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How good are people in assessing their own navigation ability?

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Abstract

In many fundamental or clinical studies, self-reports are used to measure navigational ability but in this study the navigational ability was measured both objectively and subjectively. The aim of this study is to examine how good people are in assessing their own navigational ability and whether this estimate is influenced by gender of the participants as well as the experimenters. A group of 119 healthy participants completed an objective navigation task, the Santa Barbara Sense of Direction Scale (SBSOD), the Wayfinding Questionnaire (WFQ) and a self-created questionnaire. The self-created questionnaire contains the following questions, Who navigates better? And ‘Compared to people of my own gender, my navigational ability is’: A vertical line had to be placed on a line of 10 cm to indicate the answer. There were four age groups (18-30, 31-45, 46-60 and 61-75) and two genders (60 females and 59 males) what made it a 4 x 2 design. In this study we found that the objective navigation ability of males and females is comparable (p =.984, ηp^2 = .000). However on the SBSOD (p =.008, ηp^2 = .058) and WFQ (p =.008, ηp^2 = .058) we found that males believe they are better at navigating, whereas females underestimate themselves. We also found that males and females think mainly that males navigates better or both genders navigates just as well (χ^2 (2, N = 118) = 4.277, p = .118). In contrast with our expectation, there was no correlation between the estimation of the navigation ability compared with people of the same gender and the objective navigation performance (r = .028, n = 119, p = .762). It did not matter for the estimation of the navigation ability compared with people of the same gender, what the gender of the experimenters was, because there was no difference in the estimation between the three (male, female and mixed) gender experimenter groups $\chi^2(2) = 1.805$, p = 0.405. When interpreting self-reports in existing articles and new surveys, it is important to keep in mind that males may overestimate their navigational abilities and females underestimate their navigational ability and perhaps to compensate for this, separate norm scores are needed for the different genders.

Preface

This research was carried out within the framework of the thesis for the master Clinical Neuropsychology at the University of Leiden. With this research I hope to be able to complete the master year. My special thanks go to my supervisor Ineke van der Ham who helped me during this process.

Introduction

We use our navigation skills daily, when we have to find our way to school or just to the kitchen. The term “wayfinding” has originally been introduced by Lynch (1960) and Golledge (1999) defines wayfinding as “the process of determining and following a path or route between an origin and destination”. When you are doing this, you use one of the most fundamental cognitive functions. Basic perceptual and memory related processes are involved, but also spatial navigation is concerned, which is a very complex multisensory process. In this process information needs to be integrated and manipulated over space and time. Spatial navigation can be based on externalized representations such as maps and on internal representations which are derived from sensory experiences. It is not surprising given the complexity of cues, processes and representation that humans differ widely in this ability (Wolbers & Hegarty, 2010). Differences may occur in the (sensory) perception of the environment, the processing and re-use of the information (Wolbers & Hegarty, 2010).

Individuals getting information from the environment from different perspectives. There are two fundamental ways from which a location can be determined: an egocentric perspective and an allocentric perspective (Ruggiero, D'Errico, & Iachini, 2016). The egocentric perspective means that the location of objects is coded or perceived from the position of the observer. The allocentric perspective means that the location of objects is coded or perceived in relation to other objects, regardless of where the observer is at that moment (Vasilyeva & Lourenco, 2012). Locating an object from an allocentric perspective is called ‘cue learning’. With cue learning you use landmarks. The landmarks are used as a direct indication of the location of another object, but they can also serve as a reference point indicating the location of other objects (Jansen-Osmann & Wiedenbauer, 2004).

Navigation skills can be measured using five different aspects (Claessen & van der Ham, 2017): (1) recognizing 'landmarks', (2) determining the route using egocentric perspectives, (3) determining the route based on an allocentric perspective, (4) determining the location based on an egocentric perspective and (5) determining the location based on an allocentric perspective. Landmark, location and path knowledge represents the what, where and how of navigational knowledge (Claessen & van der Ham, 2017). These three aspects taken together with the allocentric and egocentric perspectives give a complete picture of the navigation capability.

A general stereotype exists that men are better at navigating than females, but experimental evidence indicates that males and females are equally able to use landmark cues

(Saucier et al., 2002). However, males show a clear advantage compared with females on geometric cues (Sandstrom et al., 1998). They differ in their use of spatial strategies and this preference causes gender differences (Rosenthal, Norman, Smith & et al., 2012). Looking at previous studies, it can be expected that there are no differences in objective navigation ability between males and females and that males and females mainly believe that males are better at navigating than females.

