Do We Bump into Things More While Speaking on a Cell Phone?

Abstract
We observed more than 8,800 cases of people passing by an obstacle that was placed at different heights at the entrance to a university cafeteria. Of those cases, 491 were of pedestrians speaking on a cell phone. Overall, 2,422 bumping cases were recorded. Using a cell phone while walking did not increase the risk of bumping into protruding obstacles. The results suggest that the effective visual field of people who are involved in a highly automated, relatively slow-paced task, such as walking, under low rates of information input, is not degraded by speaking on a cell phone.

Keywords
Bumping; walking; cell phones; safety; dual task; visual field; automaticity.

ACM Classification Keywords
K.4.1 Public Policy Issues – Human safety; J.7 COMPUTERS IN OTHER SYSTEMS – Consumer products.

Introduction
Research suggests that the use of cell phones as a secondary activity interferes with performance on primary activities. Such findings are especially alarming when degradation of performance in the primary activity endangers the speaker and/or others. The most
salient context of this phenomenon is drivers' over-involvement in crashes when using the cell phone while driving [21, 24]. However, perhaps the most frequent task combined with cell phone use is walking. Most people do not consider talking while walking a difficult or dangerous task -- perhaps because walking is one of the most practiced tasks, most often conducted in a safe environment, and one that is commonly time-shared with talking. But is this assumption correct? One of the impacts of attention-demanding tasks is to shrink one's visual field. This results in what is commonly labeled as 'tunnel vision' [33]. In laboratory environments, conversations on cellular phones were found to limit users' visual field [3, 10, 29].

According to [7], improper road crossing, inattentiveness, and failure to obey traffic signs account for nearly half of pedestrian deaths in traffic accidents. These last two risk factors are similar to those ascribed to drivers who use cell phones [5, 7]. In addition, speaking on cell phones may distract pedestrians elsewhere, whether in the workplace, at home, or on the street. It may decrease people's situational awareness, causing them to bump into objects or to wander into inappropriate or unsafe places. This is important given the very high penetration rate of mobile phones in most countries. Also, people’s discretion over where and when to use their mobile phone is restricted. For example, in 2006 almost half of the people surveyed in the U.K. stated that they use their mobile phone as part of their job. About the same proportion reported that they never, or hardly ever, turn their phones off [30], meaning that cell phone interruptions and conversations are likely anytime and anywhere. Still, despite the ubiquitous usage, only a handful of studies have been published regarding the effect of mobile phone usage on pedestrian's safety.

Numerous studies, however, have demonstrated the negative effects of cell phone usage on drivers’ skills and behaviors [1, 6, 11, 14, 12, 18, 22, 23]. These findings are consistent with theories of human information processing and with experimental evidence from divided attention studies, which indicate that our central processing capabilities are limited, and overloading them by time-sharing multiple tasks is likely to degrade performance (e.g. [32]). Although the use of the phone is mostly based on auditory inputs, several studies have shown that visual performance is also impaired when people converse or perform other information processing tasks on the phone ([3]). It was also shown that a phone task also significantly reduces the functional field of view [2].

However, the same theoretical foundation for the interference of the phone task with non-auditory tasks due to the sharing of attention, also posits that with practice, we become better at performing time-shared tasks by automating various parts of these tasks. Interestingly, this has been ignored in nearly all studies demonstrating the deleterious effects of cell phones on driving. An exception was a recent study [28] that demonstrated how with continued practice at driving and talking on the cell phone, drivers become better at both tasks. In fact, much of the distracting effects of the cell phone conversations on driving diminished with practice. Also, in a naturalistic driving study [27] found that among drivers who were used to talking on the phone while driving, those who drove more were less likely to miss traffic signals while talking on the phone than those who drove less.
Still, because of ethical concerns about actually causing a crash, most driving studies are conducted in artificial contexts [20]. In contrast, the effect of cell phones on pedestrians can be studied in risk-free, naturalistic environments. This is important for two reasons. First, it can shed light on the degree to which cell phone conversations compromise pedestrians' attentiveness and safety. Pedestrians are as susceptible to shrinkage of the visual field as drivers. Even without being distracted by cell phones, “bumping mishaps are among the most frequent accident types in industry” [34, p. 671]. When using cell-phones pedestrians may be at greater risk of being involved in accidents because of the shrinkage in the visual field and the resulting ‘tunnel vision’ effect. Second, to the extent that driving is nearly as highly-practiced as walking (both involve many automated components), we may be able to learn about some of the effects of using cell phones in driving from observing the effects of such use on the effective visual field of pedestrians.

