy questionnaire (Lawton 1994), and a wayfinding competence questionnaire (Hegarty et al. 2002). For both men and women, higher masculine cognitive characteristics significantly correlated with greater use of orientation wayfinding strategies typical of men. For men, both higher masculine and feminine cognitive characteristics predicted better overall wayfinding competence whereas for women, only higher masculine cognitive characteristics predicted better

overall wayfinding competence. For both men and women, higher feminine personality characteristics predicted poorer wayfinding competence. These results demonstrated the importance of considering cognitive and personality characteristics of masculinity and femininity in explaining individual differences in wayfinding.

Keywords Wayfinding · Masculine · Feminine · Cognitive · Personality · Orientation strategy

Bem (1974) introduced an important reconceptualization of masculinity and femininity. A primary feature of her perspective was to consider masculinity and femininity as independent and orthogonal psychological constructs. Bem also suggested that men and women have varying degrees of both masculine and feminine traits and skills. With respect to behavior, these gender-typed characteristics can impact one's behavior such that high masculine traits promote masculine activities and high feminine traits limit masculine activities (Bem 1981; Eagly and Wood 2012; Nash 1979). Therefore, it is reasonable to consider that gender-typed characteristics may partially account for gender differences that have been observed in different cognitive activities. One class of cognitive activities that has consistently been targeted as a domain in which gender differences can be found reflects the operation of spatial abilities, with men often performing better than women (Halpern 2011; Kimura 2000; Linn and Peterson 1985; Maccoby and Jacklin 1974; Voyer and Voyer 1995).

The current study examined one form of spatial ability—wayfinding. Wayfinding, colloquially called navigation, refers to the ability to identify one's current location and successfully navigate to an unseen location in the environment (Golledge 1999). In the United States, men perform better in wayfinding tasks in both laboratory and real-life settings (Merrill et al.

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2016; McGuiness and Sparks 1983; Miller and Santoni 1986). Wayfinding has also been perceived as a masculine task in the United States (Egerton 2014). Our study focused on how perceived masculinity and femininity relate to the cognitive behavior of wayfinding in men and women. We specifically assessed the independent contributions of cognitive and personality characteristics of gender, as identified by Diekmann and Eagly (2000), to explaining gender differences in wayfinding by U.S. undergraduate students. In our literature review, nationality is identified for studies conducted outside the United States, with all unidentified studies based on U.S. samples.

The Importance of Wayfinding

Wayfinding represents an important real-life skill that most individuals undertake on a daily basis. At the extreme, large deficiencies in wayfinding put individuals at risk for getting lost, which can result in high levels of personal distress (Taiwan: Chiu et al. 2004; Rowe 2003). Smaller perceived deficiencies in wayfinding can produce anxiety in new environments that can in turn lead to decreased exploration and social engagement (Lawton 2010). To the extent that women have difficulties in wayfinding, regardless of the cause, they would be less able to engage in meaningful activities afforded to them in the natural environment. These could include opportunities associated with entertainment (e.g., going to the park for a concert), health (e.g., hiking and jogging), education (e.g., visiting museums and libraries), and work (e.g., traveling to clients or to conferences).

Investigating how gender-typed characteristics relate to wayfinding competence and behavior can help us better understand the underlying mechanisms of observed gender differences in wayfinding. This understanding is important for at least two reasons. First, as suggested by Hyde (2005), there can be serious consequences at work and in relationships to identifying differences as being related to self-reported gender identity as male versus female when they may actually be due to other factors. Second, interventions to ameliorate observed gender differences may vary as a function of the cause of the difference. Identifying the relationship between gender-typed characteristics and wayfinding may have important implications for reducing cognitive differences between genders in wayfinding.

Gender-Typed Characteristics

Gender-typed masculine and feminine characteristics reflect qualities that are traditionally ascribed to men and women respectively. Early conceptualizations of masculinity and femininity treated the constructs as opposites on a single bipolar

dimension (see Cook 1985). Bem (1974) introduced a novel approach for understanding masculinity and femininity by treating them as separate dimensions. In her conceptualization, the traits that defined masculinity and femininity were those that were identified by society as being more stereotypical of one gender than of the other. The Bem Sex Role Inventory (BSRI) was created to assess an individual's self-reported identification with a small number of these gender defined traits. Individuals could self-identify as high or low relative to societal norms on either dimension. According to Bem, they could be classified as masculine gender-typed, feminine gender-typed, androgynous (scoring high on both dimensions), or undifferentiated (scoring low on both dimensions). For Bem, the goal of the BSRI was to identify individuals as highly gender-typed versus androgynous.

Bem (1977) suggested that androgynous men and women may be more adaptive because they can express either masculine or feminine traits as required by the current situation, resulting in a higher quality of mental health and greater overall competence. The BSRI has produced nearly 40 years of research on gender characteristics in general and androgyny in particular and is still widely used (e.g., Spain: Calvo-Salguero et al. 2008; Brazil: Carver et al. 2013). However, the stated purpose for the development of the BSRI, distinguishing between highly gender-typed and androgynous personality types, also served to limit the types of items included on the measure. In particular, Bem (1974) primarily focused on personality traits, and she selected masculine and feminine traits that were both positive and highly endorsed as stereotypically feminine or stereotypically masculine.

