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Police and public perspectives on the use and impacts of technology that expose enforcement locations for phone use while driving

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ABSTRACT

Avoiding being caught and punished has consistently been demonstrated to be a key predictor of continued engagement in risky and illegal phone use while driving. This is a large concern, as the presence of applications such as Google Maps, Apple Maps, Waze, and social media pages/groups that share the location of enforcement activities related to phone use while driving has increased. The present investigation aimed to understand the impact of these technologies on phone use while driving using a mixed-methods approach. First, to obtain an enforcement perspective, 15 police officers from Queensland (Australia) were interviewed. Three main themes were identified, suggesting that the use of the technologies 1) can encourage dangerous driving and allow drivers to avoid punishment more often, 2) do not impact police enforcement of the phone use while driving law and 3) can promote exposure to enforcement. Next, a quantitative survey was implemented with Queensland drivers (n = 622, 58.7% females). A cluster analysis was initially conducted to categorise the different types of phone offenders (acknowledging differential deterrability). Two clusters (high-frequency and low-frequency phone offenders) were created. A hierarchal binary logistic regression indicated that using Apple maps, Facebook police location sites and checking these Facebook sites predicted membership in the high-frequency phone offender group (Waze and Google maps were not significant). After controlling for the use of these technologies, avoiding being caught and punished predicted being in the high-frequency phone offender group. The results confirmed the impact of these technologies on phone use while driving behaviour.

1. Introduction

Using a hand-held mobile phone while driving increases crash risk (e.g., Dingus et al., 2016; McEvoy et al., 2005), which has resulted in numerous jurisdictions worldwide implementing bans and legal penalties (and in many cases, increasing the severity of these penalties) to deter drivers from engaging in this behaviour. Nevertheless, recent research has identified that the deterrent effect of legal sanctions has been insufficient (Kaviani et al., 2020; Nguyen-Phuoc et al., 2020; Truelove et al., 2019; Oviedo-Trespalacios et al., 2019), with many drivers avoiding being detected for the offence (Truelove et al., 2021; Oviedo-Trespalacios, 2018). It has recently been purported that the use of emerging technologies (that notify the user of the locations of police and/or traffic enforcement cameras), may contribute to this problem (Oviedo-Trespalacios & Watson, 2021). For example, there are navigation mobile phone applications that can notify a user of the locations of these enforcement activities while they're driving (Oviedo-Trespalacios et al., 2021), as well as pages on Facebook (the most popular social media platform; Statista, 2022a) where users can also post these locations (Mills et al., 2022). Such features may exacerbate the issue of punishment avoidance, which refers to engagement in criminal behaviour without detection (Stafford & Warr, 1993). For instance, these online platforms and tools (which will be referred to as "technologies") may enable offenders to change their driving route to avoid detection, however no study to date has examined this directly. As such, this study aimed to identify how the use of technology that can notify a driver of enforcement locations for mobile phone use while driving (MPUD) impacts enforcement of, and engagement in, the offending behaviour. This will be referred to as "punishment avoidance technology" in this manuscript.

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It is also noteworthy that research in deterrence and MPUD has only looked at the general population (Kaviani et al., 2020; Truelove et al., 2019). Previous research has identified that road rule offenders can be classified into different groups, and interventions that are tailored to these groups may be more influential on behaviour than a universal intervention (Rabelo-da-Ponte et al., 2021; Scott-Parker et al., 2013). Research has yet to identify if drivers can be classified into different groups based on the extent of engagement in MPUD and associated factors. Classifying drivers into these different groups (for example frequent vs non-frequent offenders), would allow subsequent analyses to be undertaken to determine if the legal sanctions, as well as drivers' use of punishment avoidance technology, can have differential effects on these groups of drivers. Such findings would provide the first steps in determining if more targeted interventions may be beneficial to further prevent engagement in illegal MPUD.

