Gender, Memory, and Geographic Tasks

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Abstract

We hypothesised that men would do better than women on difficult tasks pertaining to the geography of the United States. Undergraduates from the southeastern United States (mostly white) comprised five groups (n=125–127 each). One group was instructed to list the 50 states and the 25 largest cities from memory; a second group additionally received an outline map of the United States as an aid; a third group labelled each of the states within their outlines on a map of the United States and labeled the 25 largest cities on a second map of the United States; a fourth group wrote the name of the states and cities on separated and randomly presented outlines of the states; and the fifth group performed a map reproduction task. Percent correctly identified was lower for the last three tasks and men did significantly better for states and cities on the map-labelling (context-present) and the fragmented states (context-absent) tasks. The results suggested that the men performed better on the two more challenging tasks, partly, presumably because they had learned the outlines of the United States better, independent of the context – the outlines of the surrounding states.

Introduction

The results from research on spatial performance have frequently favored men (Bryant, 1982; Dabbs, Chang, Strong, & Milun, 1998; Galea & Kimura, 1993; Halpern, 2004; Herman, Hawkins, & Berryman, 1985; Holding & Holding, 1989; Kalichman, 1989; Lawton, Charleston, & Zieles, 1996; Levine, Vasilyeva, Lourenco, Newcombe, & Huttenlocher, 2005; Zinser, Palmer, & Miller, 2004). On geographic knowledge, male education majors were more effective in locating 10 countries (Herman et al., 1985); men did better with cities of the United States (Beatty and Tröster, 1987; Montello, Lovelace, Golledge, and Self, 1999); men were more accurate with local cities, large U. S. cities, world cities, countries, oceans, and continents (Zinser et al., 2004). The above sample of findings suggest that geography may need to be taught differently to males and females. The purpose of the present study was to explore the idea that men possess greater configurational knowledge/memory of the geography of the United States than do women.

Theories of Gender Differences and Geographic Knowledge

The hunter-gatherer (evolutionary) theory suggests that men develop a superior sense of direction and knowledge of more distant locations, and that women develop superior memory for locations nearer to the home-site. The theory attributes this gender difference to nature and to the roles men and women have played from the beginning of human history; men assumed responsibility for hunting for food at greater distances and women assumed responsibility for gathering food at shorter distances from the home site. As a result, men and women developed greater spatial and memory skills in their respective realms of activity (Eals & Silverman, 1994).

Other explanations have been offered, focusing on a deficiency, a difference, and an inefficiency between men and women (Self, Gopal, Golledge, & Fenstermaker, 1992). The deficiency hypothesis relates gender differences in performance to gender differences in physiology and/or hormone levels (Halpern et al., 2007).

The difference theory states that men and women differ in spatial performance because of a wide range of socio-cultural factors, such as differences in early childhood education, courses completed in school, and expectations of parents and institutions (Halpern et al., 2007). Studies also suggest (e.g., Feng, Spence & Pratt, 2007; Terlecki & Newcombe, 2005) the gender difference can be offset by training women, e. g. on computer-oriented tasks and video games.

On the role of experience, investigators have reported that men and women perform equally well when asked to learn a map with which they initially had equal experience (Kitchin, 1996; Beatty & Tröster, 1987; Beatty & Bruellman, 1987; Montello et al., 1999; Pearce, 1977). Others have reported that experience does not relate to spatial performance (Adams, 1998; Beatty, 2002; Beatty & Tröster, 1987; Beatty & Bruellman, 1987; Cross, 1987; Eve, Price & Counts, 1994; Herman, et al.

1985; Zinser et al., 2004). In these studies, men scored better although experience, like travel experience, was the same.

