Registered Report:

Effects of roadside memorials on drivers' risk perception and eye movements

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Abstract

Road crashes are a leading cause of death worldwide. In many countries, it is common to see spontaneous roadside memorials constructed in response to road fatalities. These memorials are controversial and are explicitly banned in many jurisdictions. Advocates argue that the presence of memorials improves safety, by making other drivers aware of an especially dangerous road where others have died, whereas opponents argue that they are distracting and decrease safety by diverting drivers' attention away from the road. However, almost no previous research has examined the effects of roadside memorials on road user behavior and safety. In this study, 40 drivers will view videos of road scenes with and without memorials, to examine how the presence of roadside memorials in a driving scene influences drivers' attentional allocation (as indicated by eye movements towards the roadside area), and their safety-related behaviors (as indicated by their ratings of how risky the road is and their preferred travel speed for the road).

Keywords

Visual attention; Driver behavior; Road safety; Roadside memorials

Significance Statement

Many cultures have a tradition of establishing spontaneous roadside memorials following a fatal road crash. These memorials mark the place where someone died prematurely, which allows their loved ones to publicly mourn the death and may also serve to warn other drivers of dangerous road conditions. Government policies around roadside memorials are mixed, with many authorities believing they distract drivers. Despite this, almost no scientific research has examined whether the presence of roadside memorials is distracting or if they influence safety-related behaviors. In this registered report, we propose a study examining whether roadside memorials divert drivers' attention away from the road (i.e., by recording their eye movements when they view videos of road scenes) and whether it affects their judgements of how safe the road is and what speed they should adopt. The underlying aim is to determine whether the presence of roadside memorials affects drivers' behavior, and if so, whether the effect is likely to impact road safety. The findings could have implications for government policy, specifically whether roadside memorials should be permitted and, if so, whether any restrictions should be imposed on their design or placement.

Introduction

Road crashes are a leading cause of death worldwide, with an estimated 1.25 million fatalities annually (World Health Organization, 2015). In many countries, it is common to see spontaneous roadside memorials constructed in response to such fatalities (Clark & Cheshire, 2003). These memorials are typically placed on or near the roadside to commemorate the location where an individual died (Collins & Rhine, 2003). They vary in appearance but often feature motifs such as crosses, flowers, the deceased's name and their date of death (Clark & Cheshire, 2003; Hartig & Dunn, 1998). Studies have indicated that roadside memorials disproportionately memorialize young drivers (Clark & Cheshire, 2003; Collins & Rhine, 2003), especially young males (Hartig & Dunn, 1998), reflecting the fact that young drivers are over-represented in the road toll (Bureau of Infrastructure, Transport and Regional Economics, 2016). The exact prevalence of roadside memorials is unknown, but research in the Hunter Valley region of New South Wales, Australia, found that approximately 20% of fatal crash sites were memorialized and 95% of drivers have seen a roadside memorial at some point (Hartig & Dunn, 1998).

Roadside memorials are often controversial: many authorities believe they have the potential to distract drivers (Churchill & Tay, 2008) but others have incorporated memorials into road safety campaigns (Clark, 2004). Surveys in the USA and Canada have revealed substantial diversity in the existence and nature of government policies regarding roadside memorials, ranging from complete prohibition (i.e., compulsory removal of memorials) to allowing memorials to remain in place indefinitely (Churchill & Tay, 2008; Dickinson & Hoffman, 2010). Although few jurisdictions explicitly permit memorials, many informally allow them and do not routinely dismantle them unless they are the subject of complaints (Churchill & Tay, 2008; Dickinson & Hoffman, 2010). Notably, none of these policies are based on evidence regarding the impacts of memorials on road users. There are two especially relevant questions regarding the impact of roadside memorials: first, do they capture attention? Second, do they alter behavior in a way that impacts safety?