Research on the effects of cell phone usage on pedestrian behavior is scarce. A study of the behavior of distracted pedestrians at a signalized crosswalk found that distraction was weakly associated with reckless or dangerous behavior (e.g., not obeying traffic signals and safety guidelines when crossing a busy street) [7]. However, the definition of distraction included not only talking on the phone, but also wearing headphones, eating, drinking, smoking or talking in general. In an observational field study, [13] compared the crossing behavior of pedestrians using cell phones to those not using cell phones. While most of the cell phone effects were quite weak, women who spoke on the phone tended to pay less attention to traffic and crossed more slowly than men. Hatfield [5] found that elderly people who scored poorly on the useful field of view were more likely to bump into objects while walking, and [34] found that “the likelihood of bumping into an object is a positive function of the distance between that object and the axis of the effective visual field of the walking person” (p. 671).

Based on the aforementioned studies, and given the near-consensual agreement among researchers regarding the deleterious effects of cell phones conversations on primary tasks, we hypothesize that speaking on a cell phone while walking will reduce the visual field of view and increase the likelihood of bumping into objects.

Method
We use an experimental paradigm developed by [34] to study bumping accidents. The basic idea behind this paradigm is that “when an object is perceived or expected to exist in a walking person’s dynamically changing perceptual field, any contact with it will be avoided. When the protruding object is not being perceived, the likelihood of bumping into it increases markedly” [34, p. 671]. The probability of an object not being perceived (and hence the probability of bumping into it) is positively related to the distance between the object and the axis of the walker’s effective visual field. In the absence of a specific expectation, the walker is much less likely to be actively engaged in a visual search for obstacles, and the likelihood of colliding with them should increase proportionately to their distance from the axis of their effective visual field; i.e., the direction of fixation. [34] demonstrated this in two
experiments involving the placement of obstacles in people’s paths. People were increasingly more likely to bump into things that were placed closer to the pavement. People were also more likely to bump into objects if they were less exposed given the approach route. In both cases, the likelihood of bumping into the obstacles increased the further the obstacles were from the axis of the pedestrians’ effective visual field.

**Apparatus**

Based on the paradigm developed by [34], a portable horizontal flexible aluminum rod was placed at the entrance to the main cafeteria of an Israeli university campus (see figure at the margin for a schematic diagram of the setting). The rod extended about one third inside the cafeteria’s 2.3 meter-wide doorway. The rod could be moved vertically to any desired height along a vertical bar. In this experiment, as in [34], seven heights were used based on anthropometric data. These heights represented major body parts based on two sources of information. First, the proportional distances between the heights were derived (from [8]). Then the actual heights were calculated based on the average population height in the Israeli Army’s anthropometric data tables (in Israel most people are conscripted into service, and therefore the Army’s anthropometric data are highly representative of the 18-25 years old Israeli population in general.) The seven heights were: 8, 48, 69, 78, 94, 115, and 137 cm. Each of these heights was within 2 cm of Zohar’s heights. Because the heights were based on population means, the rod’s positions did not always correspond to the same body part for all people. This problem was mitigated by using a large sample to approximate a normal distribution of people’s heights at each rod height.

**Data Collection and Preparation**

Data were collected on school weekdays over a two-month period. On each data collection day, the experimental rod was set at two different heights. The entire experiment was videotaped using a hidden camera, located about seven meters from the entrance to the cafeteria. Overall, 37 hours were recorded of people entering and exiting the cafeteria. The following cases were excluded from further analysis: employees of the cafeteria; patrons of the cafeteria who were seated inside the cafeteria in a small room adjacent to the entrance who could have seen the experimental rod from their seats; persons who entered or left the cafeteria in groups of four or more (in such groups the probability of bumping into the rod could have been an artifact of the lack of sufficient clearance); persons carrying large objects; and small children.