The inefficiency hypothesis suggests men and women are the same; however, because of stereotyping, stereotype threat, self-fulfilling prophecy, and cultural expectations, women do not perform as well (Halpern et al., 2007; Hyde, 2007). For example, in one study college women did equally well in several geography courses, but less well on a Knowledge of Geography test (Nelson, Aron, and Poole,1999). Possibly, women perform well in courses but are less motivated or culturally more intimidated by geographic tests. Brosnan (1998) learned that women did less well on the Group Embedded Figures Test (EFT), but only when the test was described as a 'spatial abilities' test. The results of this and other studies (i.e., Spencer, Steele, & Quinn, 1999) imply that women may be affected by situational or social factors and stereotyping.

Configurational Knowledge and Geography of the United States

Cognitive mapping and configurational knowledge played a significant role in the present study. Cognitive mapping refers to the process by which spatial information is represented internally (Curiel & Radvansky, 1998; Golledge, Dougherty, & Bell, 1995; Jacobs, Thomas, Laurance, & Nadel, 1998). Golledge (1992) suggested that there are three types of spatial knowledge: declarative, procedural, and configurational. Declarative knowledge refers to information that exists in long-term memory, like information about places. Procedural knowledge refers to how declarative knowledge about orientation, angles, and direction of items is integrated with movement in space. And, configurational knowledge is about understanding shape, pattern, and the distribution of items and how they are related to other objects in space.

Relevant to the present study, researchers have reported evidence that people represent the outlines of the states of the U. S. by way of images, structurally similar to but not necessarily identical to the shape of the states (Shepard and Chipman,1970; Lloyd & Steinke 1986); however, they also wondered whether they do so consistently. Also, mental representations may be structured verbally or in the form of propositions (Kosslyn, Reiser, Farah, & Fliegel, 1983).

On sketch-mapping, men often have been found to be more effective, particularly in showing more details (e.g., Harrrell, Bowlby, Hall-Hoffarth, 2000). By the age of 11, boys have produced more accurate sketches of their neighborhood than have girls (Boardman, 1990; Matthews, 1987). Moreover, men and women may use images, verbal terms, propositions, and numerical representations differently. Women use images to remember objects in static situations, whereas men use images more frequently when movement is involved, as in mental rotation tasks (Harshman & Paivio, 1987). Tobin (1982) concluded that men tend to carry a mental picture of individual shapes, while women remember shapes by comparing them to the shape and size of familiar objects (as cited in Caplan, MacPherson, & Tobin, 1985). Of particular interest to the present study is the ability of people to encode shapes in the context of other shapes and their ability to encode and form mental images of shapes separate from others.

Difficulty of Tasks of the Geography of the United States

Straub and Seaton (1993) asked one group of college students to list the fifty states of the United States from memory and a second group to do the same but with the aid of a map and obtained no differences between men and women on number of states correct. The third group wrote the names of the states within the state outlines; the fourth group did the same but was also presented with an alphabetical list of the names of the states. The performances of the latter two groups was lower than those of the first two groups. Although the tasks of the latter two groups were evidently more difficult, the men still performed better than the women in these two groups. Writing the names of the states on the map may have provided men with an advantage, possibly in configurational knowledge; and, the men may have formed a better association between the state outline and its associated name. Zinser et al. (2004) also had college students list the fifty states with and without the aid of a map and like Straub and Seaton (1993) reported no gender differences on these easier tasks. However, they found that men displayed superior knowledge in matching geographic outlines of continents and countries with their names and local and regional cities and international cities with their names. Accordingly, the thesis of the present study is that men on the whole perform better than women on difficult tasks involving configurational knowledge.

The Present Study

The first objective of the present study was to compare the performances of college students on the geography of the United States varying in difficulty: the easier site-name and site-name with map-aid conditions as compared to the more difficult map-labelling, fragmented states, and map-reproduction conditions. Straub and Seaton (1993) had employed the map-labelling task. The

fragmented states task was of our own creation; in this condition, we presented state outlines in random order and like for map-labelling the participants were to write the names of the states in proximity (in or outside) of their boundaries. The map reproduction (sketch-mapping) task required that the participants sketch and label each of the U. S. states and 25 largest cities into the outline of the United States divided into five visually defined regions. Hypothesis 1 predicted participants would identify a larger percentage of states and cities on the easier than on the more difficult tasks.

