Appendix I: Introductory Background to the Review

Billboard Advertising in the United States

According to the Outdoor Advertising Association of America (OAAA), there were approximately 361,810 billboards in the United States (US) in 2013 (OAAA 2013). This figure includes 158,868 bulletins (ranging from 378 sq. ft. to 672 sq. ft.; located along highways and major local roads), 165,606 posters (typically ~236 sq. ft.; located along major local roads), 33,336 junior posters (typically 55 sq. ft.; located in urban areas and along smaller roads), and 4,000 digital billboards (DBBs) (similar in sizes to bulletins or posters; typically with two display faces, each of which rotates through a selection of unique advertisements by changing displays every 6-8 seconds; located along highways and major local roads). This figure does not include an additional 49,082 bus shelter displays, an unknown number of kiosk and commercial stand displays, 4,029 wall murals (occupying some or all of a building face; located in urban areas and visible to local traffic as well as some major highways) and "spectaculars" (made to order in larger-than-standard sizes; may employ bright lights, motion, and other special effects; located in urban areas and visible to urban traffic as well as some major highways), and 262,213 vehicle-borne displays, any of which may be visible to drivers in some locations and at some times (OAAA 2013).

It is difficult to estimate how the total number of billboards in the US will change in the near future. However, it is predicted that DBBs will continue to grow as a proportion of this total (Global Industry Analysts Inc. 2013). This is significant because DBBs may in some ways be more distracting than passive billboards, especially because of the following factors identified by Wachtel (2011): the ability to display related messages in temporal sequence; high luminance and glare, and a failure to reduce luminance to appropriate levels at night; and display durations that are short enough to allow a given driver to see more than one message transition during his approach. The use of full motion video is also of concern. Although full motion video may be used on DBBs in some countries, as well as on on-premises signs in the US, its use on DBBs in the US is prohibited by most Federal-State Agreements

required by the Highway Beautification Act (Sisiopiku et al. 2013) and discouraged by the Outdoor Advertising Association of America (OAAA 2014).

External Distraction and MVCs in the US

According to the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System (FARS) and General Estimates System (GES) records for 2011, driver distraction was a factor in 15.5% of all motor vehicle collisions (MVCs), and specifically 17.0% of MVCs causing injury but no fatalities and 10.2% of MVCs causing at least one fatality (NHTSA 2013). Available FARS-GES data for 2011 indicated that external agents accounted for part or all of the cause of distraction in at least 6.0% of distraction-affected MVCs in that year, or approximately 49,164 MVCs (NHTSA 2013). In the National Motor Vehicle Crash Causation Survey Report to Congress (NHTSA 2008), it was estimated that external distractions were the critical causative factors in 9.4% of all MVCs attributable to driver recognition errors (i.e., all forms of inattention), or 3.8% of all MVCs attributable to any form of driver error. Over the 2.5-year study period (July 3, 2005 to December 31, 2007), these figures represent an estimated 30,998 MVCs per year.

Methods for Studying Billboard-Related Driver Distraction

Several approaches may be employed in the study of billboards' effects on driver attention. First, one may investigate whether correlations exist between billboard presence and MVC incidence along selected sections of road, or investigate how the rate of MVCs on a given section of roadway changes after billboards are installed. Both of these study types have the advantages of being quantitative and reporting directly on traffic safety outcomes. However, correlational studies cannot prove causation no matter how well-controlled they are, and before-and-after studies require both spatial and temporal controls that can be quite difficult to implement (Elvik 2002). Alternatively, one can conduct interviews and/or forensic analysis at the scenes of MVCs. Though easy to execute and capable of providing large sample sizes, this method provides qualitative data and is likely to suffer from underreporting (Wallace

2003). Finally, all three of these study types tend to treat all billboards as being the same regardless of features and context, and so none are likely to yield detailed information on the specific aspects of a billboard or its context that cause distraction. Two other methods are interviews of focus groups and surveys of the general population, outside of the immediate context of an MVC. These approaches allow for very large samples of respondents and likely yield more honest responses than questioning at the scene of an MVC. However, because information is gathered outside of the driving context and because distractions may occur subconsciously, respondents may not recall or ever have been aware of information that is specific and accurate enough to be useful.

A third class of methods includes naturalistic driving studies, controlled experiments in instrumented vehicles (typically with onboard observers), and driving simulators. In a naturalistic study, participants' vehicles are equipped with various data collection instruments with the goal of recording driver behavior as unobtrusively as possible. There is no onboard observer, and the driver might have unfettered use of the vehicle for weeks or months. The major strengths of a naturalistic approach are that detailed information can be obtained on the behavior of the driver as well as conditions on the roadway at any given time, and that essentially normal driver behavior can be observed. However, the unscripted nature of the driving experience makes it more difficult to study specific scenarios or control for confounding variables. In a controlled on-road experiment, less external validity in driver behavior can be expected, due to increased driver awareness of being in a “test” (e.g., due to onboard observers, intrusive instrumentation, etc.). However, the ability to control and document the experiment is increased. Finally, the use of a simulator allows the roadway and distracting agents to be designed exactly as desired, but it cannot be presumed that the driver is behaving naturally. In any of these three study types, the outcome measures may include the incidence of MVCs or other traffic incidents; performance-based surrogate measures of traffic safety, (e.g., speed variance and deviations from the lane); and changes in the driver's use of any of his four attention/control systems (biomechanical, auditory, visual, cognitive) (Pettitt et al. 2005).

All of the outcome measures discussed thus far can be useful in studying billboard-related driver distraction. However, this review focused on measures that assess driver visual behavior, because they offer several unique advantages over other measures despite the fact that they are ultimately only surrogates for more direct assessments of traffic safety risk. Most importantly, visual behavior measures are likely to be the most sensitive to billboard-related driver distraction. Because billboards are exclusively interpreted using the sense of sight and must necessarily attract a driver's gaze to be effective, any distraction caused by billboards must involve changes in a driver's visual behavior. In contrast, billboard-related distraction might not be manifest in the driver's own description of his experience, in measures of changes in any of the driver's three other attention/control systems (biomechanical, auditory, visual, cognitive) (Pettitt et al. 2005), or in increased rates of traffic incidents. Even if distractions caused by billboards were not severe enough to cause significant changes in driving performance measures or the rates of traffic incidents, there would still be value in understanding the scope and characteristics of the distraction, because this information might inform other areas of research and policy. Therefore, this review focused on measures of visual behavior because they appear to offer the most complete and most sensitive understanding of the scope and context of billboard-related driver distraction.

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