Attentional Capture

To our knowledge, no previous research has examined the extent to which roadside memorials capture attention by using objective measures, such as eye movements. Several studies have asked drivers to

self-report whether they consider memorials distracting, with mixed opinions. Many drivers believe memorials are potentially distracting but some drivers, especially young adults, believe constitute a "positive distraction" (i.e., making drivers think more about road safety; Churchill & Tay, 2008; Hartig & Dunn, 1998; Tay, 2009). Advocates of roadside memorials argue that they are typically small and designed as a subtle place marker for grieving individuals, rather than trying to divert drivers' attention away from the road (Collins & Rhine, 2003).

From a psychological perspective, it is plausible that even small memorials may capture drivers' attention if they are visible from the roadway, because they are visually distinctive (i.e., white crosses and flowers pinned to a railing). Furthermore, they signal danger ("someone died here") and threat-related stimuli have been found to preferentially capture attention (e.g., Öhman, Flykt, & Esteves, 2001). This so-called *threat superiority effect* has been found for both phylogenetic or evolutionary threats (e.g., angry faces, spiders, snakes) and ontogenetic or modern threats, such as weapons (Fox, Griggs, & Mouchlianitis, 2007), even though different brain areas are involved in processing biological versus manmade threats (Yang, Bellgown, & Martin, 2012).

If a threat superiority effect occurs for roadside memorials, then in the presence of roadside memorials drivers should display a greater number of fixations and longer dwell times to the roadside area, away from the road. This diversion of eye movements could potentially negatively impact vehicle control, as extended glances away from the road are correlated with increased crash risk (Horrey & Wickens, 2007; Liang, Lee, & Yekhshatyan, 2012; Simons-Morton, Guo, Klauer, Ehsani, & Pradhan, 2014).

Safety Impacts

There is currently very little research examining the effects of roadside memorials on road user behavior and safety (Churchill & Tay, 2008; Tay et al. 2011). Collins and Rhine (2003) reported that a "troubling number" of rear-end collisions in Arizona, USA, involved a driver slowing down to look at a roadside memorial, but did not provide quantitative data to support this claim. Tay and colleagues (Tay, 2009; Tay et al., 2011) conducted studies in which they evaluated short-term effects of roadside memorials by erecting fake memorials, and long-term effects by comparing a real memorial site with two control sites. They found

that placing a memorial near an intersection reduced red-light violations by an estimated 28.7% (Tay, 2009), but placing a memorial on a freeway did not influence traffic speeds (Tay et al., 2011). Some drivers self-report that they slow down or otherwise become more cautious after seeing a memorial, but the proportion of drivers who report this behavior varies greatly, from 7-8% in a sample of young Canadian drivers (Churchill & Tay, 2008) to half of all survey respondents in rural Australia (Hartig & Dunn, 1998). This suggests the effect of roadside memorials may be context-specific, although the evidence is limited.

The Current Study

The current study was designed to examine the potential effects of roadside memorials on drivers, specifically by examining how the presence of memorials in road scenes affects observers' eye movements and risk perception. Participants viewed videos of road scenes, some of which contained roadside memorials. It was predicted that participants would make more eye movements, and eye movements of longer duration, to the roadside when a memorial was present. Participants were asked to indicate what speed they would drive (travel speed), and how safe or risky it would be to drive on the road (risk ratings). Based on previous research, participants were expected to give higher risk ratings to roads that feature roadside memorials. Logically, higher risk ratings should be associated with adopting lower travel speeds (as in Charlton, Starkey, Perrone, & Isler, 2014); however, given the inconsistent findings from previous research on roadside memorials, there may be no significant difference in speeds. As a control, participants were also asked to report the posted speed limit for each road, as this should not be affected by the presence of memorials.

Method

Participants

Forty observers will be recruited and will be offered a gift card (AUD$20/hour) as compensation. Participants must be aged 20-45 years, hold a current valid open (unrestricted) driver's license and drive at least once a week. These criteria were imposed to ensure all participants are experienced, regular drivers. Participants must also be fluent in English and have normal or corrected-to-normal visual acuity. Participants will be pre-screened to ensure they meet these selection criteria.

