Sex Differences in Wayfinding Behavior Using Well- or Poorly- written Route Descriptions

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Sex Differences in Wayfinding Behavior Using Well- or Poorly-Written Route Descriptions

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We investigated sex differences in actions and levels of anxiety during wayfinding using a well- or poorly-written route description, which we selected from a pool of route descriptions in our previous research. Participants were asked to navigate through an unfamiliar environment using well- or poorly-written directions. Results revealed that when given a poor direction, (1) females had more difficulty than males in following a route, (2) females displayed more hesitation and looked around more than males, and (3) higher levels of anxiety were reported by females. Directional errors and anxiety during wayfinding related to different wayfinding actions. In particular, the participants who did not have confidence in their decision-making showed more peeping in environmental features and frequent short pauses, whereas the participants who chose wrong directions showed more signs of hesitation and long pauses.

Key words: route descriptions, wayfinfing actions, sex differences, and anxiety during wayfinding

Introduction

Wayfinding with verbal route descriptions

Wayfinding is the process of determining and following a path or route between an origin and a destination. It is a purposive, directed, and motivated activity (Golledge, 1999). Human movement is often guided by external aids (such as verbal route descriptions, visual maps, charts). Travelers not only depend on their spatial memory but also make use of verbal directions as well as visual maps in finding their way to unfamiliar places.

Route description is the linguistic medium that is used to transmit navigational information to a person who is in a new environment (Denis, 1997). Route directions consist essentially of selecting salient features in the environment which allow the user to create a visual model thereby he/she will be able to anticipate crucial decision points that lead to action (Daniel and Denis, 2004). Several researchers tried to find the components or structures in most intelligible route descriptions (Allen, 1997; Allen, 2000; Denis, Pazzaglia, Cornoldi, & Bertolo, 1999; Honda & Nihei, 2003; Lovelace, Hegarty., & Montello, 1999; Streeter, Vitello., & Wonsiewicz, 1985; Wunderlich & Reinelt, 1987). Lovelace *et al.* (1999) pointed out several aspects of good route descriptions based on the findings of previous researchers. These aspects include a) priming the traveler for upcoming choice points, b) mentioning landmarks at choice points, c) giving "you've gone too far if" statements in case a choice point is missed, d) giving landmarks rather than street

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names, e) giving distance between choice points, f) telling the traveler which way to proceed at a choice point, g) providing information to allow recovery from errors, h) providing clearly linear information (e.g. using 'then', and focusing on a sequential rather than global view), and i) providing a limited amount of redundant information (Lovelace *et al.*, 1999). Denis *et al.* (1999) investigated the communicative value of route descriptions and navigational performance in the city of Venice. Route descriptions were collected from residents of the city of Venice and participants were asked to rate each of the route directions on a seven-point scale for quality in navigational assistance. The results revealed navigation with good route descriptions gave significantly lower error scores than navigation with poor descriptions. In addition, poor descriptions also resulted in more errors from subjects who tend to use a survey perspective than from subjects expressing a preference for visual memories of landmarks (Denis *et al.*, 1999).

Some research reported wayfinding with route descriptions relates to several variables, such as gender, age, working memory capacity, and spatial information processing strategies. However, very few studies have investigated the effects of verbal instructions on subjects' performance in the execution of navigational tasks in large-scale environments (Denis *et al.*, 1999).

Sex-related differences in wayfinding performance

We investigated sex differences in actions and mental states in the course of wayfinding with route descriptions. Sex-related differences on wayfinding, orientation tasks, and spatial information processing strategies are reported frequently (Allen, 2000; Galea & Kimura, 1993; Holding & Holding, 1989; Sandstrom, Kaufman, & Huettek, 1998). In all of these researches, males have outperformed females, executing the tasks more quickly and/or making fewer errors. The human sex differences have been used to explain several evolutionary psychological theories that are based on the different types of evolutionary pressure (Gaulin & FitzGerald, 1989; Eals & Silverman, 1994; Ecuyer-Dab & Robert, 2003).

When navigating, women typically focus on landmarks within the environments, whereas men tend to focus on the Euclidian properties of the environments (Galea & Kimura, 1993; Saucier, Green, Leason, MacFadden, Bell, & Elias, 2002). The differences in spatial information processing strategies result in the sex-related wayfinding performance with route descriptions. Allen (2000) investigated the effects of practices for communicating route knowledge. The results showed following route directions were facilitated by the practice of (a) presenting the correct temporal-spatial order, (b) concentrating information in statements concerned with choice points, and (c) using spatial designations with which most listener are facile. Interestingly, women had more difficulty than men in following the route from verbal directions in all experiments. Pazzaglia & De Beni (2001) reported that males showed better wayfinding performance than females by using both verbal route descriptions and visual maps.

