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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 44(44)

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Publication Date
2022

Peer reviewed

Large-Scale vs Small-Scale Spatial Abilities: Development of a Broad Spatial Activities Questionnaire

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Abstract

There is growing evidence that spatial abilities can be improved through training, including participation in hobbies and everyday activities that involve spatial thinking. In order to better assess the contributions of everyday spatial activities to the development of spatial skills, we developed a new self-report questionnaire of spatial activities by adding updates and navigation activities to an existing questionnaire. A principal component analysis revealed five interpretable components which were compared to measures of perspective taking, mental rotation and two other self-report scales. Small but significant correlations were found between the 'navigation' component of the spatial activities questionnaire and a self-report measure of sense of direction, as well as self-reported childhood wayfinding experience. No sex difference was found on the 'navigation' component. This questionnaire is currently being used in a large study of spatial abilities.

Keywords: spatial activities; hobbies; navigation; large-scale vs. small-scale spatial ability; sex differences; individual differences

Introduction

Spatial abilities vary across individuals, and this variation is associated with success in STEM fields (Wai, Lubinski, & Benbow, 2009) and in everyday tasks including navigation (Wolbers & Hegarty, 2010). Although some of this variance is due to genetic differences (Malanchini et al., 2020), there is increasing evidence that performance on measures of spatial ability improves with training and participation in other spatial activities. For example, a meta-analysis (Uttal et al., 2013) found an average improvement of half a standard deviation as a result of spatial experience, which included courses, video games, and task practice. The result that not just formal (courses) but also informal (video games) experiences can enhance spatial ability raises questions about the contribution of other everyday spatial activities to the development of spatial skills.

To address these questions, it is important to first consider what makes an activity "spatial." In an early study of spatial activities, Newcombe, Bandura, and Taylor (1983) stated that "...no consensus exists concerning which of the multitude of adolescent and adult activities are spatial" (p. 378), and this statement remains true today. Generally, definitions in the literature only include small-scale spatial abilities; that is, the ability to perform mental transformations of objects that are smaller than the body, from a single vantage point. This includes the more commonly-tested processes of mental rotation (Vandenburg & Kuse, 1978), spatial visualization (e.g., paper folding, Eckstrom, French, & Harman, 1979), and cross sectioning (e.g., Cohen & Hegarty, 2012; Titus & Horsman, 2009). Large-scale or environmental-scale spatial abilities, i.e., thinking about spaces (such as a building or neighborhood) that are apprehended by moving through space (Hegarty et al., 2006; Montello 1993), have been overlooked in studies of spatial activities. For example, Peterson et al. (2020) define them as "...activities that involve reasoning about qualities of space (e.g., distance, proportion), practicing mental visualization (e.g., imagining spatial layouts or spatial trajectories), and observing the positions of physical objects. These activities can include sports, play activities, artistic endeavors, and technological pursuits" (p. 2).

Self-report Questionnaires of Spatial Activity Involvement

Small-Scale Activities The majority of self-report questionnaires assessing spatial activity participation have also focused on small-scale spatial activities. The earliest and most widely used scale is the Spatial Activities Questionnaire (SAQ) developed by Newcombe et al. (1983), which began with 231 activities and was shortened to 81 items by including only those which were judged to involve spatial skill by at least 75% of judges. This initial scale was validated against the Spatial Relations portion of the Differential Aptitudes Test (Bennett, Seashore, & Wesman, 1947), a measure of paper folding ($N = 45$, $r = .33$, $p < .05$). The activities were also classified as masculine, feminine, or neutral. Signorella et al. (1986) shortened the SAQ to 30 items (the 10 masculine, feminine and neutral items most correlated with the scale score), and this shortened version

In J. Culbertson, A. Perfors, H. Rabagliati & V. Ramenzoni (Eds.), *Proceedings of the 44th Annual Conference of the Cognitive Science Society.*

was found to be correlated with Piaget's water level task (WLT; Wittig & Allen, 1984) for female participants (n = 28, r = .50, p < .01), but not for male participants (r = .10). More recently, Nazareth et al. (2013) found a significant correlation (r = .21, p < .001) between scores on a mental rotation test (MRT; Vandenberg & Kuse, 1978) and the "masculine" items on the scale, and that participation in masculine spatial activities mediated sex differences in mental rotation.

