The Learning Curve
Annual Academic Journal
Psychology Department, Lady Shri Ram College for Women, University of Delhi

Ability or Experience- What Matters (more)?

An Experimental Investigation of the Factors that Contribute in Building Spatial Representations

Shraddha Kaur
BA (Hons) Psychology, Lady Shri Ram College for Women
Project Supervisor: Ms. Sentisungla Longchar; Manuscript received on March 16, 2013 and sent for review on March 18, 2013. Correspondence may be sent to the author at sk1601@gmail.com.

Abstract

The present research used a between-group experimental design to investigate spatial representations of female undergraduates with different levels of exposure (none, less than a year, or more than two years) to the building of Lady Shri Ram College (LSR). 60 participants selected through convenient sampling were divided into subgroups based on driving experience and navigating tendency. Each participant traversed through a pre-decided route in LSR and completed three experimental tasks (mapping, landmark-recognition, and orientation task) based on the route. Two tests were administered to measure object- and spatial-visualization. Preliminary statistical analysis (t-test and one-way ANOVA) indicated significant (α=0.05) difference in the mapping and orientation tasks (but not for landmark-recognition task) between active- and passive-navigators. No such difference was found based on driving experience. A significant group difference based on exposure to LSR was also found. Object and spatial visualization ability correlated significantly with landmark-recognition and orientation task, respectively. This suggested that both individual differences as well as experience contribute to building spatial representation. Implications of present results were discussed, especially in the context of current cognitive psychology literature.

Ability or Experience: What Matters (more)?—An Experimental Investigation of Factors that Contribute in Building Spatial Representations

Spatial representations

The term "spatial representations" is most often used in psychological research to label an individual's mental representation of space (Blades & Spencer, 1994). The concept of a spatial representation or a "cognitive map" was first developed and used by Tolman (1948) to refer to the internally represented spatial models of the environment. These maps include knowledge of landmarks, route connections, and distance and direction relations; non-spatial attributes and emotional associations may be stored as well.

Development of Spatial Representations

According to Siegel and White (1975), adult representations of space develop sequentially, depending on their level of exposure to the space. They distinguish three kinds of representations. The first is a landmark-based representation (where a person has knowledge of visually distinct objects and scenes in the environment, but does not represent any relations between the landmarks); the second is a route-based representation (where a person sequentially organizes landmarks along the route traversed); the third is a survey representation (where a person spatially organizes the landmarks and routes). The theory proposes that the development of spatial representations follows a particular course of stages:

1. landmarks are first remembered,
2. actions are associated with landmarks,
3. landmark-action sequence pairings are organized to form routes,
4. an objective frame of reference is established, and
5. the routes are remembered within the objective frame of reference as survey representations (Siegel & White, 1975, as quoted from Blajenkova, et al, 2005)

Several studies support this sequential experience-based spatial learning. One study that tested four groups of participants with different levels of experience in a building, and found that accurate performance on all experimental tasks designed to study spatial representation correlated with greater experience of the building (Thorndyke & Hayes-Roth, 1982). Another study found age differences in tasks of spatial knowledge: younger participants, who have had lesser time to learn and represent the area around their neighborhoods, gave more landmark-based directions while older participants (independent of sex) tended to use more abstract directions indicative of survey representations of the space (Dabbs, Chang, Strong, & Milun, 1998). A third study found that the greater the experience with a particular area or route-segment, the greater was the likelihood of representing it correctly and anchoring strong relevant landmarks on the same (Presson, 1987).

Despite such evidence to support the Siegel and White's theory, several other researches point to the importance of individual differences and to the relative unimportance of experience as an explanatory variable. For example, one researcher found that several participants could draw survey maps, supposed indications of the highest level of spatial representation, following only a 3-week exposure (Devlin, 1976) and after only one exposure (Blajenkova, Motes, & Kozhevnikov, 2005). Another researcher found that despite high levels of exposure to a building, participants did not develop survey representations of the same (Moeser, 1988). These results are at odds with the sequential theory because they imply that experience is neither necessary nor sufficient to develop accurate and abstract survey-type representations. The following sections review research that has been done to identify some of the possible variables that may play a role in determining the individual differences in spatial representations. The variables that will be considered are: visuospatial abilities, driving experience and natural navigating tendency.

