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Wayfinding Strategy and Gender – Testing the Mediating Effects of Wayfinding Experience, Personality and Emotions

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Background: Individual differences have been seen to play a key role in spatial orientation. Gender implications have been previously described but little is known about how other variables, such as wayfinding anxiety, emotional difficulties and wayfinding experience can mediate this relationship.

Methods: A group of 269 participants were involved in this study and completed questionnaires on their self-reported allocentric orientation strategy, wayfinding experience and satisfaction with the ability for wayfinding. Emotional outcomes were also investigated: spatial and trait anxiety, neuroticism, difficulties in emotion regulation, and personal safety. First, a principal component analysis was conducted and the studied variables were grouped into four components: outdoor wayfinding experience, wayfinding-related fear, emotional difficulties, and effective wayfinding skill. Afterwards, structural equation modelling was performed, using the MPLUS statistical program.

Results: The results showed that gender constitutes a predictor for using an effective wayfinding skill and for feeling wayfinding-related fear. However, outdoor wayfinding experience, wayfinding-related fear and emotional difficulties did not mediate the relationship between effective wayfinding skill and gender.

Conclusion: These results highlight the differential contribution of gender in the emotions that are experienced during spatial orientation and emotions that are related to other types of situations. The limitations, strengths and theoretical implications of the proposed model are discussed. Further investigation is needed in order to understand the role of emotions in spatial orientation.

Keywords: anxiety, neuroticism, outdoor wayfinding experience, spatial allocentric strategy, spatial orientation

Introduction

Spatial orientation is a cognitive process that enables the person to move successfully in familiar or unfamiliar environments without getting lost.[1] Humans and other animals live, move and act in space; therefore, manipulating spatial information is crucial for their survival. Consequently, when brain diseases such as Alzheimer's disease,[2] epilepsy,[3] stroke[4] or topographical disorientation[5] impair navigational abilities, patients suffer devastating effects on their everyday lives. Additionally, it has been seen that healthy people widely vary in their navigational abilities, but what determines the differences between people with high or low ability to orientate spatially is still not well known.

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Gender-related differences in spatial orientation have been widely reported and investigated.[6–12] Many studies show that men outperform women in several spatial tasks such as mental rotation tests[13,14] or the performance of virtual reality-based tasks.[15,16]

Gender differences in spatial orientation have been related to cognitive and personality variables. Regarding the former, men and women have been described to differ in the environmental cues and the spatial information used for spatial orientation.[17] Two types of frameworks are used for spatial orientation: egocentric, or body-centred, and allocentric, or environmentally-centred.[18] In the egocentric framework, the person estimates self-location in an environment by using internal cues such as directions, distances and turns from a given reference point.[19] On the other hand, in the allocentric framework, location and orientation are independent of the navigator's position but refer instead to the spatial relationship between landmarks. This spatial information conforms a cognitive map, that is, a visual and mental representation of our world.[20] Men have been considered to be prone to use allocentric strategies more than women,[21,22] whereas women might prefer using egocentric strategies.[10,22]

Other factors that might be involved in spatial orientation are personality and emotional dimensions.[7,23] For example, neuroticism has been associated with a poorer performance in spatial tasks.[24] Neuroticism is defined as the tendency to experience frequent and intense negative emotions, including anxiety, fear, anger, sadness, among others. These emotional responses are often accompanied by beliefs that the world is a threatening place and that one cannot cope with or control negative events.[25,26] People with high scores on neuroticism are more likely to use avoidant emotion regulation strategies such as behavioural or cognitive avoidance (thought suppression, rumination and worry) which have a paradoxical effect and serve to increase and maintain the intensity and frequency of negative emotions.[27]

Emotion regulation refers to processes that individuals use to influence the nature of those emotions and how such emotions are experienced and expressed.[28] We hypothesized that difficulties in spatial orientation could trigger the spiral of negative emotional reactions (ie, spatial orientation anxiety) in people with high neuroticism and, as a consequence, the attempts to regulate emotions through maladaptive emotion regulation strategies (ie, avoidance behaviour or stop thinking). Despite the relationship between neuroticism and emotion regulation difficulties, anxiety,[29] and specifically, spatial anxiety,[21,30] is the emotional factor that has received the most attention in spatial orientation anxiety studies.

Spatial anxiety refers to the anxiety and the fear of getting lost when spatially navigating[21,30] and it has been associated with a poorer performance in spatial tasks.[7,31] Gender differences have been described in spatial anxiety, with women being more spatial-anxious than men.[21,22,30,32] A possible explanation for women's being more spatial-anxious is related to personal safety, or a person's perception of the risk of being attacked. Accordingly, women have been observed to be more concerned about personal safety than men, and this leads to greater anxiety about getting lost when they are orientating themselves in unfamiliar and potentially dangerous environments.[10]

In addition, the wayfinding experience has also been involved in spatial orientation.[10,30] In fact, it has been hypothesized that people who had less freedom to explore the environment during childhood (usually girls) might feel more uncomfortable and anxious and are more likely to develop an egocentric strategy when performing spatial tasks in adulthood.[10] Also, the use of active means of transport during childhood and adulthood contribute to practicing the wayfinding skill. Moreover, it has been reported that people who prefer the use of active means of transport (eg, driving a car or riding a bike) orientate themselves using an allocentric strategy, whereas egocentric strategy users tend to prefer passive means of transport (eg, buses, taxis, trains).[33]