Diekmann and Eagly (2000) extended the idea of independent masculinity and femininity dimensions by further dividing them into personality, cognitive, and physical subdomains. Featuring similar personality attributes to those used by Bem (1974), the personality component of their new questionnaire reflected characteristics such as individualism as well as self-promoting, assertive, and dominant traits in men and friendliness, unselfishness, and caring traits in women (Barratt et al. 2014; Eagly and Wood 1991). However, they also included both cognitive and physical characteristics in their assessment of gender-typed characteristics. The cognitive component identified analytical, rationale and mathematical thinking in men and intuition, creativity, and expressiveness in women. The physical component identified, for example, masculine physical characteristics with strength and feminine physical characteristics with beauty. It is also the case that gender-typed identification in their approach reflects an ongoing process of self-categorization that can vary with current situational contexts (White and Gardner 2009) and can change as a function of current societal views of the role of men and women (Eagly and Wood 2012).

It is important to highlight that the primary impetus for the current research was Bem's (1974, 1981) proposal that both

women and men have varying degrees of feminine and masculine traits and skills, although we did not use her scales in the current study. In addition, as suggested by Bem as well as other theorists (Nash 1979; Wood and Eagly 2010), it was our expectation that the expression of these variations in gender-typed characteristics would impact behavioral choices and experiences of both men and women. Individuals who are likely to endorse masculine gender-typed characteristics, whether they are a man or woman, would likely exhibit behaviors that are more consistent with expectations reflecting societal norms for men. U.S. society has generally cast successful wayfinding activities as a stereotypically masculine behavior (see Hayes 2010). Therefore, extrapolating from Bem's work, we evaluated whether individuals' perceptions of their own wayfinding competence would be related to the perceptions of their own adherence to gender-typed cognitive and personality characteristics in addition to self-reported gender identity as male versus female.

An individual's endorsement of gender appropriate traits would guide behaviors through self-regulatory processes (Bem 1981). Gender-typed expectations encourage people to conform and internalize gender-based beliefs and act according to those beliefs (Wood and Eagly 2010, 2012). Hence, a strongly gender-typed person would gravitate toward activities that are consistent with, and avoid activities that are inconsistent with, their gendered beliefs. Nash (1979) proposed that one's expectation of the appropriate behaviors associated with his/her gender would affect cognitive functioning based on the perceived gender type of a particular cognitive task. Similarly, social role theory (Conway et al. 1996; Eagly and Wood 2012; Wood and Eagly 2010) predicts that gender-typed characteristics can emerge from role/occupation differentiation and in turn facilitate performance in gender-appropriate activities. According to these perspectives, the endorsement of masculine gender-typed characteristics would thus encourage engaging in masculine activities which in turn would foster higher levels of performance in cognitive tasks perceived to be masculine. In contrast, endorsement of feminine gender-typed characteristics would discourage masculine activities which would in turn hamper masculine cognitive performance (Wood and Eagly 2015).

Wayfinding

One behavior that gender-typed characteristics may influence is wayfinding. Men commonly perform better than women in two aspects of general wayfinding. First, empirical studies of wayfinding found that men learn spatial environments faster and make fewer errors than do women (Astur et al. 2004; Coluccia and Louse 2004; McGuinness and Sparks 1983; Miller and Santoni 1986; Canada: Ross et al. 2006). In a review of the literature, Coluccia and Louse (2004) found that

61 % of wayfinding studies that compared the performance of men and women found better performance in men, with the remaining studies reporting no difference. Hence men exhibit greater overall wayfinding competence. Second, men are more likely than are women to successfully use orientation strategies during wayfinding (Lawton 1994, 2010). Orientation strategies are generally considered a more sophisticated spatial approach to wayfinding in that they involve integrating spatial knowledge acquired at different times, transforming it into a cognitive map, and maintaining a sense of one's own location in relation to the environment (Italy: Bosco et al. 2004; Choi and Silverman 2003; Dabbs et al. 1998; Canada: Galea and Kimura 1993; Canada: Saucier et al. 2002). The use of orientation strategies is positively correlated with wayfinding competence (Hegarty et al. 2006). Hence, men also exhibit a strategic advantage during wayfinding.

In U.S. culture, wayfinding has been perceived as a masculine activity. It has often been portrayed in movies, magazines, and television in a manner consistent with the view that men are better at finding their way than are women (Egerton 2014; Hayes 2010; see also Walton 2012 as an example in the UK). Indeed, research indicates that boys tend to have a larger environmental range of activities at 8-years-old (Matthews 1986; U.K.: Webley 1981) and as teenagers (Van Vliet 1983). Further, according to the U.S. Department of Transportation (2015), men drive considerably more than women do (60 % of the time, on average) across all age ranges. At least twice the number of men are employed as professional wayfinders, such as pilots and taxi drivers in the United States than are women (Bureau of Labor Statistics 2014). Because experience is highly related to wayfinding competence (deGoede and Postma 2015), increased wayfinding experiences for men may increase their wayfinding competence relative to women. Women may also be impacted by the gender-typed beliefs of their inferiority in wayfinding (U.S. and Hungary: Lawton and Kallai 2002). For example, stereotype threat reflects a likelihood of behaving in a manner consistent with a negative stereotype (Steele 1997). Women endorsing the negative gender-typed expectation of poor spatial ability may exhibit negative self-perceptions and reduced interests in wayfinding, which would limit both future experience and competence.

