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The impact of police speed enforcement practices on self-reported speeding: An exploration of the effects of visibility and mobility

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Abstract

Research has highlighted the relationship between vehicle speed and increased crash risk and severity. Evidence suggests that police speed enforcement, in particular speed camera operations, can be an effective tool for reducing traffic crashes. A quantitative survey of Queensland drivers ($n = 852$) was conducted to investigate the impact of police speed enforcement methods on self-reported speeding behaviour. Results indicate that visible enforcement was associated with significantly greater self-reported compliance than covert operations irrespective of the mobility of the approach, and the effects on behaviour were longer lasting. The mobility of operations appeared to be moderated the visibility of the approach. Specifically, increased mobility was associated with increase reported compliant behaviour, but only for covert operations, and increased longevity of reported compliant behaviour, but only for overt operations. The perceived effectiveness of various speed enforcement approaches are also analysed across a range of driving scenarios. Results are discussed in light of the small effect sizes. Recommendations for policy and future research are presented.

Keywords

Speed enforcement, police, speed cameras, visibility, mobility, legitimacy.

Introduction

Road traffic crashes are a significant problem worldwide. Each year more than a million people are killed and an additional 50 million persons are seriously injured on roads throughout the world (Richter, Berman, Friedman, & Ben-David, 2006); statistics that are not restricted to highly motorised countries. Based on current trends it is estimated that traffic crashes will be the sixth leading cause of death and morbidity by the year 2020 (Murray & Lopez, 1997). Road traffic crashes have an enormous economic and social impact and are estimated to cost Australia approximately \$17 billion per year (Connelly & Supangan, 2006). Excessive speed is an issue that often dominates discussions regarding illegal high-risk driving behaviours contributing to road crashes.

Empirical research has consistently highlighted a positive relationship between vehicle speed and crash risk (Aarts & van Schagen, 2006; Kloeden, McLean, & Glonek, 2002; Kloeden, McLean, Moore, & Ponte, 1997). This relationship has been identified as exponential and more pronounced on urban roads than open roads (Fildes, Rumbold, & Leening, 1991). In addition, speed has been consistently found to increase crash severity, as evidenced by the greater contribution of speed to the proportion of fatal crashes compared to overall crashes or crashes resulting in less damage or injury (Aarts & van Schagen, 2006; Kloeden et al., 2002; Kloeden et al., 1997). However, quantifying the actual impact of speed as a contributing factor in traffic crashes is difficult for a number of reasons. These include differences in data collection; issues regarding the reliability and accuracy of data; and, underestimation due to more easily identifiable contributing factors such as alcohol, driver error in judgement and loss of control. Nonetheless, a number of studies have analysed crash data in an attempt to estimate the role of speed in crashes.

In Queensland in 2006, speed was reported to contribute to 27.2% of fatalities (Queensland Transport, 2007). This represented a marked increase from 2003 data which suggested speed was a contributing factor in 16% of fatal crashes, 5% of hospitalisation crashes, 7% of other injury crashes and 5% of all crashes (Queensland Government, 2005). However, it is difficult to ascertain whether this increase reflects changes in driver behaviour or differences in data collection methods. Similar estimates have been reported internationally, with excessive speed found to contribute to 14% of British fatalities (Robinson & Singh, 2006) and almost one third of fatal crashes in the United States (Liu, Chen, Subramanian, & Utter, 2005). Speed is also a major contributor toward novice driver crashes, with as many as 37% of fatal crashes being speed-related (Braitman, Kirley, McCartt, & Chaudhary, 2008; Gonzales, Dickinson, DiGiuseppi, & Lowenstein, 2005; Williams, Preusser, Ulmer, & Weinstein, 1995).

Given the relationship between speed and increased crash risk and severity, the development of road safety initiatives designed to reduce driver speeds is of paramount importance. One of the major

approaches to speed management has been police use of speed detection technologies such as cameras and radars. The use of such technologies is widespread throughout the world. Speed cameras were first implemented in Australia in Victoria in 1985 and were operational in all jurisdictions by 1997 (Delaney, Ward, & Cameron, 2005). Mobile speed cameras were first introduced in Queensland in May 1997 and more recently (December 2007) a small number of fixed cameras were introduced¹. Routine traffic patrols, as well as hand-held and moving-mode radars, are also used throughout the state.

