SHS Web of Conferences **12**, 01001 (2014)
DOI: 10.1051/shsconf/20141201001

The Effects of Senses of Direction on Wayfinding Behaviors: Evidence from Biking Tourists

Jo-Hui Lin[1], Ching-Hua Ho[2], Kok-Lim Ngan[3,a], Jin-Hua Tu[4], and Wongladda Weerapaiboon[5]
[1,3,4,5]Graduate Institute of Recreation, Tourism and Hospitality Management, National Chiayi University, Chiayi, Taiwan (R.O.C)
[2]Graduate Institute of Travel & Tourism Management, National Kaohsiung University of Hospitality and Tourism, Kaohsiung, Taiwan (R.O.C)

Abstract. The purpose of this study is to examine and observe the effects of senses of direction (i.e., abilities of memory and awareness of orientation) on wayfinding behaviors for biking tourists. A total of 295 biking tourists completed a questionnaire using a purposive sampling method. The hierarchical regression model was employed to test the proposed hypotheses. Results show that biking tourists' abilities of memory and awareness of orientation have a direct effect on their wayfinding behaviors. The contribution of this study is to demonstrate the implication of senses of direction to biking tourists' wayfinding behaviors and to provide biking tourists suggestions for wayfinding strategies.

1 Introduction

In the last twenty years, issues of climate change and global warming have been highly discussed [1,20]. Climate has a great impact on travel behaviors. When actions of the energy conservation and carbon footprint reduction are taken by the public, for example, biking to replace other fuel consuming vehicles, biking tourism has become a popular trend. Many tourists find wayfinding both a challenging task and a decision.

Research on wayfinding in the tourism focuses on individual differences of wayfinding, landmark facilities, wayfinding fashions, and process and decision-making [21, 22]. Existing research findings, however, are not suitable for explaining wayfinding behaviors for biking tourists.For biking tourists, understanding wayfinding behaviors has important implications, especially in the way to explain environment-behaviors for their attempts to organize and design the unfamiliar environment for travel.

Up to now, there is little literature investigating which sense of direction predicts the biking tourists' wayfinding ability. The difficulties of biking tourists are on how to use the sense of direction to make effective wayfinding decisions. The purpose of this study is to examine how biking tourists apply senses of direction to their wayfinding behaviors at the tour. A better understanding of the effects of senses of direction on wayfinding behaviors can help biking tourists to develop accessibility to spatial information.

2 Literature Review and Hypothesis

2.1 Senses of Direction

Sense of direction is mostly defined by psychologists as recognition of location and it specifies where a person is when he or she navigates around the environment. Psychologists also view it as a talent of regular cognitive abilities [8]. Sense of direction refers to an individual's awareness and knowledge of where he or she is located, based on the environmental information, to make a routing judgment [18].

Environmental psychologists indicated that some wayfinders refer to their mental cognitive maps in order to control the environmental information or related spatial location [9]. Kozlowski and Bryant found that differences between good sense of direction and poor sense of direction were increased with individuals being introduced to a route in a novel environment when they were asked to point back to the starting point after traversing the route [8]. Kato argued that individuals with a good sense of direction can effectively employ memories with assistive spatial targeted objects and landmarks to integrate their experiences with the environment [6].

2.2 Wayfinding Behaviors

Wayfinding is a fundamental activity that individuals do as they move from one place to another [16]. Wayfinding was first introduced by architecture Kevin Lynch in the book, The Image of the City, as a process of determining and following a path or route between origin and destination [11]. Passini conceptualized the term of wayfinding as a spatial problem solving, including decision making, decision executing, and information processing [14]. Wayfinding is a human ability to identify the location and arrive at the destination, both cognitively and behaviorally [14, 17].

In 1960's, research on wayfinding behaviors and wayfinding performance ensued successively, and the wayfinding topics started being widely discussed [12, 15, 17]. Theories related to environmental and geographic psychology have been employed to analyze wayfinding behaviors for humans [2, 19]. Limited research has been conducted regarding tourists' wayfinding decision making and wayfinding problem solving. Xia et al. used tourists in the Koala Conservation Centre at Phillip Island Nature Park, Australia to study their wayfinding behaviors and processes within the area and to provide wayfinding suggestions based on tourists' levels of familiarity in the park environment [21]. Xia et al. investigated the relationship between tourists' attributes and wayfinding behaviors, and identified differences in travel wayfinding behaviors according to their gender, age, type of tour group and environmental familiarity [22].

2.3 Hypotheses Development

Wayfinding is a purposeful, directed, and motivated means for bikers to move from origin to destination, and wayfinding behavior transforms wayfinding strategies into decisions when tourists explore the touring sites [21, 22]. Bike tourists' identification ability to routing direction at tour is similar to the sense of direction in geography. This study views sense of direction as one of biking tourists' personality traits. In wayfinding strategies, individuals with a good sense of direction appear to have a better performance on route learning and be more flexible in using effective strategies than those with a poor sense of direction [7]. Xia et al. found that tourists who are more familiar with the environment tend to use landmarks less and are more likely to navigate by using the wayfinding strategies [22].