Several attempts have been made to investigate the individual factors involved in spatial navigation. Accordingly, the influence of gender and cognitive variables in spatial orientation has been extensively studied.[21,22,34,35] However, relatively little attention has been paid to the role of personality factors.[7,24,31,36] In fact, only a few studies investigated the importance of the wayfinding experience,[10,30,37] personal safety,[10] and neuroticism[24] when navigating in an environment. Moreover, to our knowledge, this is the first time that the effect of emotion regulation in spatial orientation has been studied.

The proposed structural equation model is represented in Figure 1. As suggested by previous studies, we hypothesized that gender would directly predict the use of self-reported effective wayfinding allocentric strategies.[6–15] Additionally, we investigated the possible mediating role of wayfinding experience, emotional difficulties (ie, emotion regulation, trait anxiety and neuroticism) and wayfinding-related fear

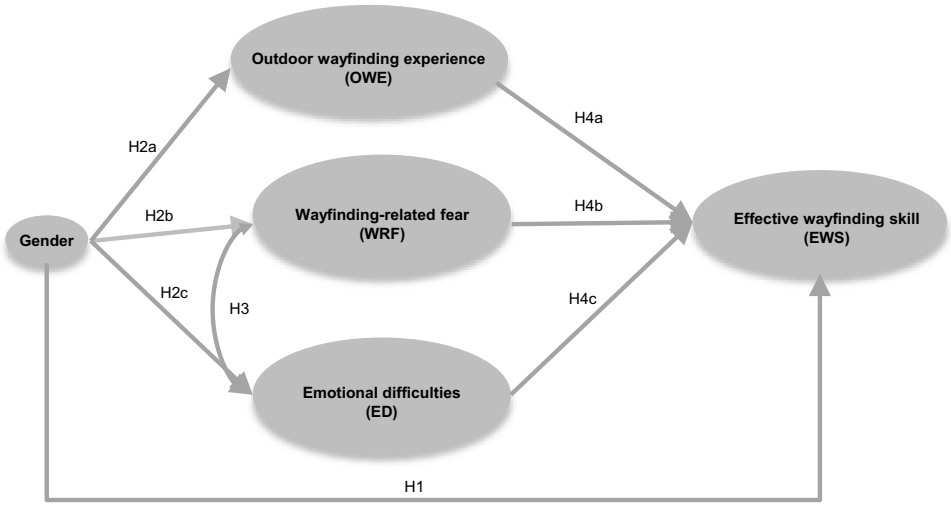

Figure 1 Conceptual model.
Notes: Hypotheses: H1 = Gender predicts EWS; H2a = Gender predicts OWE; H2b = Gender predicts WRF; H2c = Gender predicts ED; H3 = WRF is positively associated with ED; H4a = The relationship between Gender and EWS is mediated by OWE; H4b = The relationship between Gender and EWS is mediated by WRF; H4c = The relationship between Gender and EWS is mediated by ED.
Abbreviations: EWS, Effective Wayfinding Skill; OWE, Outdoor wayfinding experience; WRF, Wayfinding related fear; ED, Emotional difficulties.

(ie, high spatial anxiety and low feeling of personal safety) in this relationship (see Table 1).

Previous research pointed out that women have less wayfinding experience during childhood,[10] which determines their preference for using egocentric orientation strategies despite the fact that they are less efficient.[10,30] On the other hand, gender differences have been described in emotional difficulties. For example, gender seems to be a good predictor of trait anxiety.[38] In fact, trait anxiety was significantly higher in women in the Spanish version of STAI.[39] We hypothesized that trait anxiety may have an effect on spatial task performance due to its influence in cognitive domains such as attention and concentration.[40,41] Interestingly, a positive correlation between trait anxiety and the learning phase of a spatial task was previously found by our group.[37] However, the specific role of trait anxiety in spatial orientation is not clear.

In our model, we also expect that neuroticism, which has been observed to reach higher levels in women compared to men,[42,43] would be related to spatial orientation

Table 1 Variables/Measurements for Each Proposed Mediator and the Dependent Variable

Mediator	**Variable**		**Measurement**
Outdoor wayfinding experience	Use of an active means of transport Childhood wayfinding Experience		FSCSS CWES
Wayfinding-related fear	Wayfinding anxiety Feeling of personal safety		WQ PSS
Emotional difficulties	Self-reported difficulties in emotion regulation		DERS
	Anxiety - related personality traits	Trait anxiety Neuroticism	STAI NEO-FFI
Dependent variable	**Variable**		**Measurement**
Effective wayfinding skill	Allocentric strategy	Indoors Outdoors	IWES FSCSS
	Satisfaction with wayfinding ability		QSR