Gender differences are also found when people report their daily navigation strategies. Males more often report using strategies like taking shortcuts and focusing on distal landmarks, while females more often report using route-based strategies of following well-learned routes and depending on local landmarks (Coluccia & Louse, 2004; Lawton, 1996; Lawton & Kallai, 2002). Furthermore, in a study of Picucci, Caffò & Bosco (2011) where females and males had to report their spatial confidence, woman judge their confidence with spatial orientation ability poorer than men did. The aim of this study is to examine how good people are in assessing their own navigational ability and whether this estimate is influenced by gender of the participants as well as the experimenters.

In a study by West, Welch, and Knabb (2002) gender differences in spatial self-efficacy and location recall were examined. Females performed better than males on the task for location recall, but despite of the performance, females showed consistently lower self-efficacy than males. Males showing significant greater spatial memory self-efficacy than females. Analyses shows that males tend to overestimate their ability to remember object locations. In addition Picucci, Caffò & Bosco (2011) also found that, from a behavioural point of view, woman have a lower level of spatial confidence than men despite the level of accuracy. Therefore we expect that males estimate their navigation ability better and females estimate their navigation ability worse than people of their own gender. These previous findings are based on the self-efficacy theory of Bandura (1992). Self-efficacy is defined as people's beliefs regarding their capability to succeed and attain a given level of performance (Bandura, 1977). According to this theory, gender differences are based on social expectations, personal experience and vicarious experience (Hackett & Betz, 1981). It has been known that females and males vary in self-confidence about their abilities and for typical male tasks this gender gap is even bigger (Betz & Hackett, 1983; Beyer, 1990; Deaux & Farris, 1977). In a study from O'laughlin & Brubaker (1998) it was found that males have a higher level of spatial confidence than females. From the studies of O'laughlin & Brubaker 1998; Piccuci, Caffò & Bosco 2011; Betz & Hackett, 1983; Beyer, 1990; Deaux & Farris, 1977, we can expect that males perform higher on the subjective navigation tasks than females. A strong impact of level of spatial confidence has been showed in both psychometric and navigation assessment (Wraga, Duncan, Jacobs, Helt, & Church, 2006). Furthermore it has been shown that a sense of self-efficacy increases performance by 28%, which is a stronger effect than goal setting, feedback interventions, or behaviour modifications (Stajkovic & Luthans, 1998). From these study we can expect that the estimation of how navigation abilities are compared with people of the same gender have a significant positive correlation with the performance on the objective navigation test.

Furthermore, Cornell, Sorenson and Mio (2003) found not consistent gender differences in actual wayfinding. However, females rated their sense of directions as worse than males. The results imply that self-evaluation of sense of direction is associated with evaluation of one's familiarity with characteristics of particular environments, as well as memories of successes and failures in recent wayfinding performances (Cornell, Sorenson & Mio, 2003). Moreover, lack of opportunity or motivation to practice particular skills can be related to stereotyped-based expectations about gender and abilities. These ideas have found considerable support in research on career choices (Bandura, 1997; Eccles, 1994; Golombok & Fivush, 1994; Hackett, Betz, O'Halloran, & Romac, 1990).

The navigational ability can be objectively measured, but in many fundamental or clinical studies self-reports are used. How reliable are these self-reports and to what extent are they influenced by stereotyping? Self-reports measures have the limitation that they trust on people having accurate metacognitive knowledge of their own abilities and strategies therefore it is important to validate self-reports against objective navigation performance (Boone, Gong & Hegarty, 2018). Wittmann et al. (2016) found that ratings of our own abilities are strongly influenced by the performance of others.

A recent concern across several disciplines of scientific inquiry is the failure to replicate significant findings (Open Science Collaboration, 2015). A potential factor that could explain for diversity in gender findings with regard to navigation is the role of experimenter gender (Chapman, Benedict & Schiöth, 2018). Experiments are regularly carried out without any report of the experimenter's gender, however there is some evidence that experimenters gender have influence on a variety of psychological and physiological variables (Rumenik, Capasso & Hendrick, 1977; Carter, McNeil, Vowles, Sorrell, Turk & et al., 2002). First experimenter's gender could have an impact on the mind for example: learning, memory, intelligence and creativity. This could be an indication that gender of the experimenters may have an influence on navigational ability, because different cognitive functions are used when navigating. Furthermore, it could affect behaviour such as communication, aggression and sexual behaviour. Finally, it may influence the body in terms of physical performances and pain sensitivity (Chapman, Benedict & Schiöth, 2018). Despite the many studies on the role of gender on navigation ability, there are no studies that investigate the role of the experimenter's gender on navigation ability. We will explore this matter.

