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# The Relationship Between Way-Finding Strategies, Spatial Anxiety, and Prior Experiences

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Abstract

Spatial activities during childhood and adolescence are believed to play a role in the development of spatial cognitive abilities. The current study investigated the relationship between spatial activities, way-finding strategy preferences, and spatial anxiety in a sample of 89 female undergraduate students from Brescia University College. Participants completed four online questionnaires addressing childhood spatial activities, adolescent spatial activities, spatial anxiety, and way-finding strategy. Individuals who reported more participation in childhood and adolescent activities reported using a cognitive map way-finding strategy, but the amount of participation in spatial activities reported by an individual did not relate to their use of a route way-finding strategy. No relationship was found between spatial anxiety and other factors. The relationship between spatial activities and way-finding strategies suggests that the development of spatial abilities is dependent on experience.

The Relationship Between Way-Finding Strategies, Spatial Anxiety, and Prior Experiences

Successful navigation of an environment is believed to rest on two strategies: routes and cognitive maps (Siegel & White, 1975; Tolman, 1948). Although very different, route strategy and cognitive map strategy both allow an individual to reach their goal. Way-finding strategies related to route representations involve the association of stimuli in the environment, highlighting only important environmental information to enact a step-by-step sequence, which is quite easy for an individual to follow (Lawton, 1994). These route representations are believed to include landmark information, as well as allocentric information regarding an individuals' movement in the environment surrounding them (Bennett, 1996). According to Siegel and White (1975) internal route-representations of the environment a person is travelling through are formed and used as stepping stones in creation of a larger, hierarchical cognitive map. It has been shown that removal of important visual information from the environment (such as, landmarks) will cause more confusion to a navigator who is using a route strategy than a navigator using a cognitive map strategy, as this navigator is left with no way to infer whether they are continuing on the correct path (Siegel & White, 1975). Siegel and White (1975) proposed that not every individual is able to form a complete cognitive map due to the strain it puts on an individual's cognitive resources. According to Weisberg and Newcombe (2015) those individuals who rely on route strategy are those who have yet to form a complete cognitive map. Tolman (1948) has defined a cognitive map as a mental representation made up of routes, paths, and environmental relationships, such as cardinal directions, which an individual uses for making way-finding decisions. Using a cognitive map strategy is thought to give an individual more flexibility in navigation, and allows more successful use of shortcuts (O'keefe & Nadel, 1978).

Individuals differ in their ability to perform navigational tasks when instructions require the use of a cognitive map strategy (Saucier et al, 2002). Researchers have concluded that these differences lie in the ability to encode spatial information from sensory experience, the quality of preserved internal representations, and the ability to infer from and transform spatial representations once they have been created (Weisberg & Newcombe, 2015). Expanding on this Ishikawa and Montello (2006) observed that some people form metric knowledge of their environment quite quickly, and some people never seem to form accurate metric knowledge of their environment at all. In order to describe the individual differences people display in their ability to navigate and build a cognitive map Weisberg, Schinazi, Newcombe, Shipley, and Epstein (2013) classified individuals using three distinct groups. Those who performed highest on both within route pointing tasks (pointing to a building on the route a participant is currently on) and between route pointing tasks (pointing to a building on a route separate from the route they are currently on) in a virtual environment were labeled “integrators”, as it is believed that the integration of multiple learned routes allows an individual to make cross-route inferences. Weisberg et al. (2013), concluded that integrators are not necessarily more likely to use a cognitive map strategy, but are more successful than others when they choose this strategy to navigate, while non-integrators (those individuals who perform well on within route pointing tasks, but struggle with between route pointing tasks) perform better when using a route strategy.

The differences between peoples’ ability to acquire and perform way-finding with a cognitive map may be influenced by factors such as feelings of stress or anxiety during navigation in a new environment. Lawton (1994) investigated whether way-finding strategy was related to spatial ability and spatial anxiety. Lawton created a way-finding strategy scale to determine a participant’s preference for either route or cognitive map strategy during large scale navigation in a vehicle, which established evidence that men self-report a higher preference for cognitive map strategy, and women self-report a higher preference for route strategy (Charleston, 2008; Lawton, 1994). Lawton and Kallai (2002) took this gender difference research a step further by making the way-finding strategy scale relevant cross-culturally. Using the newer way-finding strategy scale, it has been established that individuals who self-report preference of the cognitive map strategy were found to be more effective navigators, as they were quicker and made less mistakes than those who preferred a route strategy (Hund & Minarik, 2006). The self-reported preference for cognitive map strategy is also seen more in older individuals than in younger individuals (Lawton, 1994), which suggests that experience may allow an individual to improve their spatial skills and, therefore, be able to use more reliable way-finding strategies.