The second objective of the present study was to compare men and women on knowledge the states and the largest cities of the United States for all of the three more difficult tasks. The purpose of the map-labelling condition was to reveal whether women or men make more effective use of the context, the other states, in identifying the states and cities. The fragmented states task was designed to measure context independence. Do men know the shapes and cities of the states and their names better independent of the context of its surrounding states, oceans, and/or countries? In the reproduction task, the participants were presented with a map of the United States within which only national and regional boundaries (southeast, northeast, mid-west, west, and southwest) were drawn. If men are more effective in the use of context and in knowledge of the shapes of the states, this would be apparent in a reproduction task. The participants were asked to draw-in and label the forty-eight continental states within their regions and also to mark and label the locations of the twenty-five largest cities. Hypothesis 2 was that the men would do better on the more difficult tasks on the percentage of states and cities correctly identified.

The third objective was to compare the participants on their knowledge of the states in contrast to the 25 largest of U.S. cities across all five of the tasks. Hypothesis 3 was that the participants would correctly identify a larger percentage of states than of cities.

The fourth objective was to explore the relationship between the accuracy of the recall scores of states and cities of the five groups and travel experience. The purpose was to learn more about the role travel experience plays in the gender differences of the knowledge of the United States.

Method

Participants

The participants were 626 (270 men and 356 women, about 55 men and 72 women in each treatment group) mostly white undergraduates (average age of 20 years; SD = 4) who attended a public university located in the southeastern United States.

Materials

Five test booklets consisted of the following elements (in the order listed): a cover sheet of preliminary instructions, one pair of the U. S. states and cities maps in accord with one of the five conditions described below, and the demographic/experiences questionnaire.

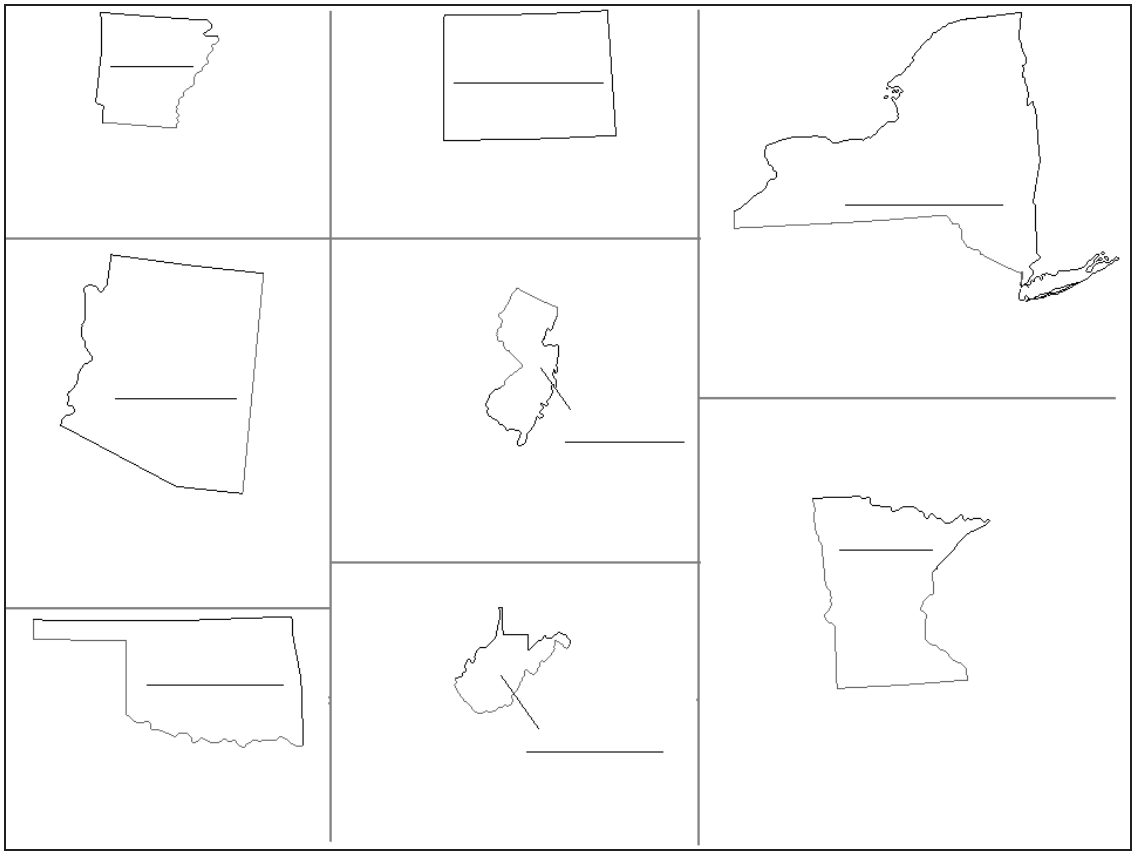
Site-name and Site-name with Map-aid. The site-name task (one version of the five booklets) measured verbal memory. Participants received a lined sheet on which they were to write the fifty states of the United States and a second sheet for the twenty-five most populated U. S. cities. These cities were identified by way of the U. S. Census Bureau (2000). The site-name with map-aid task, additionally, provided participants with maps of the United States, one map showing all fifty state boundaries outlined (Alaska and Hawaii, lower left corner), and the second map, with dots marking the location of the 25 largest cities. The task of the participants in the map-aid condition was to list all of the states and cities on lines provided next to the maps.