The Current Study

The overall goal of the current study was to assess the degree to which differences associated with men and women's perceived masculinity and femininity can account for often reported gender differences in wayfinding (McGuinness and Sparks 1983; Miller and Santoni 1986). An important feature of our study was to distinguish between cognitive and

personality characteristics that are associated with masculinity and femininity. To accomplish this goal, we explored associations between men and women's perceived masculinity and femininity and the self-reported real-life wayfinding competence and strategies among U.S. college students. We evaluated wayfinding both from an overall competence perspective and from a strategic difference perspective.

Overall wayfinding competence was assessed by environmental spatial skills and general sense of direction as in Hegarty et al. (2002). Previous studies using this measure have suggested that men report a higher level of overall wayfinding competence than do women (Hegarty et al. 2006). It has correlated highly with large-scale navigation tasks both in desktop virtual environments (Italy: Pazzaglia and Taylor 2007) and real-life environments (Japan: Ishikawa and Nakamura 2012). To assess strategic differences in wayfinding, we used the orientation strategy questionnaire developed by Lawton (1994). As indicated earlier, several theorists suggest that a fundamental gender difference in wayfinding is that men are good at using orientation strategies whereas women are not, and hence men show better wayfinding performance than women when the task involves orientation strategies relative to when it does not (Lawton 1994). The benefit of using these self-reports is that they include more diverse aspects of wayfinding that cannot be measured in one or two laboratory tasks. In addition, based on a meta-analysis, Sas and Mohd Noor (2009) concluded that self-report questionnaires are among the most valid tools for measuring environmental spatial ability and that they correlate better with wayfinding skills than do other spatial tasks (e.g., spatial memory).

Given that wayfinding is a cognitive behavior rather than a social behavior or personality attribute, it is important to include the gender-typed cognitive characteristics included by Diekmann and Eagly (2000) in addition to the gender-typed personality characteristics originally identified by Bem (1974). This approach will offer a better understanding of the relationships between gender-typed characteristics and wayfinding, and it is detailed further in the next paragraph. Diekmann and Eagly (2000)'s gender-stereotypic characteristics questionnaire was used to evaluate gender-typed personality and cognitive characteristics. The personality and cognitive characteristics of masculinity and femininity appear to be relatively independent domains (Cejka and Eagly 1999; Schneider and Bos 2014; Germany and Spain: Zafra and Garcia-Retamero 2011). For instance, a man can score high on masculine personality characteristics but low on masculine cognitive characteristics, whereas a woman can be perceived as having high masculine cognitive characteristics, but lower feminine personality or cognitive characteristics (Schneider and Bos 2014).

Based on research and theory indicating a relationship between gender-typed characteristics and human behavior (Bem

1981; Nash 1979; Wood and Eagly 2010), we expected that, in general, higher masculinity should be associated with better wayfinding competence and greater use of orientation strategies, and higher femininity should predict poorer wayfinding competence and less use of orientation strategies among U.S. men and women college students. However, distinguishing between gender-typed cognitive and personality characteristics was also an important focus of the current study.

For several reasons, it is reasonable to expect that cognitive characteristics in particular will predict cognitive behavior. The principle of compatibility (Ajzen, and Fishbein 1973) suggests that for gender-typed characteristics to successfully predict a behavior or response, the behavior or response should be in the same domain as the measured characteristics (Wood and Eagly 2015). Wayfinding competence and using orientation strategies, which both rely on problem solving and information integration (Golledge 1999), should benefit from having high masculine cognitive characteristics such as good at analytical thinking and problem solving. In addition, gender-typed personality characteristics are associated with choices in behavior so that high masculine personality characteristics may increase the interest and motivation towards masculine behaviors and hence promote masculine behaviors. High feminine personality characteristics may reduce interest and motivation towards masculine behaviors and hence hamper masculine behaviors. Therefore, gender-typed personality characteristics may also promote gender-typed behaviors, especially when that behavior involves choices. Taken together, because wayfinding is a masculine cognitive behavior, if significant, higher masculine cognitive and personality characteristics should predict better wayfinding behavior (i.e., greater overall competence and use of orientation strategies), and higher feminine personality characteristics should predict poorer wayfinding behavior.

We did not make any predictions regarding feminine cognitive characteristics. How it may predict wayfinding is exploratory in our study. Because daily wayfinding tasks can be successfully completed using techniques other than orientation strategies, such as remembering landmarks and specific turns (Hegarty et al. 2006), it is reasonable to expect that persons high in feminine cognitive characteristics (such as being expressive or imaginative) may perform better in wayfinding than do persons low in feminine cognitive characteristics. However, if feminine cognitive characteristics function in the same way as feminine personality characteristics and lead to refraining from performing masculine tasks, this variable may negatively predict better overall wayfinding competence.