Research regarding youth experiences with spatial activities, including childhood and adolescent activities, has suggested that spatial activity participation contributes to individual differences in spatial ability (Charleston, 2008; Lawton & Kallai, 2002; Uttal et al., 2013). Activities defined as masculine tend to require a higher degree of spatial ability than activities that are defined as feminine or neutral (Lawton, 1994), and a higher engagement in these masculine activities is believed to play a role in the preference for a cognitive map strategy (Lawton, 1994). The spatial activities a child participates in during early youth (up to age 13) are predictive of not only the spatial activities that child will participate in later on in adolescence, but also the way that an individual tends to think about spatial matters (referred to as their spatial habits of mind) later in life (Peterson et al., 2016). These spatial habits of mind and spatial activity participation have been found to be particularly important for the development of spatial ability in women (Peterson et al., 2016).

A male advantage has been demonstrated in a variety of spatial tasks, suggesting that spatial ability is more developed in males than in females (Maeda & Yoon, 2013). For example, Weisberg and Newcombe (2015) found that men tend to score higher than women in spatial perception tasks, such as pointing tasks and model building tasks. Also, Lawton (1994) found that men have a higher preference for use of a cognitive map strategy than women. Next, Lawton and Kallai (2002) showed that women tend to prefer the use of a route strategy and self-report more spatial anxiety than men. Finally, Weisberg and Newcombe (2015) found that men are less likely to fall into the category of imprecise navigator (those who scored low on both between and within route pointing tasks in a virtual environment) than women, but that both genders are equally likely of falling into the non-integrator category. These differences in spatial ability may be attributable to the way that men and women cognitively represent spatial information. It is believed that men tend to represent spatial information in large configurations, whereas women tend to represent spatial information segmentally, or broken down into smaller parts instead of as a singular mental representation (Hegarty, Montello, Richardson, Ishikawa, & Lovelace, 2006).

The tendency for men to report a higher preference for the use of cognitive map strategy than women has been attributed to greater childhood experience in navigation and spatial activities (Lawton & Kallai, 2002). Research on the types of activities children tend to participate in has shown that boys tend to participate in more masculine-defined activities, such as sporting games (baseball, basketball, etc.) and building (woodworking, automotive, etc.), whereas girls tend to participate in more feminine-defined activities (such as embroidery, ballet, etc.), leading women to have less spatial experience (Signorella, Krupa, Jamison, & Lyons, 1986). Boys also possess an advantage in direct navigational experience, as they are given more freedom to travel greater distances from home than girls are due to the perception that females are at a higher risk of physical attack and harassment than males (Lawton & Kallai, 2002). This exposure to navigational experience has been found to be related to the male preference for cognitive map strategy, as well women's self-report of spatial anxiety such that women who report less experience with navigation report higher levels of spatial anxiety than do women who have more experience in navigation (Lawton & Kallai, 2002).

Lawton and Kallai (2002) described anxiety about taking a new route, using an unknown shortcut, or figuring out which way to turn when leaving a parking lot as way-finding or spatial anxiety. Lawton (1994) demonstrated that as spatial anxiety increased, the use of a cognitive map strategy decreased in participants. Self-reported spatial anxiety has been linked to performance on real-world navigation tasks - efficiency on these tasks increases as spatial anxiety decreases (Hund & Minarik, 2006). Women, having less experience with spatial tasks and navigation in general (Lawton & Kallai, 2002), may begin their way-finding experience with spatial anxiety present. This increased anxiety may itself lead to a lack of motivation to explore new environments or reduce the ability to focus on important aspects of the environment, negatively impacting the amount of navigational experience or exposure for women.