The speed camera program in Queensland is based on the theoretical underpinnings of deterrence theory, in particular general deterrence, and thus speed camera operation is inherently overt. Speed camera zones are chosen on the basis of crash history and public complaints, and cameras are randomly scheduled within these zones². Speed camera sites are the locations within a zone where a speed camera will operate, and there are currently over 4000 speed camera sites located throughout the state. Speed cameras are operated day and night by uniformed police officers and operated with an unspecified enforcement tolerance. While the accuracy of speed camera technology has been questioned elsewhere in Australia, Queensland has high standards of operation including regular device calibration and annual servicing (Queensland Police Service Traffic Camera Office, 2007).

Despite the widespread use of speed enforcement technology, there is still much debate regarding the effectiveness of such speed management efforts. While much of the empirical evidence suggests speed cameras are an effective tool for reducing road crash fatalities and casualties a number of significant methodological shortcomings are present in many studies. For instance, studies typically review enforcement programs at a macro level making it extremely difficult to disentangle the impact of various aspects of programs, and thus difficult to make recommendations regarding what works, or does not work, in police speed enforcement (Harrison, 2001; Pilkington & Sanjay, 2005). Nonetheless, much can be learned about the various aspects of speed law enforcement by reviewing the available research.

In an evaluation of overtly operated speed cameras in Queensland, Newstead and Cameron (2003) found reductions in a number of outcome measures, including fatal crashes within close proximity of the camera site (45%), injury crashes (19%) and non-injury crashes (21%). Operational variables were reported to strongly influence the effectiveness of the speed camera program, with effects greatest at times when more camera sites were operational and true randomness of camera deployment was achieved. However, it has been suggested that the highly visible nature of Queensland speed camera enforcement can lead to time and distance halo effects surrounding camera locations (Champness, Sheehan, & Folkman, 2005). Studies evaluating speed enforcement programs in Victoria, where programs tend to be more covert in nature, have also reported reductions in crash frequency and severity (D'Elia, Newstead, & Cameron, 2007; Delaney, Diamantopoulou, & Cameron, 2003). Specifically, the full implementation of covert mobile speed cameras was found to produce a significant reduction of 10% in casualty crashes and 27% in fatal crashes (D'Elia, Newstead, & Cameron, 2007). In addition, fixed cameras were found to reduce vehicle speeds (Delaney et al., 2003).

Non-camera based speed enforcement methods have also been evaluated, but not as extensively as camera-based methods. Diamantopoulou, Cameron and Shtifelman (1998) evaluated the effectiveness of hand-held and moving mode lasers in Victoria and found that hand-held laser operation was associated with reductions in crash frequency, but not severity. Again, the overt nature of this type of enforcement was found to be associated with relatively localised effects on vehicle speeds. Moving mode radar devices were found to be effective in reducing casualty crashes on open roads in rural areas, however their effect in more metropolitan areas was reported to be negligible. In a similar study, Newstead, Cameron and Leggett (1999) evaluated the Random Road Watch Program in Queensland, which involved random and highly visible routine traffic policing. While not solely restricted to speed enforcement, the program was found to produce a number of positive effects on crash outcomes, including reductions in fatal crashes (33%), injury crashes (25%) and non-injury crashes (22%).

Drivers have reported a number of concerns regarding the perceived legitimacy of speed enforcement practices and reliability of speed enforcement equipment (Delaney, Ward, Cameron, & Williams, 2005). Specifically, some drivers perceive the role of police speed enforcement to predominately be a revenue-raising mechanism. Paradoxically, however many also refer to the road safety benefits of speed enforcement (Fleiter & Watson, 2006; Soole, Lennon, & Watson, 2008). Driver criticisms of police speed

¹ Data collection for this study was conducted in October to mid-December in 2007, in the months prior to the implementation of fixed speed cameras in Queensland.