Some research also revealed that females have higher levels of wayfinding anxiety or environmental confusion than males. For example, Lawton and Kallai (2003) examined gender and cultural (United States and Hungary) differences in wayfinding strategies and anxiety related to wayfinding. The results revealed that males in both countries reported a greater preference for

strategy of orienting to global reference points, whereas females reported a greater preference for strategy of route information. Women in both countries reported greater wayfinding anxiety than men (Lawton and Kallai, 2003). Burns (1998) surveyed drivers in Britain, and found females were more likely than males to report difficulty in wayfinding. Kallai, Karadi, & Kovacs (2000) reported that spatial anxiety correlates with gender and agoraphobic behavior. These findings suggest that wayfinding anxiety relates to various navigational actions with route descriptions.

The previous researches studied human sex differences during navigation or route learning with various external aids. However, the sex differences in navigational actions or mental states (e.g., wayfinding anxiety) during wayfinding tasks using route descriptions were not previously investigated in large-scale environments. Therefore, we sought to investigate sex differences in specific actions and anxiety in the course of wayfinding with well- or poorly-written route descriptions.

Method

Participants

Forty-eight young adults (males = 24; females = 24) participated in this study. All participants were students at the Sendai Welfare Academy, between the age of 19 and 21. They had never been to the Tohoku University campus (Kawauchi campus). They were randomly assigned to one of the descriptions (well- or poorly-written route descriptions), maintaining the same proportions of male/female in each condition.

Materials

We selected two route directions from a pool of descriptions collected in our previous study (Honda & Nihei, 2001, 2003). In this study, eighteen Tohoku University students were asked to write down the description of a route on their own campus so that a visitor unfamiliar with the campus can easily reach the designated room of a particular building (Honda & Nihei, 2003). The distance was about 800 m. Then, 72 judges were asked to read and rate each of the 18 descriptions on a seven-point scale based on intelligibility of the verbal descriptions. Thirty-six of them were familiar with Tohoku University campus. The other 36 students from Yamagata University were unfamiliar with this campus. The ratings of intelligibility of the descriptions resulted in very similar responses from familiar and unfamiliar judges ($r = .77$ $p < .001$). This result supported the findings of Denis *et al.* (1999). We chose the well- or poorly-written route description based on the intelligibility scores (Mean $= 4.5 \pm 0.6$) and number of words (the good description: 420 words; average rating of two groups: 5.1, the poor description: 407 words; average rating of two groups: 3.9). Table 1 shows the components in two route descriptions.

Table 1 The number of components in good or poor route descriptions used in the present experiment

	Good description	Poor description
Landmarks	6	6
Pathways	3	1
Choice points	1	1
Distinctive features in environments	5	1
Standard units (metric distances)	0	1
Vague judgments (vague expressions of distance)	1	1
Abstract frames of references (cardinal directions)	0	0
Environment-based frames of references	4	3
Body-based frames of references	10	6
Orders	0	1
Verbs of movement	10	9

Note. The definitions of the components in route descriptions were shown by Honda & Nihei (2001).

Procedure

All participants were tested individually. The participants read either the well- or poorly-written route descriptions at the starting point (Kawauchi post office). They were asked to navigate from the starting point to the destination (an experiment room in the Psychology Department) using the well (N = 24) - or poorly (N = 24) -written route directions. The route directions were printed on a paper in black, size-18 font on a white background. They could read the description whenever they wanted during the wayfinding task. They were told that the experimenter would follow them to record their progress on video.

The experimenter gave the following instructions: (a) "Please walk at a normal pace and navigate yourself to the destination given in the description", (b) "Do not ask any other passerby for additional route information", and (c) "Please stop and reread the route description if you need further assistance."

When a participant went the wrong way, the experimenter informed him/her that the direction was incorrect. Data recording of wayfinding ended when the participants had reached the destination. Then, participants were asked to rate their level of anxiety during wayfinding. The anxiety was rated on a 7-points scale, which ranged from 1 = *Not at all* to 7 = *Very much*.