Prior research has been focused on the differences in way-finding strategy between sex (Hund & Minarik, 2006; Lawton, 1994; Lawton & Kallai, 2002; Saucier et al., 2002), in the current study an all female sample was used to observe the difference found within sex. Peterson et al. (2016) reported that females are more affected than males by spatial activities in youth. In their study involving self-report of both childhood and adolescent activity participation, it was concluded that female spatial habits of mind were explained at a greater proportion by childhood activities than males. In the current study, the spatial anxiety and way-finding strategy tools created by Lawton and Kallai (2002) were used to investigate the relationship between spatial anxiety and way-finding strategy in an all female sample. Along with these, Signorella et al.'s (1986) childhood activities subscale (CAQ) of the Newcombe, Bandura, and Taylor (1983) spatial activities questionnaire was used to investigate the relationship between childhood activities and way-finding strategy preference. Finally, Voyer, Nolan, and Voyers' (2000) spatial activities questionnaire (SAQ) was used to investigate the relationship between adolescent activities and way-finding strategy preference. It was expected that lower spatial anxiety scores would be associated with increased use of a cognitive map strategy, while higher scores would be associated with increased use of a route strategy. It was also expected that higher scores related to childhood and adolescent spatial activities would be positively correlated with a preference for cognitive map strategy and negatively correlated with preference for a route strategy. Furthermore, and consistent with Siegel and White (1975), it was expected that all participants who preferred cognitive map strategy would also show a high preference for route strategy, but not all participants who preferred route strategy would also show a high preference for cognitive map strategy. This final prediction allowed for exploration of not only individual differences within an all female sample, but also replication of the findings produced by Weisberg and Newcombe (2015), which supported the sequential formation of way-finding strategy, such as proposed by Tolman (1948).

# Method

## Participants

Participants were 89 female introductory psychology students from Brescia University College. Participants were recruited through the Brescia Psychology Research Participation System. The mean age of participants was 19 years of age (ranging from 18 to 42). Participants received Psychology 1000 class credit for participating in this research. Data from one participant was omitted from the sample due to failure to complete the entire study. Data were used from a total of 88 participants.

**Materials**

**Spatial Anxiety Scale.** The revised Spatial Anxiety Scale (Lawton & Kallai, 2002), measured self-reported anxiety during a recent way-finding experience. The questionnaire consisted of 8 items, and responses to these items were rated on a 5-point scale from not at all anxious to very anxious. The revised version was created to accommodate for cross-cultural differences, but is also more applicable to the student population in the current research than the original Spatial Anxiety Scale (Lawton, 1994), due to the replacement of “driving” items with general “travelling” items.

**Way-finding Strategy Scale.** The revised Way-finding Strategy Scale, (Lawton & Kallai, 2002), was used to measure participants’ preference for way-finding strategy. Lawton and Kallai reworded and combined the original Way-Finding Strategy Scale (Lawton, 1994) with Lawton’s (1996) Indoor Way-Finding Scale for purposes of cross-cultural use, but as with the Spatial Anxiety Scale, the replacement of “driving” items with “travelling” items made this scale more applicable to the population of interest in the current research. The scale presents 17 items, which were comprised of different behaviours used for navigation in an unknown environment. Participants were asked to think of a recent way-finding experience and rate the items on a 5-point scale from not true at all to very true, regarding how well these items fit with their experience.

**Childhood Activities Questionnaire (CAQ).** Ratings of childhood spatial activities were measured using the spatial activities subscale of the Childhood Activities Questionnaire created by Voyer, Nolan, and Voyer (2000). The CAQ consisted of 21 common spatially related childhood play activities (e.g. puzzles, softball, and painting). Participants were asked to rate their participation in these 21 activities prior to the age of 13. Ratings were recorded on a 7-point scale from never participated to participated more than once a week.

**Spatial Activities Questionnaire (SAQ).** Adolescent spatial activities were measured using the shortened version of Newcombe, Bandura, and Taylor's (1983) Spatial Activities Questionnaire created by Signorella, Krupa, Jamison, and Lyons (1986). The questionnaire consisted of 10 masculine, 10 feminine, and 10 neutral spatial activities. Participants were asked to rate their participation in these 30 activities during their time in high school. Ratings were recorded on a 7-point scale from never participated to participated more than once a week.