Individual Differences in Spatial Representations

Visuospatial ability. Visuospatial cognition refers to the internalized reflection and reconstruction of objects and space in thought. Visualizers tend to have the ability or mental skill to solve spatial problems of navigation, visualize objects from different angles and space, recognize objects, faces or scenes or notice fine details. Maria Kozhevnikov and colleagues show that two distinct groups exist within the umbrella term of visualizers: the spatial visualizers and the object visualizers (Kozhevnikov, Kosslyn, & Shephard, 2005). Spatial visualizers, as the name suggests, tend to focus on spatial aspects of the environment, such as spatial relations, metric distances, directions, locations, orientations, etc. of objects. Object visualizers, on the other hand, tend to focus on the details of the objects in the environment, such as colors, shapes, sizes, and are involved in the identification of the objects.

Blajenkova, et al. (2005) reported the higher the spatial visualization ability (measure in terms of mental rotation), the greater complexity in the spatial representations and accuracy in the orientation ability. However, other studies show that psychometric tests tend not to measure individual differences in spatial representations and way-finding very well (Allen, et al, 1996 as quoted in Smelser & Baltes, 2001). It is possible that using different psychometric tests of the same construct leads to disparate results.

Driving experience and navigating tendency. Research shows that the type of navigation that a person engages might explain some of the differences in landmark memory and spatial learning. One study differentiated between active navigators, i.e. those individuals who self-pace themselves when traversing routes and control their own navigation, and passive navigators, i.e. those individuals who tend not to be in control of the route they traverse, and found that active navigators showed better spatial cognition and learning than passive navigators (Hahm, et al., 2007).

Another study compared the relative role played by driving and navigation in determining spatial representations. Participants were asked to either play the role of a driver or a passenger. Each participant was also given different levels of detail using maps, i.e. different levels of navigational control, of the route to be taken. Results showed that active navigation contributed to better route memory, while driving led to better landmark memory (Stülpnagel & Steffens, 2012).

The objective of the present study was to investigate the relative importance of experience and individual differences with respect to spatial representations. The present study also attempted to identify the variables that might lead to individual differences. Previous research showed some disparate results, as was discussed, and the present study attempted to address at least some of these issues.
The following hypotheses were tested:

1. There will be no significant difference in the spatial representations of participants with different levels of exposure to the place of administration.
2. There will be no significant difference in the spatial representation of drivers and non-drivers.
3. There will be no significant difference in the spatial representation between passive navigators and active navigators.
4. There will be no significant correlation between visualization ability and spatial representation.

Method

Participants

Table 1
Organization of participants based on different variables

	Levels of exposure to LSR college building		
	LSR0 (Non-LSR students) n	LSR1 (1st year students) n	LSR3 (3rd year students) n
Driver (3 times a week For more than a year)	10	10	10
Non-driver (no driving experience)	10	10	10

A total of 60 participants were selected using convenient and snowball sampling technique. Care was taken to meet exact pre-set inclusion and exclusion criteria while selection. Participants were divided into six groups of students, based on the level of exposure they had of the main building of Lady Shri Ram College for Women (LSR) and their driving experience (see Table 1). A participant was considered a driver only if she had been driving regularly (three or more times a week) for more than a year. Three different levels of exposure to the college building were used- non-LSR students with no exposure, first year students of LSR with less than a year's exposure, and third year students of LSR with more than two years' exposure. As LSR is a girls' college, two-thirds of the sample was necessarily female undergraduates. To maintain matching between the groups, the sample was limited to female undergraduates only, although the course and college of study was flexible for all groups.

Research Design

A between-subjects quasi-experimental design was used for the present study. *The independent variables that were measured for each participant were as follows: level of exposure to the college building, driving experience, and navigating tendency.* The dependent variables that were measured for each participant were as follows: performance on psychometric tests of spatial visualization (paper folding test) and object visualization (vividness of visual imagery questionnaire) and performance on experimental tasks (sketch-mapping, orientation, and landmark-recognition task).

The experimental tasks were designed to measure spatial knowledge of participants. The mapping task required the participants to sketch a map of the route they had traversed as accurately as they could, without focusing on artistic abilities. In the orientation task, the participants were asked to point to five unseen target locations in the college building from their present location. These locations had been previously pointed out to them during route traversing. In the landmark recognition task, the participants were shown fifteen stimuli in a randomized order (pictures of handmade colorful posters, see Figure 1), ten of which had been part of the route that they participants traversed and the remaining five were controls. They were required to respond with a “yes/no” to each based on whether they had seen it during the route tracing. These tasks were designed based on the tasks used by Blajenkova and colleagues in their study in 2005.