1.1. Legal sanctions

Sanctions for crimes are typically categorised into legal and non-legal santions, with the former referring to any penalty defined by law (e.g. a monetary fine, demerit points, imprisonment), and the latter encompassing other potential consequences from engagement in that behaviour (e.g. social loss, physical damage to oneself or others) (Homel, 1988). The current study is focussed on the legal sanctions. When examining the impact of current legal countermeasures on MPUD, it is important to consider deterrence theory. There are two main types of deterrence: specific deterrence and general deterrence (Beccaria, 1764/2007; Bentham 1780/1970). General deterrence refers to indirect exposure with enforcement and stipulates that the general public will be deterred from committing an offence provided they believe they have a high perceived certainty of being apprehended, and they believe the punishment is severe and would be delivered swiftly. Specific deterrence refers to direct exposure to enforcement to deter recidivist offenders from continued engagement in the transgression; their experiences with the certainty of apprehension and severity and swiftness of the punishment is suggested to act as a future deterrent. Notably, deterrence research has consistently suggested that the perceived certainty of being apprehended is the most influential component of deterrence theory (Homel, 1988; Nagin, Solow, & Lum, 2015; Piquero et al., 2011). Research that has applied deterrence theory to MPUD has found that typically, drivers perceive that their chances of being caught using their phone while driving are low, resulting in legal sanctions not acting as a significant deterrent for the behaviour (Kaviani et al., 2020; Truelove et al., 2019; 2021). Importantly, MPUD deterrence research has utilised the variable of punishment avoidance (from Stafford and Warr's extension of deterrence theory) to help explain the lack of deterrent effect. Specifically, it has been found that drivers are frequently avoiding punishment for the behaviour, with those who are successful in evading detection for using their phone while driving being significantly more likely to continue engaging in that behaviour (Truelove et al., 2019; 2021). As experiencing punishment avoidance involves a direct experience with avoiding enforcement, it is suggested to be part of specific deterrence (albeit lowering the deterrent effect; Stafford & Warr, 1993).

Worldwide, the primary enforcement method used for a driver engaging in MPUD is via police officer enforcement. In Queensland, Australia (where this study is conducted), a total of 13, 847 infringment notices were issued by police officers for mobile phone use while driving during 2019 (TMR, 2022). Meanwhile, Queensland, as well as numerous other jurisdictions worldwide, have also implemented mobile phone detection cameras. These cameras take pictures of every vehicle that passes them, and artificial intelligence is used to filter the photos that involve possible mobile phone infringements. These possible detections are then sent to the Queensland Revenue Office to be confirmed by authorised personnel before an infringement notice is sent to offenders (Queensland Government, 2022). In the first year that the cameras were implemented in Queensland (2022), a total of 119, 862 infringment notices were issued (The Queensland Cabinet and Ministerial Directory, 2022). The current infringement for illegal MPUD in Queensland is $1078 and 4 demerit points[1] (QLD Government, 2022). The cost and demerit point penalty varies state-to-state. For instance, in New South Wales, the fine is $352 and increases to $469 for offences committed in school zones, and 5 demerit points are taken (New South Wales Government., 2022).

1.2. Punishment avoidance technology

Despite punishment avoidance being recognised as one of the most salient contributors to continued engagement in illegal MPUD, there has been limited attention given to how drivers avoid being caught for the offence. The research in this area to date has focused primarily on behavioural strategies such as concealed MPUD, including holding their phone down low in attempt to avoid detection (Gauld et al., 2014; Oviedo-Trespalacios et al., 2017; Truelove et al., 2021), covering it with the hand (Oviedo-Trespalacios et al., 2017), and scanning the road environment more often to detect police (Oviedo-Trespalacios et al., 2017). In the Australian context, Oviedo-Trespalacios (2018) demonstrated that drivers who engage in these behaviours to conceal MPUD report significantly more frequent risky and illegal MPUD, e.g., texting and browsing.

Another area largely overlooked in the literature is the use of technology that reveals and notifies drivers of approaching road rule enforcement activities (such as police operations and enforcement cameras). To the best of the authors' knowledge, there is currently no research on the application of this technology to MPUD. Oviedo-Trespalacios and Watson (2021) recognised that mobile phone applications to support driving and navigation, such as Google Maps and Waze, allow users to share the locations of road rule enforcement police operations. Such applications can notify a driver of these locations (visually and/or via audio alerts) as they approach the area so they can adapt their driving behaviour accordingly. Meanwhile, it has also been identified that police location pages and groups on the social media platform Facebook exist, where users reveal the location of road policing operations and road rule enforcement cameras (Mills et al., 2022; Wood & Thompson, 2018). Previous research has only looked at the use of these groups applied specifically to the avoidance of Roadside Drug Testing to avoid drug driving charge (Mills et al., 2022). Mills and colleagues (2022) identified that a sub-group of participants used the groups to avoid drug driving detection. However, more research is needed to identify the impact of mobile phone applications and social media activities that reveal road rule enforcement police operations targeting illegal MPUD.

