A Preliminary Study on the Effect of Time Pressure to Pedestrian Navigation Behaviors

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Abstract
This paper presented a user experiment aiming to explore the effect of time pressure on pedestrian navigation behaviors in the circumstance of both outdoor and indoor navigation tasks. The experiment was conducted in the context of pedestrian navigation, with the independent variable of the time pressure and the dependent variables of behaviors like clicks, slides and zooms. It was showed as results that users without time pressure took more time to finish the task and slid more often on the screen when they looked for catering information during the outdoor navigation. Users’ behaviors had no significant differences between groups with and without time pressure when looking for an unknown location during outdoor navigation. But when users under no time pressure conducted an indoor navigation, the number of screen zooms was less. Above all, users suffering time pressure preferred to do less unnecessary screen operations and tried to quickly reach the destination. Therefore, the map system should take users’ time pressure into consideration when planning the optimal route.

Keywords: time pressure; pedestrian navigation; navigation behavior


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1 Introduction
With the rapid development of mobile networks and the improvement of mobile map functions, the pedestrian navigation provides a great convenience for users’ mobile navigation needs in daily life. Navigation refers to planning a route and moving through space to the destination (Ishikawa, T, 2008). Pedestrian navigation means getting to the destination by walking and it contains both outdoor navigation (ON) and indoor Navigation (IN). A Research Report of China Mobile Map Navigation Market (Bigdata, 2016) shows that the number of active mobile map navigation users reaches 226 million in 2016 and over 60% users use the navigation function when using the mobile map. Studying users’ pedestrian navigation behaviors can help us know users’ navigation information needs and improves users’ travel experience with the provision of better location-based services.

Many studies focused on the relationship of navigational information search behaviors and search time. A survey conducted by Church et al. (2011) found that 91.9% of portal based mobile searches were looking for navigational and transactional information. And Teevan, J. et al. (2011) found that nearly 50% of the users would go as soon as possible to the place just found via mobile search. Besides, several studies focused on the navigation system and users’ spatial experience. Aslan, I. et al. (2006) found that users who used mobile map navigation could have poor spatial knowledge acquisition. Ishikawa et al. (2008) found that users who used GPS-based mobile navigation traveled longer distances and made more stops during the walk than map users. Willis, K. S. et al. (2009) found that during the mobile map navigation, it required users’ more attention than that of the paper map.

Users’ navigation activities are usually associated with the time pressure. For example, in our daily life, we usually have to look for a nearby restaurant, cafe, or bus stop within a short time when travelling. But the related study is relatively few. The report (Bigdata, 2016) also showed that two of users’ commonly
used outdoor navigation functions were finding catering information and unknown locations. Meanwhile, the indoor navigation has been rapidly developed and been connected to our daily life. Therefore, we want to explore the effect of time pressure on different kinds of pedestrian navigation.

2 Research Design

2.1 Hypothesis
When under time pressure, users will pay less attention to external objects and do less screen operations in order to arrive the destination quickly. But when users are without time pressure, they will pay more attention to their mobile context and cannot focus on their mobile navigation for a long time. Thus, they will do more screen operations and focus on map details. Therefore, we made the following hypotheses:

a) Hypothesis 1: When users look for the catering information, both the average time length of completing the task and performing screen operations (i.e. clicks, slides and zooms) of time pressure group are less than that of no time pressure group.

b) Hypothesis 2: When users look for unknown locations, both the average time length of completing the task and performing screen operations of time pressure group are less than that of no time pressure group.

c) Hypothesis 3: For the indoor navigation, both the average time length of completing the task and performing screen operations of time pressure group are less than that of no time pressure group.

2.2 Research Method
We conducted a controlled experiment and all the tasks were based on the Baidu Map application, the navigation users’ market share of which accounts for 57% in China (Bigdata, 2016). The questionnaire survey with five-point Likert scale (Borlund, P et al., 2012) was used to collect users’ subjective feelings. Two screen recorder applications, named Screen Recording Master and Screen Recording Expert and running on the Android platform, were used to record screen images and sounds of their screen interactions, such as clicks, slides, zooms and so on. After the data collection, we used the qualitative analysis and comparative analysis method to analyze the data from screen recorders and questionnaires. The Mann-Whitney U test was used to test the significance difference.

2.3 Pedestrian Navigation Task
In this study, we simulated three contexts of outdoor navigation with three navigation tasks, which were the outdoor navigation for catering information, the outdoor navigation for an unknown location, and the indoor navigation. Those three tasks were used to verify our three hypotheses separately. The order of the following tasks in the experiment was random.

a) Outdoor Navigation1 (ON1): your start point is the Shopping Mall, please go to one of the nearby Hubei cuisine restaurant with the highest review score according to the Baidu Map.

b) Outdoor Navigation2 (ON2): your start point is the Shopping Mall, please go to the Sun Modern Health Club.

c) Indoor Navigation (IN): your start point is the New World Shopping Center, please find the shop of TEENIE WEENIE.