Methods

Design

This project was a sub-project of a larger research project. The larger research project contained an online survey in which people in the Netherlands of eight years and older could participate. The aim of the larger project was to measure how well people can find their way and how they differ in this. The aim for the sub-project was to look for additional cognitive explanations for individual differences. There were four age groups and two genders what made it a 4 x 2 design.

Participants

In this research 120 participants of a healthy population participated. An exclusion criteria was having a psychiatric disorder. We had to remove one female participant from the age group 31- 45 because she had a transient ischemic attack (TIA). The final sample was 119 people. In order to participate in the study, the participant had to fit the age range (18-75) and master the spoken and written Dutch language. Several advertisements have been placed on multiple platforms and participants have been recruited from the researchers' social environment.

Measures

The online-test was used to measure objective navigation abilities. The five navigation systems, landmark recognition, egocentric and allocentric location and egocentric and allocentric route were tested. Ultimately, a sum score was achieved. The landmark recognition was requested first and then the others followed randomly.

The information given in advance to the video was as follows: 'You are an astronaut who has been sent to an unknown planet. It is your job to explore the planet. You walk a route through a forest where you encounter different objects. You will see a video of this exploration. It is your mission to remember as much information about the environment as possible. You will get questions about this later.' When the video has started you cannot stop or restart it. The route that the astronaut has to follow is: you first go left then you have to turn left then right, left, right, right, right and finally turn left.

In the egocentric location part an object was shown from the video. For each trail six images were shown with an object and arrows in different directions. The objects were iron barrels, a UFO, a box, a car, a boat, a purple crystal, a buoy and a container. From the eight objects four of these were randomly chosen (16.66% chance level). The question was where the white spaceship (end point of the route) is when you are at the object. You had to choose the arrow that points exactly to the white spaceship.

In the allocentric location part, you saw an object from the video and a map of the area. The objects were a UFO, a box, a boat, a car, a purple crystal, a buoy, iron barrels and a container. From the eight objects four of these were randomly chosen (25% chance level). The assignment was to indicate on the map where you had come across this object. Four locations were indicated on the map and one of these had to be chosen.

In the egocentric route part, a crossroad was shown and you had to indicate in which direction the route went. Two or sometimes three arrows were shown in a certain direction and you had to choose the right arrow (25-33% chance level).

In the allocentric route part three objects from the video were shown. Two objects were closest to each other and should both be selected (33% chance level). The objects that were shown together were; 1. a boat, a UFO and a container, 2. iron barrels, a box and a car, 3. a container, a buoy and iron barrels, 4. a purple crystal, a buoy and a UFO. A total of 24 points could be achieved for all components. This sum score consisted of the five different scores of the objective navigation test. For the landmark task, eight points could be achieved and for the other four navigation domains four points per component could be acquired. To ensure that all components count equally, the landmark task was divided by two.

‘The Santa Barbara Sense Of Direction scale’ (SBSOD) was used to test the subjective navigation abilities, so that there was a measurement of the estimate of the participant of their navigation ability. The score of all items from the SBSOD were summed up after the scores have been reversed and then divided by the number of items (15). The score was a number between one and seven, the higher the score the better the perceived sense of direction.

The Way Finding Questionnaire (WFQ) is a self-report questionnaire and was used to test the subjective estimation of navigational ability (Rooij de, Claessen, Ham van der, & Visser-Meily, 2017). The participants gave based on 22 statements how he or she thinks about their own navigational skills. The statements had to be answered on a Likert scale from 1 to 7. The first subscale "Navigation and Orientation" (1-3, 6, 7, 16, 18-22) relates to the cognitive skills needed to find the way. The second subscale "Spatial Anxiety" (8-15) measures the degree of fear when carrying out navigation tasks and getting lost. Finally, the subscale "Distance Estimation" (4, 5, 17) measures the specific ability to estimate distances (Claessen et al., 2016). Only the sub-scales 'Navigation and orientation' and 'Distance estimation' were used.

A questionnaire has also been created, with the following questions:
The first question is ‘With which statement do you agree?’: 1. Women are better at navigating than men. 2. Men are better at navigating than women. 3. Men and women can just as well navigate. One of the three statements had to be chosen. The second question is: ‘Compared to people of my own gender, my navigational ability is’: A vertical line had to be placed on a line of 10 cm to indicate the answer. All the way to the left is much worse and all the way to the right is much better. Eventually, a score between 0 and 100 percent came out. A score under the mean (50%) is considered a low evaluation and a score above is a high evaluation.