Theoretically, there are two possible means through which modern technologies (i.e., navigation applications and Facebook police location pages) might affect MPUD, which can be explained through the lens of deterrence theory. First, it can be suggested that this technology may allow drivers to avoid punishment more frequently, thereby increasing their likelihood of engaging in the behaviour. For example, drivers may avoid driving in certain locations if they plan on breaking the MPUD law. On the other hand, drivers may refrain from using their phones while driving at specific locations where they are made aware of police enforcement activities. Alternatively, it should also be considered that this technology could optimise deterrence by raising drivers' perceptions of the certainty of being apprehended. For example, considering the amount of time people spend driving, road rule enforcement exposure, of any kind, can be rare. Therefore, if drivers are using these

[1] In Queensland, drivers on an open licence can accrue up to 12 demerit points in a 3-year period before they receive a licence sanction notice, while novice drivers on a learner or provisional licence can accrue 4 demerit points in a 1-year period before they receive a licence sanction notice (Queensland Government, 2023).

technologies, they could be exposed to the array of road rule enforcement activities more frequently than they would have without using them. Thus, it can be hypothesised that using these technologies may create a more substantial general deterrent effect for some people. No previous research has provided empirical data demonstrating detrimental or favourable road safety outcomes associated with technologies that reveal and notify drivers of approaching road rule enforcement activities. This information is necessary to develop a clear understanding of the impacts of these emerging technologies on distraction-related crashes and trauma and inform road safety policy.

1.3. Differential deterrence

When investigating the impact of deterrence on MPUD, it is also important to consider differential deterrence, which acknowledges the heterogeneity of the population, such that sanctions do not have a uniform effect across all individuals (Piquero et al., 2011, Oviedo-Trespalacios et al., 2020). Previous research that has applied deterrence theory to MPUD has averaged the effect of legal sanctions from samples of the general population (e.g., Kaviani et al., 2020; Truelove et al., 2019). However, it is important to acknowledge that deterrence perceptions may differ according to factors such as demographics, history of offending, etc (Oviedo-Trespalacios et al., 2018). This may also help explain why legal sanctions have consistently been found to have limited influence on engagement in the behaviour. To obtain a more thorough understanding of the impact of deterrence on MPUD, research is needed to identify how these sanctions may differentially impact different subsets of the population. It is important to acknowledge that this concept should also be extended beyond simply legal sanctions. In other words, non-legal factors should also be onsidered.

As outlined above, research is needed to examine how modern technology (that can be used to avoid punishment) can impact MPUD, and whether the use of such technology may differ across subgroups of the population (e.g., frequent offenders vs non-frequent offenders). This is supported by previous research on the use of Facebook police location pages for drug driving, where only a subset of the sample was identified to actively use these pages to avoid being detected by police (Mills et al., 2022). On a similar note, it might be the case that those who witness others successfully evading detection for offending behaviours via these technologies, might have lower perceptions of apprehension certainty compared to those who are not exposed to such content. Consequently, examining if legal sanctions and punishment avoidance technology have a different impact on different subsets of the population is an important gap in the literature that needs to be addressed.

Previous research highlights important factors/characteristics that need to be considered in differentiating between frequent and non-frequent offender subgroups. First and foremost, it is important to consider the frequency with which drivers engage in risky MPUD, and which functions (of the technology) they most often utilise while driving. For example, the key functions that have been reported in the literature include reading messages, sending messages, talking on a hand-held phone and the use of social media (Truelove et al., 2019; Gauld et al., 2017). Second, previous research has also suggested that engagement in MPUD can differ among different demographic factors such as age, gender, and the average amount of driving (Costantini et al., 2022; Nguyen-Phuoc et al., 2020; Oviedo-Trespalacios et al., 2019b; Truelove et al., 2023).

1.4. The current research

As outlined above, it is common knowledge in deterrence research that drivers' experiences of punishment avoidance need to be substantially minimised in order to maximise compliance with the MPUD law (Oviedo-Trespalacios, 2018; Truelove et al., 2019). Reducing drivers experiences of punishment avoidance cannot be accomplished without first identifying the myriad of ways in which drivers avoid punishment. It has been recognised that punishment avoidance technology, such as the use of navigation applications (Oviedo-Trespalacios & Watson, 2021) and Facebook police location communities (Mills et al., 2022) may be used to avoid detection for traffic crimes. However, research is yet to explore these technologies concerning MPUD. As police officers are primarily involved in the enforcement of the MPUD law, obtaining their perspective on this topic would provide an essential first step in understanding the impact of this technology on MPUD and enforcement of the behaviour. Therefore, to address this gap in the literature, interviews with police officers in the Australian state of Queensland were conducted to explore how these applications impact MPUD enforcement.