Abbreviations: CWES, Childhood Wayfinding Experience; DERS, Difficulties in Emotion Regulation Scale; FSCSS, Familiarity and Spatial Cognitive Style Scale; IWSS, Indoor Wayfinding Experience Scale; NEO-FFI, NEO Five-Factor Inventory; PSS, Personal Safety Scale; QSR, Questionnaire on Spatial Representation; STAI, State-Trait Anxiety Inventory; WQ, Wayfinding Questionnaire.

abilities.[24] The role of emotion regulation difficulties in effective wayfinding has never been studied before, and their association with components of cognitive abilities is controversial.[44–46] Nevertheless, gender differences between emotion regulation strategies have been found.[47]

In our model, we consider the possible mediating effects of high spatial anxiety and a low feeling of personal safety in the relationship between gender and effective wayfinding. Accordingly, gender differences have been observed in spatial anxiety, with women being more spatial-anxious than men.[21,22,30,32] This may be at least partially influenced by the variable personal safety. In this sense, women´s perception of the risk of being attacked is higher than men's perception, leading to greater spatial anxiety,[10] which has been associated with a poorer performance in spatial tasks.[7,31]

Lastly, in this model, we also investigated the relationship between wayfinding-related fear and emotional difficulties that occur at a more general level. Previous studies have reported a direct correlation between trait anxiety and the fear of getting lost.[10,37]

Materials and Methods

Participants

Participants were 176 women and 93 men (269 individuals; 65.4% women; 91.1% right-handed). The mean age for the sample was 31 ± 11.9 years. The women's mean age was 29.24 ± 10.97 years, and the men's mean age was 34.37 ± 13.00 years. The participants included 44.6% undergraduates and 55.4% graduates. The final participants met the inclusion criteria of an initial sample of 316 volunteers. They were not treated with a medication that could potentially impair their cognitive functioning, did not have any motor or sensory impairment and had not suffered a brain injury.

Measurements

Self-reported questionnaires were used in this study. These questionnaires were previously used in several investigations.[10,22,30,34,36,37,48–55]

Self-Reported Allocentric Orientation Strategy

In order to assess participants' self-reported preference for an allocentric orientation, we used the 6 items related to this strategy indoors from the Indoor Wayfinding Strategy Scale[22] and the item related to the use of this strategy outdoors from the Familiarity and Spatial Cognitive Style Scale[34] (FSCSS). We used the translated version of these items, which measured the degree of importance/usefulness of allocentric information on a 5-point Likert scale, where 1 represents "useless" and 5 "very useful". The minimum−maximum scores obtained with these scales are 6−30 and 1−5, respectively. The internal consistency of all of these items in our sample was good, Cronbach's $\alpha = 0.76$. Of the sample, 2.9% of the women and 13% of the men scored ≥ 24 on the scale related to allocentric strategy indoors, whereas 8.5% of the women and 19.4% of the men who scored ≥ 4 on the item related to the allocentric strategy outdoors.

Self-Reported Active Wayfinding Experience

We used the translated version of the Childhood Wayfinding Experience Scale[30] to determine participants' wayfinding experience at ages 3 − 15 years. Participants were asked how far from home in km. they were allowed to go without an adult at the following ages: 3 − 4 years old, 5 − 7 years old, 8 − 10 years old, 11 − 13 years old and 14 − 15 years old. A 6-point Likert scale was used to measure this experience (ie, 1 = 0 km., 2 = 0.5 km., 3 = 1 km., 4 = 2−3 km., 5 = 4 −7 km., 6 ≥ 8 km.). The total score on this test was the sum of the item score at each age range, Cronbach's $\alpha = 0.82$ in this sample. The minimum−maximum score obtained with the scale is 6−26.

The frequency of use of an active means of transport was also measured both in the current situation and during childhood. This measure was based on a modified version of the measure about means of transport of the FSCSS scale.[34] The scale asked the participants how often they used the following three types of active means of transport at present: driving a car, driving a bike/motorbike, and going on foot. In relation to the childhood period, the scale asked the participants about the frequency of use of the following two types of active means of transport: driving a bike/motorbike, and going on foot. All the items were scored on a 5-point Likert scale, were 1 means "never" and 5 "always". A score for each period was calculated by the sum of the scores obtained for each means of transport separately. The minimum−maximum score obtained with the scale is 2−10 in relation to the childhood stage and 3−15 in relation to the current situation.

Satisfaction with the Ability for Wayfinding

An item referred to satisfaction with one's own sense of orientation was included and scored on a 4-point Likert scale where 1 means "strongly disagree" and 4 means "strongly agree". The item consisted of the following statement "I have a good sense of direction".[49]

Emotional Outcomes

We considered five measures related to emotional outcomes: emotion regulation, neuroticism, personal safety feeling, trait anxiety and wayfinding anxiety.