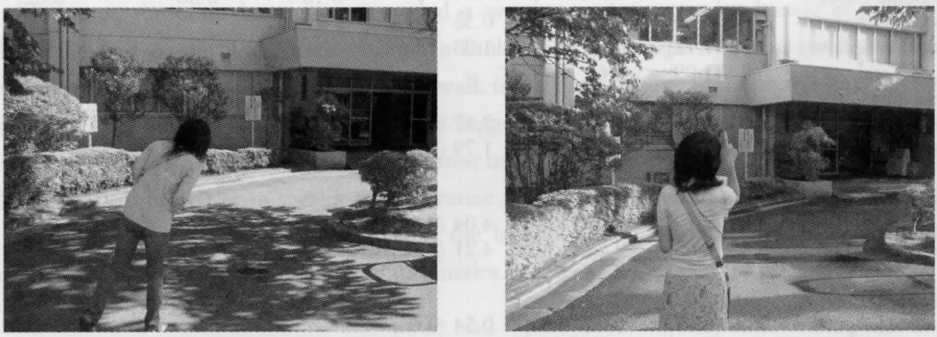
Dependent variables

We analyzed the directional errors, various wayfinding actions, and the rated anxiety for each participant. We categorized the actions based on the definition from previous research (Denis *et al.*, 1999; Garden *et al.*, 2002; Pazzaglia & De Beni, 2001). Moreover, we defined specific actions that were not used by previous research but seemed to provide important

information in human wayfinding behaviors (see Table 2. and Figure 1.).

Table 2 The definitions of directional errors and wayfinding actions

	Definitions
Directional errors	When the participant walked in a wrong direction at a decision point or at any other point.
Short pauses	A pause of 5 seconds' duration or less.
Long pauses	A pause of 6 seconds' duration or more.
Hesitations	When the participant repeated the short or long pauses around a point.
Looking around	When the participant stopped and looked around to find the correct direction.
Peeping through	When the participant stopped and peeped into a building or a pathway.
Counting	When the participant looked up to a building and counted the number of a building's stories.



(a) Peeping through (b) Counting

Figure 1. Examples of wayfinding actions

The reliability of the categorization was obtained from two independent judges (including the first author). We chose six participants' wayfinding behaviors randomly from the records and the two judges independently categorized them. The categorization had an adequate reliability, which corresponding rate being 89.0%. Finally, the first author categorized all the behaviors once again. If questions arose in the categorization, the questions were resolved by discussion between the two judges.

Results

Wayfinding errors and actions

Two factor between-subjects ANOVAs were used to test sex differences and intelligibility of route descriptions (good or poor) on each of the dependent variables. Means and standard deviations for each of the wayfinding behaviors, along with ANOVA results, are shown in Table 3.

The main sex-related differences were observed in hesitations ($p < .01$), in looking around ($p < .01$), peeping through ($p < .05$), and counting ($p < .05$). Females made more of these wayfinding actions than males during the wayfinding task. And the main effects of the intelligibility of route descriptions were found in directional errors ($p < .01$), peeping through ($p < .05$), and counting ($p < .001$). Counting was significantly lower in the participants using a

Table 3 Means and standard deviations of directional errors and wayfinding actions by sex and intelligibility of route descriptions