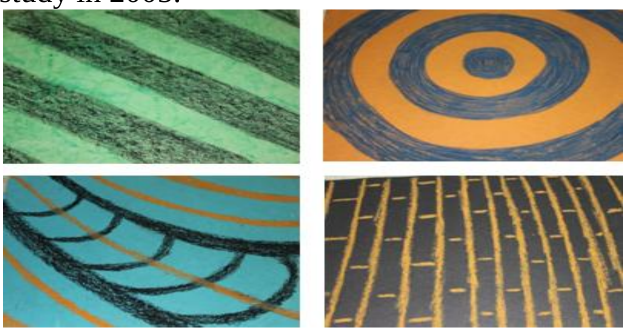


***Figure 3*. Examples of some of the posters used for the landmark recognition task.**

Measures

Two psychometric tests were employed- Paper Folding Test (PFT) and Vividness of Visual Imagery Questionnaire (VVIQ).Paper folding test was a speeded test developed by Educational Testing Service (1962, 1976) measured spatial visualization ability, where the participants were given 6 minutes to go through 20 trials. Each trial involved a square piece of folded paper which was then punched through at different points, and participants had to visualize the result in each trial. The reliability of this instrument ranged from 0.75 to 0.84 as reported by Ekstrom et al (1976). Scoring of the test was done in accordance with the test manual for administrator; the higher the score (maximum was 20); the better was the spatial visualization of the participant. The second test that was used was called the Vividness of Visual Imagery Questionnaire, developed by David Marks (1973) to measure object visualization. As the name suggests, this test measured the ability to visualize, that is, the ability to form mental pictures, or to "see in the mind’s eye". Its reliability ranged from 0.74 to 0.88 as reported by McKelvie (1995).The participant was given sixteen images to consider and asked to rate the vividness of each image based on a 5-point scale, where 1 was “perfectly clear and as vivid as normal vision” and 5 was “no image at all”. The rating of each was added to make a final vividness score; the higher this score, the lower was the object visualization ability.

Procedure

The study was conducted at Lady Shri Ram College for Women (LSR), New Delhi. The time spent for each participant was approximately 45 minutes. First the participants completed a consent form, a socio-demographic questionnaire, and two paper-and-pencil tests (PFT and VVIQ). Next, they were led through a pre-decided route through the building. The participants were then asked to complete the three experimental tasks (Landmark recognition, mapping, and orientation task). Finally, an interview was conducted with each participant, about the particular cues that they may have employed to learn and represent the route, with specific emphasis on landmarks, directions, spatial relations, and distances, and the difficulties that they may have encountered on the way.

Results[3]

Map Classification. The maps drawn by all participants were analysed independently and classified into three categories: one-dimensional (1D), two dimensional (2D), and three-dimensional (3D) based on the classification criteria used by Blajenkova, et al. in their 2005 paper.

1D Sketch Maps (16 out of 44). Participants might have incorporate some turns and aligned a few corridors, but the overall accuracy of the spatial relations (such as directions, distance, perpendicular and parallel corridors, floor separation, etc.) between different segments of the route were not accurately depicted.

2D Sketch Maps (10 out of 44). Participants showed relatively higher levels of accurate representations of the spatial relations among the various locations, and the overall shape of the route was preserved. They did depict the route segments on both the floors, but failed to separate these segments onto different planes.

3D sketch maps (17 out of 44). Participants showed most of the characteristics of the 2D sketch maps, but also included an additional property of floor separation. The route segments on the ground- and the first-floor were distinctly separate and aligned vertically.

Based on the classification system used by Siegel and White (1975), 1D maps showed properties of both landmark-based and route-based spatial representation, where relations were not integrated into a larger picture, while both 2D- as well as 3D- maps showed properties of survey-type spatial representation, where global structure was preserved. Refer to Figure 2 for an illustration of the three types of maps.

When the sketch maps were compared between the groups based on driving experience and navigating tendency, results indicated that drivers and active navigators had a much greater tendency to represent the route in 3D-maps as compared to the non-drivers and passive navigators, while the latter two groups used the 1D-maps more than the former. The use of 2D-map was similar across all groups (see Figure 3).