In order to assess self-reported difficulties in emotion regulation, all participants completed the Difficulties in Emotion Regulation Scale[56] (DERS; Spanish version by Hervás & Jódar[57]). The scale consists of 28 items which are scored on a 5-point Likert scale, ranging from 1 (almost never) to 5 (almost always). The scale is composed of five subscales, in which higher scores indicate greater difficulties: (1) lack of emotional awareness (Lack Awareness; minimum−maximum score: 4−16); (2) lack of emotional clarity (Lack Clarity; minimum−maximum score: 4−17); (3) difficulty regulating behaviour when distressed and lack of access to strategies to feel better when distressed (Lack Control; minimum−maximum score: 9−42); (4) difficulty engaging in goal-directed cognition and behaviour when distressed (Lack Goals; minimum−maximum score: 4−20); and (5) unwillingness to accept certain emotional responses (Lack Acceptance; minimum−maximum score: 7−35). The Cronbach alpha of the total scale was 0.94 and of the subscales, it was: Lack Awareness: 0.71; Lack Clarity: 0.81; Lack Control: 0.91; Lack Goals: 0.94; and Lack Acceptance: 0.92.

Neuroticism was measured using the Spanish version of the NEO Five-Factor Inventory[58] (NEO-FFI); only the 12 items related to neuroticism were administered in the present study. The neuroticism subscale is composed of twelve 5-point Likert scale items, ranging from 0 (totally disagree) to 4 (totally agree). We used the raw scores that are positively related to high levels of neuroticism traits (minimum−maximum score: 1−41). The Cronbach alpha was 0.85 in this sample.

We measured participants' level of self-reported safety when walking alone in different environments through the translated version of the Personal Safety Scale.[10] This is a 5-point Likert scale of 6 items ranging from 1 (not at all safe) to 5 (very safe). The scale measures how safe the participants would feel walking alone during daytime and night time in their neighbourhood, being at home alone or being at work or school alone. The total score on this scale was the sum of the scores of the 6 items. High scores are related to high self-reported personal safety (minimum−maximum score: 11−30), Cronbach's $\alpha = 0.80$ in this study.

Trait anxiety was measured using the State-Trait Anxiety Inventory[59] (STAI, Spanish validation by Guillén-Riquelme and Buela-Casal[39]). The STAI items were scored on a 4-point Likert scale ranging from 0 (almost never) to 3 (almost always), and only the raw scores of the 20 Trait Anxiety items were used in the present study. High scores are associated with high levels of trait anxiety (minimum−maximum score: 0−50). Cronbach's $\alpha = 0.90$ in this study.

Finally, we used the eight items related to the wayfinding anxiety factor of the Wayfinding Questionnaire to measure participants' self-reported spatial anxiety when navigating in unfamiliar places.[48] The items were translated into Spanish and scored on a 1–7 Likert scale ranging from 1 (not applicable to me at all) to 7 (totally applicable to me). High scores are related to high wayfinding anxiety (minimum−maximum score: 8−56). We used the raw scores of this factor. Cronbach's $\alpha = 0.89$ in this study.

Procedure

Participants were recruited at the University of Zaragoza and Universitat Politècnica de València (Spain), through campus advertising. In the advertisement, potential participants were encouraged to learn more about their emotions and spatial behaviour by receiving a brief report describing their results on the tests of the study as a reward. Also, an e-mail address was provided in order to contact for participation. Each volunteer who contacted us was informed about the aims of the study, and the anonymity of his/her responses was clearly stated. The Google Forms through the Internet were used to create a survey for data collection. Each participant received the link to the form and a personal code to complete the survey though e-mail. The survey included items related to the participants' sociodemographic information, the inclusion criteria, and the scales described in "Measurements", which were included in the following order: frequency of use of an active means of transport (modified of the FSCSS[34]), wayfinding anxiety,[48] childhood wayfinding experience,[30] personal safety,[10] preference for an allocentric orientation strategy,[22,60] neuroticism,[58] difficulties in emotion regulation,[57] trait anxiety[39] and satisfaction with one's own sense of orientation. Participants gave written informed consent to participate in the study. The Ethics Committee of the leader's university, Universitat Politècnica de València, approved the study. The study was conducted in accordance with the declaration of Helsinki.

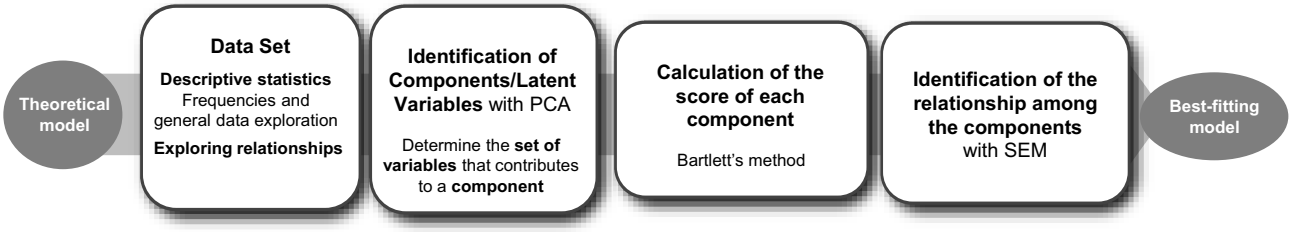

Figure 2 Statistical design.
Abbreviations: PCA, Principal Component Analysis; SEM, Structural Equation Modeling.