The gender of the experimenters was also included because this can have an influence on different psychological factors. The gender groups of the experimenters will be divided into two groups, namely the ‘male present group’ with only males or one male and one female and the ‘male absent group’ with only females. The groups with only males or one female and one male were merged, because otherwise the size of the three gender experimenter groups (only males, only females and mixed) differ too much from each other. The gender of the participant was also included.

Procedure

The Ethical Committee of Leiden University approved the current study. The research was conducted in the Pieter de la Court building of the University of Leiden. Ten researchers, all students at the University of Leiden, had taken the tests in pairs of two. A protocol had been drawn up, so that the test taking would be the same for all participants. After the respondent was thanked for his or her participation, the intention of the research was discussed once again and the information letter was once again reviewed. The duration (75 minutes) of the test taking was also repeated. Before starting the tests, the respondents were asked to sign an informed consent. Respondents were reminded that participation in the study is voluntary and completely anonymous. The participant first made the online test, followed by neuropsychological tasks with which, for example, planning and working memory were tested. At the end, the participants filled in a number of questionnaires with general questions about, for example, their living environment and computer use. For this research, data from the online test and questionnaires WFQ, SBSOD and the self-created questionnaire were used.

Statistical analyses

The statistical software package IBM SPSS version 22 was used to test the hypotheses. A one-way ANOVA was conducted two times to determine whether males score higher on the performances of the SBSOD and the WFQ. To verify whether males and females perform the same on the objective navigation task, the sum score on the objective navigation task and gender were compared in a one-way ANOVA. Z-scores were calculated for the performance on the SBSOD, WFQ and the objective navigation task, so that these scores could be compared with each other. An independent sample T-test was performed to compare the genders with each other on the estimation of their navigation ability compared to people with the same gender. The genders were compared with each other and a comparison will be made with the center of the scale (50%). To compare the estimation of the navigation ability compared to people with the same gender with the center of the scale (50%) a one-sample T-test was performed for both genders. A chi-square test was performed to examine if males and females have the same idea, that males are better at navigating than females. the relation between gender and the answer on the question who navigates better males, females or equally well. To verify whether the estimation of how navigation abilities are compared with people of the same gender had a positive correlation with the performance on the objective navigation test a Pearson product-moment correlation was performed. The gender of the researchers can influence different psychological factors. To explore this matter, a Kruskal Wallis test (a non-parametric test of a one-way ANOVA) was performed to examine the effect of the three gender experimenter groups (male, female, mixed) on the estimation of their own navigational ability compared to people with the same gender. A non-parametric test was performed because the three experimenter gender groups were not equal. A one-way between subjects ANCOVA will be calculated to examine the effect of the male present and the male absent group in the experimenter group on the estimation of their own navigational ability controlling for the effect of gender of the participants. To test if there was an effect of gender of the participants and the male present/absent experimenter groups on the estimation of the navigational ability a two-way ANOVA was conducted. For all analyses, a significance level of $\alpha = .05$ was used.

Results

Table 1 shows the characteristics of the participants. Percentage males and females is equal between the groups. The participants were divided into four groups of 30 people, 15 females and 15 males (age groups 18-30, 31-45, 46-60 and 61-75). The coding system for education level of Verhage (1964) was used and an average education level of 5.8 was aimed for all four age groups and both genders.

Table 1. *Participants Characteristics*

Gender	Mean age	Mean education level[a]	N(total)
Males	46.0 (17.1)	5.88 (.76)	60
Females	44.5 (16.4)	5.86 (.77)	59
Total	45.2 (16.7)	5.87 (.77)	119[b]

Note: [a] The range of this score is 4 to 7. The coding system for educational level of Verhage (1964) was used (1=low to 7=high).
[b] One female participant (age group 31-45) is removed due to neurological condition.

A one-way ANOVA was conducted three times to determine whether there was a significant difference in performance on the SBSOD, subscales ‘Navigation and orientation’ and ‘Distance estimation’ of the WFQ and the objective navigation test between males and females. The mean score of males was significant higher than the mean score of females on the SBSOD, this is the same for the performance on the two subscales of the WFQ. On the objective navigation test there was no significant difference between males and females.