Design

The experiment will use a repeated-measures design with a single factor (memorial presence: present, absent).

Apparatus

Visual stimuli will be presented on a 22" monitor with 1920 x 1080 resolution. Viewing distance will be approximately 60cm, but head position will be not be fixed to allow naturalistic observation. Eye movements will be tracked using a SensoMotoric Instruments (SMI) REDn eye-tracker, which tracks eye movements at 60Hz. Stimulus presentation and data acquisition will be controlled via SMI Experiment Center.

Stimuli

Stimuli will be 40 short video clips of daytime road scenes filmed from the driver's perspective using a GoPro. This comprises 10 videos of roads with roadside memorials and 30 videos of roads without roadside memorials. Among the 30 memorial-absent videos, 10 will be "matched" clips and 20 will be "filler" clips. Clips will be selected and classified by three individuals (two authors and one independent researcher) to ensure that each clip unambiguously fits in a single category (i.e., memorial or non-memorial), and to code key events (e.g., weather conditions, traffic volume, presence of vulnerable road users, presence of hazards or potential hazards). The location, posted speed limit, and date/time of recording will be noted for each clip. A summary of each clip will be presented in supplementary information.

Memorial-present clips will be filmed by driving a passenger vehicle on real public roads with genuine roadside memorials present. It is anticipated each clip will be 25-60s long, including at least 3s of footage before the roadside memorial becomes visible and at least 3s after it is passed.[1] The precise duration of time before and after the memorial will be varied. Clips will only be included if the roadside memorial is located on the left roadside (which is where most roadside memorials in Australia are situated, as Australians drive on

[1] Note that the period in which the roadside memorial is visible will vary depending on the road geometry and speed limit. As a rough estimate, on a lower-speed suburban street (50 km/h) we can estimate that a memorial would be visible a maximum of 250m away – approximately 18-19s. In contrast, on a straight highway it may be possible to see the memorial from farther away, but because travel speeds are higher (80-110km/h) it will be visible for a similar or even shorter duration.

the left). This is because drivers will naturally differ in the amount of time they fixate on the near vs. far side of the road, so it is necessary to control which side of the road the memorials appear on.

Matched clips will be selected such that for each memorial-present clip, there is a matching memorial-absent clip that is filmed on the same road or a similar road, with similar traffic conditions, travel speed and weather. If it is not possible to film matched clips on the same road (e.g., because the road is too short, or because the road sections with memorials differ markedly from sections without memorials on the same road), then matched clips will be filmed on a nearby road that has the same speed limit, width, classification and other relevant features (i.e., number of lanes, presence/width of shoulder, horizontal and vertical curvature, roadside foliage).

Filler clips will be included to lower the relative prevalence of memorials in the stimulus set. They will be filmed on roads that do not include roadside memorials, but do include other features of interest that may influence drivers' risk and speed ratings, such as school zones, high pedestrian activity, and road works.

Procedure

Participants will be individually tested in a quiet, dark room. Prior to the experiment, participants will provide written informed consent and will be informed that the research is examining risk perception and eye movements when viewing different types of roads (with no explicit mention of roadside memorials). They will be instructed to view each clip and to make three judgements: what travel speed they would adopt on the road (in km/h); what they believe the posted speed limit is for the road depicted (in km/h); and how risky or safe it would be to drive on this road (rated on an 11-point scale where 0 represents *very safe* and 10 represents *very risky*). Participants will be asked to verbally explain their reasons for these judgements as they are making them. Verbalizations will be recorded using a digital audio recorder and transcribed verbatim for analysis.

Participants will complete 3 practice trials before beginning the experiment. During the practice block eye movements will not be tracked and participants will have an opportunity to clarify instructions and task requirements as necessary. None of the practice clips will contain memorials.