Data Analysis

There were four steps in the statistical design of this study (see Figure 2). In the first step, we explored the general data, calculating descriptive statistics and correlations among the observed variables. In the second step, we simplified the structure of the data set, identifying components with principal component analysis (PCA).[61] In the third step, the score of each component was considered as a factor score that was used, in the fourth step, to determine the relationship among the components with structural equation modelling (SEM).[62,63]

Data analyses were conducted using IBM SPSS for Windows, version 20.0 (IBM SPSS Inc., Chicago, Illinois) and Mplus 6.12.[64]

More specifically, a PCA was conducted on the scales with the varimax orthogonal rotation method. Sampling adequacy for PCA was good (KMO = 0.80[65]; and Bartlett's sphericity test: χ^2 (105) = 1461.88, $p < 0.001$; limit of acceptance < 0.50 for both statistics). An analysis was conducted to obtain eigenvalues for each component of the data. Five components had eigenvalues over Kaiser's criterion of 1[66] and combined, they explained 68.22% of the variance. Factor loadings lower than 0.40 were not interpreted.[67] Table 2 shows the factor loadings after rotation. Component 1 represents emotional difficulties, which involves difficulties in emotion regulation and anxiety-related personality traits. Component 2 represents an effective wayfinding skill, which involves two factors that are

Table 2 Summary of PCA Results (N = 269)

Measurements	Rotated Factor Loadings				
	Emotional Difficulties	Effective Wayfinding Skill	Outdoor Wayfinding Experience	Wayfinding-Related Fear	Emotion Unclarity and Unawareness
E. Lack Control	0.87				
E. Lack Acceptance	0.83				
Trait anxiety	0.79				
Neuroticism	0.78				
E. Lack Goals	0.77				
E. Lack Clarity	0.64				0.49
Allocentric strategy indoors		0.84			
Satisfaction with wayfinding ab.		0.77			
Allocentric strategy outdoors		0.71			
Active means of transp. (c.)			0.82		
Active means of transp. (at p.)			0.78		
Childhood wayfinding exp.			0.47		
Wayfinding anxiety				0.76	
Feeling of personal safety				−0.69	
E. Lack Awareness					0.91
Eigenvalues	4.46	2.01	1.57	1.11	1.08
% of variance	29.71	13.40	10.45	7.41	7.23

Abbreviations: Ab, ability; C, childhood; E, Emotion; Exp, experience; P, present; Transp, transport.

directly related to successful wayfinding behaviour: preference for an allocentric orientation and satisfaction with the wayfinding ability. Component 3 represents an outdoor wayfinding experience, which involves aspects helping to promote wayfinding through experiences outdoors. These consist of the use of active means of transport and childhood wayfinding experience. Component 4 represents a wayfinding-related fear, which involves symptoms of anxiety and feelings of personal unsafety during wayfinding tasks. Finally, Component 5 represents a lack of both emotional clarity and of awareness (ie, subscales of the DERS).[56] These two subscales evaluate difficulties understanding emotions. We only considered Components 1–4. The subscale Lack Clarity was grouped in Component 1 and also in Component 5 (ie, subscales Lack Awareness and Lack Clarity). The subscales included in Component 5 showed low internal consistency in the Spanish validation study.[57] Therefore, we only considered the Lack Awareness subscale as part of Component 1.

The factor scores were calculated using Bartlett's method, which is a refined method that produces unbiased estimates of the factor scores.[68] Then, structural regression analysis within SEM was conducted to investigate the associations between the factors: gender, emotional difficulties, effective wayfinding skill, outdoor wayfinding experience, and wayfinding-related fear (the conceptual model is shown in Figure 1). Gender was considered as an independent variable. Emotional difficulties, effective wayfinding skill, outdoor wayfinding experience, and wayfinding-related fear were considered as dependent variables. Three indices were considered to determine the goodness of fit of the model to the data:[69] the root mean square error of approximation (RMSEA; ≤ 0.06 good fit, at a 90% confidence interval [CI]), the comparative fit index (CFI), and the Tucker-Lewis index (TLI). The last two indices indicate a good model fit with values equal to or above 0.97.

Results

Descriptive statistics (Table 3) and correlations of the subscales of the included measurement instruments (Table 4) are presented.

Using maximum likelihood estimation with robust standard errors, the data presented an excellent fit to the model shown in Figure 3 (χ^2 (2) = 0.189, p < 0.910, RMSEA = 0.001, 90% CI [<0.001, 0.048], CFI = 1.000, TLI = 1.000). In the model, the results supported that gender directly predicts effective wayfinding skill and wayfinding-related fear (β = −0.28, β = 0.38, respectively, both p < 0.001). However, neither outdoor wayfinding experience (β = −0.02, p = 0.76), nor wayfinding-related fear (β = 0.11, p = 0.09), nor emotional difficulties (β = 0.02, p = 0.69) had a relationship with effective wayfinding skill. In addition, gender did not predict outdoor either wayfinding experience (β = −0.06, p = 0.29) or emotional difficulties (β = 0.08, p = 0.17). Finally, our results did not support the association between wayfinding-related fear and emotional difficulties (β = −0.03, p = 0.58). See Figure 3.