² Zones are one kilometre in diameter in urban areas and five kilometres in diameter in rural areas.

enforcement have included: perceived inappropriate criteria for choosing site locations of cameras; perceived illegitimacy of covert operations; perception that automated technologies do not allow for extenuating circumstances to be properly accounted; and, negative perceptions regarding the reliability of speed enforcement technology. Finally, some drivers have argued that enforcement tolerances should allow an acceptable leeway for inconsistencies in speedometer calibrations and simple driver error (Delaney, Ward, & Cameron, 2005).

Following reviews of the empirical literature a number of operational recommendations regarding best practice in police speed enforcement have been made, taking into consideration the methodological shortcomings of the current literature and operational differences across jurisdictions. Firstly, it has been argued that speed enforcement should focus primarily on increasing the risk of detection rather than levels of apprehension for offending (Zaal, 1994). That is, general deterrence should be the underlying philosophy of any speed enforcement package, in order to maximise its impact on community-wide behaviour. Secondly, public support for speed camera operation will be greatly improved if site locations are chosen on the criteria of prior documented speed-related crash history at those sites (Zaal, 1994). Thirdly, a balance of overt and covert, and stationary and mobile, operations is likely to result in the greatest road safety benefit (McInerney, Cairney, Toomath, Evans, & Swadling, 2001; Zaal, 1994), however the precise optimal combination of approaches is yet to be ascertained. Fourthly, strategies should allow for network-wide implementation of speed enforcement efforts (McInerney et al., 2001; Zaal, 1994). Finally, enforcement tolerances should be set at the minimal practical level while considering device accuracy and accidental driver speed inconsistencies (Fleiter & Watson, 2006; Harrison, 2001; McInerney et al., 2001; Zaal, 1994).

Typically, the effectiveness of police speed enforcement approaches have been evaluated through studies investigating the impact of such methods on traffic crashes and speeding recidivism. This study seeks to extend on the current literature by examining the impact of driver perceptions toward police speed enforcement on self-reported behaviour. Traditionally, policy makers have been concerned very little with what drivers report as the most effective tools for changing their behaviour. This study explicitly asked participants to state the speed enforcement methods they believed would be most effective in impacting on their driving speed, irrespective of their perceptions of the acceptability of the use of such methods. The rationale behind the study is that it could be argued that an increased perception of the legitimacy of speed management policies and practices might be associated with an increased willingness to comply among drivers. This paper reports the results of quantitative survey with 852 Queensland drivers which explored the difference between perceptions towards camera-based and non-camera-based speed enforcement methods, of varying degrees of mobility and visibility, and the differential impact of these approaches on self-reported speeding behaviour.

Method

Participants

A total of 909 individuals participated in the quantitative survey conducted with drivers from throughout Queensland. Participants were recruited using a variety of strategies, including recruitment at urban and regional shopping centre food courts (85.7%), service station food courts (6.5%), and a university student participation program (7.7%). A total of 915 participants refused³ to participate, representing a 49.8% response rate. There were no significant differences between respondents and non-respondents in relation to gender, age or residency. The most common reason for non-participation was disinterest (52.8%, $n = 483$), while slightly more than a third reported not having time to participate (37.6%, $n = 344$) and 8.5% ($n = 78$) did not meet eligibility criteria.

Of the 909 participants surveyed, those aged 15 or 16 years old ($n=31$) were excluded from the analysis given that they were not likely to have had sufficient exposure to police speed enforcement methods. An additional 21 participants that listed interstate postcodes were also excluded given the confounding effects that might result due to exposure to different methods and speed management philosophies of other states. Finally, two participants were excluded given incomplete or missing data and three due to evidence of response set (bias created when participants choose the same response for all questions; typically

³ Of those who refused to participate some basic information was recorded including gender, estimated age and reason for non-participation.

identified by illogical response sets to negatively worded items). Thus, the final sample size for the study was 852.