Our general prediction was complicated by the fact that we also assessed two different components of wayfinding: overall competence and orientation strategy use. It is possible that masculinity and femininity may differentially predict each component. In fact, we expected that overall wayfinding

competence should be strongly related with both cognitive and personality characteristics, whereas orientation strategy use would likely be more strongly related to cognitive than to personality characteristics. Our rationale was that as a more general wayfinding measure (Hegarty et al. 2002), the overall wayfinding competence measure includes not only competence (e.g., “I am very good at reading maps”), but also motivation (e.g., “It is not important to me to know where I am”) and interests (e.g., “I enjoy reading maps”). Individuals with high feminine personality characteristics typically show less interest and motivation towards masculine tasks (Park et al. 2011). Reduced interest and motivation may in turn limit one’s wayfinding experience and hamper one’s wayfinding competence (Lawton 2010). Personality characteristics of masculinity and femininity may therefore play a role in predicting overall wayfinding competence. We expected that higher masculine cognitive and personality characteristics should predict better overall wayfinding competence, whereas higher feminine personality characteristics should predict poorer wayfinding competence. In contrast, orientation strategy use is less reliant on interests and motivation (Lawton 1994). Hence, use of orientation strategies should be more related to gender-typed cognitive than personality characteristics, the latter of which may not significantly predict orientation strategy use.

Finally, if gender-typed cognitive and personality characteristics influence wayfinding independently from self-reported gender identity, then the patterns of relations between gender-typed characteristics and wayfinding measures will be similar for men and women. To test this expectation, we conducted separate regressions on the data for men and women. We felt that finding a similar pattern of significant predictors for men and women separately would be the most appropriate test of this hypothesis.

As our preliminary hypothesis, we expected to replicate the gender differences in wayfinding found in previous studies (e.g., Hegarty et al. 2006; Lawton 1994). Men should self-report greater use of orientation strategies and a higher level of overall wayfinding (Preliminary Hypothesis) competence than do women. Furthermore, high endorsement of masculine cognitive characteristics should predict greater orientation strategy use, and do so to a greater degree than would gender-typed personality characteristics (Hypothesis 1). We offer no specific prediction concerning feminine cognitive characteristics. Finally, higher endorsement of masculine cognitive and personality characteristics should predict greater overall wayfinding competence (Hypothesis 2a). Higher endorsement of feminine personality characteristics should predict poorer overall wayfinding competence (Hypothesis 2b). Again, no specific prediction concerning feminine cognitive characteristics is offered. Hypotheses 1 and 2 will be evaluated by regressing orientation strategy use on the four gender-typed characteristics separately for men and women

participants. Because we are expecting a similar pattern of predictors for men and women, we felt that analyzing the data separately and finding a similar pattern of significant effects would be a more stringent test of our hypothesis than would reporting a null effect of men versus women.

Methods

Participants

Participants were recruited from Introductory Psychology classes from a public university in the United States, and they participated for course credit. Data for our study were collected in Fall 2013 and Spring 2014. A total of 510 participants began the study. However, 58 participants did not complete the gender-typed characteristics questionnaire and their data were not included. In the final sample, there were a total of 251 women and 201 men. Although participant’s year in college was not collected, the majority of students (over 80 %) taking Introductory Psychology are freshman. Approximately 10 % of them were psychology majors and the others self-identified as nursing, nutrition, political science, engineering, etc. See Table 1 for demographic information. There was no difference in ages between men and women, $t(450)=1.45$, $p=.15$, and no difference in the percentage of White participants between genders, $\chi^2(1)=.04$, $p=.84$.

Measures

All the recruitment and testing procedures followed the guidelines of the university IRB. Participants completed all questionnaires online via Qualtrics software in two sessions. Participants read consent forms before starting each session. In both sessions, participants were asked to provide their names so that we could link their results. Only the first author had access to the names, which were subsequently removed from the data to protect the confidentiality and the privacy of

Table 1 Demographic characteristics of participants

| | Women <i>n</i> = 251 (56 %) | Men <i>n</i> = 201 (44 %) |
|----------------|--------------------------------|------------------------------|
| Age (in years) | | |
| Mean | 18.91 | 19.07 |
| SD | .96 | 1.38 |
| Range | 18–24 | 17–27 |
| Race | <i>n</i> (%) | <i>n</i> (%) |
| White | 208 (46 %) | 168 (37 %) |
| Black | 30 (7 %) | 14 (3 %) |
| Hispanic | 7 (2 %) | 2 (<1 %) |
| Other | 6 (1 %) | 17 (4 %) |

participants. The gender-stereotypic characteristics questionnaire was completed at least 1 week prior to the other measures to prevent participants from identifying the purpose of our study. The wayfinding survey questions of the second session were part of a larger project. Pertinent to the current research, participants first completed the social comparison questionnaire, then the orientation strategy questionnaire, and finally the overall wayfinding competence questionnaire.

Gender-Stereotypic Characteristics

We used six subscales from the original Gender-Stereotypic Characteristics Questionnaire by Diekmann and Eagly (2000) to reflect masculine cognitive characteristics, masculine positive personality characteristics, masculine negative personality characteristics, feminine cognitive characteristics, feminine positive personality characteristics, and feminine negative personality characteristics. Two subscales (masculine and feminine physical characteristics) were omitted because they were not relevant to the research questions. Masculine and feminine personality characteristics also incorporate negative and less desirable, in addition to positive and more desirable, traits (Spence and Helmreich 1981; Spence et al. 1979). There is no reason to expect that gender-specific positive and negative personality characteristics would be highly correlated (see Athenstaedt 2003). In fact, the correlations were relatively small in our sample: $r(450) = .10, p = .03$ for feminine positive and negative characteristics; $r(450) = .38, p < .001$ for masculine positive and negative characteristics. However, Athenstaedt (2003) found that both positive and negative masculine personality characteristics are higher in men than in women and that both positive and negative feminine personality characteristics are higher in women than in men. Hence, we added the positive and negative masculine personality scores to create a total masculine personality score and the positive and negative feminine personality scores to obtain a total feminine personality score. These are referred to as *masculine personality characteristics* and *feminine personality characteristics* hereafter.

