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The effect of billboard design specifications on driving: A pilot study

Hadas Marciano*, Pe'erly Setter

Ergonomics and Human Factors Unit, University of Haifa, Israel

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ABSTRACT

Decades of research on the effects of advertising billboards on road accident rates, driver performance, and driver visual scanning behavior, has produced no conclusive findings. We suggest that road safety researchers should shift their focus and attempt to identify the billboard characteristics that are most distracting to drivers. This line of research may produce concrete guidelines for permissible billboards that would be likely to reduce the influence of the billboards on road safety. The current study is a first step towards this end. A pool of 161 photos of real advertising billboards was used as stimuli within a triple task paradigm designed to simulate certain components of driving. Each trial consisted of one ongoing tracking task accompanied by two additional concurrent tasks: (1) billboard observation task; and (2) circle color change identification task. Five clusters of billboards, identified by conducting a cluster analysis of their graphic content, were used as a within variable in one-way ANOVAs conducted on performance level data collected from the multiple tasks. Cluster 5, labeled ***Loaded Billboards***, yielded significantly deteriorated performance on the tracking task. Cluster 4, labeled ***Graphical Billboards***, yielded deteriorated performance primarily on the color change identification task. Cluster 3, labeled ***Minimal Billboards***, had no effect on any of these tasks. We strongly recommend that these clusters be systematically explored in experiments involving additional real driving settings, such as driving simulators and field studies. This will enable validation of the current results and help incorporate them into real driving situations.

1. Introduction

The effect of advertising billboards on crash rates, driving performance, and allocation of attention while driving has been explored over the last seven decades, yet no convincing conclusions have been drawn. During the 1950s-1970s, the presence of billboards was shown to correlate with higher accident rates (e.g., Ady, 1967; Holohan et al., 1978; Rusch, 1951; Staffeld, 1953). However, more recent studies have found only minimal correlations (e.g., Smiley et al., 2005) or no correlation at all between the presence of billboards and accident rates (e.g., Izadpanah et al., 2014; Yannis et al., 2013).

Over the years contradicting findings regarding the effect of billboards on speed were reported. For example, Horberry et al. (2006), found that visually loaded settings with multiple elements, including a greater number of advertising billboards, yielded decreased mean speed. A similar effect of billboards was also reported by Edquist and Johnston (2008). Yet Lee et al. (2003) found no effect of advertising billboards on driving speed, and other studies reported an insignificant increase in mean speed (Bendak and Al-Saleh, 2010) or a minor effect of increased standard deviation of speed (e.g., Lee et al., 2007). Recently, Marciano and Yeshurun (2012) showed that although overall visual load decreased driver speed, the presence of billboards yielded increased speed.

Similar conflicting findings were also reported in studies that assessed lane-keeping. While Lee et al. (2003) found no effect of billboards on lane-keeping performance, Lee et al. (2007) reported a slight trend towards deteriorated performance in the vicinity of billboards. Yet others reported that time spent out of lane was higher when billboards were present (e.g., Bendak and Al-Saleh, 2010; Young et al., 2009).

Other studies explored visual attention drawn to billboards using eye trackers in the field or in a driving simulator. These studies attempted to assess visual scanning behavior as a reflection of attention allocation. For example, a field experiment conducted by Herrstedt et al. (2013) showed that drivers glanced at a billboard at least once in 69% of all drives and at least twice in about 50% of all drives. In addition, eighteen percent of drivers glanced at the billboards for one second or more, compromising road safety. Shorter glance durations of 0.86 s (Misokefalou et al., 2016) or even 0.2 s were reported recently (Samsa, 2015). Some researchers claim that these short durations imply that billboards do not distract the driver's attention to a dangerous degree. For example, in a recent literature review Decker et al. (2015)

* Corresponding author.
E-mail address: hmarcia1@univ.haifa.ac.il (H. Marciano).

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found that the time spent looking at the roadway ahead was not affected by the billboards' presence and that the driver can regulate attention allocated to the billboards when driving demands increase.

Finally, the influence of various experimental conditions on eye movement patterns was explored. For example, Dukic et al. (2013) showed longer dwell times for dynamic billboards compared to traffic signs, and others reported that the driver's age is a crucial factor in the effect of advertising billboards on visual scanning behavior (e.g., Edquist et al., 2011; Stavrinos et al., 2016).

In sum, the ever-growing body of literature on the effect of advertising billboards on the risk and rate of road accidents, driver performance, and visual scanning behavior is quite indecisive, with inconsistent conclusions drawn from different studies. After decades of research on this topic, it can be assumed that the ambiguous findings that have accumulated over the years might reflect the effect of different types of billboards on different types of drivers under different driving conditions. Still, the inconclusive evidence regarding the effect of billboards on road safety makes it difficult to propose any mandatory recommendations for banning or restricting the presence of billboards on the roads. When considering the power of the advertising industry and its financial interests, as well as the political climate in most countries around the world, it is probably quite reasonable to assume that billboards are here to stay. Thus, the argument that banning advertising billboards altogether would be difficult or even impossible is also a convincing one. It is therefore quite crucial for road safety researchers to shift their efforts in a different direction and try to identify the billboard characteristics that are the most distracting. This line of research might help develop concrete guidelines for permissible billboards that would, hopefully, reduce the driving risks imposed by the presence of billboards.