Meanwhile, a second survey-based study was conducted to obtain an understanding of how the use of the punishment avoidance technologies impacts experiences with punishment avoidance and MPUD from a driver's perspective. The aims of study 2 are outlined below:

1) Classify drivers into groups based on demographics and frequency of engagement in MPUD
2) Identify if drivers use of punishment avoidance technology and perceptions of the current legal countermeasures can predict membership of the groups identified in aim 1

2. Study 1

2.1. Method

This study was part of a larger project on police perceptions of MPUD enforcement. In total, 15 Queensland police officers completed the study. All participants provided informed consent to participate in the study via a secure online Qualtrics form. Demographic information is not included to ensure confidentiality of participants. Interviews were first conducted to explore how the punishment avoidance technologies impact enforcement of the MPUD law, from a law enforcement perspective. Participants included police officers who were 1) over the age of 18 years, 2) a current police officer in the Australian state of Queensland and 3) had experience enforcing the MPUD law. The study was approved by the University of the Sunshine Coast Human Research Ethics Committee (ethics number A211520) and received senior management approval from Queensland police. Participants had an average of 19.17 (SD = 11.46) years experience working in law enforcement. Senior police management also provided the list of contact details for participants that met the recruitment criteria and had sufficient experience with enforcing the phone use while driving laws as determined by management.

Before completing the interviews, participants were asked to complete a short (approximately 5 min) survey on their demographic information. After completing the survey, a time was arranged with participants to take part in a phone interview. For this study, participants were first asked if they were aware of the technology that can show the locations of police cameras, such as Facebook pages and groups, Google maps, Waze, Apple maps etc. All participants said they were aware of these technologies. Next, participants were askled "What do you think of Facebook pages/groups that show the location of police and cameras capturing MPUD?" and "What do you think of the navigation applications, such as Google Maps, Apple Maps and Waze, that can show the location of police and cameras capturing MPUD?" If participants provided limited response to these questions, they were pompted with "How do you think this technology impacts enforcement of mobile phone use while driving?".

2.2. Data analysis

Data was analysed using Braun and Clarke's' six phases of thematic analysis (Braun and Clarke, 2006, 2021). An inductive approach was taken since there is limited literature on the topic. First, familiarisation

with the data occurred. Next, codes were developed based on the data's most appropriate semantic or latent meaning. Codes were grouped into initial themes. Coding was undertaken by two researchers who are experts in road policing, misuse of technology, distracted driving and road safety. An additional researcher reviewed the themes, and any disagreements on codes and themes were discussed until resolved. Finally, the themes were refined and finalised. The results are discussed with literature in the general discussion.

2.3. Study 1 results

Three themes (and two subthemes) were developed from the interview data. These themes can be interpreted on a continuum (based on the range of different perspectives on the punishment avoidance technology presented by police officers), as outlined in Fig. 1. Themes are presented below with the inclusion of direct quotes from participants. While participants were asked about their perceptions towards two different technologies (i.e. Facebook and navigation applications that display enforcement relating to MPUD), it was stated by all participants that their views were the same across these technologies. Therefore, the themes below refer to 'punishment avoidance technology' generally.

Theme 1: The use of the technologies can promote exposure to enforcement.

When asked about what they thought of avoidance technologies that revealed locations of police and cameras capturing phone use while driving, one perception that emerged was that, instead of being detrimental to police operations and traffic enforcement cameras, the technology can be useful by promoting exposure to MPUD enforcement. Two subthemes were created that relates to this overarching theme: 1) the technologies remind drivers of the presence of enforcement and 2) the technologies can be used as an additional tool for enforcement.

Subtheme 1a: The technologies remind drivers of the presence of enforcement.

A common subtheme that emerged among participants was that being told of specific enforcement locations would remind drivers that they can be caught for using their phone while driving, since there are police officers and cameras that are in operation to enforce the road rules. Without being reminded of the presence of these enforcement operations, drivers may only rarely come across them. Therefore, it was suggested that viewing the locations of some traffic enforcement operations may reduce engagement in MPUD as drivers will be more cognisant of the fact that there is a chance they could be caught and punished for the offence. Extending on this, some participants also mentioned that being made aware of the traffic enforcement locations will ensure drivers do not engage in the offending behaviour on that stretch of road. The below quotes provide some examples of these perceptions:

> *"If people know where they are and can see them it reminds people not to use those devices.*
> *I don't really have a problem with it. People can do what they want. We live in a free society. People can post what they want on Facebook. I don't think there's anything wrong with them. We're interested in road safety so if that's going to change someone's behaviour then that's good."*
> *"I know for a fact that the ones [Facebook sites] here make statements about where cameras are and where they aren't. But I say hey guess people are going through that particular section, so good on them."*
> "Deterrent effect in a way, people look at where they are."

Subtheme 1b: The use of the technologies can be an additional tool for enforcement.