In a related research program, Voyer, Nolan, and Voyer (2000) assessed childhood activities which were categorized as either non-spatial (14) or spatial (21), and as toys (18) or sports (17) and found that preference for spatial toys in childhood was associated with better performance on the MRT and the WLT. Cherney and Voyer (2010) developed an improved Childhood Activities Questionnaire (CAQ) based on a factor analysis of items from this and other scales (Bates & Bentler, 1973; Newcombe et al., 1983). Using this questionnaire, Doyle, Voyer, and Cherney (2012) found that spatial activities were significantly correlated with the MRT (r = .27, p < .01) and WLT (r = .26, p < .01), and the same held for masculine activities (MRT, r = .27, p < .01; WLT, r = .25, p < .01). In sum, researchers have been relatively successful in finding relationships between spatial activities and small-scale spatial abilities, and have considered the additional factor of sex differences in these findings.

Large-Scale Activities In contrast with small-scale spatial activities, only a handful of studies have focused on the effects of childhood activities on navigation abilities and strategies. Lawton and Kallai (2002) assessed wayfinding experience by asking people how far they were allowed to travel alone (*¼ mile* to *5 miles or more*) and how often they went on errands alone (*almost never* to *once a week or more*) at three different ages (8-10, 11-13, and 14-15). Men reported more childhood wayfinding experience than women, and wayfinding experience was significantly correlated (r = .13) with self-reported use of an orientation strategy for navigation and significantly negatively correlated (r = -.18) with route strategy use in a large study (n = 684). Similar results were observed by Vieites, Pruden, and Reeb-Sutherland (2020), who also found that childhood navigation experience predicted wayfinding anxiety (r = -.24) and mediated the difference between sexes in route-based strategy use. Malinowski and Gillespie (2001) developed a nine-item questionnaire focused on outdoor activities (e.g. orienteering, camping). In a study of students in a military college (n = 978), men reported participating in significantly more of the spatial activities (M = 3.1) than women (M = 2.4), and spatial activities predicted performance on an orienteering task. Finally, in a study of middle schoolers in Australia, Harris et al. (2018) created the broadest spatial activity questionnaire to date, which encompassed both small-scale and large-scale spatial abilities and included four categories (creative, sport, construction-games, and navigation). These three questionnaires provide a good starting point, but do not fully encompass the range of modern spatial activities.

Developing an Updated Questionnaire

The goal of this research was to develop an updated and more comprehensive measure of everyday spatial activities. We believe that this is necessary for several reasons. First, the most widely used spatial-related activities self-report questionnaire, the SAQ (Newcombe et al., 1983; Signorella et al., 1986) was developed over 35 years ago. As a result, some of the items (e.g., disco dancing) are out of date, while rapid changes in technology over the past several decades have resulted in new spatial activities such as video games. GPS technologies have also drastically changed how we camp, travel, hike, etc. and facilitated the creation of Augmented Reality (AR) games such as Pokemon Go. These changes in technology have likely affected the way modern activities impact spatial ability.

Second, research on individual differences in spatial cognition has broadened to encompass large-scale spatial abilities involved in navigation, including the ability to learn the layout of an environment (Ishikawa & Montello, 2006; Weisberg & Newcombe 2018). It is well supported that large-scale and small-scale spatial abilities, although correlated, involve dissociable cognitive processes (Allen et al., 1996; Hegarty et al., 2006). Most of the past questionnaires focused on activities that might enhance small-scale spatial abilities (such as mental rotation and paper folding), while others have focused exclusively on large-scale abilities (Lawton & Kallai, 2002; Malinowski & Gillespie, 2001; Vieites et al., 2020). There is a need for a questionnaire that assesses *both* large-scale and small-scale abilities using a common methodology, following the lead of Harris et al. (2018).