Map Labelling. Using the same map, participants were to write the name of the state on a line within its boundaries; for the smaller states, leader lines were drawn, extending from inside to outside the state outline. On the second map, again dots marked the location of the cities and participants wrote the names of the cities on leader lines next to their marked locations.

Fragmented States of the United States. In this booklet, participants received outlines of the 50 states (twice the size shown in the previously described maps) on six sheets separated from each other (5–9 states per 8½ x 11 in. sheet) in random order (see example in Figure 1). Students wrote the state's name on a line, next to or beneath the state outline. The second task consisted of two pages of random displays of states with at least one of the 25 largest cities (marked with large dots). Students wrote the name of the city on a line within the outline of the state (see Figure 2).

Map Reproduction of the States and Cities of the United States. Participants received an outline map of the United States with regional

Figure 1: Sample page of the states task of the fragmented states condition.



boundaries drawn defining the five major U.S. regions: southeast, southwest, northeast, west, and mid-west. The participants were asked to simultaneously draw the outlines and label the forty-eight contiguous states in the appropriate U.S. region and to mark with a dot the location and label the 25 largest U.S. cities.

Demographic/Experiences Questionnaire. After completing the map tasks, participants supplied the following information: age, gender, major, grades acquired in mathematics, history, political science and geography courses taken in high school and in college, previous states and cities of residence, the states and major cities visited, most frequent travel destinations, number of hours spent monthly watching local and national news and geography-oriented television programming (e.g., Travel Channel, History Channel), number of hours spent each week watching college and professional sports on television, and the number of hours spent each week reading magazines and books that provide knowledge of current events (excluding textbooks).

Procedure

Sets of the five versions of the booklets were distributed in random order separately to men and women. Each participant received one of the booklets. The above booklet distribution method ensured that the five booklets were distributed equally among men and women. For all conditions, in half of the booklets the states task appeared first – other half, the cities task first.