Table 3 Descriptive Statistics of the Measurement Instruments

	M (SD)	M_{men} (SD)	M_{women} (SD)
Indoor AWS	16.67 (4.39)	18.37 (4.50)	15.78 (4.07)
Outdoor AWS	2.16 (1.02)	2.30 (1.12)	2.09 (0.96)
Childhood WE	15.63 (3.81)	15.69 (3.57)	15.60 (3.94)
AMT Childhood	6.94 (1.54)	7.00 (1.58)	6.90 (1.52)
AMT at Present	9.13 (1.82)	9.48 (1.98)	8.94 (1.72)
Satisfaction WAb	2.94 (0.81)	3.28 (0.74)	2.77 (0.80)
E. Lack Accept.	13.7 (6.39)	13.31 (6.48)	13.90 (6.36)
E. Lack Goals	10.03 (4.04)	9.49 (4.07)	10.31 (4.01)
E. Lack Control	16.37 (6.84)	15.51 (5.92)	16.82 (7.26)
E. Lack Clarity	7.92 (2.82)	7.82 (2.96)	7.98 (2.74)
E. Lack Aware.	9.19 (2.69)	9.54 (2.78)	9.01 (2.64)
Neuroticism	20.39 (8.20)	17.77 (8.07)	21.77 (7.95)
Personal Safety	25.80 (3.70)	27.78 (2.41)	24.74 (3.83)
Trait anxiety	19.51 (9.87)	17.44 (11.26)	20.60 (8.89)
W. Anxiety	27.24 (10.47)	23.28 (9.61)	29.33 (10.32)

Abbreviations: Accept, Acceptance; AMT, Active Means of Transport; Aware, Awareness; AWS, Allocentric Wayfinding Strategy; E, Emotion; W, Wayfinding; WAb, Wayfinding Ability; WE, Wayfinding Experience.

Overall, these results show that gender is the main factor to explain wayfinding behaviour and anxiety in wayfinding tasks. These results also indicate the distinction between the emotional symptoms that occur in a wayfinding situation and negative emotional reactions that occur in other types of situations.

Discussion

The main focus of this study was to explore the influence of gender on the use of an effective wayfinding skill. Specifically, we hypothesized a theoretical model in which wayfinding experience, emotional difficulties and wayfinding-related fear could play a possible mediating role in the explanation of the relationship between the use of effective wayfinding skills and gender.

Our main hypothesis was supported: gender significantly predicted a set of self-reported behaviour trends when

Table 4 Correlations Matrix of the Measurement Instruments

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Indoor AWS	–													
2. Outdoor AWS	0.40[c]	–												
3. Childhood WE	0.06	0.01	–											
4. AMT Childhood	0.12[a]	0.02	0.21[b]	–										
5. AMT at Present	0.17[b]	0.06	0.11	0.43[c]	–									
6. Satisfaction WAb	0.62[c]	0.27[c]	0.05	0.06	0.14[a]	–								
7. E. Lack Accept.	−0.02	−0.03	0.07	0.01	−0.08	−0.11	–							
8. E. Lack Goals	−0.13[a]	−0.09	0.04	−0.03	−0.13[a]	−0.16[b]	0.57[c]	–						
9. E. Lack Control	−0.09	−0.01	0.03	0.01	−0.19[b]	−0.17[b]	0.69[c]	0.69[c]	–					
10. E. Lack Clarity	−0.02	0.03	0.07	0.01	−0.06	−0.15[a]	0.49[c]	0.39[c]	0.56[c]	–				
11. E. Lack Aware.	−0.02	−0.01	−0.03	−0.03	−0.09	−0.11	0.15[a]	0.08	0.20[b]	0.41[c]	–			
12. Neuroticism	−0.07	0.06	0.07	−0.05	−0.21[b]	−0.19[b]	0.56[c]	0.48[c]	0.64[c]	0.51[c]	0.11	–		
13. Personal Safety	0.19[b]	−0.08	0.14[a]	0.17[b]	0.30[c]	0.22[c]	−0.20[b]	−0.21[b]	0.24[c]	−0.25[c]	−0.07	−0.35[c]	–	
14. Trait anxiety	−0.10	0.02	0.01	−0.08	−0.22[c]	−0.25[c]	0.62[c]	0.50[c]	0.67[c]	0.58[c]	0.19[b]	0.79[c]	−0.34[c]	–
15. W. Anxiety	−0.22[c]	−0.01	−0.06	−0.11	−0.17[b]	−0.37[c]	0.20[b]	0.20[b]	0.23[c]	0.25[c]	0.07	0.31[c]	−0.39[c]	0.37[c]

Notes: [a]$p < 0.05$; [b]$p < 0.01$; [c]$p < 0.001$. Correlations with coefficients > 0.5 are displayed in grey.
Abbreviations: Accept, Acceptance; AMT, Active Means of Transport; Aware, Awareness; AWS, Allocentric Wayfinding Strategy; E, Emotion; W, Wayfinding; WAb, Wayfinding Ability; WE, Wayfinding Experience.