The current study is one step in a long journey towards classifying various characteristics of advertising billboards according to their effect on drivers' performance and on the risk of accidents. The ultimate goal of this line of research is to lay initial foundations for regulations concerning advertising billboards. In the current study, we focused on billboard characteristics such as percentages of text versus graphics, text size, and the number of colors, logos, and information items. A pool of real advertising billboards photographed throughout Israel was utilized in a psychophysical experiment consisting of a triple-task method. The objective was to define clusters of billboards classified according to their design specifications, and to examine their effect on the performance of two different driving-related tasks − a tracking task and a color-change identification task.

2. Material and method

2.1. Creation of the billboard pool

One hundred sixty one actual advertising billboards were photographed throughout Israel. Each billboard was ranked according to different categories via two ranking methods, objective and subjective. In the objective ranking method the exact values of various characteristics of the billboards were measured, counted, and documented. These characteristics included the billboard's shape, percentage of area occupied by text, percentage of area occupied by graphic elements, number of small, medium sized, and large letters, number of colors, number of words, background color, number of information items (such as telephone numbers, postal addresses, email addresses, URLs, etc.), and number of logos. In addition, we performed an inter-rater agreement procedure in order to test whether our objective ranking method reflects observers' subjective assessments of the billboards. Each billboard was subjectively ranked by eight naïve participants, including four women, mean age – 25.7, ranging from 23 to 32. All participants had normal or corrected-to-normal sight and all of them were students at the University of Haifa who participated in the ranking process for a monetary reward. Each of the 161 billboards was presented for an unlimited amount of time on a computer screen. The participants were asked to mark their level of agreement with the following eight statements: 1. The photo is colorful; 2. The level of contrast in the photo is considerable; 3. There is a large amount of text; 4. The photo attracts attention; 5. I wish I could keep on looking at the details of the photo; 6. The message can be understood at a glance; 7. It will be easy to remember the details of the billboard; and 8. The photo is loaded with details. The scale ranged from 1 = "very much" to 5 = "not at all". Cronbach's Alpha analyses, with the aid of IBM SPSS Statistics software, were administered to reveal inter-rater agreement on each statement. The correlation of the second statement was less than 0.5 and therefore it was not further analyzed. The analyses showed high significant correlations for all of the other statements (Table 1). Accordingly, it can be concluded that the inter-rater agreement was high.

Table 1
Results of inter-rater agreement (Cronbach's Alpha).

Statement	ICC (Cronbach's Alpha)	P value
The photo is colorful	0.83	< 0.0001
There is a large amount of text	0.89	< 0.0001
The photo attracts attention	0.80	< 0.0001
I wish I could keep on looking at the details of the photo	0.76	< 0.0001
The message can be understood at a glance	0.78	< 0.0001
It will be easy to remember the details of the billboard	0.81	< 0.0001
The photo is loaded with details	0.81	< 0.0001

The correlations between the objective rankings of each photo and the mean subjective ranking of each statement for each photo were tested using Spearman's Rank-Order Correlation coefficients. This analysis, as well as all the other following statistical analyses reported in the current study, were performed with the aid of SAS 9.4 software. Only two items were phrased in practically the same way in both ranking methods, namely 'the number of colors' in the objective method ('Colors number' in Table 2) and 'the photo is colorful' in the subjective method ('Colorful photo' in Table 2), and 'the percentage of area occupied by text' in the objective method ('Text percentage' in Table 2) and 'there is a large amount of text' in the subjective method ('A lot of text' in Table 2). As can be seen in Table 2, the correlations between the ranking methods for these two pairs of items were strong (above 0.60) and significant. Likewise, the correlation between the objective ranking of 'Words amount' and the subjective ranking of 'A lot of text' was also strong and significant. The more colors counted by the objective ranking method the higher the subjective colorful assessment. The larger the text percentage and the larger the amount of words measured by the objective ranking method, the greater the quantities of text subjectively assessed in the photo.

In addition, as can be seen in Table 2, strong significant Spearman's Rank-Order correlations were found between the objective ranking 'Text percentage' and the two subjective rankings 'The photo attracts attention' ('Attention attracting' in Table 2) and 'I wish I could keep on looking at the details of the photo' ('Wish to keep on looking' in Table 2). The larger the percentage of text on the billboard, the less the participants assessed the photo as attracting and the less they were interested in continuing to look at the details of the photo. In addition, a strong significant correlation was found between the objective ranking of 'Words amount' and the subjective ranking of 'The photo is loaded with details' ('Loaded with details' in Table 2). The larger the amount of words measured by the objective ranking method, the more the participants subjectively assessed the photo as loaded with details. A strong significant correlation was also found between the objective ranking of 'Graphics percentage' and the subjective ranking 'Wish to keep on looking', indicating that the larger the percentage of graphics