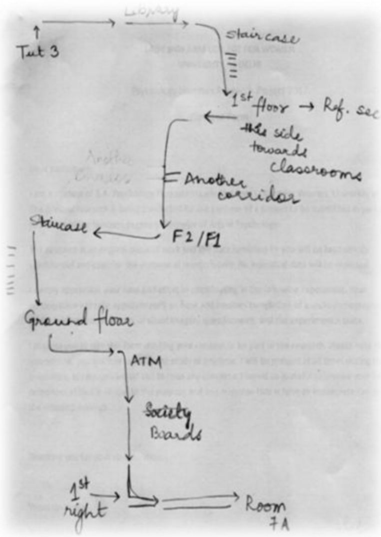
A comparison of the maps based on levels of exposure indicates that the non-LSR students drew 1D-maps significantly more than LSR students and the latter drew 3D-maps more significantly than the former. Another important result was that no significant difference based on the mapping task was found between the two groups of LSR students, i.e. 1st year and 3rd year students (see Figure 4).

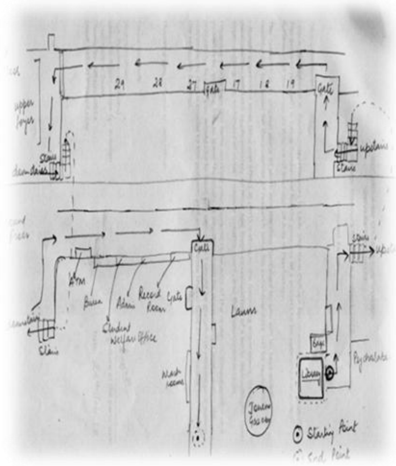
Other Experimental Tasks

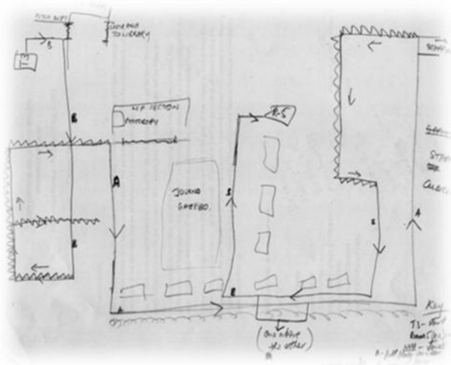
A comparison was made between the groups for their performance on the landmark recognition task (i.e. the number of landmarks correctly recognized) and the orientation task (i.e. the average orientation error measured in degrees, quantifying the discrepancy between the actual direction of a target location and the direction marked by the participants). An independent samples t-test was done to compare between drivers and non-drivers, and between active- and passive-navigators. Results (see Table 2) indicated that there was no significant difference between the performances of drivers versus non-drivers on either the landmark recognition task or the orientation task. A significant difference (at 0.01 level of significance) was found between the performances of active- and passive- navigators on the orientation task, but not the landmark recognition task (see Table 3).

[3] Please note the following is based on a preliminary data analysis of 44 participants.

Figure 2: Illustration of three types of maps classified in this paper







1D map- Route was accurate, but spatial relations were not depicted.	2D map-Spatial relations were depicted, but both the floors were represented on the same plane.	3D map- Spatial relations were depicted, and the two floors represented separately, and oriented correctly.

Figure 3. Map classification, based on driving experience and navigating tendency

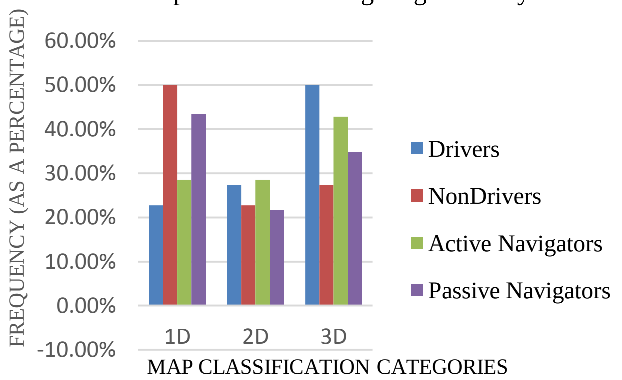
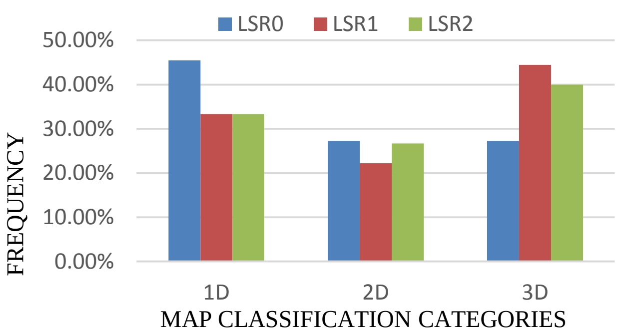


