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Speed control with and without advanced warning sign on the field: An analysis of the effect on driving speed

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ABSTRACT

Speeding is an important risk factor in road safety and police activities with regard to traffic (safety) are therefore to a large extent focused on tackling this problem. Within this study, researchers from Hasselt University worked together with 3 regional police units to test the effect of two frequently used speed interventions namely a speed control (i.e. stationary police control in an unmarked police car equipped with a mobile radar) with and without an advanced (digital) warning sign alongside the road. The effect of these 2 types of interventions is tested on two road segments of regional roads (with a maximum speed of 70 and 90 km/h), whereby interventions were switched between both roads during the second field experiment. To measure the effect of both methods, the average speed, 85th percentile of speed and odds of drivers exceeding the speed limit were analyzed, mainly by using general linear regression models. Results show for each tested intervention, significant speed reductions during the time that enforcement was in place. Generalizing these results, allows us to conclude that the effect during the speed control with advanced warning sign is larger compared to the speed control only (respectively −4.5 km/h and −2.5 km/h in the V85 speed) and also the continuing effect until one week after the intervention is higher. In the future, we recommend repeating the experiment on more locations, to enhance the reliability and generalizability of the results. To do so, further cooperation between knowledge institutions and field practitioners is advisable.

1. Introduction to the speeding problem

Speeding – i.e. driving at a speed above the posted speed limit – is considered to be one of the most important risk factors in road safety (ETSC, 2006; GRSP, 2008). Numerous research studies show that excessive speed increases the risk of getting involved in a crash as well as the severity of the crash outcome (Aarts and Van Schagen, 2006; Evans, 2004; Elvik et al., 2009). Also speed differences between vehicles increase both crash as well as injury risk (Aarts and Van Schagen, 2006). The National Highway Traffic Safety Administration (NHTSA) (2014) found that speeding was a contributing factor in 30% of fatal crashes in the United States in 2012, resulting in 10,219 lives lost in speed-related crashes. This corresponds largely with the general estimate that can be found in road safety research, stating that excessive speed (together with inappropriate speed) plays a role in one third of fatal crashes (OECD/ECMT, 2006; TRB, 1998). A (rather) large proportion of the general drivers' population recognize the problem (Boets and Meesmann, 2014; SARTRE 3 consortium, 2004; Schroeder et al., 2013), for example 78% of the European citizens agree with the statement that excessive speed is a major safety problem (European Commission, 2010). Despite the negative impact on traffic safety, drivers all over the world frequently drive above the posted speed limit (excessively or not) and in general speeding is still regarded as fairly normal, acceptable behavior (SARTRE 4 consortium, 2012). In Europe, the European Transport Safety Council (ETSC) reports speed violation rates of 30% on motorways, up to 70% on roads outside built-up areas and as many as 80% in urban areas (2010). In Belgium, speed violations of 56%, 52% and 27% were measured in 2012 respectively on 50 km/h, 70 km/h and 90 km/h roads (Riguelle, 2013). As in other European countries, speeding is the most common road traffic violation (SARTRE 4 consortium, 2012). Given the negative impact of speeding on road safety (e.g. Elvik et al., 2009), reducing the number of speed violations is an important priority (NHTSA, 2008a), creating high potential road safety benefits (Elvik and Amundsen, 2000). Further building upon Nilsson's Power Model, Elvik et al. (2009) estimate for example a general reduction from 100 to 69 fatal accidents when speed is reduced by 10% on all roads. The effect of changes in speed on road safety is higher in rural areas than in urban areas. Various measures – which are preferably integrated within a

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broader package of speed measures ('speed management') – can reduce the speeding problem (NHTSA, 2005; OECD/ECMT, 2006). For example, infrastructural measures to ensure that speed limits are safe and credible in function of the road characteristics can prevent a large part of speed offences (Van Schagen et al., 2004). Furthermore, speed enforcement is one of the measures to tackle speeding behavior within the concept of speed management.

2. Literature review on speed enforcement

The 'Model of the mechanism of traffic law enforcement' (Mäkinen et al., 2003), shows that a raise in the level of speed enforcement activities increases the objective risk of detection as well as drivers' perceived chance of apprehension. The latter can also be influenced by characteristics of the speed control such as the visibility of the control, the presence in the media, and predictability of speed controls on certain roads (e.g. Elliot and Broughton, 2005; ERSO, 2006). By influencing driver's perception of the risk of detection, not only drivers that already have been apprehended for speeding are deterred to speed (specific deterrence) but also drivers who have not, are influenced by the threat of punishment and will therefore possibly refrain from the prohibited act (in this case speeding) in the future (general deterrence) (Elliott, 2003; Ross, 1982 in: Chen et al., 2002).