Table 2. *Overview Performances*

	One-way ANOVA	**Mean score males (SD)**	**Mean score females (SD)**
SBSOD[a]	$F(1,117) = 7.225$ $p = .008$ $\eta p^2 = .058$	.238(.86)	-.242(.96)
WFQ[b]	$F(1,117) = 31.340$ $p = <.001$ $\eta p^2 = .211$	.454(1.03)	-.462(.92)
Objective navigation test	$F(1,117) = 0.000$ $p = .984$ $\eta p^2 = .000$	.001(1.04)	-.002(.96)

Note: The mean scores for males and females on the performances are standardized.
ηp^2 = partial eta squared
[a] SBSOD= Santa Barbara Sense of Direction Scale
[b] WFQ= Wayfinding questionnaire

To test the differences between males and females on the estimation of their own navigational ability compared to their own gender, a one-sample t-test was performed to compare this with a 50% mean percentage. The average percentage of 50% has been chosen because on the question: ‘Compared to people of my own gender, my navigation ability is?’ a score comes out between 0% and 100%. A score under the mean (50%) is a low evaluation and a score above is a high evaluation. The gender comparison score of males ($M = 57.67$, $SD = 18.52$) was higher than the standard mean score of 50, $t(59) = 3.206$, $p = .002$. For females ($M = 47.98$, $SD = 23.11$) this was not lower than the mean score of 50, $t(58) = -.673$, $p = .504$.

An independent sample t-test was run to compare males and females with each other on the estimation of their own navigation ability. The mean score of males ($M = 57.67$, $SD = 18.52$) was significant higher, $t(117) = 2.522$, $p = .013$ than the mean score of females ($M = 47.98$, $SD = 23.11$).

A chi-square test was run to determine if males and females believe that males are better at navigating than females. The chi-square test showed that males and females have similar ideas about which gender is better at navigating (χ^2 (2, $N = 118$) = 4.277, $p = .118$). An overview with the exact answers can be found in table 3.

Table 3. *What Males And Females Have Answered On The Question Who Navigates Better*

		Females navigate better	**Males navigate better**	**Males and females navigate equally well**	**Total**
Gender	**Male**	3(2.5%)	33(28.0%)	24(20.3%)	60(50.8%)
	Female	5(4.2%)	21(17.8%)	32(27.1%)	58(49.2%)
	Total	8(6.8%)	54(45.8%)	56(47.5%)	118(100%)

To test the hypothesis that there is a significant positive correlation between the estimation of how navigation abilities are compared with people of the same gender and the performance on the objective navigation test a Pearson product-moment correlation was performed. There was not a significant correlation between the estimation of their own navigational ability compared with people of the same gender and the performance on the objective navigation test (r = .028, n = 119, p = .762).

A Kruskal-Wallis H test showed that there was not a significant difference in estimation of their own navigational ability between the different gender experimenters groups $\chi^2(2) = 1.805$, p = 0.405, with a mean rank percentage line score of 56.66 for the group with only female experimenters, 48.20 for the group with only males experimenters and 63.75 for the mixed group.

The gender groups of the experimenters were divided into two groups, namely the ‘male present group’ with only males or one male and one female and the ‘male absent group’ with only females. The groups with only males or one female and one male were merged, because otherwise the size of the three gender experimenter groups (only males, only females and mixed) differ too much from each other.

The gender of the participant will also be included. A one-way between subjects ANCOVA was calculated to examine the effect of the male present group and the male absent group in the experimenter group on the estimation of their own navigational ability controlling for the effect of gender of the participation. Gender of the participants was significantly related to the gender comparison score, $F(1, 119) = 5.964$, p = .016, $\eta p^2 = .049$. The male present and the male absent experimenter group did not show significant difference in the estimation of the navigational ability, ($F(1, 116) = .321$, p =.572, $\eta p^2 = .003$) after eliminating the effect of gender of the participants. To test if there was a significant effect of gender and of the male present and male absent experimenter groups on the estimation of the navigational ability a two-way ANOVA was conducted. There was not a significant interaction between the effects of the male present and male absent experimenter group on the estimation of the navigational ability, $F(1, 115) = .932$, $p = .336$.

Discussion

The aim of this study was to investigate how well people can assess their own navigation ability and how this assessment is influenced by gender of the participants as well as the experimenters. In many fundamental or clinical studies, self-reports are used to measure navigational ability (Boone, Gong & Hegarty, 2018) but in this study the navigational ability was measured both objectively and subjectively. This will lead to more information about how people fill in this type of cognitive screening lists, how to interpret self-reports of cognitive performance and to what extent these self-reports are influenced by stereotyping.