If a group of up to three persons entered the cafeteria together, the attributes and the behavior of only the person closest to the rod was recorded. The videotapes were coded using a coding scheme that classified each passerby according to the four independent research variables: rod height, body side, gender, use of cell phone, and whether or not bumping occurred.

**Results**

Overall, 8,812 pedestrians were observed while entering or exiting the cafeteria; 5,607 (or 63.6%) were males and 3,205 (36.4%) were females. Of these, 491 (5.6%) were speaking on a cell phone (6.9% of the females and 4.8% of the males). Overall, 2422 persons (27.5%) bumped into the rod. Table 1 shows the frequencies of people entering and exiting the cafeteria and the frequency and percentage of people bumping into the rod by three independent variables: Cell Phone
Usage, Body Side, and Gender. Figure 1 depicts the bumping likelihood profile for users and non-users of cell phones given body side and the fourth independent variable: Rod Height.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Overall</th>
<th>Bumping incidents (% of overall in category)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Phone Usage</td>
<td>8321</td>
<td>2303 (27.7%)</td>
</tr>
<tr>
<td></td>
<td>491</td>
<td>119 (24.2%)</td>
</tr>
<tr>
<td>Body Side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>4893</td>
<td>1636 (33.4%)</td>
</tr>
<tr>
<td></td>
<td>3919</td>
<td>786 (20.1%)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5607</td>
<td>1631 (29.1%)</td>
</tr>
<tr>
<td></td>
<td>3205</td>
<td>791 (24.7%)</td>
</tr>
</tbody>
</table>

Table 1. Total observations and bumping incidents by cell phone use, body side, and gender.

Logistic regression with Bumping (yes/no) as a dependent variable, using the Forward method, showed significant main effects of Body Side, Gender, and Rod Height on the probability of bumping into the rod (Table 2). However, whether a person used a cell phone or not did not have a residual significant main effect on the overall probability of bumping into the rod (p = 0.210).

Similar to Zohar’s results, the likelihood of bumping into the rod was related to the rod’s height. Specifically, the likelihood of bumping significantly increases for very low rods (8cm). Beyond this common effect, bumping likelihood changed as a function of body side and gender as described in Table 2.

The gender effect by cell phone use is depicted in Figure 2. Under most conditions, women were less likely than men to bump into the rod. For non-cell phone users (N = 8321), binary logistic regression with bumping as the dependent variable revealed small but highly significant gender effect (Odds ratio = .824, p < .001). This effect is shown on the right hand side of Figure 2. For cell phone users (N = 491), the regression revealed a stronger gender effect (Odds ratio = .574, p=.014) (see the left hand side of fig. 2).
<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>S.E.</th>
<th>Wald χ²</th>
<th>Df</th>
<th>p</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (0 = male; 1 = female)</td>
<td>-0.217</td>
<td>0.052</td>
<td>17.41</td>
<td>1</td>
<td>0.000</td>
<td>0.805</td>
</tr>
<tr>
<td>Body Side (0 = left; 1 = right)</td>
<td>-0.718</td>
<td>0.051</td>
<td>195.64</td>
<td>1</td>
<td>0.000</td>
<td>0.488</td>
</tr>
<tr>
<td>Height</td>
<td>354.49</td>
<td>6</td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 vs 48</td>
<td>1.100</td>
<td>0.087</td>
<td>160.51</td>
<td>1</td>
<td>0.000</td>
<td>3.004</td>
</tr>
<tr>
<td>48 vs. 69</td>
<td>0.107</td>
<td>0.099</td>
<td>1.17</td>
<td>1</td>
<td>0.279</td>
<td>1.113</td>
</tr>
<tr>
<td>69 vs. 78</td>
<td>-0.402</td>
<td>0.096</td>
<td>17.42</td>
<td>1</td>
<td>0.000</td>
<td>0.669</td>
</tr>
<tr>
<td>78 vs. 94</td>
<td>-0.097</td>
<td>0.092</td>
<td>1.10</td>
<td>1</td>
<td>0.294</td>
<td>0.908</td>
</tr>
<tr>
<td>94 vs. 115</td>
<td>0.657</td>
<td>0.099</td>
<td>44.07</td>
<td>1</td>
<td>0.000</td>
<td>1.929</td>
</tr>
<tr>
<td>115 vs. 137</td>
<td>-0.304</td>
<td>0.100</td>
<td>9.29</td>
<td>1</td>
<td>0.002</td>
<td>0.738</td>
</tr>
<tr>
<td>Phone Use (0 = no; 1 = yes)</td>
<td>0.140</td>
<td>0.112</td>
<td>1.57</td>
<td>1</td>
<td>0.210</td>
<td>1.150</td>
</tr>
</tbody>
</table>