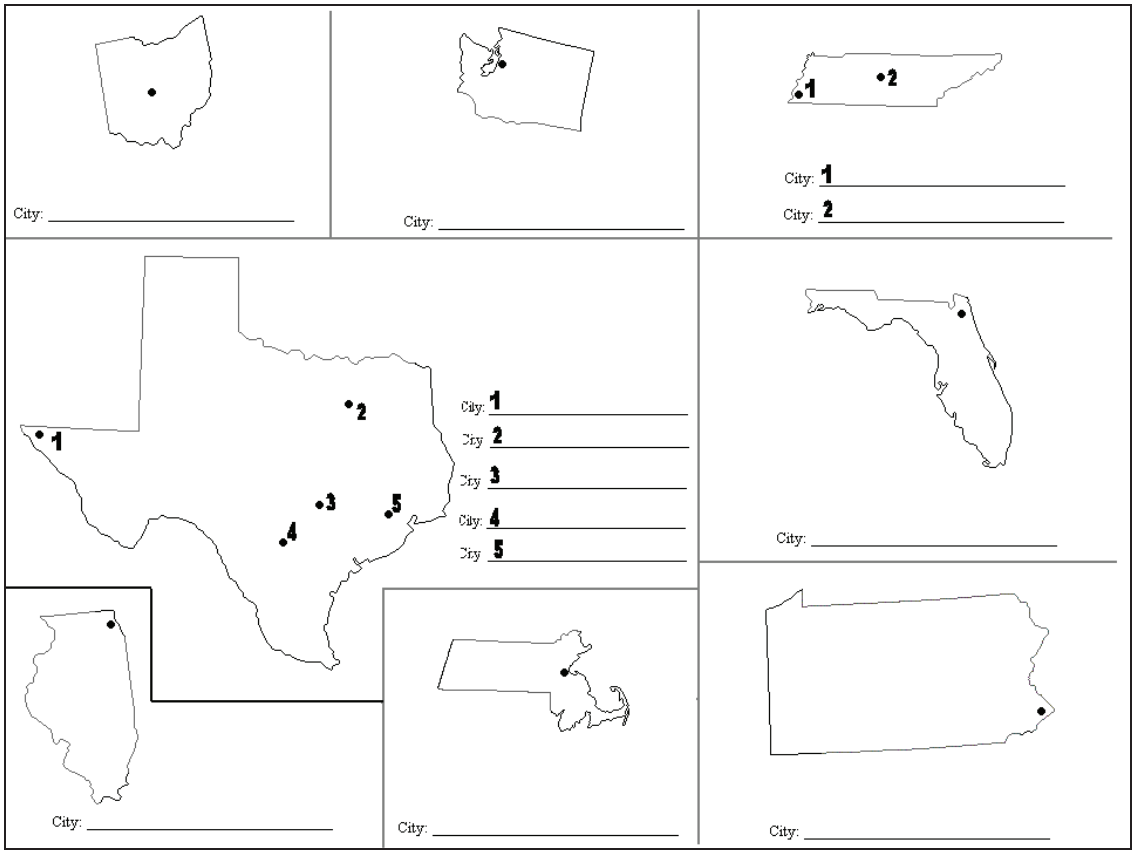
Participants were told that they will have three minutes to complete their booklet. Those in the map reproduction condition were instructed that they could work for up to 12 minutes. Participants were tested in classroom settings with group sizes ranging from 25 to 97 students.

Scoring. For all groups and tasks, one point was credited for each site identified correctly. For the map reproduction task, one point was awarded for each state correctly sketched and placed and each city correctly placed (separate measures) within its region. For all conditions, the number of states and cities identified correctly was converted to percentages.

Results

A 5 × 2 × 2 mixed factorial analysis of variance was conducted to test for differences across treatment conditions, gender, and geographic class on percentage of states and cities identified (the dependent variable), with repeated measures over geographic class. Statistics for states and cities correct, broken down by men and women, and the two geographic classes for each of the

Figure 2: Sample page of the cities task of the fragmented states condition.



five conditions are displayed in Table 1. Effects for gender, $F(1, 612) = 11.789$, $p < .01$ partial $\eta^2 = .02$, conditions, $F(4, 612) = 100.965$, $p < .001$, partial $\eta^2 = .40$, and geographic class, $\Lambda = .32$, $F(1, 612) = 128.47$, $p < .001$, partial $\eta^2 = .68$, were found. The condition x gender interaction, $F(4, 612) = 2.818$, $p < .05$, partial $\eta^2 = .02$, and the condition x geographic class interaction, $\Lambda = .80$, $F(4, 612) = 38.07$, $p < .001$, partial $\eta^2 = .20$ were also significant.