Participants rated how much each characteristic described themselves on a scale of 1 (*not at all like me*) to 7 (*very much like me*). The six masculine cognitive characteristics are: good with numbers, analytical, good at problem solving, quantitatively skilled, good at reasoning, and mathematical. The six feminine cognitive characteristics are: imaginative, intuitive, artistic, creative, expressive, and tasteful. The list of 16 masculine personality traits include items such as competitive, daring, hostile, and arrogant. The 16 feminine personality traits included items such as affectionate, gentle, servile, and subordinate to others. Items within each scale were aggregated and the total scores were used in the analysis. Higher scores on each scale indicated greater self-perceived traits or cognitive characteristics. Good internal reliabilities were obtained for

each subscale (masculine cognitive characteristics: $\alpha = .86$; masculine personality characteristics $\alpha = .77$; feminine cognitive characteristics: $\alpha = .76$; feminine personality characteristics: $\alpha = .80$).

Orientation Strategy

Although participants completed the full 17-item Orientation Strategy Questionnaire (Lawton 1994; Lawton and Kallai 2002), only responses to the orientation strategies (11 items) were used in the present study. Participants rated how typical it was for them to use each orientation wayfinding strategy on a 5-point scale from 1 (*not at all typical of me*) to 5 (*extremely typical of me*). The scale measures the ability to keep track of one's own location while traveling and to know the relationships between different locations in the environment. Example items are: "I kept track of the direction (north, south, east, west) in which I was going" and "I kept track of where I was in relation to the sun (or moon) in the sky as I went." Individual item scores were summed to obtain a measure of orientation strategy use ($\alpha = .82$). This total score was used in the analysis and higher score indicated greater use of orientation strategy.

Overall Wayfinding Competence

We used the Santa Barbara Sense of Direction Questionnaire (Hegarty et al. 2002) to assess overall wayfinding competence. Participants rated statements about learning the environment on a 7 point scale from 1 (*strongly disagree*) to 7 (*strongly agree*). There are 15 items such as "My sense of direction is very poor" (reversed scored), "I very easily get lost in a new city" (reversed scored), "It is important to me to know where I am," and "I am very good at judging directions." The total score of all items was calculated for each participant, with higher scores indicating greater overall wayfinding competence ($\alpha = .82$).

Results

Correlations among all study variables are reported in Table 2. To test our preliminary hypothesis that men will report being better at using orientation strategies and in overall wayfinding competence than will women, we conducted an overall MANOVA for gender differences in all primary study variables. The main effect of gender was significant, Wilks' $\lambda = .78, F(6445) = 20.70, p < .001, \eta^2 = .22$. Univariate analyses indicated that gender differences were present for both measures and in the expected direction: $F(1450) = 29.82, p < .001, \eta^2 = .062$ for orientation strategies; $F(1450) = 29.96, p < .001, \eta^2 = .062$ for overall wayfinding competence. Men used orientation strategies more often than

Table 2 Correlations of study variables by participants' gender

| | Masculine Cognitive | Feminine Cognitive | Masculine Personality | Feminine Personality | Orientation Strategy | Wayfinding Competence |
|-----------------------|---------------------|--------------------|-----------------------|----------------------|----------------------|-----------------------|
| Masculine Cognitive | – | .30** | .30** | .24** | .18** | .16* |
| Feminine Cognitive | .18* | – | .05 | .37** | .07 | .09 |
| Masculine Personality | .14* | .16* | – | .05 | .13* | .12 |
| Feminine Personality | –.02 | .25* | .03 | – | –.02 | –.06 |
| Orientation Strategy | .24** | .09 | .09 | –.09 | – | .41** |
| Wayfinding Competence | .29** | .11 [^] | .02 | –.24** | .42** | – |

Correlations for women are reported above the diagonal; for men, below. $n_s = 251$ women and 201 men

[^] $p = .053$. * $p < .05$. ** $p < .01$

women, and men reported a higher level of overall wayfinding competence than women (see Table 3). Hence, our preliminary hypothesis was confirmed.

To test our first hypothesis that men's and women's higher masculine cognitive characteristics will predict greater use of orientation strategies, and do so to a greater degree than do masculine or feminine personality characteristics, we regressed orientation strategy use on both masculinity (cognitive and personality) and both femininity measures (cognitive and personality) in a single step separately for men and women (see Table 4). For men, the overall model was significant, $F(4, 196) = 3.66$, $p = .007$, adjusted $R^2 = .05$. Specifically, the endorsement of masculine cognitive characteristics predicted the greater use of orientation strategies, $\beta = .22$, $t(196) = 3.04$, $p < .001$, semi-partial $r = .21$. Higher masculine cognitive characteristics were associated with more use of orientation strategies. For women, the overall model was also significant, $F(4, 246) = 2.79$, $p = .027$, adjusted $R^2 = .28$. More specifically, the endorsement of masculine cognitive characteristics positively correlated with the greater use of orientation strategies, $\beta = .16$, $t(246) = 2.32$, $p = .02$, semi-partial $r = .15$.