Variable	Female (N = 24)	Male (N = 24)	Total	*F*		
				Sex	Intelligibility	Sex × Intelligibility
Directional errors				0.76	8.56**	6.82*
Good description	0.17 (0.39)	0.58 (0.79)	0.38 (0.65)			
Poor description	1.50 (1.12)	0.67 (0.78)	1.08 (1.06)			
Total	0.83 (1.09)	0.63 (0.77)				
Short pauses				2.75	0.36	0
Good description	2.67 (2.77)	1.67 (2.53)	2.17 (2.65)			
Poor description	2.33 (1.67)	1.25 (1.42)	1.79 (1.61)			
Total	2.50 (2.25)	1.46 (2.02)				
Long pauses				1.98	0.04	3.65†
Good description	3.83 (2.12)	4.25 (3.49)	4.04 (2.84)			
Poor description	5.58 (3.65)	2.83 (1.80)	4.21 (3.12)			
Total	4.71 (3.66)	3.54 (2.78)				
Hesitations				9.21**	1.56	3.89†
Good description	0.67 (0.65)	0.42 (0.67)	0.54 (0.66)			
Poor description	1.42 (1.24)	0.25 (0.45)	0.83 (1.09)			
Total	1.04 (1.04)	0.33 (0.56)				
Looking around				8.18**	0	0.01
Good description	1.33 (1.30)	0.42 (0.67)	0.88 (1.12)			
Poor description	1.25 (1.29)	0.50 (0.52)	0.88 (1.03)			
Total	1.29 (1.27)	0.46 (0.59)				
Peeping through				6.60*	5.78*	1.99
Good description	0.67 (0.65)	0.01 (0.29)	0.38 (0.58)			
Poor description	2.58 (3.26)	0.58 (1.00)	1.58 (2.57)			
Total	1.63 (2.50)	0.33 (0.76)				
Counting				4.15*	37.32***	2.88†
Good description	2.17 (1.27)	1.25 (0.97)	1.70 (1.20)			
Poor description	0.25 (0.45)	0.17 (0.45)	0.21 (0.42)			
Total	1.21 (1.35)	0.71 (0.91)				
Pause (sec)				0	0.09	2.1
Good description	56.67 (38.39)	76.75 (78.93)	66.71 (61.56)			
Poor description	82.42 (64.02)	52.17 (51.67)	67.29 (58.96)			
Total	69.54 (53.27)	64.46 (66.44)				

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$

poor description than those with a good description. The participants using a poor description made significantly more directional errors and peeping through than those using a good description. The only significant interaction between sex and the intelligibility of descriptions was found in directional errors ($p < .05$). Post hoc analysis (Bonferroni's) indicated the females using the poor description made significantly more errors than those with the good description ($p < .001$) or males used the poor description ($p < .05$).

Sex differences in directional errors and the characteristics of the route descriptions

Seventy-four percent directional errors occurred at two decision-making points (point A: find a gate and turn to your right, point B: find a building and turn to your left). At point A, the poor description provided *metric distances to landmarks* (... and *walk about 20 or 30 meters*. There will be a gate to your right. Then turn to the right, ...). The well-written description provided *salient features of landmarks* (...There will be a path to your right, then turn to the right. You will see a gate. *It looks like a crossing bar.* ...). Chi-square analyses suggested that females using the poor description (25%) made more errors than those using the good description (0%) (χ^2 (1, 24) = 3.43, $p = .06$). The difference between males using the poor description (17%) and those using the good description (17%) was not significant ($\chi^2(1, 24) = 0$, n.s), suggesting that Euclidian information in the poor description caused directional errors in female participants.

Moreover, the poor description provided *a simple orientation for landmarks* at point B (... walk to the end of the path, there will be a building *to your left.* ...). The good description provided *salient features of the landmarks* (... walk to the end of the path, there will be a *nine-story building* to your left. ...). Chi-square analyses suggested that females using the poor description (42%) made significantly more errors than those using the good description (0%) (χ^2 (1, 24) = 6.32, $p < .05$). However, a significant difference was not observed in male participants (χ^2 (1, 24) = 0.75, n.s). The results indicate that the lack of salient and distinctive information of landmarks resulted in directional errors in females.

Anxiety during wayfinding

A two factor between-subjects ANOVA was performed, with the total level of anxiety during wayfinding as the dependent variable and the sex of the participants and intelligibility of route descriptions as independent variables (see Figure 2).

Analysis of wayfinding anxiety revealed significantly higher rating for females than for males (F (1, 44) = 8.23, $p < .01$). The anxiety was significantly higher in the participants using the poor description than those using the good description (F (1, 44) = 5.97, $p < .05$). The interaction between sex and the intelligibility of route descriptions was not significant (F (1, 44) = 1.91, n.s).

Correlations among the actions and anxiety during wayfinding

Pearson product-moment correlations were performed among the various actions and anxiety during wayfinding (see Table 4.). Directional errors positively correlated with long pauses ($p < .05$), hesitations ($p < .01$), and pause times ($p < .01$). A negative correlation was observed