Third, as noted by Weckbacher and Okamoto (2012), most previous research on spatial activities was focused on understanding sex differences in spatial abilities. This may have resulted in a limited number of activities (e.g. to balance the number of "masculine" and "feminine" activities). Given changes in gender roles and stereotypes over the last 35 years, a priori classification of activities in this way seems inadvisable. Moreover, our goal is to examine activities that may affect spatial abilities in general, rather than sex differences in these abilities, while we also consider the empirical question of the extent to which men and women report different types of spatial activities.

Finally, several questionnaires' scales for rating involvement in each activity were vague, such as a rank of favorite activities (Weckbacher & Okamoto, 2012) or a simple 'yes' or 'no' indicating participation (Malinowski & Gillespie, 2001). Others did not specify what period of their lives the participants should consider for involvement in the activities (e.g., Signorella et al., 1986).

Goals of present study

The present study aimed to create an up-to-date, comprehensive spatial activities questionnaire by including large-scale spatial abilities (e.g. Pokemon Go, geocaching, rideshare driving, etc.) while also updating the list of small-scale activities to include modern activities that have been invented since the original SAQ (Newcombe et al., 1983). Another goal of this study was to remove items that may have decreased in popularity since the 1980s. Because the time period asked about in previous studies varied and was often ambiguous, we used more specific wording, including specific labels for what we mean by “frequent” vs. “occasional” participation for different activities. We used a principal component analysis to reduce the 65 items on our scale to a smaller number of dimensions that captured different types of spatial activities. We report correlations of these dimensions with existing measures of both large and small-scale spatial abilities, and sex differences in these dimensions. Overall, the questionnaire was designed to include a wide enough variety of items to catch important factors that contribute to individual differences in spatial abilities, while also keeping it short.

Method

Participants

205 students from introductory Psychology and Geography courses were invited to participate for course credit. Incomplete responses (47) were removed. Five additional participants averaged less than five seconds per problem (and more than three standard deviations below the mean time) in each of the three mental rotation tasks and were not included in the data analysis leaving 153 participants (61 male, 92 female). Participants’ ages ranged from 17 to 29 (M = 18.97, SD = 1.39).

Materials

Southern California Spatial Activities Questionnaire (SoCalSAQ). The spatial activities questionnaire that was administered included the short version (30 items) of the SAQ (Signorella et al., 1986) and 35 additional items. To generate the new items, approximately 25 members of our labs were prompted with the question: “What are some activities or hobbies you've participated in that you feel have improved your navigational ability, spatial awareness, or your sense of direction?” Similar responses were combined in order to keep the list short. Activities were also drawn from the questionnaires of Harris et al. (2018) and Malinowski & Gillespie (2001), i.e., *walking to school, using public transportation e.g. to go to school, hiking, horseback riding, fishing,* and *camping*. The scale was a 6-point Likert scale, as in the original SAQ. In answering, the participants were asked to “think of the time in their lives in which [they] were most involved in the activity”. The labels for the upper extremes of the scale were varied for different activities. For example, for playing video games, “often” was defined as “daily”, whereas for hiking, often was defined as “weekly”, and for sailing, often was defined as “once per month”. The items were grouped based on likely frequency of participation and new instructions indicating the change in scale labels were given in between the “daily”, “weekly”, and “monthly” activities.

Santa Barbara Sense of Direction (SBSOD) A 15-item questionnaire developed by Hegarty et al. (2002) to assess individuals’ self-reported sense of direction. This was included to test for a relationship between sense of direction and participation in navigation-related activities.

Childhood Wayfinding Experience (CWE) This questionnaire, developed by Lawton and Kallai (2002) to assess exploration and distance traveled during three different age groups (8-10, 11-13, 14-15), was used as an additional self-report measure of navigation experiences, to compare with large-scale activity participation.

Money Road Map Test (RMT). A version of the Money Road Map Test (Money, Alexander & Walker, 1965), a measure of perspective taking, was adapted for Qualtrics administration. Participants were shown a map of a path with many turns through a city environment and had a 30 second time limit to judge the direction (left or right) of each turn on the path. The ‘S’ and ‘K’ keys were used to indicate a left turn and a right turn, respectively. The test was scored by giving one point for each correct response.