Procedure

The survey was conducted throughout Queensland including in Brisbane suburbs (Chermside and Mt Gravatt) on the Gold Coast (Reedy Creek), Sunshine Coast (Glasshouse Mountains and Gympie) and north Queensland (Townsville). As stated, participants were recruited at urban and regional shopping centre food courts, service station food courts and through a university student participation program. Student participants received course credit and non-students were offered \$10 cash as reimbursement for their participation. Participants were required to hold a current Queensland drivers licence (Provisional or Open) for a car, motorcycle or truck to be eligible for participation.

Participants provided written consent and demographic details as per university ethical requirements. Participation involved an approximately 15 to 20 minute survey exploring a range of topics including: knowledge of current speed enforcement policies and practices; perceived effectiveness of and support for camera-based and non-camera-based enforcement approaches and overt versus covert operations; the importance of legitimacy in speed enforcement policy and practice; and, self-reported behaviour in response to police speed enforcement practices. Participants were approached by the first author, explained what was required of them to participate and then left to complete the survey in their own time. The first author was on continual stand-by to answer any questions.

Dependent and independent variables

Participants were classified as either compliant, moderate speeders, or excessive speeders based on patterns of responses to a series of self-report speeding behaviour questions. The construction of this speed classification variable was based on responses to questions investigating the self-reported frequency (never = 1 to always = 7) and degree (at or below the posted limit, 1-10km/h over, 11-20km/h over or more than 20km/h over) of compliant and speeding behaviour for each participant. Those participants reporting that they always (or nearly always) drive at or below the posted speed limit, never (or always never) drive 1 to 10km/h over, and never drive more than 11km/h over were classified as compliant. Excessive speeders were defined as participants reporting that they more often than not (score of 4 or above) drive between 11 to 20km/h over or more than 20km/h over the posted speed limit. All other participants were categorised as moderate speeders. Participants with more than one item of missing data or illogical response sets (1 or 7 on all items) were coded as missing.

There were eight speed enforcement methods of interest in this study. These included: fixed speed cameras; overt and covert mobile speed camera vans; overt and covert operation of hand-held radars; marked and unmarked patrol vehicles (using either moving-mode radars or conducting general traffic duties) in the traffic flow; and, marked patrol vehicles parked on the side of the road using moving mode radars. Fixed speed cameras refer to permanent cameras typically affixed to poles located on the roadside. These differ to mobile speed cameras that are generally operated from inside police vans and 4WD vehicles which can be driven to various locations within the road network. Both fixed and mobile speed cameras detect speeding motorists automatically and infringement notices are delivered via the mail. There are two types of radar operation. The first involves use of a hand-held radar device by police officers who typically situate themselves by the roadside outside of, but in close proximity to, their police vehicle. Upon detecting a speeding vehicle the officer generally directs the vehicle to stop or another officer located downstream is radioed and intercepts the driver. The second type of radar operation involves moving-mode radars which are attached to police vehicles and can be operated when the vehicle is stationary or moving. Finally, police conducting general patrols can observe speeds of motorists based on average following speeds.

Given that eight speed enforcement methods were analysed, error variances and associated degrees of freedom were high in analyses assessing the impact of police speed enforcement method. As a result, the eight methods were reduced to four separate categories based on two enforcement variables; visibility and mobility of method. Visibility refers to whether the method is overt or covert in nature while mobility refers to whether the method is stationary or mobile in its operation. In this study a method was operationalised as covert when unmarked police vehicles are used or when attempts are made to make operations less visible (e.g., hand-held radar operation behind a tree/bus stop; mobile speed camera

Figure 1. Classification of enforcement methods by visibility and mobility.

		Mobility	
		<i>Stationary</i>	<i>Mobile</i>
Visibility	<i>Visible</i>	Fixed/permanent speed cameras. Overt mobile speed camera vans.	Marked patrol vehicle in the traffic flow. Marked patrol car on the side of the road. Overt operation of a hand-held radar.
	<i>Hidden</i>	Covert mobile speed camera vans	Unmarked patrol vehicle in traffic flow. Covert operation of a hand-held radar.

operation where the police vehicle is parked behind a fence/obscured from plain sight). Mobility somewhat overlaps with the issues of immediacy of punishment and contact with authority. That is, mobile methods such as hand-held radar operation are typically associated with immediate issue of an infringement notice at the time and site of the offence and direct contact with police officers. Conversely, stationary methods such as fixed cameras or mobile speed camera vans are typically associated with a delay between the time of the offence and issuing of the infringement notice and no direct contact with authorities. Figure 1 below shows how each of the eight police speed enforcement approaches was classified.