When biking tourists visit certain destinations and if they can easily refer to local geographic features, they would further be able to determine the direction and location of the environment. Based on geography psychology [2] and environment psychology [7, 15], this study proposes that biking tourists' senses of direction have positive effects on their wayfinding behaviors.

H_1: Biking tourists' abilities of memory have a positive effect on their wayfinding behaviors.

H_2: Biking tourists' awareness of orientation has a positive effect on their wayfinding behaviors.

3 Methodology

3.1 Sampling and Data Collection

This study conducts a purposive sampling strategy using biking tourists from the main provincial highways as study samples. A total of 450 questionnaires were distributed to tourists who had some biking touring experiences in the past 12 months. 295 questionnaires were valid and a 65.56% effective response rate was reported. Table 1 shows the profiles of the respondents. More than half (57.6%) of the respondents were males. Less than three-fourths (72.5%) the respondents were under the age of 35, and approximately two-thirds (65.1%) had college or university degrees. Less than half (46.1%) of the respondents' annual income were below NT$250,000 (US$8,300), followed by students, semi-professionals and professionals representing 26.1%, 26.1% and 14.9%, respectively. The number of annual biking touring experiences reported includes "5 or less times" (30.2%), "6-10 times" (38.6%), "11-15 times" (18.3%), and "16 times or above" (12.9%).

Table 1. Profiles of the Respondents (n=295)

Profiles	n	%	Profiles	n	%
Gender			***Occupation***		
Male	170	57.6	Executive/managerial	10	3.4
Female	125	42.4	Self-employed	14	4.7
Age			Professional	44	14.9
18~25 years	108	36.6	Government employees	18	6.1
26~35 years	106	35.9	Semi-professional	77	26.1
36~45years	53	18.0	Educational/academic	20	6.8
Above 46 years	28	9.5	Student	77	26.1
Education			House keeper, retired or other	35	11.9
High school or less	76	25.8			
College or university graduate	192	65.1	***Number of annual biking touring experiences*** (times)		
Post graduate education	27	9.1	5 or less	89	30.2
Annual income (NT$)			6~10	114	38.6
Under 250,000	136	46.1	11~15	54	18.3
250,001~500,000	96	32.6	16 or above	38	12.9
500,001~750,000	39	13.2			
Above 750,001	24	8.1			

3.2 Measurement

3.2.1 Sense of direction

Senses of direction are seen as biking tourists' perceived spatial relationships at the tour and also a personality trait. This study uses the abilities of memory scale (4 items) and awareness of orientation scale (4 items) adapted from the sense of direction research conducted by Kato and Takeuchi [7, 19].

3.2.2 Wayfinding behaviors

Wayfinding behavior is the procedural behavior that facilitates biking tourists to arrive in the destination. This study uses a survey strategy scale (6 items) adapted from the wayfinding strategy scale conducted by Lawton and Kallai [9, 10].

3.2.3 Control variables

Research on wayfinding strategies found gender differences existed in spatial abilities and males outperform females [9]. Sholl et al. also found the relationships of sense of direction with spatial orientation ability may relate to different performance between male and female college students [18]. Based on findings of previous studies [3, 4, 5, 10, 22], demographic variables, such as age, gender, education, income, and biking touring experiences, were treated as control variables in this study.

3.3 Descriptive Statistics, Correlation, Reliability, and Validity

Table 2 displays the descriptive statistics and correlations for all variables, as well as the Cronbach's alpha for each scale. Because all alpha values ranged from 0.81 to 0.88, the constructs in the model were reliable. The evidence indicates that these measurements were acceptable. The means of the three primary variables, abilities of memory, awareness of orientation, and wayfinding behaviors, in this study are between 3.65-3.80, and their standard deviations are between 0.69-0.77.

The relationships between all variables ranged from -0.26 to 0.76. A significant positive relationship was found between abilities of memory and wayfinding behaviors ($r = 0.28$, $p<0.01$), as well as awareness of orientation and wayfinding behaviors ($r = 0.76$, $p<0.05$). A significant positive relationship was also found between annual biking touring experiences and awareness of orientation ($r = 0.18$, $p<0.05$). The variance inflation factor (VIF) is tested to insure that there are no potential problems of multicollinearity for variables (Neter, Wasserman, & Kutner, 1989). The VIF is the inverse of tolerance; the smaller the value, the less the collinearity between variables. In Table 2, the VIF of the predictors for the regression model ranged from 1.03 to 1.52 (< 10).