An additional subtheme consisted of the idea that the punishment avoidance technologies may be used as an additional enforcement tool, as it can notify drivers of the location of traffic enforcement operations that are not currently in place. There were two main circumstances that were identified to contribute to these technologies being an additional enforcement tool. First, it was stated that people could post inaccurate locations of traffic enforcement operations. Notably, while the focus of this study was on the punishment avoidance technology consisting of phone navigation applications and posts on Facebook groups and pages, it was also identified that inaccurate enforcement information could be shared on radios that are used by truck drivers. For example, if there was a risky driving situation, such as a large number of trucks exceeding the speed limit in a certain area, someone could go onto the radio frequency used by truck drivers and say that there is a speed camera in that area. This may make truck drivers obey the traffic rule in specific areas, without additional resources being expended. Second, even if the technology accurately reported the location of a traffic enforcement operation, there is the possibility that drivers may believe the operation is still going, hours after it has already ended, resulting in drivers avoiding engaging in the road rule violation for a longer period of time. It was also suggested that this could lead to drivers overestimating the number of enforcement operations that are taking place at any given time point. The below quotes provide examples of these perceptions:

> *"Realistically, we want them not committing offense because they believe the cameras are there. Then it's served its purpose really. One school of thought is basically we do 3 h at a speed camera and a person will get a message that it's there but by then we've already packed up, we're not even there so its better value for our money."*
> *"Great. Fantastic. Because it's telling people that there's something going on. The more they know that police are out doing things the more people that are going to comply to the rules. Sometimes [X] will get on the radio*

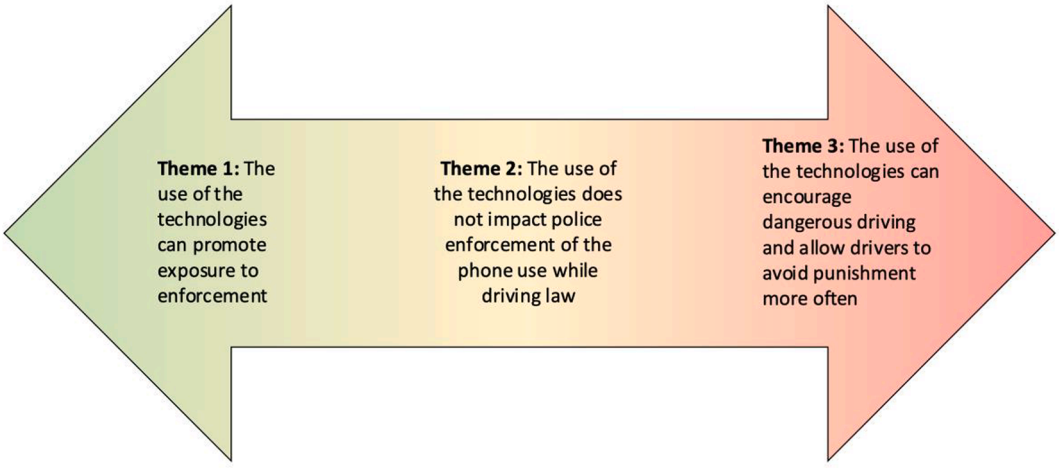

Fig. 1. The themes created from police officers' perceptions of the punishment avoidance technology presented on a continuum.

and say that police are doing an operation in a certain area just to make them slow down. It makes truck drivers do the right thing. It improves road safety so I'm all for it."

"I know they get it wrong a lot. That way it becomes a tool for us, if they claim there was a camera there and its not, it may influence their behaviour in that spot. Some of those sites can be beneficial for the message we are trying to send. Again, not a fan but again they are very rarely live time so they can make it appear there are more police out there doing enforcement than there actually is."

Theme 2: The use of the technologies does not impact police enforcement of the MPUD law.

Another perspective that emerged among police officers was that the use of this technology does not have an impact on enforcing the MPUD law. Specifically, it was suggested that drivers have the right to communicate the locations of enforcement activities, and even with this technology, police will still be able to capture drivers breaking road rule violations. Further, it was suggested that the punishment avoidance technologies would not accurately display all enforcement operations. While the focus of the questions was on MPUD, police officers expanded this idea to other road rule violations as well, such as speeding and drink driving, allowing a deeper understanding of the topic. In relation to fixed enforcement cameras, it was acknowledged that information on their locations was available on government websites so drivers would have access to that information even without the use of the punishment avoidance technologies. Similarly, it was also stated that drivers would be aware of the locations of fixed cameras when they drive past the location frequently, without the need for checking the punishment avoidance technologies. Examples of these perceptions are demonstrated in the quotes below:

"Yeah, look I think with that it tells where police are and the people have the right to communicate. Does it have an effect of what we do? Minimally, don't think it makes much difference at all."

"I don't have any social media, but I think its fine. The public has the right. The government even advertise it"

"It's not going to show them all as well, it is going to show most or some of them, won't show all of them. They won't know I am up the road with a speed gun. To me it's a good thing, we know there is speed enforcement or anything else, just a reminder to not commit those offences"

"The ones where more people are sharing, RBT stops and things like that. I don't have such an issue with fixed speed cameras, you can map it yourself and learn where they are, not sharing many secrets."