## Procedures

Participants were recruited through the Brescia Psychology Research Participation System. Once logged in they had the option to choose participation in this study. At this time an introductory statement was presented, informing them of the requirements of the study and also informing them that completion of the questionnaires was indication of their consent to participate. After the participant had read this information she was able to move on to the questionnaire portion of the study. All questionnaires were presented and completed online using the Brescia Psychology Research Participation System. Questionnaires were presented in the following order: Spatial Anxiety Scale, Way-finding Strategy Scale, Childhood Activities Questionnaire, and Spatial Activities Questionnaire. Once all questionnaires were complete the participant was presented with closing information including a debriefing which could be printed for her records.

# Results

Average participation scores for adolescent spatial activities (SAQ) ranged from 1.00 to 4.47 out of a possible total of 7.00 ($M$ = 2.07, $SD$ = 0.64), while average participation scores for childhood activities (CAQ) ranged from 1.33 to 5.05 out of a possible total of 7.00 ($M$ = 3.16, *SD* = 0.77). Correlations displayed in Table 1 were conducted to determine the relationship between spatial activities, anxiety, and way-finding strategies. Adolescent spatial activity participation had a strong, positive, significant correlation with childhood spatial activity participation, $r(86) = .68$, $p < .001$ (see Figure 1) indicating that the more an individual participated in childhood spatial activities the more they also participated in adolescent spatial activities. To analyze the way-finding strategy scale, items were divided to create a route strategy score and a map strategy score. The initial 11 items in the scale were used to calculate a map strategy score, which expressed the degree of preference for way-finding methods associated with the use of a cognitive map. The final six items in the scale were used to calculate a route strategy score, which expressed the degree of preference for way-finding methods associated with the use of routes. Route strategy scores ranged from 1.00 to 5.00 out of a possible 5.00 (*M* = 3.88, *SD* = 0.73), and map strategy scores ranged from 1.00 to 4.55 out of a possible 5.00 (*M* = 2.50, *SD* = 0.71). As shown in Table 1, adolescent spatial activity participation had a moderate, positive, significant correlation with map strategy scores, $r(86) = .34$, $p = .001$ (see Figure 2), while no correlation was observed between adolescent spatial activity participation and route strategy scores, $r(86) = .03$, $p = .82$ (see Figure 3). Similarly, childhood spatial activity participation had a moderate, positive, significant correlation with map strategy scores, $r(86) = .31$, $p = .002$ (see Figure 4), and no correlation observed with route strategy scores, $r(86) = -.05$, $p = .62$ (see Figure 5). A weak, positive, significant correlation was observed between route strategy and map strategy scores, $r(86) = .28$, $p = .004$. Spatial anxiety scores ranged from 1.00 to 4.50 out of a possible 5.00 (*M* = 2.82, *SD* = 0.72) and had no significant correlation with other variables measured.

A stepwise multiple regression was completed in SPSS to determine whether childhood

Table 1
Summary of Correlations, Means, and Standard Deviations of Age, Scores on the SAQ, CAQ, Spatial Anxiety Scale, and Way-Finding Strategy Scale

| Measure | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1. Age | - | | | | | |
| 2. SAQ | -.12 | - | | | | |
| 3. CAQ | -.003 | .68* | - | | | |
| 4. Spatial anxiety | -.08 | -.11 | -.13 | - | | |
| 5. Route strategy score | -.02 | .03 | -.05 | .17 | - | |
| 6. Map strategy score | -.01 | .34* | .31* | .03 | .28* | - |
| *M* | 19.24 | 2.07 | 3.16 | 2.82 | 3.88 | 2.50 |
| *SD* | 3.46 | 0.64 | 0.77 | 0.72 | 0.73 | 0.71 |