wayfinding which are grouped into a single component: preference for using allocentric strategies, both outdoors and indoors, and a higher satisfaction with one´s own wayfinding ability. Accordingly, people with excellent orientation skills have been seen to prefer using allocentric strategies to orientate themselves. Allocentric strategies are more sophisticated than egocentric strategies, requiring conforming a cognitive map, and they are more flexible, allowing the navigator to take shortcuts when necessary.[21] Therefore, people who orient themselves using an allocentric strategy might be more satisfied with their orientation abilities than people who navigate using egocentric strategies. Our results are in accordance with previously published evidence which reported that men and women differ in their self-reports of spatial orientation strategies, with men being more prone to use an allocentric strategy than women.[10,21,22] In addition, self-efficacy has also been seen to influence spatial orientation abilities,[70–72] and gender differences have also been reported. Accordingly, women have been shown to be less satisfied with their orientation abilities than men. In fact, women's lower levels of confidence in their ability to solve spatial tasks such as drawing a floor plan, carrying out a wayfinding task or performing a distance estimation task have been reported.[22,71,73,74]

Our results show that the factor representing the outdoor wayfinding experience, which includes the variables

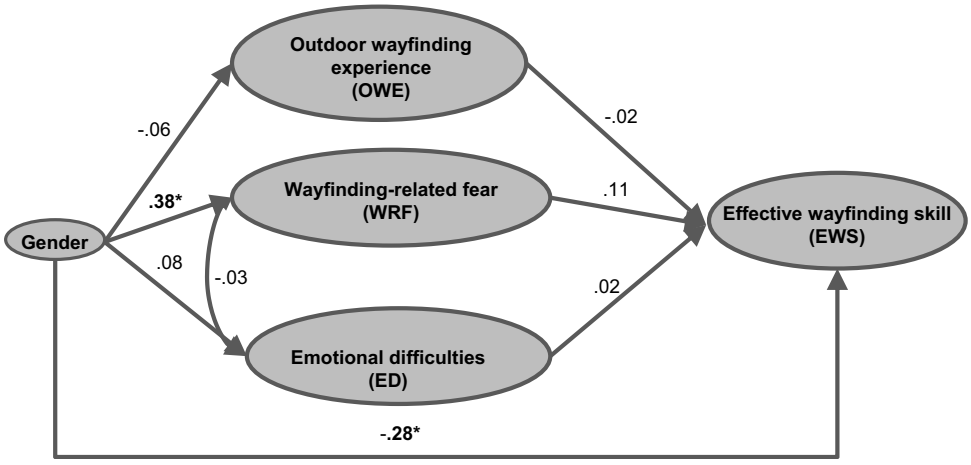

Figure 3 Results of the structural equation model.
Notes: Numbers indicate standardized betas; *$p < 0.001$.

wayfinding experience during childhood and the use of active means of transport during childhood and adulthood, did not have a mediation effect. This contradicts previous research in which gender was observed to influence wayfinding experience during childhood.[10,30] It has been hypothesized that girls often have less freedom to explore the environment and this stunted the development of their spatial skills.[10,30] However, it should be noted that the men and women in our sample reported a similar wayfinding experience in childhood. Likewise, in a previous study, we found no gender differences in this variable.[37] Additionally, our results show a similar preference for using active means of transport both in men and women (Table 3). In the literature, gender preference for public transport (passive means of transport) is unclear. For example, women have been seen to be more willing to reduce car use because of their stronger ecological norms[75] and to have a more positive attitude towards public transport than men,[76] whereas another study reported less intention in women to use public transport.[77] On the other hand, it has been seen that women walk (which is an active means of transport) more than men for leisure, exercise and for fun.[78]

Another kind of variables that might influence spatial orientation is personality and emotion regulation. The literature supports a relationship between spatial orientation and some personality traits such as neuroticism[24] or wayfinding anxiety.[7,31] In our results, personality variables were grouped into two components: wayfinding-related fear (grouping variables related to anxiety when wayfinding: wayfinding anxiety and personal safety) and emotional difficulties (grouping negative emotional reactions: lack acceptance of emotional responses, lack of goals, lack of control, lack of clarity, trait anxiety, and neuroticism). It is noteworthy that neither wayfinding-related fear nor emotional difficulties mediated effective wayfinding skills in our model, but a significant relation between gender and wayfinding-related fear was observed.

When we analyzed emotional difficulties, we observed no mediating effect of gender on using an effective wayfinding skill. First, our results showed that gender did not predict negative emotion regulation, neuroticism or trait anxiety. However, it should be noted that other studies have not reported gender differences in neuroticism, trait anxiety or emotion regulation difficulties as measured by DERS in healthy participants.[37,79,80] In fact, when a relationship between neuroticism or trait anxiety and an allocentric strategy use was assessed, it was after gender was controlled for.[37] Regarding emotion regulation, Bardeen, Stevens, Murdock, and Lovejoy investigated the role of gender in emotion regulation of healthy participants and observed gender-dependent associations between cognitive processes and difficulties in emotion regulation as measured by DERS.[81] The authors investigated executive functioning measures such as verbal fluency, colour-word interference, and questions related to abstract thinking and categorical processing. However, it is important to bear in mind that although emotion regulation has been seen to be associated with components of cognitive abilities such as reappraisal frequency[82] or episodic memory,[44] there is also evidence of the contrary.[45] Shamosh and Gray suggested that higher order cognitive abilities might not predict emotion regulation ability.[45] Due to the fact that, to our knowledge, this is the first work studying the contribution of difficulties in emotion regulation in the prediction of spatial orientation, more investigation is needed to understand why difficulties in emotion regulation did not mediate the relationship between gender and the use of an effective wayfinding strategy in our model.