Flags Rotations Test. The Flags Rotations Test (Thurstone & Jeffrey, 1959), a measure of two-dimensional spatial ability, was adapted for Qualtrics. Each problem presented a standard flag with six answer choices that were either rotated (in the picture plane) versions of the example or rotated and mirrored versions. Participants were instructed to select all answer choices that were rotations of the standard and leave mirrored versions unselected, and were allowed 5 minutes to complete the 21 test items. The score was the number of items correctly marked (or correctly rejected) minus the number incorrect (misses or false alarms). Unattempted items were scored as zero.

Card Rotations Test. The Card Rotations Test (Ekstrom et al., 1979) was adapted to be administered through Qualtrics. For each problem, a 2-dimensional shape was shown with eight answer choices representing either a rotated (in the picture plane) version of the same shape or a rotated and mirrored version. The participants were instructed to select all answer choices that were the same shape as the example, and leave any mirrored shapes unselected. They completed two sections of 10 items and were allowed three minutes for each section. The scoring procedure was the same as for the Flags Rotations Test.

Purdue Spatial Visualization Tests: Visualization of Rotations (PSVT:R) The revised PSVT:R (Yoon, 2011) was administered through Qualtrics. Each problem gave an example of a 3-dimensional figure which was also shown rotated over at least one axis. The participant then had to apply the same rotation(s) to a different 3-dimensional figure. Five answer choices were given. The test had 30 items which were presented in a random order on one page. Participants were given unlimited time to complete all items. The task was scored by totaling the number correct.

Procedure

We sent participants a link to a Qualtrics survey once they enrolled in the study. All tasks were completed online. Participants first provided informed consent and were told that it must be completed on a computer, not a phone or tablet (as the RMT required use of a keyboard). The questionnaires and tasks were presented in the same order (Demographics, RMT, short SAQ, Flags, our additional 35 spatial activities, Cards, SBSOD, PSVT:R, CWE). Items on the Flags, Cards, PSVT:R and SBSOD were presented in a random order. Due to experimental error, 60 participants completed the Flags and Card Rotation tests without a time limit, so data for these tests are reported only for the 93 participants who had the usual time limits. The total study time was between 45 minutes and an hour.

Results

Descriptive Statistics

The mean responses for items in the short SAQ (Signorella et al., 1986) and our additional items ranged from 1.05 (*baton twirling*) to 4.79 (*jogging/walking*) out of a maximum of 6. Four items (*baton twirling, building go-carts, quilting, making/fixing radios*) from the short SAQ had low means (<= 1.11 out of 6) and low standard deviations (<= .42), supporting the claim that activity participation has changed since the SAQ was developed. These items were removed due to low variance.

Principal Component Analysis

A principal component analysis (PCA) was conducted, using Varimax rotation with Kaiser normalization. The analysis converged in 10 iterations and a Scree plot suggested five components. There were eight items which did not load at least .32 on any component (*walking to school, astronomy, car repair, knitting, biking, softball, target shooting* and *using public transportation*) and were removed based on criteria from Tabachnik and Fidell (2007). The five components accounted for 41.5% of total variance.