table 2. Binary logistic regression results with bumping as a dependent variable (N = 8812).

Table 3 shows bumping frequencies and percentages by cell phone usage and gender, when the rod was on the right and when the rod was on the left of the person. Body side had a strong effect on bumping likelihood. With the rod on the left side (i.e., for people exiting the cafeteria with a longer sight distance of the doorway), the likelihood of bumping into the rod was 20.1%. When the rod was on the right side (people entering the cafeteria shortly after making a right turn into the hallway before the doorway) the likelihood of bumping into the rod was more than 50% greater (33.4%).

Figure 2. Bumping likelihood profile for cell phone users (left side) and non-users (right side) at seven rod heights, for females (solid lines) and males (dashed lines).

Because of the disparity in rod visibility between the entry route (lower visibility) and the exit route (higher visibility), we repeated the logistic regression for data obtained from each of the two routes separately. The analysis of the exit data (N=3919) showed that cell phone usage did not have an effect on the likelihood of bumping (p=.64), nor were there any gender differences (p=.41). Rod height remained a significant factor; bumping likelihood decreased significantly (p<.001) when the rod height was lowered from 115cm to 94cm, and from 48cm to 8cm.
Table 3. Percent of bumping incidents as a function of body side, cell phone usage and gender.

<table>
<thead>
<tr>
<th></th>
<th>Right (Enter)</th>
<th>Left (Exit)</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cell Phone</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>26.6%</td>
<td>21.5%</td>
<td>24.2%</td>
</tr>
<tr>
<td>No</td>
<td>33.8%</td>
<td>20.0%</td>
<td>27.7%</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>29.0%</td>
<td>19.6%</td>
<td>24.7%</td>
</tr>
<tr>
<td>Male</td>
<td>35.9%</td>
<td>20.3%</td>
<td>29.1%</td>
</tr>
</tbody>
</table>

Logistic regression analyses were conducted separately for the data from the entry route (N = 4893) and for the exit route data (N = 3919). Phone usage and gender had no effect on bumping likelihood in the exit route. There was a marginally significant effect of cell phone usage on bumping in the entry route (p = .035). However, the effect was not in the expected direction: the likelihood of bumping into the rod was actually lower for people using cell phones than for non-users (Odds ratio = 1.359). Also, in the entry route, women were considerably less prone to bump into the rod than men (p < .001, Odds ratio = .728).

Lastly, rod height had a stronger effect on bumping likelihoods in the entry route. Here, significant differences (p < .001) were observed between four pairs of adjacent heights (8 vs. 48, 69 vs. 78, 94 vs. 115, and 115 vs. 137). In the exit route, the bumping likelihood of only two pairs of adjacent heights were significantly different (8 vs. 48 and 94 vs. 115, p < .001). Here, as expected, at the height of 137cm, non-cell phone users were less likely than users to bump into the rod ($\chi^2 = 5.423$, p = .020).