*p < .01

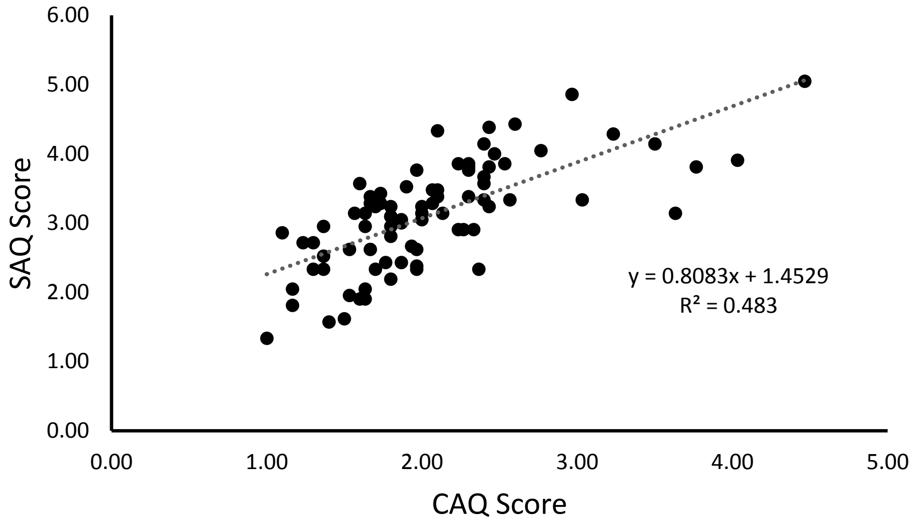


Figure 1. Correlation between self-reported adolescent activity participation (SAQ) and childhood activity participation (CAQ).

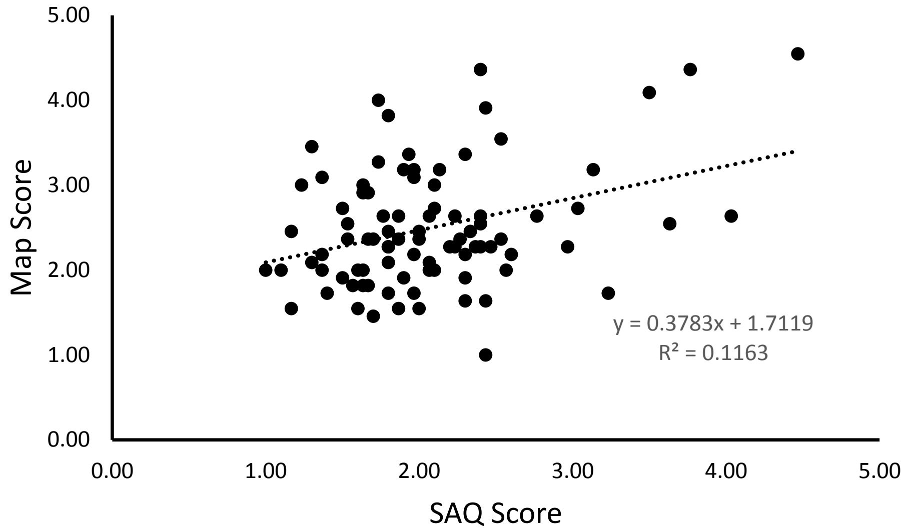


Figure 2. Correlation between self-reported adolescent activity participation (SAQ) and map strategy score.

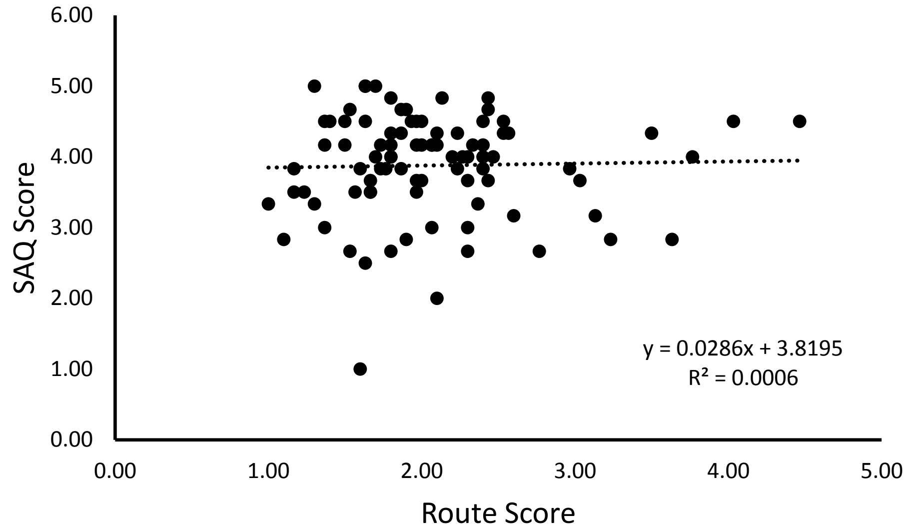


Figure 3. Correlation between self-reported adolescent activity participation (SAQ) and route strategy score.