Analysis

Analyses were conducted using SPSS for Windows Version 16.0. Analyses involved a series of one-way repeated-measures analysis of variances (ANOVAs). Given the large sample size, a more stringent alpha level of .01 was used to assess the statistical significance of the results. Mauchly's Test of Sphericity was used to assess homogeneity of covariance, with the Greenhouse-Geisser statistic reported in instances of a breach of homogeneity. Pairwise comparisons were conducted, adjusted using the Bonferroni correction.

Results

Sample characteristics

The sample consisted of 61.8% females. The mean age of the sample was 32.34 years (sd = 15.3 yrs, range = 17-87 yrs). The majority held an open drivers licence (66.2%), while a quarter held a provisional licence and the remainder a learner licence (9.1%). Interestingly, 8.2% of the sample reported having been suspended or disqualified from driving at some time. The majority of the sample were from urban areas (62.5%), with slightly more than a third from rural areas (37.5%). Most drivers reported either driving mainly on suburban roads only (47.6%) or both suburban and rural or open roads (47%). Only 5.5% reported mainly driving on rural or open roads. The majority of the sample reported most commonly driving a privately owned vehicle (93.4%). A total of 130 drivers (15.3%) reported having been involved in a crash in the previous three years, with most reporting just one crash during that time. Close to a third (29%) reported having received a speeding ticket in the past three years, with the maximum number reported by any one individual being 20 and 13 drivers reporting having received more than five infringements. Finally, 41.6% reported completion year 12, 31.8% had some tertiary experience and a quarter reported completion of year 10 as their highest educational attainment.

Differences in self-reported compliance by enforcement method

A series of one-way repeated measures ANOVAs were conducted to analyse the impact of the four speed enforcement approaches (stationary/overt; stationary/covert; mobile/overt; mobile/covert) on self-reported compliance by speeder classification. The data was gathered by asking participants how likely each of the eight original speed enforcement methods was in encouraging them to drive at or below the posted speed limit. Scores were then summed and averaged to create scores for the four grouping classifications. The means and standard deviations are presented in Table 1 below, with higher scores representing greater compliance. Results of the repeated measures ANOVAs indicated significant differences in self-reported

Table 1. Self-reported compliance by speed enforcement type: speeder classifications.

<i>Speed Enforcement Method</i>	<i>Self-Reported Compliance – M (sd)</i>			
	<i>Compliant</i>	<i>Moderate Speeder</i>	<i>Excessive Speeder</i>	<i>All Drivers</i>
Stationary/overt	6.23 (1.55) ^a	5.99 (1.55) ^a	5.47 (1.70) ^a	5.98 (1.59) ^a
Stationary/covert	5.20 (1.99) ^b	4.73 (1.89) ^b	4.23 (1.87) ^b	4.78 (1.94) ^b
Mobile/overt	6.31 (1.43) ^a	5.93 (1.49) ^a	5.36 (1.58) ^a	5.95 (1.51) ^a
Mobile/covert	5.56 (1.70) ^c	5.12 (1.51) ^c	4.75 (1.63) ^c	5.18 (1.60) ^c
Greenhouse-Geisser	.624	.693	.779	.701
<i>F</i>	60.64 [‡]	157.13 [‡]	26.74 [‡]	241.88 [‡]
<i>df</i>	3, 657	3, 1494	3, 366	3, 2526
Partial eta squared	.22	.24	.18	.22

N for groups: compliant drivers = 220, moderate speeders = 499, excessive speeders = 123; all drivers = 843.

Significant within-group differences on self-reported behaviour by enforcement method are represented by different letters (read vertically for each speed categorisation group); Bonferroni adjusted.

[‡] *p* < .001.