Various studies report positive effects of speed enforcement in terms of speeding behavior as well as road safety outcomes (e.g. DaCoTa, 2012; Elvik, 2001; Elvik et al., 2009; Goldenbeld and Van Schagen, 2005; Mäkinen et al., 2003; Zaal, 1994), and more specifically of the use of mobile radars in stationary controls (Decina et al., 2007; Elliot and Broughton, 2005; Erke et al., 2009; Thomas et al., 2008; Wilson et al., 2010). For example, Thomas et al. (2008) conclude that the effects of covert, mobile speed enforcement programs varies from a 20% to 25% reduction in the number of daytime casualty crashes. Fewer studies have measured the more direct effect on vehicle speed (Champness et al., 2005). Champness et al. (2005) report that the average speed is reduced by 6 km/h during the time mobile overt speed cameras were operational on highways with a speed limit of 100 km/h. Furthermore, a review made by Elliot and Broughton (2005) shows a general reduction of 4.8 km/h in the mean speed over all considered studies in which the effect of stationary and visible enforcement was tested. For stationary and hidden enforcement, studies consulted by Elliot and Broughton show diminishments of 1–2.4 km/h in the average speed. Though several studies exist, Goldenbeld and Van Schagen (2005) note that a good insight in the effects of this speed enforcement method is missing. This (partly) because of the limited studies that provide a thorough, well-documented overview of the study design, including information on several factors (such as the intensity of enforcement, the scheduling of activities, the chosen locations, and the visibility of the control) which can influence the established effect. Consequently, it is difficult to explain variations found in several studies, in terms of the magnitude of the effect of a certain tested enforcement method (e.g. Wilson et al., 2010; Decina et al., 2007).

In this study, we aim at getting a better insight in the effect of stationary speed controls with mobile radar on speeding behavior (see detailed description in Section 3). Moreover, we wish to assess the effect of this repressive enforcement method (as the baseline) with and without the usage of an advanced warning sign alongside the road. Several studies report positive effects of digital signs alongside the road in terms of a reduction in the traveled speed (Wrapson et al., 2006; Walter and Broughton, 2011; Cruzado and Donnell, 2009). For example Walter and Broughton (2011) report a decrease in the average speed of 2.25 km/h (or 1.4 mph) when speed indicator devices were in place (on road section with a speed limit of 30 mph). Few studies however examine the particular kind of combination that is tested in this study (e.g. NHTSA, 2008b). In a study from Woo et al. (2007), speed-monitoring displays coupled with enforcement cameras downstream was evaluated to be an effective approach. Though, in this study the study design differs as we test a more temporary combination of a repressive speed control with a preventative, warning signage.

In general, such a combination has been found to be more effective given the fact that (digital) signage raises the visibility of the enforcement activities (Erke et al., 2009; NHTSA, 2008b). Furthermore, the use of (digital) signage creates a more generalized deterrent effect, as it informs all passing drivers and therefore influences drivers' perceived risk of being caught. In other words, speed enforcement which is signposted, does not only raise the actual detection rate (objective risk of detection) but also raising drivers' subjective risk of detection. The latter is generally considered as more important (e.g. ETSC, 2006; GRSP, 2008; Mäkinen et al., 2003; Zaal, 1994). A research in Queensland (Australia) found that more visible enforcement consequently raises self-compliance and creates longer lasting effects on behavior (Soole et al., 2009). Moreover, public support for more visible enforcement methods – e.g. additional measures alongside the road such as signs – is generally higher (e.g. Goldenbeld et al., 1999; SWOV, 2014).

3. Method

3.1. Experimental design and goal

As mentioned, the main goal of the present study is to analyze and compare the effect on speeding behavior of a stationary speed control with mobile radar with and without an advanced warning sign. To do so, a field experiment was set up (by Hasselt University) in collaboration with 3 regional police units ('HaZoDi', 'Kempenland' and 'West-Limburg') in the province of Limburg (in the Flemish region of Belgium). As speeding is an important problem in Belgium, regional police spent a lot of effort and resources on tackling this problem in their area. They are therefore interested to learn more about the effect of their commonly used enforcement methods. The experimental design was tested on two locations on regional roads, and speed data was recorded before, during and after the tested enforcement method (before-and-after study). The latter, was valuable to get insight in the potential lasting effects in time. Vaa (1997) describes this so-called 'time halo effect' as 'the length of time during which the effect of enforcement is still present after police activity has been withdrawn'. The existence of a certain effect can be explained by the fact that drivers exposed to the enforcement activity will possibly anticipate for the presence of enforcement on subsequent occasions when passing the same site (Elvik et al., 2009; Hauer, 1997). Elliot and Broughton (2005) found that among the different consulted studies the time halo effect for stationary speed control varies from 1 h to 8 weeks. The present study includes the assessment of the 'time halo effect', since it can give valuable information on when the effect of a speed method on a certain road section has worn out and thus new repressive or preventative activities are necessary to sustain an acceptable speed level. This knowledge is important input for the design and planning of enforcement activities. The so-called 'distance halo effect' (or kangaroo effect) which describes the distance over which the effect of a certain intervention lasts, was not included in the experimental design.

Next, we describe the selected enforcement method and road sections in more detail.

3.1.1. Selected enforcement method

The speed control took place in an unmarked, inconspicuous police car that was (visibly) parked (stationary) alongside the road.