Table 1: Component loadings by questionnaire item

	Component				
Item	1	2	3	4	5
Navigation (Component 1)					
camping*	**0.673**	0.113	0.069	0.213	0.044
hiking*	**0.665**	0.134	0.068	0.271	-0.022
parkour*	**0.613**	0.206	0.132	-0.168	0.007
geocaching*	**0.612**	0.146	0.084	-0.135	0.060
fishing*	**0.602**	0.239	-0.023	0.107	0.176
sailing / boating*	**0.600**	-0.024	0.143	-0.027	0.363
planning routes for travel / vacation*	**0.580**	-0.191	0.011	0.187	0.339
bird watching*	**0.548**	-0.113	0.111	0.101	0.217
mountain biking*	**0.537**	0.069	-0.195	0.008	0.161
intentional wandering*	**0.527**	0.048	0.281	0.090	-0.070
delivery / rideshare driving*	**0.514**	0.147	0.088	-0.117	-0.206
finding your way around a new place *	**0.503**	-0.114	0.191	0.305	0.221
Rubik's cube*	**0.468**	0.237	0.176	0.078	-0.015
finding your way in an amusement park*	**0.434**	0.063	0.146	0.246	0.181
horseback riding*	**0.425**	-0.071	0.350	0.192	0.201
walking your dog*	**0.381**	0.009	-0.032	0.142	-0.353
Gaming & Competition (Component 2)					
video games – navigate with a map / mini-map*	0.015	**0.811**	-0.122	0.008	0.231
video games - 1st person navigation*	-0.012	**0.766**	-0.081	0.026	0.228
video games – flying a spaceship or airplane*	0.121	**0.720**	-0.100	-0.017	0.286
video games - 3rd person navigation*	0.112	**0.710**	0.036	-0.026	0.081
touch football	-0.020	**0.564**	-0.086	0.415	-0.034
tackle football	-0.034	**0.536**	-0.204	0.158	-0.093
Pokemon Go*	0.163	**0.535**	0.129	0.078	0.068
baseball	0.062	**0.469**	0.078	0.187	-0.111
chess*	0.303	**0.463**	0.084	0.037	0.118
Geoguessr*	0.275	**0.459**	-0.013	0.051	-0.083
role-playing games (e.g., Dungeons & Dragons)*	0.032	**0.451**	0.174	0.104	0.241
Creative & Artistic (Component 3)					
drawing	0.079	0.121	**0.706**	0.035	-0.041
sketching clothes designs	0.093	0.110	**0.705**	-0.034	0.208
painting	0.163	0.066	**0.677**	0.068	-0.116
embroidery	0.130	-0.042	**0.643**	0.057	-0.069
gymnastics	0.216	-0.093	**0.546**	0.280	0.015
figure skating	-0.123	0.096	**0.533**	0.162	0.161
crocheting	0.035	-0.038	**0.525**	0.214	0.118
ballet	-0.014	-0.236	**0.514**	0.344	-0.126
interior decorating	0.172	-0.216	**0.477**	0.073	0.115

playing a musical instrument*	0.119	0.226	**0.366**	-0.134	0.143
Fitness & Other Sports (Component 4)					
bowling	0.112	0.192	0.034	**0.666**	-0.119
dodge ball	0.063	0.414	0.034	**0.654**	-0.093
ping pong	0.279	0.276	0.119	**0.525**	0.012
racquet ball	0.035	-0.011	-0.215	**0.499**	0.189
tennis	-0.053	0.188	0.127	**0.495**	0.161
in-person shopping*	0.179	-0.094	0.200	**0.441**	0.093
volleyball	0.077	0.155	0.173	**0.434**	-0.056
jogging / walking*	0.139	0.012	0.189	**0.420**	-0.045
diving	0.028	-0.161	0.258	**0.359**	-0.050
building train or racecar sets	-0.055	0.329	0.104	**0.342**	0.069
Technical (Component 5)					
programming*	0.165	0.199	0.062	0.039	**0.699**
web / game design*	0.049	0.236	0.127	-0.058	**0.686**
electrical circuitry	0.058	0.206	0.048	-0.014	**0.686**
drawing maps*	0.512	0.048	0.072	0.116	**0.547**
math / geometry (outside of school)*	0.311	-0.111	0.048	0.104	**0.439**
carpentry	0.279	0.132	-0.059	0.004	**0.392**

*items added in this study (other items were on the original SAQ)

The first component was interpreted to be navigation-related as 16 activities considered to involve large-scale spatial ability loaded at least .32 on this component. The second component was interpreted to be gaming or competition as the four video game items loaded heavily on this component as well as the popular team sports such as *tackle football* and *baseball*. The third component was interpreted to be creative or artistic related because of the high loadings from *sketching clothes designs, drawing,* and *painting*, as well as expressive types of sports which involve an element of creativity such as *gymnastics* and *ice skating*. The fourth component was interpreted to be fitness or just being generally active, as non-team sports such as *tennis, racquetball, and bowling*, as well as exercise activities such as *jogging/walking* loaded heavily on this component. The fifth component was interpreted to involve technical, mechanical, or computer-related skills due to high loadings from *web/game design, programming,* and *electrical circuitry*.