Further, there was the perception among some participants that nothing could be done to stop the use of these police avoidance technologies. This is demonstrated in the below comments.

"I'm not sure there's anything from a police perspective that can be done. Just have to react and respond to it as it comes. It's hard to enforce people using it. You can try to curb that behaviour but I personally don't have a problem with it, its just a thing that happens I guess"

"There is no way we will ever stop it, they will just be there if people read them or use them if its for speed or phone, people won't use it in those locations so having some sort of effect."

Theme 3: The use of the technology can encourage dangerous driving and allow drivers to avoid punishment more often.

Another perspective proffered by some police officers was that the use of the punishment avoidance technology could embolden drivers to illegally use their phone while driving. While it was acknowledged that drivers may not engage in the behaviour at the locations where enforcement was present, it was identified that drivers may simply change where they engage in the offending behaviour (e.g., start using their phone while driving after they have passed the enforcement location). This is demonstrated in the below quotes.

"You will always get that section of society that wants to rebel. Once they are notified locations change, that's why we need to be proactive and not just have fixed locations, people will be notified and change. People won't always understand why we do what we do and that's how it is. Everyone has the ability for free speech as long as it doesn't hurt others, it is what it is"

"I see how that works for red light cameras and stuff like that, once you stop for that one period of time. But for mobile phone use we don't want you to use mobile phones anywhere.

"How do they see it whilst they're driving when it's an electronic device? At the end of the day its warning about police stops, preventing people from committing offences. Do I agree? Yes and no. As long as it's used to prevent crime rather than avoid detection."

Importantly, it was also acknowledged that the use of any of the punishment avoidance technology while driving can be a distraction, which may increase the risk of a crash. The below quotes demonstrate this perception.

"If you have to look away and look at that map that's not a good thing."

"I would like to see someone get caught on one of those while actually looking at it, that would be quite funny."

"How are they accessing that information while driving?"

3. Study 2

While Study 1 offered important insights into how such technologies are perceived by police officers, more research is needed from the perspective of the driver, and how these technologies might have differential effects on MPUD in these groups (which is a focus for study 2). A cross-sectional survey was administered to Queensland drivers for study 2. The aims of study 2 are outlined below:

1) Classify drivers into groups based on demographics and frequency of engagement in MPUD
2) Identify if drivers use of punishment avoidance technology and perceptions of the current legal countermeasures can predict membership of the groups identified in aim 1

3.1. Participants

Six-hundred and twenty-two participants were included, ranging from 17 to 88 years of age ($M = 32.08$, $SD = 16.6$), with 365 (58.7%) females and 257 (41.3%) males. This study was part of a larger project on how exposure to different forms of media influence road rule violations. Eligibility criteria for the study included: must reside in Queensland Australia, hold a Queensland drivers' licence and have a Facebook account. The study was approved by the University of the Sunshine Coast Human Research Ethics Committee (A211542).

Participants were recruited online through paid Facebook advertising and posts (e.g., posted on community group pages where permission was granted). In addition, participants were recruited from the University of the Sunshine Coast via the student/staff newsletters, the research participation system, and in-person recruitment. A total of 205 (33%) participants were students recruited from the University research participation system. Informed consent was provided in writing using a secure online Qualtrics form, with consenting participants completing an anonymous online survey. Participants in the research participation system were granted one-course credit. All other participants were offered entry into a draw to win one of 10 AUD$50 VISA Gift Cards. Participants were included in this study if they responsed to the questions surrounding phone use while driving, use of the punishment avoidance technology and deterrence questions.

3.2. Materials

The full set of questions used for this study are included in the supplemtary material.

Demographic information & driving history.

The survey contained questions regarding age, gender, drivers licence type (learner/permit, provisional 1 or 2, or open) and average hours driving per week.

Frequency of MPUD.

Frequency of MPUD was examined using 5 items, with responses ranging on a scale from zero (never) to 100% (every time I drive). Participants were asked to indicate the frequency with which they engage in hand-held phone functions while driving, including checking notifications, talking on the phone, sending text messages, reading text messages and taking/sending videos or pictures while driving.

Use of technology.