The pattern of associations between masculine cognitive characteristics and use of orientation strategies was consistent with the hypothesis for both men and women. No other

masculinity or femininity measure (i.e., feminine cognitive, masculine personality, feminine personality) was significantly related to the use of orientation strategies. For all participants, the correlation coefficients between masculine cognitive characteristics and orientation strategy use ($r = .25$) was not significantly stronger than that between masculine personality characteristics and orientation strategy use ($r = .16$) but was stronger (ignoring the direction of the effect) than that between feminine personality and orientation strategy use ($r = -.12$, $p = .04$). Hypothesis 1 was therefore partially confirmed in that masculine cognitive characteristics predicted greater use of orientation strategies for both men and women.

To test our second hypothesis that for both men and women, higher masculine cognitive and personality characteristics will predict better self-perceptions of overall wayfinding competence (Hypothesis 2a) and higher feminine personality characteristics will predict poorer wayfinding competence (Hypothesis 2b), we used the same approach as we did to test Hypothesis 1, regressing overall wayfinding competence on all four masculinity and femininity measures in a single step separately for men and women (see Table 5). For men, the overall model was significant, $F(4, 196) = 9.21$, $p < .001$, adjusted $R^2 = .14$. More specifically, endorsing masculine cognitive characteristics was a positive predictor of overall

Table 3 Descriptive statistics for study variables by participants' gender

| | Masculine Cognitive | Feminine Cognitive | Masculine Personality | Feminine Personality | Orientation Strategy | Wayfinding Competence |
|-----------------|---------------------|--------------------|-----------------------|----------------------|----------------------|-----------------------|
| Possible Range | 6–42 | 6–42 | 16–112 | 16–112 | 11–55 | 15–115 |
| Men | | | | | | |
| Mean | 30.11 | 26.53 | 56.79 | 54.53 | 30.76 | 68.31 |
| SD | 6.13 | 6.06 | 10.07 | 9.22 | 7.67 | 13.06 |
| Women | | | | | | |
| Mean | 26.90 | 27.95 | 51.55 | 61.09 | 26.83 | 61.21 |
| SD | 7.11 | 5.91 | 11.34 | 10.35 | 7.53 | 14.19 |
| Mean Difference | 3.21** | –1.42* | 5.24** | –6.56** | 3.93** | 7.10** |

$n_s = 201$ men and 251 women. The mean difference tested is between men's and women's scores

* $p < .05$. ** $p < .01$

Table 4 Perceived masculinity and femininity predict orientation strategies for men and women

| Predictors | β | t | p | sr | VIF |
|-----------------------|---------|-------|--------|------|------|
| Men ($n = 201$) | | | | | |
| Masculine cognitive | .22 | 3.04 | < .001 | .21 | 1.05 |
| Feminine cognitive | .07 | .95 | .34 | .07 | 1.13 |
| Masculine personality | .05 | .69 | .49 | .05 | 1.04 |
| Feminine personality | -.10 | -1.39 | .17 | -.10 | 1.07 |
| Women ($n = 251$) | | | | | |
| Masculine cognitive | .16 | 2.32 | .02 | .15 | 1.23 |
| Feminine cognitive | .04 | .56 | .58 | .04 | 1.23 |
| Masculine personality | .08 | 1.29 | .20 | .08 | 1.10 |
| Feminine personality | -.07 | -1.07 | .29 | -.07 | 1.18 |

sr semi-partial correlation, VIF Variance Inflation Factor

wayfinding competence, $\beta = .27$, $t(196) = 3.97$, $p < .001$, semi-partial $r = .26$. Furthermore, endorsing feminine cognitive characteristics was related with better overall wayfinding competence, $\beta = .14$, $t(196) = 2.04$, $p = .004$, semi-partial $r = .13$. Finally, higher feminine personality characteristics predicted poorer overall wayfinding competence, $\beta = -.27$, $t(196) = 3.99$, $p < .001$, semi-partial $r = -.26$. Hence and as expected, higher masculine cognitive characteristics was associated with better wayfinding and higher feminine personality characteristics was associated with poorer wayfinding. In addition, higher endorsement of feminine cognitive characteristics was related to better wayfinding for men. However, masculine personality characteristics did not influence wayfinding competence.