Figure 4: Map Classification, based on exposure



When performance on the tasks is compared based on exposure level using a one-way ANOVA, results (see Table 4) indicate a significant level of difference on both the landmark recognition (at 0.05 level of significance) and the orientation task (at 0.01 level of significance).

Visualization Ability.

A pearson's correlational analysis was made to investigate the relationship between object and spatial visualization ability and performance on experimental tasks. Results (see Table 5) indicated that object visualization ability (measured by the Vividness of Visual Imagery Questionnaire, VVIQ) significantly correlated with performance on the landmark recognition task, and spatial visualization ability (measured by the Paper Folding Test, PFT) significantly correlated with performance on the orientation task.

Table 2
Results of a t-test Comparison of Means between Drivers and Non-Drivers

t-test for Equality of Means (Drivers vs. Non-drivers)			
	t	df	Sig. (2-tailed)
Landmark Recognition	.323	42	.748
Orientation Task	1.159	42	.253

Table 3
Results of a t-test Comparison of Means between Passive- and Active-Navigators

t-test for Equality of Means (Passive and Active Navigators)			
	t	df	Sig. (2-tailed)
Landmark Recognition	-.026	42	.979
Orientation Task	2.873	42	.006**

**Correlation is significant at the 0.01 level (2-tailed).

Table 4: Results of a one-way ANOVA between three levels of exposure

One-way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Landmark	Between Groups	31.09	2	15.547	3.21	.050*
	Within Groups	198.06	41	4.831		
	Total	229.15	43			
Orientation	Between Groups	4916.53	2	2458.26	3.86	.029**
	Within Groups	26093.98	41	636.43		
	Total	31010.51	43			

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Table 5
Pearson' Correlational Analysis between VVIQ and Landmark Recognition

		Landmark Recognition
VVIQ	Pearson Correlation	-.320*
	Sig. (2-tailed)	.034
	N	44

*. Correlation is significant at the 0.05 level (2-tailed).

Table 6
Pearson's Correlational Analysis between PFT and Orientation Task

		Orientation
PFT	Pearson Correlation	-.310*
	Sig. (2-tailed)	.041
	N	44

*. Correlation is significant at the 0.05 level (2-tailed).

In summary, results indicated that exposure to the LSR building, visualization ability, and navigating tendency contributing to the building of spatial representations. No differences based on driving experience were found. Based on these results, hypotheses (1), (3), and (4), were rejected at either 0.05 or 0.01 level of significance, as the case may be. Hypothesis (2) was retained. These results are discussed in the next section.

Discussion

The objective of the present study was to quantify some of the variables that might contribute to building mental spatial representations. The variables that were studied were as follows: exposure, driving experience, navigating tendency, and visuospatial ability. Previous research has revealed some inconsistent results about the role of some of these variables. The present results will be discussed in relation to relevant previous literature.

Role of Exposure

Exposure or experience with a particular area was suggested by Siegel and White (1975) as the primary variable that determines spatial representation in their sequential theory. Other researches (Dabbs et al, 1998; Presson, 1988) also reveal the importance of experience. However, these results are contradicted by studies where a few, or even a single exposure, to an environment can lead to extensive survey –type spatial representations (Blajenkova, et al, 2005; Delvin, 1976, etc.). The present study supports both the positions. It was found that there was a significant difference between the performances of non-LSR students who had zero exposure to the LSR building and LSR students who have had at least a few months of exposure to the building. This indicated that exposure was definitely an important criteria in determining spatial abilities. However, it was also found that within the non-LSR students, more than 50% did in fact draw survey-type spatial representations of the building. This shows that even after a single exposure it is possible to make complex representations of space. Further, it was seen that there was not much difference between the 3rd year students of LSR, who have greater exposure to the building, and the 1st year students of LSR. Thus, this paper argues that after a certain level of exposure, there is a ceiling effect, i.e. further experience does not contribute to further gains in spatial representations.