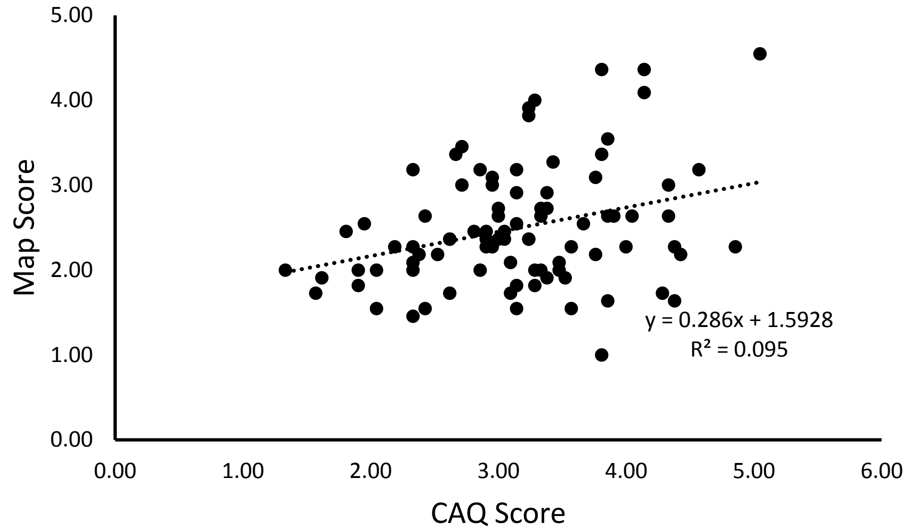


Figure 4. Correlation between self-reported childhood activity participation (SAQ) and map strategy score.

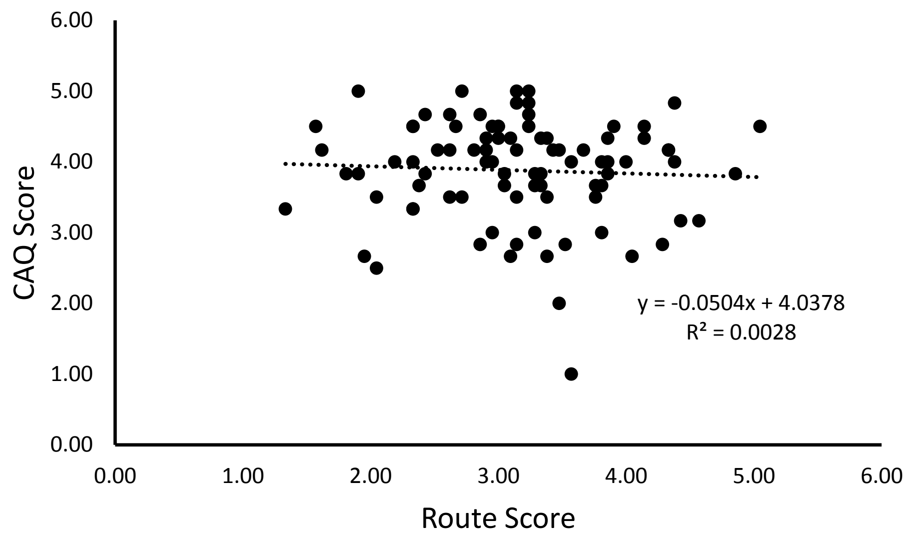


Figure 5. Correlation between self-reported childhood activity participation (SAQ) and route strategy score

and adolescent spatial activities would predict the degree of preference for map strategy. Only one variable was entered into the model, adolescent spatial activities, β = .38, *p* = .001, this predictor significantly accounted for 12% of variance in map strategy scores, $R^2 = .12$, $F(1, 86) = 11.32$, p = .001. Childhood activity participation was excluded from the final model as it did not predict a significant amount of variance in map scores, β = .14, p = .31.

A second stepwise multiple regression was completed in SPSS to determine whether childhood and adolescent activity participation would predict the degree of preference for route strategy, however, no variable was a significant predictor (adolescent spatial activities r(86) = .03, p = .41; childhood spatial activities r(86) = -.05, p = .31).