Component Score Correlations

Component scores were computed for the five components, and their correlations with the mental rotation measures and other questionnaires are shown in Table 2. Navigation (Component 1) was significantly correlated with sense of direction (SBSOD) and wayfinding experience (CWE), but not rotation tasks. Gaming (Component 2) was significantly correlated with mental rotation, but only of 3-dimensional figures (PSVT:R). Creative/Artistic (Component 3) activities significantly correlated with both 2 and 3-dimensional mental rotation (Cards and PSVT:R) and RMT. They also negatively correlated with sense of direction (SBSOD). Fitness (Component 4) was not significantly correlated with any of the ability measures. Technical (Component 5) activities were significantly correlated with sense of direction (SBSOD).

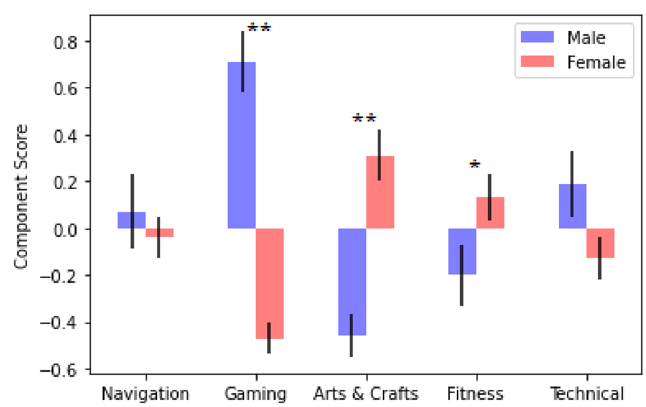
Table 2: Correlations of Measures and Principal Components

	Navig.	Gaming	Creative	Fitness	Technical
RMT	0.16	0.14	**0.19***	-0.04	0.03
Flags[i]	0.04	0.20	0.19	0.08	0.13
Cards[i]	0.07	0.08	**0.23***	-0.05	0.13
PSVT:R	0.10	**0.29***	**0.20***	0.03	0.12
SBSOD	**0.17***	0.13	**-0.19***	0.07	**0.24***
CWE	**0.27***	-0.01	-0.04	0.00	0.11

*correlation is significant at the 0.05 level (two-tailed)
[i] n = 93

Sex Differences

Independent samples t-tests were used to assess sex differences in the five different types of spatial activities as identified by the PCA.



*p <.05, **p <.001

Figure 1: Sex differences on the components.

Contrary to what might have been expected from earlier studies of large-scale spatial activities (e.g., Malinowski & Gillespie, 2001), no sex difference was found on the navigation component score (Component 1). A significant difference was found on the gaming component score (Component 2), with males reporting more experience in this category. The creative/artistic (Component 3) score also had a significant difference, with females reporting more participation than males. The sex differences on Components 2 and 3 are consistent with past findings, as the team sports loading on Component 2 had higher participation from males and many of the activities in Component 3 (*ice skating, gymnastics, sketching clothes designs*) had higher participation from females in Newcombe et al. (1983). Component 4 (Fitness) showed a small difference in favor of females (see Figure 1).

We also replicated previous findings of sex differences in SBSOD, $t(151) = 3.27$, $p < .001$. Interestingly, there was no sex difference in any of the spatial ability tests or childhood wayfinding experience (CWE), unlike Lawton and Kallai's (2002) and Vieites et al.'s (2020) findings.