4 Results

This study conducts a hierarchical multiple regression analysis to test the hypotheses. The analysis was carried out for the dependent variable, wayfinding behaviors. Step 1 includes the demographic variables, and Step 2 adds number of annual biking touring experiences. Senses of direction were added in Step 3. The Durbin-Watson statistic is used to determine if an autocorrelation is presented in the residuals from a regression analysis. In Table 3, the Durbin-Watson statistic in this study, ranging from 1.81 to 2.05, indicates that it matches the demand of regression analyses.

Table 2. Means, Standard Deviations, Correlations, and Cronbach's Alpha

Variables	1	2	3	4	5	6	7	8
1. Gender [c]	--							
2. Age [c]	0.04							
3. Education [c]	-0.26**	0.46**						
4. Annual income [c]	0.02	-0.23*	0.12*					
5. Number of annual biking touring experiences [c]	0.06	0.13*	0.14*	0.05				
6. Abilities of memory	0.15*	0.10	-0.14*	0.05	0.01	**(0.86)**[a]		
7. Awareness of orientation	0.05	0.18**	0.14*	0.06	0.18**	0.25**	**(0.81)**	
8. Wayfinding behaviors	0.03	0.18**	0.10	-0.15*	0.09	0.28**	0.76**	**(0.88)**
Means [b]	--	--	--	--		3.65	3.71	3.80
Standard deviations	--	--	--	--		0.77	0.69	0.71
VIF	1.13	1.47	1.52	1.14	1.03	1.10	1.15	--

a. Bold numbers on the diagonal parentheses are Cronbach's alpha of each construct.
b. Composite scores for each latent variable were obtained by averaging scores across items representing that measure; $^{*}p < 0.05$, $^{**}p < 0.01$.
c. Gender was measured as a dichotomous variable. Age was measured as a continuous variable (1 = 18-25 years, 2 = 26-35 years, 3 = 36-45 years, 4 = above 46 years); education was measured as three categories (1 = high school or less, 2 = college or university graduate, 3 = post graduate education); annual income was measured as a continuous variable (1 = under NT$250,000, 2 = NT$250,001-500,000, 3 = NT$500,001-750,000, 4= above NT$750,001); number of annual biking touring experiences was measured as a continuous variable (1= 5 or less , 2= 6-10, 3=11-15, 4= 16 or above).

The demographic variables in Model 1 and number of annual biking touring experiences in model 2 are all controlled for wayfinding behaviors. As Table 3 shows, demographic variables and number of annual biking touring experiences account for 3.8-4.5% (Adjusted R^2) of the variance in wayfinding behaviors. In Model 3, senses of direction represent 63.2% of the wayfinding behaviors variance, and the R^2 value increases from 5.1% to 60.7% in this model (ΔR^2=54.6%).

Abilities of memory are positively correlated ($\beta = 0.10$, $p < 0.01$) with wayfinding behaviors, and awareness of orientation is positively correlated ($\beta = 0.74$, $p < 0.01$) with wayfinding behaviors. In other words, the sharper the biking tourists' senses of direction, the better their wayfinding behaviors, and the predicting power of awareness of orientation to wayfinding behaviors is higher than that of abilities of memory. The result supports H_1 and H_2 that biking tourists' senses of direction have a direct effect on their wayfinding behaviors.

Table 3. Results of Hierarchical and Moderated Regression Analysis for Wayfinding Behaviors

	Model 1	Model 2	Model 3
Gender - Female	0.049	0.044	0.094**
Age	0.116*	0.128*	0.005
Education	0.073	0.080	0.010
Annual income	-0.136**	-0.129**	-0.112**
Number of annual biking touring experiences		0.105*	0.055
Senses of direction—abilities of memory			0.101**
Senses of direction—awareness of orientation			0.742**
F statistic	3.876**	3.784**	63.308**
R^2	0.051	0.061	0.607
ΔR^2	--	0.010*	0.546**
Adjusted R^2	0.038	0.045	0.597
D-W[a]	1.83	1.81	2.05

a. The Durbin-Watson statistic is between 1.83 and 2.05.
b. All coefficients reported are standardized betas; $^{*}p < 0.1$, $^{**}p < 0.05$.

5 Discussion and Conclusions

This empirical research applies senses of direction and wayfinding behaviors to explain the touring mode of biking tourists. As predicted, the results reveal that abilities of memory and awareness of orientation have positive and significant influences on wayfinding behaviors. These are the determinants to help increase the abilities of wayfinding behaviors. The results provide the significance of senses of direction to promote successful wayfinding behaviors. With a better sense of direction, biking tourists will be capable of developing orientation competence to enjoy biking touring.

Sense of direction is a personality trait [8], not an innate ability. Likewise, determinants affecting wayfinding include personal factors and environmental factors [12, 15, 22]. The findings of this study reveal that biking tourists' quality of sense of direction justifies their wayfinding behaviors. Sense of direction is significant to biking tourists. The study suggests biking tourists apply wayfinding

information as means to increase environment knowledge. Biking tourists with a better sense of direction will positively advance their wayfinding performance.