To test Hypothesis 1, the conditions x gender interaction was explored with Bonferroni post hoc comparisons (family-wise, p< .05) on percentage of states and cities identified. The percentages of states identified under the easier conditions were higher than under the three more difficult conditions. In addition, the map labelling and map reproduction conditions were higher than the fragmented states condition. (see Table 1; for states, all d>.62). The percentage of cities was higher under the site-name condition compared to the more difficult conditions. Moreover, the percent of cities was higher under site-name with map-aid than under site-name and the three difficult conditions. Finally, a larger percent of cities was identified for map-labelling compared to the fragmented states and map reproduction conditions. (see Table 1; for cities, all d>.47)

Independent *t*-tests were performed for each of the five treatment conditions to test the prediction (Hypothesis 2) that men would identify a larger percentage of sites than women under the three more difficult conditions (family-wise error rate of $p < .05$, .01 maintained). Most of the results (see Table 1) supported Hypothesis 2: under map labelling, men were higher than women, on states $t(1,127) = 2.68$, $d = .48$, and on cities, $t(1,127) = 3.46$, $d = .61$, and under fragmented states, men were higher than women on states, $t(1,126) = 2.62$, $d = .47$, and on cities, $t(1,126) = 2.83$, $d = .50$. But, Hypothesis 2 failed with no gender difference under reproduction.

For Hypothesis 3, the Condition x Geographic Class interaction (see Table 2) was explored with dependent *t* tests for each condition (family-wise, $p < .05$). The percentages were higher on states than on cities: site-name, $t(247) = 15.75$; $d = .86$; site-name with map-aid, $t(257) = 12.41$, $d = .49$; map labelling, $t(257) = 10.69$, $d = 1.38$; fragmented states, $t(255) = 5.77$; $d = .72$; and map reproduction, $t(223) = 13.57$, $d = 1.77$.

Pearson *r* correlations were calculated between percentage of states and cities; they were positive and significant for site-name with map-aid, $r = .30$, map labelling, $r = .72$, fragmented states, $r = .57$, and map reproduction, $r = .52$, (all $p < .01$). The exception was site-name, $r = .17$.

Table 1: Mean percentages of States and Cities Correct, Computed t Values, Probabilities, and Effect Sizes for Men and Women by Treatment Group

Conditions		Means					
		Men	Women	Overall	*Mean Difference*	*Standard Error*	*d*
Site-name Memory		n = 53	n = 71	n = 124			
	States	65.06 (SD = 15.09)	65.24 (SD = 16.87)	65.16 (SD = 16.07)	.18	2.88	.01
	Cities	37.89 (SD = 13.21)	31.44 (SD = 15.51)	34.19 (SD = 14.87)	6.45	2.56	.45
Site-name with Map-aid		n = 56	n = 73	n = 129			
	States	66.18 (SD = 17.16)	69.45 (SD = 16.97)	68.03 (SD = 17.06)	3.27	3.03	.19
	Cities	43.61 (SD = 15.79)	41.15 (SD = 16.78)	42.22 (SD = 16.34)	2.46	2.88	.15
Map Labeling		n = 54	n = 75	n = 129			
	States	59.15 (SD = 22.40)	49.01 (SD = 20.32)	53.26 (SD = 21.72)	10.13*	3.85	.48
	Cities	32.74 (SD = 19.18)	21.71 (SD = 16.90)	26.33 (SD = 18.63)	11.03*	3.26	.61
Labeling Fragmented States		n = 54	n = 74	n = 128			
	States	30.37 (SD = 18.09)	23.16 (SD = 13.10)	26.20 (SD = 15.75)	7.21*	2.90	.47
	Cities	19.52 (SD = 14.43)	13.24 (SD = 10.63)	15.89 (SD = 12.71)	6.28*	2.32	.50
Map Reproduction		n = 51	n = 61	n = 112			
	States	52.51 (SD = 25.04)	49.97 (SD = 24.25)	51.13 (SD = 24.53)	2.54	4.68	.10
	Cities	12.41 (SD = 16.93)	13.44 (SD = 16.92)	12.97 (SD = 16.86)	1.03	3.21	.06