In this study we found, in line with our expectations, that the objective navigation ability of males and females is comparable. Possibly, no difference was found in the objective navigation performance because all five systems of navigation (Claessen & van der Ham, 2017) were included in the objective navigation test. This may have contributed to a gender-fair assessment. Similarly, Cornell et al. (2003) also found no consistent gender differences in actual wayfinding. However gender-differences in navigation performance can occur because males and females use different spatial strategies (Sandstrom et al., 1998).

In line with our expectations, we found in this current study that males believe they are better at navigating, whereas females underestimate themselves. Females indicate their sense of direction as worse than males (Cornell et al., 2003) and men tend to overestimate their ability to remember object locations (West, Welch & Knabb, 2002). In addition, it has been known that females and males vary in self-confidence about their abilities and for typical male tasks this gender gap is even bigger (Betz & Hackett, 1983; Beyer, 1990; Deaux & Farris, 1977).

A general stereotype exists that males are better at navigating than females (Rosenthal, Norman, Smith & et al., 2012). Similarly, we found that males and females think mainly that males navigates better or both genders navigates just as well. One explanation for this is that males and females differ in their use of spatial strategies and this cause gender-differences in performance (Sandstrom et al., 1998).

In contrast with our expectation, there was no correlation between the estimation of the navigation ability compared with people of the same gender and the objective navigation performance. This is also in contrast to the research by Stajkovic & Luthans (1998), who showed that a sense of self-efficacy improve performance by 28 percent. Self-efficacy is defined as people's beliefs regarding their capability to succeed and attain a given level of performance (Bandura, 1977). This would mean that a high estimation of navigational ability would lead to a high objective performance. A strong impact of level of spatial confidence has been showed in both psychometric and navigation assessment (Wraga, Duncan, Jacobs, Helt, & Church, 2006). The explanation for the difference between the literature and this study could be due to an underestimation of navigational ability among females and an overestimation of navigation ability in males, while they score equally on objective navigation tests.

There is some evidence that experimenters gender have influence on a variety of psychological and physiological variables (Rumenik, Capasso & Hendrick, 1977; Carter, McNeil, Vowles, Sorrell, Turk & et al., 2002). In contrast to our expectations, did it not matter for the gender comparison score, what the gender of the experimenters was, because there was no significant difference in the estimation between the three (male, female and mixed) gender experimenter groups. Even though the three experimenter gender groups were divided into male present and male absent experimenter groups, and equal in number, no differences were found in the estimation of the navigational ability after eliminating the effect of gender of the participants. And there was no interaction between the effects of the male present and male absent experimenter group on the estimation of the navigational ability. In a follow-up study it would be better to have equal sets of the three gender experimenter groups (also a representative male-male group) to be able to draw an accurate conclusion about the influence of the experimenter's gender on the estimation of the navigation ability compared with people of the same gender.

While certain measures were taken to make this study as generalizable and reliable as possible, there were some limitations to this research. Because we were with eight experimenters, it is possible that the quality and carefulness the experiments fluctuates despite the fact that there was a script and several pilots were taken. In order to minimalize this mistake, because the researchers did not take the tests every time with the same researcher, we rotated the experimenter's couples.

A strength of this research is that to measure the subjective navigational ability, good instruments have been used. The WFQ is an internally valid and reliable instrument that can be used to measure navigation related complaints (Claessen, Visser-Meily, de Rooij, Postma & van der Ham, 2017). The SBSOD scale is a useful instrument for measuring the construct of self-report sense of direction and a high level of internal consistency and test - retest reliability is found (Hegartya, Richardsona, Montellob, Lovelacea & Subbiaha, 2002). Another strength of the current study methodology was that it included a large sample with equal age groups (range 18-75) that were matched in education level and gender, which contributed to the promotion of external validity.

In summary, the navigation ability of males and females is equal, but males often think they are better at navigating, whereas females underestimate themselves. So when interpreting self-reports in existing articles and new surveys, it is important to keep in mind that males may overestimate their navigational abilities and females underestimate their navigational ability and perhaps to compensate for this, separate norm scores are needed for the different genders. Another question that arises is whether there is a certain age, when males tend to overestimate their performance and females tend to underestimate themselves. If this is the case, this could also be taken into account in articles and new studies. Furthermore males and females show a very similar picture of the relationship between gender and navigational ability. Both think mainly that males navigates better or both genders navigates just as well. In this study no effect of the role of the experimenter’s gender was found. In a follow-up study, there should be three equal large experimenter gender groups with only males, only females and mixed groups.

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