Role of Visualization Ability

Some of the other variables that have been deemed important in determining spatial representations were visuospatial abilities, driving experience, and navigating tendency. Present results support previous studies such as Blajenkova, et al (2005) in that a direct significant correlation has been found between different visuospatial abilities and different experimental tasks. Spatial visualization ability was seen to correlate with performance on the orientation task- i.e. the greater the ability, the greater the accuracy in pointing to unseen locations in the building. Object visualization was seen to correlate significantly with performance on the landmark recognition task- i.e. the greater object visualization ability, the greater the landmark memory of objects seen along the route. There are some researches that do not show similar conclusions (Allen, et al, 1996 as quoted in Smelser & Baltes, 2001) but theis could be due to the use of different psychometric tests of the same constructs. The present paper shows that indeed, there is a positive correlation between innate visualization ability and spatial representations.

Further, the present research found that the extent of control that participants tend to have over their day-to-day route traversing had a significant role to play in the orientation task i.e. individuals who reported themselves to be active navigators and exerted high control over their navigation showed greater accuracy in the orientation task. No effect was found based on the level of driving experience, which is consistent with previous research (Hahm, et al, 2007; Stülpnagel & Steffens, 2012).

Role (or lack thereof) of Driving Experience

The present study did not find any difference between regular drivers and non-drivers. There may be several reasons for this. It is possible that the methodology to test the role of driving experience was inappropriate, and perhaps would show a greater group-difference when participants are asked to drive (or are driven) through a route, instead of walking through a building. This methodology has been used in previous research (Stülpnagel & Steffens, 2012); results indicated that whether the participant is driving or not had an impact on the spatial representation. The difference based on the level of driving experience was not investigated.

Further, it is possible that instead of actual driving experience, the increasing exposure that drivers gain of the roads leads to the usual view in people's minds that drivers have a better spatial sense. This is supported in several studies conducted by Maguire and colleagues (2006) in which the researchers found that taxi drivers showed a difference in their hippocampal structures (which was associated with greater spatial knowledge and experience) while bus drivers with a matched level of driving experience showed no such difference. From this study we learn that it is possible that increasing exposure with different routes (that may or may not arise out of driving experience) has a greater role to play in increasing spatial knowledge and representation ability as compared to mere driving experience.

Interactional Perspective-Recommendations for Future Research

Previous research has tended to qualify itself in simplistic binary terms of nature versus nurture (innate individual differences versus experience), and the present study argues for an interactional perspective in determining spatial skills and representations. Present results show that neither is exposure/experience a sufficient variable to understand spatial representations, and neither are individual differences. This paper agrees with Newcombe's statement: "Rather than endlessly replaying the empiricist-nativist debate, researchers need to get on with the detailed work of proposing exactly how starting points…are transformed into mature competence...in interactional ways." (Newcombe, 2002)

This paper recommends further research on similar lines to be taken up on a larger scale, using random sampling. It is also recommended that future research should incorporate sex differences as an important variable. It is hoped that future research would reveal how innate and experiential differences interact with each other to lead to different ways of representing space.

References

Allen, G., Kirasic, K., & Dobson, S. (1996). Predicting environmental learning from spatial abilities: An indirect route. Intelligence, 22(3): 327-335.

Bagot, R., & Meaney, M. (2010). Epigenetics and the Biological Basis of Gene × Environment Interactions (Vol. 49:8). Journal of the American Academy of Child & Adolescent Psychiatry.

Blades, M., & Spencer, C. (1994). The Development of Children's Ability to Use Spatial Representation. In H. W. Reese, Advances in Child Development and Behavior (pp. 157-159). Academic Press, Inc.

Blajenkova, O., Motes, M., & Kozhevnikov, M. (2005). Individual differences in the representations of novel environments. Journal of Environmental Psychology, 97-109.

Bremner, J., & Bryant, P. (1977). Place versus response as the basis of spatial errors made by young infants. Journal of Experimental Child Psychology, 23(1): 162-171.

Cutmore, T., & al, e. (2000). Cognitive and gender factors influencing navigation in a virtual environment. International Journal of human-computer studies, 223 - 249.

Dabbs, J. J., Chang, E.-L., Strong, R., & Milun, R. (1998). Spatial Ability, Navigation Strategy, and Geographic Knowledge Among Men and Women. Evolution and Human Behavior, 19(2), 89-98.