Reports in the literature indicate that maladaptive patterns of emotion regulation are an important variable in the onset and maintenance of anxiety disorders.[46,83] For example, participants suffering from anxiety disorders reported low abilities in emotion regulation.[84] In addition, lack of emotion acceptance and lack of emotion regulation strategies (ie, Lack Control in the version of the scale used) predicted social interaction anxiety in healthy participants.[85] Accordingly, our results showed significant correlations between trait anxiety and lack of acceptance of emotional responses, lack of goals, lack of control, and lack of clarity. However, the measures of wayfinding-related fear were not associated with emotional difficulties in our study. Wayfinding-related fear was specifically related to the experience of negative emotions (ie, anxiety and insecurity) during the navigation of environments.

A possible explanation for our results could be related to the nature of the study, in the sense that the results obtained would probably be different if, instead of using a self-report questionnaire, we had used a real orientation task with some degree of difficulty. In this case, participants with higher scores in neuroticism would probably have shown more spatial orientation anxiety, as predicted. In accordance with this hypothesis, a direct relationship between neuroticism and the ability to form a cognitive map in a virtual reality-based spatial task has been reported.[24] In addition, Saylik, Szameitat, and Cheeta found that participants with high neuroticism, as compared to

low-neuroticism participants, exhibited poorer performance only when the working memory task is specifically associated with switching and/or inhibition, but not in a task which is associated with the visuospatial sketchpad.[86] This is an example of how results can vary depending of the type of tasks.

In accordance with previous studies, gender predicted the factor grouping of spatial anxiety and personal safety. First, women have been observed to be more spatial-anxious than men.[21,22,30,32] A possible explanation for women's higher spatial anxiety is related to the wayfinding experience during childhood,[10] but in our sample, no differences were observed in wayfinding experience between men and women. The preference for using an egocentric strategy for wayfinding has also been related to higher spatial anxiety.[10] In fact, a negative correlation was found between using an allocentric strategy indoors and spatial anxiety.[37] Finally, greater spatial anxiety has also been related to personal safety. In this sense, women´s perception of the risk of being attacked is higher than men's, and this leads to greater spatial anxiety.[10] However, gender differences in wayfinding-related fear did not predict an effective wayfinding skill. We hypothesized that women´s fear of getting lost or concerning their personal safety might not be related to a lower performance in spatial tasks. In fact, women have been observed to have less confidence in their ability to orientate in an environment, they perform comparably and achieve similar results as men in spatial tasks.[22,72,87]

The present study has some limitations related to the composition and representativeness of the sample, which hinders the generalizability of the results. First, it would have been desirable to increase the sample size, particularly in the group of men. Second, this research relied on a sample from Spain, so generalization to other cultures and languages requires caution. However, it should be noted that the methodologies used herein have been previously used in the literature, obtaining similar results in diverse cultures and languages. As we previously suggested, another possible limitation is related to the methodology used in the study (ie, self-report questionnaires), which can affect the results obtained. Self-report questionnaires are valid tools for measuring spatial ability.[88] However, self-report questionnaires frequently do not capture the nuance of navigational ability; therefore they could be followed up by more ecological testing, for example, using virtual or augmented reality.[11,37,89–92] Thus, future research should investigate the relationship between preferred self-reported strategies for spatial orientation and spatial strategies used to perform particular types navigational tasks that require different spatial abilities (allocentric/egocentric).

Conclusion

To our knowledge, this is the first study in which a theoretical model was proposed in order to investigate the predictor role of gender in the use of an effective wayfinding skill and the possible mediating role of wayfinding experience, emotional difficulties, and wayfinding-related fear. Overall, the results showed that gender significantly predicted self-reported effective wayfinding skills, suggesting that men and women differ in their self-reports of spatial orientation strategies and in the level of confidence in their ability to solve spatial tasks. No mediating effect was observed related to the outdoor wayfinding experience, probably because of the lack of differences in gender preference for active means of transport and wayfinding experience during childhood. On the other hand, neither wayfinding-related fear nor emotional difficulties mediated effective wayfinding skills in our model. However, gender predicted wayfinding-related fear, suggesting that spatial anxiety and feelings of personal safety are gender-related, but without contributing to the prediction of the use of an effective wayfinding skill. More research is needed in order to clarify the role of emotions, especially neuroticism and emotion regulation strategies, in spatial orientation.

Ethics Statement

The Ethics Committee of the leader's university, Universitat Politècnica de València, approved the study. The study was conducted in accordance with the Declaration of Helsinki.

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Author Contributions

All authors made substantial contributions to conception and design, acquisition of data or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; gave final approval of the version to be published; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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