



One way to guide them all: Wayfinding strategies and the examination of gender-specific navigational instructions in a real-driving context

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ARTICLE INFO

Article history:

Received 20 June 2017

Received in revised form 29 March 2018

Accepted 21 June 2018

Keywords:

Real-world navigation behavior

Gender

Landmark navigation

Glance and blink behavior

ABSTRACT

Previous research suggests that men outperform women when they are required to use Euclidean information such as distances for orientation tasks, whereas women are superior in the use of landmarks. Our study examines whether this finding stands up to a test if it is put into an application context. Besides comparing self-reported wayfinding strategies between gender groups, we investigated if auditory instructions in navigation systems can be adjusted to potential gender differences in order to improve performance and to decrease distraction from the driving-task.

Participants ($N = 76$) respond to a questionnaire for wayfinding strategy use and take part in a real-world 20 min, standardized driving task. Driving behavior as well as glance and blink data are recorded via data-logging and eye-tracking. Overall, male and female orientation behavior is much more similar than indicated by previous research. Both men and women predominantly report to use landmark rather than Euclidean information. Correspondingly, even though they selectively respond to distance-versus landmark-based auditory navigational instructions when navigating while driving, the utilization of landmarks as navigation queries results in a lower visual distraction and mental workload for both, men and women. Driving performance is not selectively affected. Our results indicate that the use of landmarks as auditory navigational cues can make driving both safer and more comfortable for men and women. Consequently, in-car navigation systems can benefit from the implementation of landmark navigation prompts.

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While driving, physical, visual, and mental tasks have to be carefully coordinated. Thus, safe driving demands allocating attentional resources. The complex task of driving becomes even more complicated, if an additional wayfinding task has to be performed. To assist users with navigational tasks, technical solutions like navigation systems have been developed. Much effort is invested in the improvement of these systems with an emphasis on technical refinement. However, the human

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factor is largely neglected insofar as it is generally assumed that technical solutions are equally suitable for everyone. Thus, state of the art navigation systems mostly neglect individual user characteristics in system design. Our study considers gender-related differences in orientation behavior as a potentially crucial human factor. First, we investigate gender differences in self-reported orientation strategies as indicated by previous research. Second, we want to know if and how these potential gender differences come to application in a real-driving context by examining whether distance- versus landmark-based auditory navigation prompts are selectively suitable for gender groups.

1.1. Spatial orientation and gender-specific wayfinding strategy profiles

Due to its complexity, human spatial orientation has been a persistent theme in psychological research and the question, how humans manage to get from A to B, has been discussed extensively for decades (Allen, 1999). According to Allen (1999, p. 554) spatial orientation is also often referred to as wayfinding and is defined as “destination-directed movement through the environment”. This context-related feature differentiates spatial orientation from mere (yet highly related) spatial ability which is understood as being able to generate, represent, transform, and recall spatial information (Coluccia & Louse, 2004). Many researchers assume that humans manage the complicated task of spatial orientation by the utilization of so-called wayfinding strategies (Coluccia & Louse, 2004). Gender differences in wayfinding strategies have been reported repeatedly in previous studies (e.g. Coluccia & Louse, 2004; Dabbs, Chang, Strong, & Milun, 1998; Galea & Kimura, 1993; Lawton, 1994; Lawton & Kallai, 2002). Even though there is no unified terminology in literature with regard to these strategies, researchers mostly agree with the distinction of two major types of strategies and their gender-specific usage.

The first is the so-called survey strategy (Coluccia & Louse, 2004). To enable spatial orientation, this strategy aims at building on the formation of a cognitive map. For maintaining a sense of position in the surrounding environment, global reference points like the sun, the city center, or the starting point (Coluccia & Louse, 2004; Lawton, 1994) are used. Thus, it is based on an allocentric frame of reference (Gramann, Müller, Eick, & Schönebeck, 2005). Therefore, Euclidean information, like distances and cardinal directions (Saucier et al., 2002) are preferred. The survey strategy is also often called orientation (Coluccia & Louse, 2004; Lawton, 1994), geometric (Galea & Kimura, 1993), Euclidean (Dabbs et al., 1998) or configurational strategy (Coluccia & Louse, 2004). By contrast, the second major type is the route strategy (Coluccia & Louse, 2004). It focuses on several salient landmarks as well as their sequential organization and imposes an egocentric frame of reference (Blajenkova, Motes, & Kozhevniko, 2005; Gramann et al., 2005; Pazzaglia & De Beni, 2001). Thus, to get from the starting point to the destination, the user memorizes sequences of prominent items and their relative order in space and time (Lawton, 1994). The route strategy is also called landmark (Galea & Kimura, 1993; Saucier et al., 2002) or topographic strategy (Dabbs et al., 1998). For the sake of completeness, it has to be mentioned that some researchers make a further differentiation and assume three types of wayfinding strategies: survey, route and landmark strategy (e.g. Pazzaglia & De Beni, 2001; Bosco, Longoni, & Vecchi, 2004). However, for our study we adopted Lawton's (1994) traditional twofold distinction of strategies, because her two-factorial solution of wayfinding strategies has often been replicated (e.g. Chen, Chang, & Chang, 2009; Lawton, 1996; Prestopnik & Roskos-Ewoldson, 2000). Consequently, just like many other authors (e.g. Coluccia & Louse, 2004; Dabbs et al., 1998; Sandstrom, Kaufman, & Huettel, 1998; Saucier et al., 2002) we work on the assumption of the twofold distinction between survey and route strategy. In order to exclude misunderstandings due to the similarity of expressions, in this study wayfinding strategies are named after their most important key features. In the following, the terms used for the two strategies described above therefore are Euclidean strategy and landmark strategy.

Studies operationalize wayfinding strategies in different forms: Subjects are required to give directions from maps (Ward, Newcombe, & Overton, 1986), learn maps and give directions from memory (Dabbs et al., 1998; Galea & Kimura, 1993) or self-report their strategies (e.g., Lawton, 1994; Prestopnik & Roskos-Ewoldson, 2000). Despite the varying approaches regarding operationalization, the conclusions in most studies are generally uniform: men are superior in Euclidean information processing and tend to use Euclidean strategies whereas women prefer landmark strategies due to their superiority in landmark-based tasks (Coluccia & Louse, 2004). At first glance, reported results about gender-specific strategy usage are unambiguous. However, upon closer examination, we wondered that previous studies have analyzed gender differences separately for either Euclidean tasks/strategy use or landmark tasks/strategy use, but came to the general conclusion that men use Euclidean and women landmark strategies (Dabbs et al., 1998; Galea & Kimura, 1993; Lawton, 1994). However, according to Lawton (1994), both strategies are separate mental representations and consequently, every person uses more or less both of them. Thus, everybody has his or her own personal wayfinding strategy profile rather than only one preferred strategy. This raises the question whether conclusions based on strategy-specific gender comparisons have any significance for understanding gender-specific strategy use. For an illustration, males can have higher scores on Euclidean measures than females but a comparison of landmark and Euclidean measures within the male subgroup could result in higher landmark than Euclidean scores. In this example, men would also use the landmark strategy in real-world orientation tasks, even though they outperform women on Euclidean parameters. Thus, there is still need for clarification regarding gender-specific strategy use. So far, only Prestopnik and Roskos-Ewoldson (2000) have reported that participants used the landmark strategy more frequently than the Euclidean strategy across both gender groups. To get a better understanding about gender-specific strategy profiles, we want to consider comparisons both between and within gender groups.

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