Mauchly's Test of Sphericity breached; analyses report on the Greenhouse-Geisser statistic and subsequent statistics.

Post-hoc comparisons adjusted using the Bonferroni correction.

compliance across the various speed enforcement methods for all drivers, as well as for all three speed classification groups. Based on Cohen's (1988) criteria however, the effect size for all analyses were small.

Assessing the pairwise comparisons, a consistent pattern of results emerged across the groups. The exact same pattern of results was observed when analysing data for compliant drivers, moderate speeders, excessive speeders, or for all drivers. Specifically, stationary/overt methods were associated with significantly greater levels of self-reported compliance than covert enforcement operations regardless of whether they were stationary or mobile (*p* < .001 for each). An identical pattern of results was also observed for mobile/overt methods (*p* < .001 in both cases). That is, covert methods were associated with lower levels of self-reported compliance than visible enforcement methods. In addition, covert operations of a stationary nature were reported as being significantly less likely to evoke compliance than covert, mobile methods (*p* < .001). There were no significant differences between stationary and mobile enforcement approaches operated in a visible nature.

Differences in self-reported duration of compliance by enforcement method

Similar to the previous analysis, a series of one-way repeated measures ANOVAs were conducted to analyse the impact of the four speed enforcement approaches on self-reported duration of compliance by speeder classification. Participants were asked how long each of the eight original speed enforcement methods would encourage them to drive at or below the posted speed limit (does not slow me down at all = 1 to for the entire journey after passing the method = 5). Scores were then summed and averaged to create scores for the four grouping classifications. The means and standard deviations are presented in Table 2 below; with lower scores representing shorter durations of compliance. Results of the repeated measures ANOVAs indicated significant differences in self-reported duration of compliance across the various speed enforcement methods for all drivers, as well as for all three speed classification groups. Once again however, based on Cohen's (1988) criteria the effect size for all analyses were small.

Table 2. Self-reported compliance by speed enforcement type: speeder classifications.

<i>Speed Enforcement Method</i>	<i>Self-Reported Duration of Compliance – M (sd)</i>			
	<i>Compliant</i>	<i>Moderate Speeder</i>	<i>Excessive Speeder</i>	<i>All Drivers</i>
Stationary/overt	4.11 (1.11) ^a	3.61 (0.89) ^a	3.28 (0.80) ^a	3.69 (0.98) ^a
Stationary/covert	3.72 (1.38) ^b	3.33 (1.17) ^b	3.00 (1.01) ^b	3.38 (1.23) ^b
Mobile/overt	4.19 (1.05) ^a	3.70 (0.88) ^c	3.34 (0.82) ^a	3.77 (0.96) ^c
Mobile/covert	3.72 (1.34) ^b	3.29 (1.11) ^b	3.01 (0.85) ^b	3.36 (1.16) ^b
Greenhouse-Geisser	.679	.809	.813	.785
<i>F</i>	33.64 [‡]	45.16 [‡]	10.73 [‡]	87.08 [‡]
<i>df</i>	3, 648	3, 1485	3, 369	2,36, 1971.21
Partial eta squared	.14	.08	.08	.09

N for groups: compliant drivers = 217, moderate speeders = 496, excessive speeders = 124; all drivers = 838.

Significant within-group differences on self-reported behaviour by enforcement method are represented by different letters (read vertically for each speed categorisation group); Bonferroni adjusted.

[‡] *p* < .001.

Mauchly's Test of Sphericity breached; analyses report on the Greenhouse-Geisser statistic and subsequent statistics.

Post-hoc comparisons adjusted using the Bonferroni correction.

Assessing the pairwise comparisons for all drivers, it is revealed that mobile/overt methods were associated with significantly longer durations of self-reported compliance than all other approaches ($p < .001$ in all cases, except stationary/overt $p < .01$). In addition, stationary/overt speed enforcement methods were also associated with significantly longer durations of compliance than covert operations, regardless of the degree of mobility ($p < .001$ in both cases). There were no significant differences between covert approaches that were stationary with those that were mobile. An identical pattern of results was observed for moderate speeders however the statistical significance was not as strong. Finally, similar results were observed for both compliant drivers and excessive speeders however, among these groups, no significant differences between covert methods were found, regardless of the degree of mobility of the approach.