* $p_{fw} < .01$

Experience Measures

The experience items were subjected to principal components analysis for initial reduction and then subjected to confirmatory factor analysis to verify fit of the reduced model and validity of the derived score. The composite experience score was based on the experience variables of the demographic/experience questionnaire. Pearson *r* coefficients were calculated between the experience composite score and percent of states and of cities identified. Experience was found to correlate with percentage of states for map labelling ($r = .23$, $p < .05$) and fragmented states ($r = .37$, $p < .01$); percent of cities related overall ($r = .12$, $p < .01$) and under the site-name with map-aid ($r = .23$, $p < .05$), map labelling ($r = .31$, $p < .01$), and fragmented states ($r = .37$, $p < .01$). On gender and experience, men ($M = 133.72$, $SD = 75.96$) were higher than women ($M = 119.77$, $SD = 62.69$) on the composite of experience, $t(378) = 2.16$, $p < .05$.

Table 2: Sample sizes, Group Means, Standard Errors, and Effect Sizes for the Percentage of States and Cities Correctly Identified for the Geographic Class × Condition Interaction

Conditions	Means		*Mean Difference*	*Standard Error*	*d*
	States	Cities			
Site-name Memory	n = 124	n = 124			
	65.16 (SD = 16.07)	34.19 (SD = 14.87)	30.97*	2.25	.86
Site-name with Map-aid	n = 129	n = 129			
	68.03 (SD = 17.06)	42.22 (SD = 16.34)	25.81*	2.20	.49
Map Labeling	n = 129	n = 129			
	53.26 (SD = 21.72)	26.33 (SD = 18.63)	26.93*	2.20	1.38
Labeling Fragmented States	n = 128	n = 128			
	26.20 (SD = 15.75)	15.89 (SD = 12.71)	10.31*	2.21	.72
Map Reproduction	n = 112	n = 112			
	51.12 (SD = 24.53)	12.97 (SD = 16.86)	38.15*	2.36	1.77

* $p_{fw} < .001$

Discussion

Hypothesis 1 was confirmed: the percent of sites identified in the easier groups were higher than in the more difficult groups, the map labelling, fragmented states, and map reproduction groups. Hypothesis 2 was confirmed: no gender differences were found for the easier groups, but men identified higher percentages of states and cities in two of the more difficult, the map-labelling and fragmented states, groups. Hypothesis 3 was confirmed: students identified larger percentages of states than of cities for all five conditions. Zinser et al. (2004) also reported that a higher percentage of states than cities were identified.

Map Labelling

The lower performances under the map labelling condition, relative to the easier conditions, may have stemmed from this task having been more confusing and therefore more difficult; this result replicated Straub and Seaton (1993), under what they called the map-only condition. However, under map labelling, in the present study, men still did better with the states and cities tasks than did the women. Writing the names of states and cities into the outlines of the states, may have drawn men to give more attention to the state outlines, locations, and contexts (McNamara, Halpin & Hardy, 1992) and to configurational and verbal-spatial associative memory systems.

Labelling of the Fragmentation of the States of the United States

The map-labelling condition did not make clear whether it was knowledge of the outlines of the states or of the context of the states that accounted for the gender difference; it may be that men acquire superior knowledge of the outlines of the states. In fact, men did display superior knowledge of the outlines of the states, and this occurred although the overall number of states and cities identified under the fragmented states condition was lower than for the other conditions. Men did better in the absence of context, perhaps because they are more field independent (Witkin, 1950; Witkin, 1979; Witkin et al., 1977). It cannot be ruled out however that men may still have had access to context by way of a recalled cognitive map of the United States.