2.4 Participant
Twenty college students (12 females and 8 males) were recruited after a filter questionnaire. All of them must own an Android mobile phone, and be unfamiliar with places in the experiment. They were randomly assigned to two groups to finish the experiment. Crescenzi et al. (2016) used the time pressure to refer to a person’s internal response to a time constraint. Therefore, Group 1 finished tasks with the time pressure
(TP) while group 2 without the time pressure (NTP). In other words, for Group 1, they only had 35, 25, 15 minutes to accomplish ON1, ON2 and IN, respectively. While Group 2 had no time constraint. The time limits were determined through field research.

The ages of participants ranged from 22 to 23 years (mean=22.4, SD=0.49) in Group 1. All of them have used mobile map over 2 years and the mean of frequency of using mobile navigation was 3.4. For Group 2, their ages ranged from 19 to 24 years (mean=22.4, SD=1.685). All of them have used mobile map over 2 years and the mean of frequency of using mobile navigation was 3.2. There were no significant differences between Group 1 and Group 2 except for the time constraint.

3 Results & Discussion

From Table 1 and Table 2, under the context of ON1, in terms of time aspect, the significant difference in the average length of finishing the task (p=0.049) was found. But, no significant difference was found in the rest of items. Then for the number of screen operations, the significant difference in the average number of slides (p=0.01) was found. No significant difference was found in the rest of items. For the context of ON2, no significant difference in neither the time nor the number of screen operation was found. And when considering the context of IN, in terms of time aspect, no significant differences was found. The significant difference in the average number of zooms(p=0.037) was found. No significant difference in the rest of items.

<table>
<thead>
<tr>
<th>Average time</th>
<th>ON1</th>
<th>ON2</th>
<th>IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finishing tasks (s)</td>
<td>1065.4*</td>
<td>1438.9*</td>
<td>1041.3</td>
</tr>
<tr>
<td>Searching (s)</td>
<td>19.5</td>
<td>13.5</td>
<td>34.3</td>
</tr>
<tr>
<td>Navigation (s)</td>
<td>585.8</td>
<td>732</td>
<td>797.2</td>
</tr>
</tbody>
</table>

Table 1. Time data for completing the tasks with and without time pressure (*p<0.05)

<table>
<thead>
<tr>
<th>Average number</th>
<th>ON1</th>
<th>ON2</th>
<th>IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen operations</td>
<td>29.5</td>
<td>48.8</td>
<td>15.4</td>
</tr>
<tr>
<td>Clinks</td>
<td>16.2</td>
<td>16.1</td>
<td>5.4</td>
</tr>
<tr>
<td>Slides</td>
<td>10.8*</td>
<td>27.3*</td>
<td>7.9</td>
</tr>
<tr>
<td>Zooms</td>
<td>2.5</td>
<td>5.4</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Table 2. Screen operation data for completing the tasks with and without time pressure (*p<0.05)

Based on the data of average scores of users’ subjective sensation (time pressure, the accuracy of GPS and the obvious degree of mark locations) through the post questionnaires during navigation (see Table 3), we found that the degree of users’ subjective feelings of time pressure in TP was 3.7 while that of the NTP group was 3.8 (the smaller the number is, the greater the pressure is felt). It means when in ON2, the NTP group felt more time pressure than TP group. It’s interested to find that the NTP group spent less time completing their task of ON2 while their screen operations were more than that of the NTP group.

<table>
<thead>
<tr>
<th>Average score</th>
<th>ON1</th>
<th>ON2</th>
<th>IN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time pressure</td>
<td>3.4</td>
<td>3.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Accuracy of GPS</td>
<td>3.3</td>
<td>3.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Obvious degree of mark locations</td>
<td>3.6</td>
<td>3.9</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Table 3. Average scores of users’ subjective sensation during navigation
4 Conclusion

The pedestrian navigation is in a great demand of those who do not possess a car but still need a navigation support and those who need to pass through a vehicle-limited distance. For example, you need to walk through a street which does not allow any vehicle to pass and in this situation, the pedestrian navigation can help you arrive the destination conveniently. It was found by the experiment that users’ pedestrian navigation behaviors were influenced by the time pressure. When users sought for catering information, the time pressure was found to be effective by the time length of completing tasks and performing screen operations. Users suffering the time pressure did less screen operations and spent less time getting the destination. When considering indoor navigation, the findings were the same. When users searched the unknown location, the NTP group spent less time but did more screen operations than the TP group.

When under the time pressure, users tried to get faster arrival at destination and they spent less time doing map operations. Therefore, when optimizing the mobile navigation services, it is useful to take the time pressure into consideration. The map application system should not only design the best route but also simplify unnecessary operations to save users’ time. In actual setting, different people have different perceptions of time. Though with the same time constraint, people may feel different levels of time pressure. So the relationship between the time constraint and time pressure needs further study. In the future, we will deeply study the reasons and details on mobile navigation behaviors with time constraint, and provide concrete suggestions for the design of the map interaction interface based on this study.

5 References