Effectiveness of various speed enforcement approaches by driving situation

A descriptive analysis was performed on driver perceptions of the most effective police speed enforcement methods for a variety of driving situations. For this analysis it was decided not to categorise the eight police speed enforcement methods into the four groups based on mobility and visibility. The justification for this was that there were hypothesised differences between approaches of similar mobility and visibility across the various driving situations. The driving situations investigated included freeways (100-110km/h), country and rural roads (100-110km/h), typical urban streets (60km/h), residential back streets (50km/h), school zones (40km/h) and accident black spots. Participants were asked to indicate in which driving scenarios each speed enforcement method was most effective. Participants were not limited to select one effective method per driving scenario or one typical scenario in which a method was most effective. Participants were also given the option to say that methods were ineffective across all scenarios.

Table 3 below shows the proportion of participants who reported that a speed enforcement method was effective. Bolded figures represent the scenarios in which each of the corresponding police speed enforcement methods were reported to be most effective. Only those methods with proportions of 50% or greater will be spoken about further in detail; that is, instances where more participants believe the speed enforcement method is effective in that situation than those who do not. Italicised figures represent instances where the reported effectiveness approached 50%.

The findings were as followed:

- Fixed cameras were perceived as most effective on freeways (69.7%), in school zones (57.5%) and crash black-spots (53.0%);

Table 3. Proportion of participants reporting police speed enforcement methods to be effective by driving scenario.

	Driving Situation						
	<i>Freeway</i>	<i>Country/ rural road</i>	<i>Typical urban street</i>	<i>Residential back streets</i>	<i>School zone</i>	<i>Crash black spot</i>	<i>None</i>
Fixed camera	69.7%	15.0%	27.7%	13.6%	57.5%	53.0%	3.0%
Overt mobile camera	59.2%	33.8%	<i>46.2%</i>	24.9%	50.1%	36.1%	1.3%
Covert mobile camera	44.8%	25.8%	36.5%	25.8%	34.2%	27.7%	17.6%
Marked patrol car in traffic	74.0%	36.8%	58.4%	36.5%	<i>48.8%</i>	39.3%	2.7%
Marked patrol car on side of road	62.7%	39.2%	<i>49.4%</i>	32.7%	56.3%	40.8%	2.6%
Overt hand-held radar operation	38.3%	31.6%	59.0%	40.1%	62.7%	33.8%	2.4%
Unmarked patrol car in traffic	57.0%	28.5%	38.4%	27.8%	36.9%	27.8%	21.3%
Covert hand-held radar operation	32.8%	24.4%	40.1%	32.7%	41.5%	25.6%	20.7%

- Overtly operated mobile speed cameras were also reported as being most effective on freeways (59.2%) and somewhat effective in school zones (50.1%) and on urban streets (46.2%);
- Marked patrol vehicles in the traffic flow were reported as being most effective on freeways (74.0%), urban roads (58.4%) and somewhat effective in school zones (48.8%);
- A similar pattern of results was observed for marked patrol vehicles parked on the side of the road, with participants reporting this method as being most effective on freeways (62.7%) and school zones (56.3%), but only somewhat effective on urban roads (49.4%);
- Unmarked patrol vehicles in the traffic flow were reported as being most effective on freeways (57.0%);
- Visible operation of hand-held radars was reported as being most effective in school zones (62.7%) and urban streets (59.0%); and,
- Covertly operated mobile speed cameras or hand-held radars were not perceived as effective (by at least 50% of participants) in any of driving situations.