For women, the overall model was also significant, $F(4246) = 3.06$, $p = .018$, adjusted $R^2 = .032$. Endorsement of masculine cognitive characteristics predicted better overall wayfinding competence, $\beta = .14$, $t(246) = 2.04$, $p = .04$, semi-

Table 5 Perceived masculinity and femininity predict overall wayfinding competence for men and women

| Predictors | β | t | p | sr | VIF |
|-----------------------|---------|-------|--------|------|------|
| Men ($n = 201$) | | | | | |
| Masculine cognitive | .27 | 3.97 | < .001 | .26 | 1.05 |
| Feminine cognitive | .14 | 2.04 | .04* | .13 | 1.13 |
| Masculine personality | -.04 | -.53 | .60 | -.04 | 1.04 |
| Feminine personality | -.27 | -3.99 | < .001 | -.26 | 1.07 |
| Women ($n = 251$) | | | | | |
| Masculine cognitive | .14 | 2.04 | .04 | .13 | 1.23 |
| Feminine cognitive | .09 | 1.33 | .19 | .08 | 1.23 |
| Masculine personality | .08 | 1.15 | .25 | .07 | 1.10 |
| Feminine personality | -.13 | -1.97 | .05 | -.12 | 1.18 |

sr semi-partial correlation, VIF variance inflation factor

partial $r = .13$, and higher feminine personality characteristics predicted poorer overall wayfinding competence, $\beta = -.13$, $t(246) = -1.97$, $p = .05$, semi-partial $r = -.12$. As for men, greater endorsement of masculine cognitive characteristics was related to better wayfinding and greater endorsement of feminine personality characteristics was related to poorer wayfinding competence. Unlike men, feminine cognitive characteristics did not predict wayfinding competence for women. Nevertheless, ad hoc tests found that the correlation coefficients between feminine cognitive characteristics and overall wayfinding competence were not statistically different in men ($r = .11$) than in women ($r = .09$). Also note that gender-typed characteristics measures accounted for a smaller amount of variance for women (.032) than for men (.14). Hypothesis 2 was therefore partially confirmed. For both men and women, higher masculine cognitive characteristics predicted better wayfinding competence and higher feminine personality characteristics predicted poorer wayfinding competence. However, higher endorsement of feminine cognitive characteristics predicted better wayfinding competence for men but not for women.

Discussion

Our study evaluated the degree to which commonly observed gender differences in wayfinding competence and selection of wayfinding strategies (Lawton 1994, 2010; McGuinness and Sparks 1983; Miller and Santoni 1986) are related to perceived masculinity and femininity in U.S. women and men college students. We specifically focused on whether cognitive and personality characteristics of masculinity and femininity differentially predicted self-reported wayfinding performance. As expected, men were more likely to report using orientation strategies and reported better overall wayfinding competence than did women. With respect to our primary hypotheses, gender-typed cognitive and personality characteristics were significant predictors of wayfinding strategies and competence for both men and women and in the expected directions. More specifically, higher masculine cognitive characteristics predicted greater use of orientation strategies for both men and women. However, feminine cognitive, masculine personality, and feminine personality characteristics were not significant predictors of the use of orientation strategies for either gender. In addition, for men, both higher masculine and feminine cognitive characteristics predicted better overall wayfinding competence, whereas higher feminine personality characteristics predicted poorer wayfinding competence. For women, only higher masculine (but not feminine) cognitive characteristics predicted better overall wayfinding competence, and higher feminine personality characteristics predicted poorer wayfinding competence.

Use of Orientation Strategies

As expected, better use of orientation strategies was predicted by higher endorsement of masculine cognitive characteristics for both men and women. No other gender-typed characteristic was significantly related to the use of orientation strategies. Hence, our study showed that individuals who rate themselves higher in masculine cognitive characteristics are also more likely to employ orientation strategies. Masculine cognitive characteristics involve several general abilities, such as being analytical, mathematical, and good at problem solving. The acquisition and use orientation strategies would clearly benefit from the application of these skills during wayfinding activities because orientation strategies require the integration of spatial information across time (Hegarty et al. 2006). As expected, masculine personality characteristics played a limited role in predicting orientation strategy use, although a direct comparison of the correlation between masculine cognitive characteristics and orientation strategy use versus masculine personality characteristics and orientation strategy use was not significant. Nevertheless, it appears that the gender difference associated with using orientation strategies to perform wayfinding activities (Dabbs et al. 1998; Lawton 1994, 2010) may be due, at least in part, to differences in masculine cognitive characteristics.

Overall Wayfinding Competence

As predicted, the greater endorsement of masculine cognitive characteristics predicted better self-reported overall wayfinding competence. In fact, the greater endorsement of masculine cognitive characteristics was the only significant predictor of both wayfinding outcomes for both men and women. This result is consistent with Nash (1979) in suggesting that one's masculine identification would promote the development of skills in spatial domains. It also provides additional support for the strong relationship between the cognitive component of gender-typed characteristics and the cognitive outcome of wayfinding.

Also as expected, endorsing feminine personality characteristics was associated with poorer overall wayfinding competence. Although Reilly and Neumann (2013) concluded that endorsing feminine characteristics does not correlate with small scale spatial abilities (e.g., mental rotation), it seems that feminine personality characteristics are related to relatively large-scale and real-life spatial ability such as wayfinding. The influence of feminine personality characteristics on wayfinding may represent the general influence of gender-typed characteristics on interests and motivation. Previous studies have suggested that young adults' interests in masculine careers were negatively related to their endorsement of feminine personality characteristics and positively related to their masculine personality characteristics as measured by

BSRI (U.S.: Dinella et al. 2014). The high endorsement of feminine personality characteristics, especially negative ones such as being subordinate to others, may make individuals less interested or motivated to act as the main wayfinder when accompanied by others. Hence, they would self-select to obtain less experience. Additionally, feminine personality characteristics may also impose an emotional influence on wayfinding tasks. Those exhibiting high feminine personality characteristics may also be more anxious and less confident approaching masculine cognitive tasks (Estes and Felker 2012; Italy: Picucci et al. 2011) via stereotype threat which may in turn limit their experience in wayfinding. Both would likely reduce their wayfinding performance.