Finally, Figure 6 shows the relationship between route strategy scores and map strategy scores and provides information about the hypothesis that individuals who preferred cognitive map strategy also show a high preference for route strategy, but not all participants who prefer route strategy also show a high preference for cognitive map strategy. The data show that while very few participants did not report using route strategy, there were no participants who reported both very little use of route strategy and high use map strategy. While most participants reported a greater reliance on route strategy, and a low to moderate use of map strategy, there were also participants who reported a high use of both route and map strategy simultaneously, but no participants in indicated a low use of route strategy and a low use of map strategy simultaneously.

## Discussion

As expected higher scores related to childhood and adolescent spatial activities were positively correlated with a preference for cognitive map strategy, while counter to what was hypothesized these activities were not related to a preference for route strategy. Also, spatial

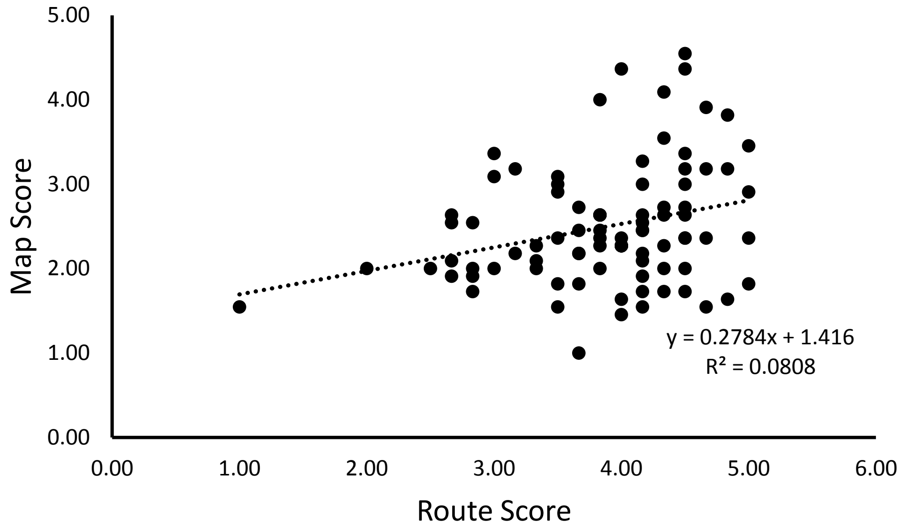


Figure 6. Correlation between map strategy score and route strategy score.

anxiety was not related to a preference of either map strategy or route strategy, and was not related to either adolescent or childhood spatial activity participation, counter to what was hypothesized. These analyses did support the prediction that participants who showed a high preference for cognitive map strategy also showed a high preference for route strategy, but not all participants who reported using route strategy also reported a preference for cognitive map strategy.

Within the current sample, route strategy scores were higher than cognitive map strategy scores, and more people could be classified as a “route person” than a “map person”, although a three-group classification may be a more complete description of the range of abilities seen within the sample. A three-group classification was proposed Weisberg et al. (2013), who described three different levels of way-finding ability (integrators, non-integrators, and imprecise navigators). Whereas the current study investigated the strategies these individuals use to navigate, Weisberg and Newcombe (2015) used within and between route pointing tasks to compare the spatial abilities of individuals who fell within each of the three groups. The relationship between these variables (abilities and strategies) have been a focus of research in the past (Weisberg & Newcombe, 2015) and those navigators who use strategies associated with cognitive maps are typically found to navigate faster and more accurately than those who rely on route strategy (Saucier et al, 2002). This model would suggest that our sample should divide into Weisberg et al.’s (2013) three groups as follows: those who reported high use of both map strategies and route strategies would fall into the category of integrators, those who reported high use of route strategies and low use of map strategies would fall into the category of non-integrators, and those who reported low use of both way-finding strategies would fall into the category of imprecise navigators.

The ability to navigate using a cognitive map has been shown to be related to lower anxiety during navigation (Lawton & Kallai, 2002). Lawton (1994) reported a weak but significant negative correlation between spatial anxiety and the use of a cognitive map strategy, and this finding was supported by Lawton and Kallai (2002), who along with a significant negative relationship between anxiety and cognitive map strategy also found a significant positive relationship between route strategy and spatial anxiety. Additional evidence of a relationship between anxiety and spatial abilities is found in research indicating that higher anxiety in participants leads to more errors on spatial tasks including directed navigation, pointing tasks, and mental rotation (Hund & Minarik, 2006; Lawton, 1994; Weisberg & Newcombe, 2015).