Participants were asked to select which GPS platforms they use, including Waze, Google maps, Apple maps, "other" and none. The options selected were based on the most popular navigation applications. Apple maps and Google maps are navigation applications that also have the ability for users to share enforcement camera locations (Apple, 2022; Google, 2022). Waze is also a navigation application, however users have the option of sharing additional road related factors, such as traffic updates, crash locations and specific camera and enforcement and police location information (Google Play, 2022). Participants were asked to indicate whether they have ever changed their driving route after checking a navigation platform to avoid being detected for illegally using their phone while driving. As the navigation applications have the ability for users to share the locations of enforcement cameras, participants were also asked "Do you report camera locations on the GPS application/s?" This question referred to enforcement cameras in general and was not specific to mobile phone detection cameras. Further, participants were asked "While driving and using the GPS application, do you use other phone functions/applications? If yes, what phone functions/applications do you use?" Participants were also asked to indicate if they follow/like any road policing location pages or groups on Facebook, and if they check these Facebook road policing pages before driving.

Deterrence.

Certainty of apprehension was measured with the item "If I were to use my phone while driving (hand-held use only), I am % confident that I would be caught". Meanwhile, punishment avoidance was measured with the item "If I were to use my phone whilst driving (hand-held use only), I am % confident that I could avoid police detection." Both items were measured on a scale ranging from 0% (not at all) to 100%. Experiencing direct punishment for MPUD was measured with the item "Have you ever been caught using a phone while driving?".

3.3. Statistical analyses

First, descriptive statistics related to use of the punishment avoidance technologies are reported. Use of the technologies is also analysed against age, gender and average hours of driving per week to determine if there are any significant differences in demographics between users and non-users of the technologies. A two-step cluster analysis was conducted on the demographic variables of age, gender, and average hours driving per week, as well as the variables of reported engagement in MPUD. A two-step clustering technique was used with the Schwarz's Bayesian Criterion and the Log-likelihood distance. The number of clusters was initially determined automatically and a total of four clusters were created. The clusters were examined for meaningfulness and cluster quality. Based on these factors, a forced two cluster solution was utilised (this cluster solution was the most meaningful and had the optimal cluster quality above 0.5 [i.e., good], higher than the four-cluster and three-cluster solutions). The ratio of cluster sizes was appropriate at 2.34. A new variable was created that identified which cluster each participant belonged to. Two clusters (referred to as low-frequency MPUD offenders [cluster 1] and high-frequency MPUD offenders [cluster 2]) were identified from the data. Further, to examine differences in variables between the two clusters (i.e., groups), t-tests were conducted on continuous variables and chi-square tests were conducted on categorical variables. Hedges g was reported as the effect size for the t-tests due to the unequal number of participants between groups.

Next, means and standard deviations are reported for the deterrence variables. A hierarchal binary logistic regression was then conducted that examined if use of punishment avoidance technologies, and the deterrence variables, were predictive of whether a driver was in a low-risk or high-risk cluster for MPUD. Consistent with requirements for logistic regression, the dependent variable (i.e., the cluster variable) was dummy coded so that 0 was the low-risk cluster and 1 was the high-risk cluster. Use of the punishment avoidance technologies (i.e., the use of Waze, Google maps, Apple Maps and Facebook police location pages) were entered in step 1, while the deterrence variables were entered into step 2. All correlations were below 0.7. Listwise deletion was used for the analysis. Unless otherwise stated, all statistical assumptions were met.

3.4. Study 2 results

Descriptive statistics of the use of punishment avoidance technology.

A total of 508 participants reported using punishment avoidance technologies (81.7% of sample). These participants were asked to indicate which technologies they used (multiple could be selected). The descriptive statistics of these technologies is reported overall by gender in Table 1, and by age and average hours of driving per week, in Table 2. The different sample sizes of those who do and no not use the technologies meets the requirements for logistic regression, where a minimum of 10 cases per predictor is required (Long, 1997; Miller & Kunce, 1973). Regarding participants engagement with these technologies, 215 (57.7%) reported posting the locations of traffic enforcement cameras and 164 (32.3%) reported also using other phone functions while driving at the same time. The list of reported phone functions is outlined in Table 3. There were 9 participants (1.7% of those using punishment avoidance technologies) who reported changing their driving route while checking a navigation application to avoid being detected illegally using a phone while driving.

Cluster Analysis.

Means and standard deviations of the demographic and MPUD variables, and the Cluster analysis results, are displayed in Table 4. The *t*-test results, comparing Cluster 1 (low frequency MPUD offenders) and 2 (high frequency MPUD offenders) on each of these variables, are also displayed in Table 4. The low and high-frequency groups were significantly different on all the variables that were entered into the cluster analysis, apart from gender. A chi-square test found that the low-frequency and high-frequency phone user groups did not significantly differ by gender, χ^2 (1, $N = 618$) = 1.586, p =.208. A significant association was identified between licence type and cluster groups, χ^2 (3, $N = 618$) = 25.52, p <.001. Among the low frequency cluster, open licenced drivers made up the greatest proportion of participants (54%), whereas in the high frequency cluster, Provisional 1 drivers were the largest proportion of participants (35%).