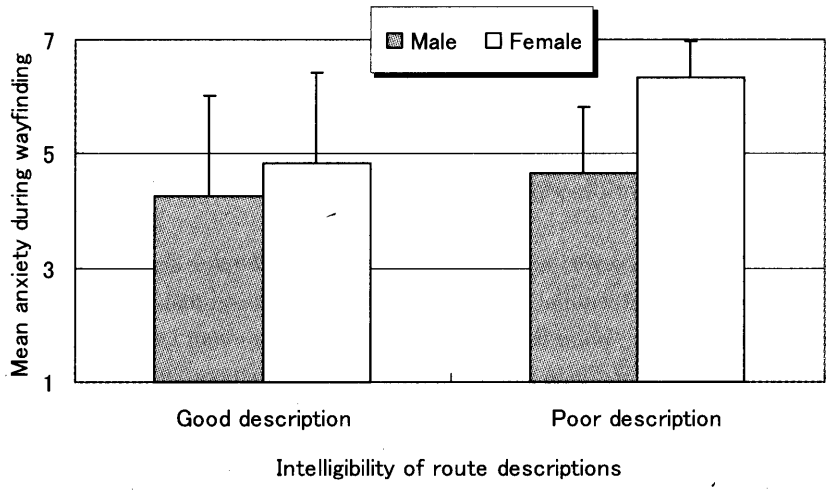


Figure 2. Means and standard deviations of anxiety during wayfinding

between the number of counting and the number of directional errors, r (48) = -.44, p < .001, indicating that counting actions in a large scale environment decreased directional errors during the wayfinding task. Moreover, this correlation was maintained even when the two sexes were considered independently: males, r (24) = -.41, p < .05; females, r (24) = -.57, p < .01.

Anxiety during wayfinding positively correlated with short pauses (p <.05) and peeping through (p <.05). Hesitations positively correlated with short pauses (p < .01), long pauses (p <. 01), looking around (p <.001), peeping through (p <.001), and pause times (p < .01). Peeping through positively correlated with long pauses (p <. 01) and looking around (p <.001).

Table 4 Correlations among directional errors, anxiety during wayfinding and various actions

	1	2	3	4	5	6	7	8	9
1. Directional errors	–								
2. Anxiety during wayfinding	.26†	–							
3. Short pauses	.04	.34*	–						
4. Long pauses	.35*	.25†	.35*	–					
5. Hesitations	.43**	.18	.43**	.63***	–				
6. Looking around	.09	-.1	.07	.26†	.49***	–			
7. Peeping through	.25†	.29*	.23	.44**	.62***	.47***	–		
8. Counting	-.48***	-.2	.07	-.09	-.11	.06	-.14	–	
9. Pause (sec)	.44**	.18	.33*	.83***	.44**	.14	.23	-.16	–

† p < .10. *p < .05. **p < .01. ***p < .001

Discussion

In the present study, we investigated sex differences in actions and anxiety in the course of wayfinding using route descriptions. Females using the poor description made significantly more errors than males. This finding corresponded to the results of previous studies (Allen, 2000; Pazzaglia & De Beni, 2001). Research on wayfinding anxiety suggested that females had higher levels of environmental confusion and wayfinding anxiety than males (Burns, 1998; Lawton and Kallai, 2003; Kallai *et al.*, 2000). As predicted, our data showed that females reported higher levels of anxiety during wayfinding than males.

Saucier *et al.* (2002) revealed that males made fewer errors than females in their real-world navigation task. These differences could be attributed to the large number of errors made by women following Euclidean information (the cardinal directions and metric distances), as men and women did not differ in the number of errors made during the landmark information (the salient landmarks and egocentric turn directions). Our data suggests that sex-related differences in spatial information processing strategies affected sex differences in wayfinding using the route descriptions. The metric distances and the lack of distinctive information of landmarks in the poor route description related to many directional errors in females. The results indicate that females used a landmark strategy during the wayfinding and were less able to use the Euclidean information. Denis *et al.* (1999) reported that poor descriptions did not specify landmark locations. In addition, the present findings suggest that some features of route description selectively relate to sex-related differences in wayfinding behavior.

The results also showed sex-related differences in wayfinding actions such as hesitations, looking around, peeping through, and counting. Females showed a larger number of hesitations and appeared to look around more than males, regardless of the intelligibility of route descriptions. Women reported less childhood wayfinding experience than did men (Lawton & Kallai, 2002). Therefore, females and males might differ in the frequency of these actions to find a correct way. Anxiety during wayfinding positively correlated with the number of short pauses and peeping through. The number of directional errors positively correlated with long pauses, hesitations, and pause times. That is, the participants who did not have confidence in their decision-making showed more peeping into environmental features and frequent short pauses, while the participants who chose wrong directions showed more hesitations and long pauses. Further research is necessary to clarify the functional meaning of the wayfinding actions in large-scale environments.

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