Consistent with the findings from the current sample, Saucier et al. (2002) found no relationship between spatial anxiety and performance on a navigational task where either geometric instructions or landmark instructions were followed. They proposed that measures of pre-navigational versus post-navigational testing create different levels of self-reported spatial anxiety in a participant and contribute to the conflicting findings. Based on their proposal, it would seem that anxiety is highest when measured before a behavioural task. In the current data, very little variation in anxiety existed. That is, the entire sample seemed to have very low scores on the spatial anxiety scale administered. It is possible that the low scores on spatial anxiety and the lack of a relationship between anxiety and other variables measured is due to the forms of methodological constraints proposed by Saucier et al. (2002). Since no behavioural task was administered before or after the SAS, and online data collection allows participants to feel more at ease, participants may have reported their feelings of anxiety during way-finding tasks less accurately than if a behavioural task was to be administered. These constraints would also explain why no relationship was found between anxiety and spatial activities experienced during childhood and adolescence, despite previous reports of negative correlations between spatial anxiety and other forms of spatial experience, that suggest spatial anxiety significantly decreases individuals ability to complete spatial tasks, such as navigation (Hund & Minarik, 2006; Lawton, and Kallai, 2002).

Spatial activities experienced in childhood and adolescence did not relate to participants' anxiety about way-finding but were related to individual preferences in way-finding strategy. Specifically, the number of spatial activities participated in during both childhood and adolescence was associated with a higher tendency to use a cognitive map strategy. Although the relationship between spatial strategy preference and experience has not been directly studied in the past, the results do support findings of previous research regarding the development of way-finding strategies. Peterson et al. (2016) has proposed that experience with spatial activities in youth may have a positive impact on pencil and paper measures of spatial ability (e.g. mental rotation tasks), as well as spatial habits of mind (Peterson et al., 2016). Peterson used a mental rotations test to investigate the relationship between spatial abilities and childhood and adolescent activities. Peterson et al. (2016) concluded that the relationship between these variables is dependant on sex and on the type of activities participated in, specifically they found that video game participation was significantly positively correlated with female mental rotation performance and that there was a positive relationship between spatial habits of mind and childhood spatial activities. Although in the current study only a moderate correlation was found between both groups of spatial activities and cognitive map strategy, this finding implies that experience in spatial activities is important for the development of way-finding habits, and strategies.

The relationship between way-finding strategies and spatial activity experience is further complicated by the finding that adolescent activities predict the use of cognitive maps, while childhood activities do not. It is possible that this relationship lies in the carrying over of activities from childhood to adolescence, such that an individual who participated in activities in their elementary years (birth to age 13) is likely to continue those activities (and possibly even expand those activities) throughout their adolescence. Meaning that the activities an individual participates in during childhood can not uniquely contribute to way-finding strategy preference when adolescent spatial activities are considered as well, this is supported by the positive correlation between childhood and adolescent activities found in the current study.

Females in the current sample reported more adolescent spatial activity participation than childhood activity participation, and there may be multiple influences on the increase in spatial activities seen in adolescence. Females may become more in control of the activities they participate in after a certain age, with parents letting their daughters become more independent in certain decision making. As well, children may discover new activities as they age, or be more inclined to participate in activities as they mature. Future research should investigate the differences in spatial activity participation and it's influences in youth and adolescence.

Future research on the differences between childhood and adolescent spatial activities could improve current understandings of spatial ability development and the role that specific forms of spatial activity have on way-finding strategies. The SAQ and CAQ both include a broad range of activities which could be broken down into subtypes to study this effect. Also, the current study did not include a measure of video game or virtual environment experience, which have become relevant to spatial learning in the present day (Peterson et al., 2016, Wolbers & Hegarty, 2010). Theories regarding the malleability of spatial abilities as put forth by Uttal et al.

(2013), suggest that with training it is possible to improve spatial abilities. Although direct experience with way-finding is believed to play a major role in development of these strategy preferences (Charleston, 2008; Hund & Minarik, 2006; Lawton & Kallai, 2002), our findings indicate that training in basic spatial activities could be a positive start.

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