**Discussion**

As far as we could determine, this study is the first to unobtrusively observe the effects of speaking on a cell phone on the probability of collision of moving pedestrians. The study was conducted on a large sample of both non-users and users of cell phones in a naturalistic context. This method has greater ecological validity than small scale laboratory experiments. The results indicated that pedestrians using cell phones while walking did not have a greater likelihood of bumping into obstacles of the type used in this study. In fact, they may have been even slightly less prone to bumping into the rod. This counterintuitive result can be attributed to two possible explanations. First, it is possible that the effective visual field changes very slowly during walking. Thus, even if people are occupied with another attention-demanding task, at the pace of walking they can still detect the obstacles and avoid them. The second explanation is that people are aware of the potential reduction of attention resources due to speaking on the phone and adjust their behavior on the other task (such as by walking more slowly) to reduce the potential of accidents. Our informal observations of the study’s videotapes indicate that at least some pedestrians using cell phones also used certain compensatory behaviors, such as slowing down or stopping momentarily.

Another interesting finding is the difference between the tendencies of females and males to bump into objects. Women were overall less likely to bump. This was consistent for both cell phone users and non-users. One explanation for this effect is that in the population males are taller than females. Accordingly, women’s axis of the effective visual field was closer to the obstacles. This explanation however, do not account for
the fact that the effect of gender was stronger for cell phone users than for non-users. There may be two other possible explanations for this result. The first is that women tend to attend to and detect details in the environment better than men. In a sign detection study conducted by one of the authors on detection of road signs [4], women had a more distributed visual pattern and were better than men at detecting signs in unexpected locations. Other research shows that women more often use unique objects (landmarks) to find their way than do men [25]; and are better than man in scanning perceptual arrays quickly to find matching objects and in memorizing location of objects [16, 17]. These findings are consistent with evolutionary theories that suggest that women's superior awareness of their immediate visual surroundings may have coevolved with their propensity towards small-scale navigation [9]. The second potential explanation is that, being more aggressive males will do less to avoid bumping into or with objects. This explanation is consistent with the observations that males are injured more than females (e.g., [31]). Both explanations work in the same direction, and are both corollaries of hunter-gatherer theories [9]. Even if the effect of each explanation is small, the combined effects may have been sufficient to create the gender differences noticed in this study.

Age, which was not a controlled variable in our study, may play a role in the obtained results. Younger people are better than older ones in performing dual cognitive-motor tasks [19, 26] and have a wider visual field [15]. It is also likely that younger people are more versed in using cell phones as a secondary activity. While the cafeteria in which the study was performed serves both students and staff, the former group is much larger, and this probably influenced the results. Thus, the results may not be generalizable to an older population.

Another potential limitation of the study is that we could not control for people who had seen the obstacle before. This could have led to some people avoiding the rod based on their familiarity with its presence. We tried to mitigate this problem by conducting the experiment not more than twice a week, and by varying the hours in which the study was done. In addition, there is no reason to assume that people who observed the rod previously belonged to any particular group. Specifically, it is difficult to assume that cell phone users were more likely to be aware of the rod than non-users and to avoid bumping into it.

In addition to the use of large sample and naturalistic setting, the ecological validity of this study’s findings is further enhanced by its replication of the general findings of [34]. That is, people's likelihood to bump into things increases as a positive function of the distance between the object and the axis of effective visual field of the walking person. This can be seen both in the overall bumping profile, and in the differences between left and right side bumping profiles where people had a better view of the rod while exiting than while entering.

**Conclusions and Implications**

The main findings of this study are that: (1) In accordance with [34], pedestrians’ effective visual field is inversely related to the distance of objects from the visual axis. (2) Contrary to our hypothesis, talking on a cell phone while walking does not affect the effective visual field significantly. Therefore, walking and talking on a phone does not compromise safety, at least under
the study's conditions: the population is relatively young; the walking path does not require special attention; and the potential obstacle is stationary. In such a case the rate of information input is exclusively determined by the walking speed. The conclusion may be quite different, however, in contexts that require cell phone users to attend to higher rates of information input, e.g. while driving. Still, even with a task like driving, as the degree of automaticity increases, so does the driver's performance in both the driving and the talking tasks [28]. Thus, future research should study the potential moderating roles of automaticity and information input rates on the effects of cell phone conversations on people's effective visual field in a greater variety of environments and tasks.

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References