The greater visual-spatial experiences that men may acquire by the time of their early teens may relate to this advantage (Boardman, 1990; Hart, 1979; Matthews, 1987). Moreover, in the preparatory school years, many children practise assembling puzzle pieces of the states of the United States. Do boys practise this task more frequently?

Map Reproduction (Sketching) of the States and Cities of the U.S.

Men and women did not vary in map-reproduction proficiency in this study. This result could indicate that there is no gender difference on this task. However, considering the difficulty of the task, the results from this condition could have been constrained, quite extensively, by a floor effect. Partitioning the country into regions may not have simplified the task sufficiently for a gender difference to emerge (Tversky, Morrison, Franklin & Bryant, 1999).

Interpretations & Experience

Men scoring higher on a composite measure of experience and this measure correlating with the states and cities percentages and the highest under the map-labelling and fragmented states conditions provided evidence of the potential influence of education, travel etc. on the gender differences observed. These results confirmed the difference hypothesis. Men having superior knowledge of cities and of the shapes of states may be a product of some combination of higher spatial abilities and greater experience with spatial tasks. But, the relevance of the deficiency and inefficiency (culture) hypotheses may have had a bearing on the results as well.

With respect to cities, males have a greater interest in cities, possibly because of a greater interest in spectator sports; men in the present study watched more college and professional sports. But, this difference does not explain why men also are more proficient in knowledge of international cities (Zinser et al., 2004), unless it is that men also may have greater ongoing interest and knowledge of world history and politics (Frazer & Macdonald, 2003).

Limitations and Future Research

A major problem for the present study, and others like it, is that gender differences, are difficult to interpret for methodological reasons (Baumeister, 1988). A second limitation is the experiences of the participant group. Despite the variability in the data, most participants were similar in travel experience, and had lived in the same U. S. region throughout most (some all) of their lives. Thus, there are concerns about the results of the present study generalising to the United States and world populations.

Additional developmental research on how girls and boys come to develop different levels of proficiency in geography likely will have implications for educators of geography (Self & Golledge, 1995), whose mission is to enhance knowledge of the United States and the rest of the world, in both girls and boys. Herman et al., (1985) reported education majors in the United States were very weak with world geography – two-thirds of a sample of elementary school majors located very few of 10 world countries – 65% missed England, France and Japan. In another study, this time on knowledge of the geography U. S., college students identified correctly about 60% of the U. S. states and capitals (Stokes & Keim, 1993). Sobering is that Bednarz (2003) found that progress with the National Geography Standards has been mixed, although progress with enhancing knowledge of geography in students is important, more than ever, to educators and others preparing individuals to interact with members of the international community.

Conclusions

Men and women are similar, but they also are different. For instance, they are different in some ways on memory of the geography of the United States. Specifically, men in the present study were more proficient in context-dependent and context-independent memory for difficult tasks involving the states and cities of the United States. Overall, some combination of genetics, biology, socio-cultural experiences, social biases, and consequent interest results in men exhibiting more knowledge and skill on difficult geographic tasks. Additional research is needed on whether men develop greater ability and interest early in life; if not, on whether the ability of women becomes neglected and degraded over time, or whether these factors prevail in combination. Prospects are good that progress in research on all fronts will afford better understanding and theory development of gender differences in geography. Relevant research will be helpful to developing the educational programs and materials needed to enhance the spatial abilities and geographic knowledge of students, student teachers, and teachers of geography.

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Footnotes

1. Now a doctoral student at the Department of Educational Psychology of the University of Nebraska.
2. Thank you to the reviewers of this paper and to John Clouse for their suggestions on a draft of the current paper.
3. A more detailed version of this paper is available from the authors.