Discussion

The results suggest that drivers typically perceive police enforcement operations conducted in an overt manner to be most effective. Overt enforcement approaches were associated with significantly greater rates of self-reported compliance than covert enforcement operations, irrespective of the corresponding mobility of the approach. That is, both stationary and mobile approaches were reported to be more effective when operated in an overt manner. This trend held for both immediate impacts on self-reported compliance and for the duration of any impact on behaviour. There were mixed findings regarding the impact of enforcement mobility on self-reported compliance and speeding behaviour. Respondents reported greater levels of compliance, and longer duration of effects, associated with mobile methods. However this impact appeared to be limited. Specifically, in regards to general compliance, the impact of mobile methods appeared to be restricted to approaches operated covertly. Conversely, in regards to duration of compliance, the impact of mobile methods appeared to be restricted to overtly operated approaches.

Analysing the perceived effectiveness of various police speed enforcement methods by driving scenario produced a number of interesting findings. Firstly, there was additional evidence to suggest greater perceived impacts on behaviour associated with overtly operated methods. Furthermore, the effectiveness of covert methods appeared to be limited to those that have greater mobility. Finally, only fixed cameras were perceived as effective in black spot areas. Prior qualitative research has revealed that drivers perceive that the effectiveness of fixed cameras in impacting on vehicle speed is restricted to crash black spots (Soole et al., 2008). Thus this finding may reflect the perceived need to reduce vehicle speeds at high-crash locations, even if only for a short period. In addition, no methods were reported as effective on either rural open roads or residential back streets. This finding may reflect the general lack of enforcement conducted on these roads.

These results indicate highly statistically significant differences in self-reported compliance and speeding behaviours associated with the various police speed enforcement approaches. However, the findings must be viewed in light of the relatively high statistical power being generated by the large sample size. However, to investigate the impact of the sample size further a random sample of 200 cases was chosen and the analyses re-run. The pattern of results was largely identical, with findings remaining highly significant. The only exception involved the pairwise comparison for mobile/overt methods associated with significantly longer durations of compliance compared to stationary/overt methods becoming non-significant. Effect sizes for analyses investigating the impact of police speed enforcement approach on general compliance remained small, however those associated with analyses investigating duration of compliance approached a medium magnitude of effect.

It must be understood that this study considers only part of the overall traffic enforcement process, specifically, policing. The study does not consider the perceived effectiveness of the penalties associated with speeding offences, including the perceived legitimacy of penalties and perceived likelihood of detection and punishment. Thus, this study generally investigates police speed enforcement from a general deterrence point of view. It is duly noted that specific deterrence and the impact on penalties, and perhaps equally important punishment avoidance, is critical to a comprehensive understanding of driver speed choice. In addition, while some approaches analysed in this study were reported to be significantly

more effective compared to others, this is not to suggest that any of the approaches are necessarily ineffective. That is, even for stationary approaches conducted in a covert manner (for which self-reported compliance and duration of compliance was lowest), mean rates of compliance still suggested that participants were more likely to be compliant than not in response to methods of that nature.

There are a number of limitations to the current study. Firstly, the study relies on data collected via self-reports. Thus, it is difficult to ascertain whether the perceptions reported by participants in this study are genuine constructive reflections of the current speed enforcement environment in Queensland or crafted responses used to justify illegal driving behaviour. This limitation could be avoided by replicating the study and expanding the methodology to include provisions to match self-report data with driving records data or behavioural observations conducted in the field. Secondly, it could be argued that improving the perception of speed enforcement methods in the eyes of drivers will not necessarily equate to changes in speeding behaviour. Nevertheless, it could be argued that an increased perception of the legitimacy of speed management policies and practices might be associated with an increased willingness to comply among drivers.

Conclusions

These findings, taken together, produce a number of interesting themes for police and road safety professionals to consider when developing speed management strategies. Future research should investigate the issue of the effectiveness of increasing the mobility of police speed enforcement methods. Prior qualitative research has highlighted that more mobile approaches are typically perceived as being more legitimate and having a more network-wide effect on driver behaviour, particularly when conducted in an overt manner (Soole et al., 2008). Furthermore, similar research in other jurisdictions, particularly those with contrasting approaches to speed enforcement, replicating the current study would help assess the generalisability of these results. Finally, future research should expand on this study to investigate the perceived effectiveness of penalties associated with speeding offences and the impact of this on driving behaviour in order to examine the impact of specific deterrence on behaviour.

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