In contrast, endorsing masculine personality characteristics was not a significant predictor wayfinding competence. It is important to be cautious about interpreting a null result. However, we speculate that the relatively high correlations between masculine characteristics and wayfinding found in previous studies (e.g., Reilly and Neumann 2013) may primarily reflect the influence of masculine cognitive characteristics. The endorsement of feminine personality characteristics is a more reliable predictor of wayfinding competence, albeit negative, than is the endorsement of masculine personality characteristics.

Although we did not make directional hypotheses regarding feminine cognitive characteristics, the results indicated that endorsing them predicted better general wayfinding competence. Hence higher endorsement of cognitive characteristics, whether perceived to be masculine or feminine, was helpful to wayfinding. This is reasonable considering that wayfinding can be approached via verbal memory and verbal encoding (e.g., route strategies of remembering landmarks), in addition to spatial encoding of the environmental layout (e.g., orientation strategies, Lawton 2010). Thus, exhibiting high feminine cognitive characteristics can also be beneficial to wayfinding performance.

Comparisons of Men and Women

Consistent with previous research, men and women reported differences in the use of orientation strategies and wayfinding competence. Men reported greater use of orientation strategies during wayfinding activities than did women (Lawton 1994, 2010). Men also reported a higher degree of overall wayfinding competence (Hegarty et al. 2002). Hence, our sample exhibited gender differences that were similar to previous samples. The evaluation of gender-typed masculine and feminine characteristics thus provided some insight into how to account these differences.

Our results demonstrated that gender-typed characteristics had a stronger influence for men than for women on overall wayfinding competence. Gender-typed characteristics measures accounted for a larger amount of variance for men than

for women. Men with higher masculinity and lower femininity, and hence exhibiting stronger traditional gender-typed characteristics, tended to have higher levels of overall wayfinding competence. On the other hand, masculinity and femininity have a relatively smaller influence on variations in women's wayfinding performance. Similarly, Rammstedt and Rammssayer (2002) found that gender-typed characteristics had a larger influence on self-estimated intelligence for men relative to women (see also Beloff 1992). Men who had stronger traditional gendered beliefs reported a higher level of mathematical-logic intelligence including spatial intelligence relative to men who did not. A similar difference was not observed among women. Perhaps men use gender role beliefs as self-serving tools (France: Croizet et al. 2004; Germany: Hausmann et al. 2009). Hence, men with stronger traditional gender-typed expectations are more likely to give higher ratings of their wayfinding competence. Apparently, whatever negative effects that women experience from the gender-typed expectations on wayfinding is smaller in magnitude than the positive effect that experienced by men.

Results also demonstrated different predictive patterns of masculinity and femininity between men and women. More specifically, feminine cognitive characteristics measure was a significant predictor of overall wayfinding competence, but only for men. This is an interesting result that was not expected. Men typically hold more rigid and stronger traditional gendered beliefs than women do (e.g., Frieze et al. 2003; Levant 1996; Twenge 1997). They also exhibited lower feminine cognitive scores than did women. Nevertheless, feminine cognitive characteristics may facilitate wayfinding because wayfinding can also be approached verbally by remembering landmarks. Hence, we can tentatively suggest that having higher feminine characteristics such as being expressive or imaginative may complement men's use of verbal processing in wayfinding. Similarly, the correlation coefficient between feminine cognitive characteristics and overall wayfinding competence for women, albeit insignificant, was also positive and thus in the same direction as that for men. Future research will be needed to fully evaluate the impact of feminine cognitive characteristics on wayfinding.

Conclusions

Although it has been more than 40 years since the publication of the BSRI (Bem 1974), Bem's work continues to inspire contemporary research on gender issues. From a broader perspective, our study demonstrates that the recognition of masculinity and femininity as two independent dimensions, as initially proposed by Bem, continues to help describe how men and women perceive themselves in the present day. In addition, self-perceptions of masculinity and femininity continue to exert influences on everyday behaviors. The current research indicates that perceived masculinity and femininity

are important contributors to explaining individual differences in real life wayfinding competence and strategies. Our study also highlights the utility of distinguishing masculinity and femininity into subdomains (Diekmann and Eagly 2000) and the importance of studying wayfinding as a multi-faceted cognitive phenomenon. There are different mechanisms through which the cognitive and personality characteristics of masculinity and femininity contribute to different wayfinding outcomes.

Overall, for both men and women, greater endorsement of masculine cognitive characteristics results in more favorable wayfinding outcomes and greater endorsement of feminine personality characteristics results in less favorable wayfinding outcomes. Perhaps young men and young women are encouraged to engage in different activities and experiences, which can subsequently lead to gender differences in real life wayfinding and career choices related to wayfinding (e.g., taxi drivers, pilots). It will be important to identify ways that our results can inform educators and policy makers interested in reducing the impact of gender differences on cognitive performance in general and more specifically on their relation to spatial ability.

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Conflict of Interest The authors state that there are no conflicts of interest.

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