The eye-tracker will be calibrated at the beginning of the experimental block using a 9-point calibration grid, and will be re-calibrated every 8 trials to ensure accurate gaze tracking is maintained. Calibration accuracy will be validated using a 4-point grid, and will only be accepted if the average error is <0.5°.

Following the eye-tracking data collection, participants will complete a brief questionnaire that asks them what they thought the study was about (i.e., to assess whether they realized the researchers were interested in roadside memorials). Finally, they will be asked a series of questions about roadside memorials, including how frequently they encounter them, whether they are aware of adjusting their behavior around roadside memorials (e.g., reducing speed, increasing following distance), and whether they believe they should be permitted.

Data Analysis

Statistical analyses will be conducted in SPSS. Quantitative variables will be analyzed using repeated-measures *t*-tests or non-parametric equivalent (i.e., Wilcoxon Signed Rank Test), as appropriate. Statistical significance will be assessed using an alpha level of .05. Power analysis using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) indicates that a sample size of 40 would have sensitivity to detect an effect size of d_z = 0.53 with power of .95. This would be considered a medium to large effect. It is likely that experimentally-induced effects would be larger than any real-world changes in behavior, as real-world travel speeds are constrained and influenced by a multitude of interacting factors (e.g., other vehicles, weather), whereas the current study involves manipulating a single factor. Further, as the results could have relevance to real-world policy, it is appropriate to adequate evidence for any potential policy (i.e., effects must not only be statistically significant, but large enough to produce a meaningful impact in the real world).

Three aspects of eye movements will be compared between the memorial video clips and the matched non-memorial clips: probability of fixating roadside area (i.e., number of trials on which roadside area where the memorial appears is fixated); number of fixations on roadside area (average number of fixations per trial in the roadside area); and total dwell time on roadside area (average dwell time on roadside

area, in milliseconds). This analysis will focus on 5s of each clip[2], which will encompass the last 5s when the roadside memorial is visible (for memorial clips) or an equivalent time period in the matched clips. Dynamic areas of interest (AOIs) will be coded during this 5s period, including the road, left roadside, right roadside (if visible within frame), and the horizon/sky. The left roadside AOI (i.e., the area containing the roadside memorials) will be focused on for analysis. Three other quantitative variables will be compared between the memorial and non-memorial clips, specifically: posted speed limit; self-nominated travel speed; and risk rating.

Verbal comments will be coded to assess which aspects of the road participants considered when making their speed and risk ratings; specifically, whether they commented on the roadside memorial, if present. This will involve qualitative coding of concepts related to memorials (e.g., flowers, cross) and accidents (e.g., crash, death). These will be used to assist in interpretation of the statistical analyses; for instance, if the presence of memorials affects eye movements but not risk ratings, this may be because participants are not considering the presence of memorials as a relevant factor when judging the safety of the road.

Finally, descriptive statistics will be reported for the post-experiment questionnaire, including the proportion of drivers who have noticed roadside memorials, how frequently they notice them on average, and whether they believe the presence of roadside memorials has a positive, negative, or non-significant impact on road safety.

[2] Note: this duration will be reviewed after the clips are filmed and selected, to ensure that all memorial clips have 5s where the memorial is visible. If the memorials are visible for considerably longer than 5s, the duration of the segment analyzed may be lengthened, whereas if memorials are visible for less time then it will be shortened to facilitate comparison across different clips.

Declarations

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Ethics approval and consent to participate. Ethical aspects of this research were approved by the University of the Sunshine Coast Human Research Ethics Committee (A/17/911). All participants will provide written informed consent prior to participation.

Authors' contributions. Conception and design of the study: VB, RAW, PMS. Stimulus creation and experiment programming: VB, RAW. Data collection: RAW. Data analysis and interpretation: VB, RAW, PMS. Drafting the manuscript: VB, RAW, PMS. All authors have read and approved the final manuscript.

Competing interests. The authors declare that they have no competing interests.

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