Despite lack of past similar studies, some findings still can be discussed with related literature. The contribution of the study is to demonstrate environmental and geographic psychology theory to bikers' touring behaviors, as well as to effectively establish the logic relationship between senses of direction and wayfinding behaviors. The study results support the notions of previous studies [7, 15]. The results of this study can only infer the touring behaviors by bikes for transportation, and it cannot be generalized to other non-biking wayfinding behaviors. As the biking touring pattern gets popular, it is suggested that future research can focus on the biking tourists at attractions. Further, how biking tourists develop personal sense of direction is also a prospective issue worth discussion.

References

1. B.Amelung, S.Nicholls, & D.Viner. Implications of global climate change for tourism flows and seasonality, Journal of Travel Research, **45**,3, 285(2007)
2. E.H.Cornell, A.Sorenson, & T.Mio. Human sense of direction and wayfinding. Annals of the Association of American Geographers, **93,**2, 399(2003)
3. A.S.Devlin & J.Bernstein. Interactive wayfinding: Use of cues by men and women. *Journal of Environmental Psychology*, **15,**1, 23(1995)
4. T.A.Dingus, M.C.Hulse, Mollenhauer, R.N.Fleischman, D.V.McGehee, & N.Manakkal,. Effects of age, system experience, and navigation technique on driving with an advanced traveler information system. *Human Factors,* **39**, 177 (1997)
5. G.Iaria, L.Palermo, G.Committeri, & J.J.Barton. Age differences in the formation and use of cognitive maps. Behavioral Brain Research, **196**,2, 187(2009)
6. Y.Kato. Microgenesis of cognitive map and sense of direction. *Revue de Psychologie Appliquée*, **37**, 261 (1987)
7. Y.Kato & Y.Takeuchi. Individual differences in wayfinding strategies. Journal of Environment Psychology, **23**,2, 171 (2003)
8. L.T.Kozlowski, & K.J.Bryant. Sense of direction, spatial orientation, and cognitive maps. Journal of Experimental Psychology: Human Perception and Performance*,* **3**,4, 590(1977)
9. C.A.Lawton. Strategies for indoor wayfinding: The role of orientation. Journal of Environmental Psychology, **16**,2, 137(1996)
10. C.A.Lawton & J.Kallai. Gender differences in wayfinding strategies and anxiety about wayfinding: A cross-cultural comparison. Sex Roles, **47**,9/10**,**389(2002)
11. K.Lynch. *The image of the city*. Cambridge, MA: MIT Press.
12. H.J.Miller. Human wayfinding, environment behaviors relationships, and artificial intelligence. Journal of Planning Literature, **7**,2,139(1992)
13. J.Neter, W.Wasserman, & M.H.Kutner. *Applied linear regression models*. Homewood, IL: Richard D. Irwin, Inc. (1989)
14. R.Passini. Spatial representations: A way-finding perspective. Journal of Environmental Psychology, **4**,2, 153(1984)
15. J.L.Prestopnik & B.Roskos-Ewoldsen. The relations among wayfinding strategy use, sense of direction, sex, familiarity, and wayfinding ability. Journal of Environmental Psychology, **20**,2,171(2000).
16. M.Raubal, & M.J.Egenhofer. Comparing the complexity of wayfinding tasks in built environments, Environment and Planning, **25**,6,895(1998)
17. M.J.Rovine, & G.D.Weisman. Sketch-map variables as predictors of wayfinding performance. Journal of Environmental Psychology, **9**, 217 (1989)
18. M.J.Sholl, J.C.Acacio, R.O.Makar & C. Leon. The relation of sex and sense of direction to spatial orientation in an unfamiliar environment. Journal of Environmental Psychology, **20**,1, 17 (2000)
19. Y.Takeuchi. Sense of direction and its relationship with geographical orientation, personality traits and mental ability. Japanese Journal of Educational Psychology*,* **40**, 47 (1992)

20. United Nations World Trade Organization (UNWTO), United Nations Environment Programme (UNEP) and World Meteorological Organization (WMO). *Climate change and tourism: Responding to global challenges.* UNWTO, Madrid, and UNEP, Paris. (2008)
21. J.Xia, C.Arrowsmith, M.Jackson & W.Cartwright. The wayfinding process relationship between decision-making and landmark utility. Tourism Management, **29**,3, 445 (2008).
22. J.Xia, D.Packer & C.Dong. Individual differences and tourist wayfinding behaviors, *18th World IMACS/MODSIM Congress*, Cairns, Australia, **13-17**, July, (2009). Retrieved July 1, 2013, from http://www.mssanz.org.au/modsim09/D3/xia_D3b.pdf