Devlin, A. (1976). The "small-town" cognitive map: adjusting to a new environment. In G. Moore, & R. Gollege, Environmental knowing. Stroudsberg, PA: Dowden, Hutchinson, & Ross.

Ekstrom, R. B., French, J. W., Harman, H. H., & Dermen, D. (1976). Manual for the kit of factor-referenced cognitive tests. Princeton, NJ: Educational Testing Service.

Feng, J., Spence, I., & Pratt, J. (2007). Playing an action video game reduces gender differences in spatial cognition. Psychological Science, 18(10):850-5.

Galton, F. (1874). English Men of Science: Their Nature and Nurture. Macmillan & Company.

Gaulin, S., & FitzGerald, R. (1986). Sex differences in spatial ability: an evolutionary hypothesis and test. American Naturalist, 74-88.

Golledge, R. (2004). Encyclopedia of Applied Psychology (Vol. 3). Elsevier.

Hoffman, M., Gneezy, U., & List, J. (2011). Nurture affects gender differences in spatial abilities. Proceedings of the National Academy of Sciences, 108(36), 14786-14788.

Jinsun Hahm, K. L.-L.-Y.-T.-H. (2007). Effects of Active Navigation on Object Recognition in Virtual Environments. CyberPsychology & Behavior, 10(2): 305-308.

Kozhevnikov, M., Blajenkova, O., & Becker, M. (2010). Trade-off in the object versus spatial visualization abilities: Restriction in the development of visual processing resources. Psychonomic Bulletin and Review, 17(1): 29-35.

Kozhevnikov, M., Kosslyn, S., & Shephard, J. (2005). Spatial versus object visualizers: A new characterization of visual cognitive style. Memory and Cognition, 33(4):710-726.

Marks, D. (1973). Visual imagery differences in the recall of pictures. British Journal of Psychology , 64: 17-24.

McKelvie, S. (1995). The VVIQ as a psychometric test of individual differences in visual imagery vividness: A critical quantitative review and plea for direction. Journal of Mental Imagery.

Moeser, S. (1988). Cognitive mapping in a complex building. Environment and Behavior, 20: 21-49.

Moore, D. (2003). The Dependent Gene: The Fallacy of "Nature vs. Nurture". Henry Holt and Company.

Newcombe, N. (2002). The Nativist-Empiricist Controversy in the Context of Recent Research on Spatial and Quantitative Development. Psychological Science, 13(5): 395-401.

Piaget, J., & Inhelder, B. (1967). A Child's Conception of Space (Langdon, F.J. & Lunzer, J.L., Trans.). New York: Norton.

Presson, C. (1987). The development of landmarks in spatial memory: The role of differential experience. Journal of Experimental Child Psychology, 44(3): 317-334.

Siegel, A., & White, S. (1975). The development of spatial representations of large-scale environments. In H. Reese, Advances in child development and behavior (pp. 10: 9-55). New York: Academic Press.

Silverman, I., Choi, J., Mackewn, A., Fisher, M., Moro, J., & Olshansky, E. (2000). Evolved mechanisms underlying wayfinding: further studies on the hunter-gatherer theory of spatial sex differences. Evolution & Human Behavior, 21(3) 201-213.

Smelser, N., & Baltes, P. (Eds.). (2001). International Encyclopedia of the Social & Behavioral Science. Oxford: Pergamon Press.

Stülpnagel, R. v., & Steffens, M. (2012). Can active navigation be as good as driving? A comparison of spatial memory in drivers and backseat drivers. Journal of Experimental Psychology. Applied., 18(2):162-77.

Thorndyke, P., & Hayes-Roth, B. (1982). Differences in spatial knowledge acquired from maps and navigation. Cognitive Psychology, 14: 560-589.

Tolman, E. (1948). Cognitive Maps in Rats and Men. The Psychological Review, 55(4): 189-208.

About the Author

Shraddha Kaur is a student in BA (Hons) Psychology Year III student at Lady Shri Ram College for Women. She is keenly interested in unraveling the mysteries of the mind. She is interested in biological underpinnings of behavior, thought, and consciousness, and is looking to continue her further studies and research in neuroscience. She has been a consistent academic performer and successfully participated in the exchange programme with National University of Singapore for a year.