Discussion

We developed a spatial activities questionnaire that included a broad and updated set of activities that may contribute to spatial abilities. Specifically, we added activities to the short SAQ (Signorella et al., 1986) that likely involve large-scale spatial thinking and modern activities that may not have existed when the previous questionnaires were developed. We also identified activities that are no longer popular due to cultural changes and removed these items. The result was a new 53-item spatial activities questionnaire which we call the SoCalSAQ (for Southern California Spatial Activities Questionnaire).

A principal component analysis identified a navigation component that was distinct from previously identified types of spatial activities. This component was correlated with both the Santa Barbara Sense of Direction scale and the Childhood Wayfinding Experience scale, adding to its validity. While it was not significantly correlated with our version of the Money Road Map test, we should note that this online measure is novel and the RMT is typically administered in person. Future research is necessary to examine the correlation of navigation activities with a more comprehensive set of objective measures of large-scale spatial abilities.

As expected, some of the items on previous spatial activities questionnaires (*baton twirling, building go-carts*) are no longer popular (at least within our sample) and were deleted due to low rates of participation and low variance. In contrast, some more updated activities (e.g., *playing video games* and *Pokemon Go*) were more popular. These results highlight the need for an updated questionnaire, and suggest that it is important to periodically revise questionnaires such as this one, to take account of technological advances and cultural trends.

In contrast with previous studies, we did not classify spatial activities a priori as "masculine" or "feminine." However, we found some sex differences in the activities that participants reported. Notably, men reported more participation in video games and competitive sports/games while women reported more participation in creative and artistic endeavors. Interestingly, while these activities showed sex differences in participation, the navigation-related activities (Component 1) did not. This could partially explain the relatively smaller sex differences found in large-scale ability (Nazareth et al., 2019) compared to those found in certain small-scale spatial abilities (Linn & Petersen, 1985; Maeda & Yoon, 2013; Voyer et al., 1995).

Previous studies have found higher correlations of so-called "masculine" spatial activities with measures of small-scale abilities such as mental rotation (Reilly & Neumann, 2013), and that a male advantage in mental rotation was mediated by participation in masculine spatial activities (Nazareth et al., 2013). In contrast, we found that both gaming activities (with more male participation) and artistic activities (with more female participation) were correlated with mental rotation measures. The correlation of artistic activities with 2-D rotation is a novel finding and needs to be investigated further in future research, but a possible explanation is that items with the highest loadings on this component such as *drawing, painting,* and *sketching clothes designs* seem to involve 2-D spatial visualization.

Although there was no sex difference for the navigation component, there was a significant difference in video games and competitive sports. This is consistent with evidence for a relationship between action video game experience and small-scale spatial ability measures (e.g. Bediou et al., 2018). There is a navigation component of many video games, and more work is needed to address whether playing these specific types of video games might influence navigation ability.

It is interesting that the fifth component, which seems to involve technical or computer related skills, correlated significantly with sense of direction. It is possible that activities such as *programming* and *web/game design* involve a schematic use of space in organizing and visualizing the structure of a computer program or a website that is similar in nature to understanding one's location in the physical world by interpreting an external representation, i.e., reading a map.

A limitation of this study is that it was conducted online, whereas the measures of spatial abilities are usually administered in more controlled laboratory conditions. Another limitation is that the sample was made up of college students and popular activities will likely vary across regions and age groups. It is also notable that the correlations, while significant, were small ($r < .3$). However, this is in line with the majority of previous studies of spatial activities and spatial abilities.

Conclusion

The SoCalSAQ developed here provides an up-to-date instrument for measuring everyday spatial activities, while supporting the dissociation between large-scale and small-scale spatial abilities. The different types of spatial activities that it identifies will provide a useful categorization for future studies of spatial experience and ability. This questionnaire is being used in a large, on-going study to examine the relationship between spatial activities and objective measures of large- and small-scale spatial abilities.

Acknowledgments

This work was funded by NSF Grant IIS-2024633 and ONR Grant N00014-21-2425. The authors would like to thank the members of the Hegarty Spatial Thinking Lab and Chrastil Lab for contributing to the list of spatial activities, and Danielle Harris for providing insight based on her spatial activity work.

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