Deterrence and Punishment Avoidance Technologies.

On average, the sample considered themselves 37% confident that they could avoid police detection if they were to use their mobile phone while driving (SD = 31.34, Median = 32, Mode = 0). For certainty of apprehension, participants considered themselves 53% confident they would be caught if they were to use their mobile phone while driving (SD = 31.58, Median = 50, Mode = 100). Regarding experiences of direct punishment, the majority had not been caught using a mobile phone ($n = 571$, 91.8%) while a small proportion had ($n = 51$, 8.2%).

Logistic Regression.

Table 1
Participants use of punishment avoidance technologies overall and by gender.

	Descriptives		Technology Use by Gender				
	Yes *n* (%)	No *n* (%)	Yes Female *n* (%)	Yes Male *n* (%)	Significance (bootstrap)	χ^2	*df*
Punishment Avoidance Technology (Any)	508 (81.7)	114 (18.3)	121 (33.15)	71 (27.63)	0.599	0.37	1
Waze	71 (11.41)	551 (88.59)	38 (10.41)	33 (12.84)	0.371	0.88	1
Google Maps	404 (64.95)	218 (35.05)	240 (65.75)	164 (63.81)	0.670	0.25	1
Apple Maps	192 (30.87)	430 (69.13)	121 (33.15)	71 (27.63)	0.159	2.16	1
Follow/like road policing pages	134 (21.54)	488 (78.45)	62 (16.99)	72 (28.02)	0.001	10.85	1
Check Facebook road policing pages before driving	90 (14.47)	532 (85.53)	43 (11.78)	47 (18.29)	0.028	5.16	1

Table 2
Participants use of punishment avoidance technologies by age and hours driving per week.

	Usage				Significance	t	*df*	Effect size
	Yes		No		(bootstrap)			Hedges'
	n	M	*n*	M	*p*			Correction
Waze	71		551					
Age		27.41		32.68	0.001	3.29	109.51	0.32
Hours of driving per week		13.81		11.53	0.076	−1.78	620	-0.22
Google Maps	404		218					
Age		31.24		33.64	0.112	1.60	357.58	0.15
Hours of driving per week		12.06		11.29	0.369	−0.90	620	-0.08
Apple Maps	192		430					
Age		26.30		34.66	<0.001	7.37	597.41	0.52
Hours of driving per week		12.52		11.46	0.230	−1.20	620	-0.10
Follow/like road policing pages on Facebook	134		488					
Age		30.22		32.59	0.116	1.58	236	0.14
Hours of driving per week		14.98		10.91	<0.001	−3.68	184.20	-0.40
Check Facebook road policing pages before driving	90		532					
Age		28.07		32.96	<0.001	3.36	170.89	0.28
Hours of driving per week		16.73		10.95	<0.001	−4.05	105.48	-0.58

Table 3
Participants use of other phone contents while using the navigation technology.

Phone function/application used	N	%
Music	113	70.63%
Phone call	20	12.5%
Text messaging	17	10.63%
Hands free phone call	9	5.63%
Podcast	8	5%
Hands free text messaging	6	3.75%
Social Media	5	3.13%
Facebook messenger	4	2.5%
YouTube	4	2.5%
Voice Memo/Chat	4	2.5%
Apple Carplay	4	2.5%
Bluetooth	3	1.88%
Audiobook	3	1.88%
Radio	2	1.25%
Siri	2	1.25%
Contacts	1	0.63%
Email	1	0.63%
Review images	1	0.63%
Tape recorder	1	0.63%

Note. Music = Spotify, Music app, Apple Music; YouTube = Videos, Music; Social media = Facebook, Snapchat, WhatsApp.

A hierarchal binary logistic regression was conducted to analyse the impact of the punishment avoidance technologies consisting of Waze, Google Maps, Apple Maps and Facebook police location pages/groups (entered in step 1) and the deterrence variables of the perceived certainty of apprehension and experiences with punishment and punishment avoidance (entered in step 2) on being in the low risk or high-risk MPUD group (created from the cluster analysis). The linearity of the logit assumption was breached for direct punishment avoidance. Therefore, this variable was changed to a categorical variable. For consistency in interpretation, the perceived certainty of apprehension was also changed to a categorical variable as this was measured on the same scale as direct punishment avoidance. After this change, all assumptions for the logistic regression were met. Table 5 displays the 5 categories for punishment avoidance and certainty of apprehension. For both variables, the 0% category was coded as 0, and the remaining categories as 1, 2, 3 and 4 (respective to the increasing percentages). The contrasts were set so that categories 1–4 were compared to the 0 category.

The results of the hierarchal logistic regression are displayed in Table 6. Block 1 was statistically significant, $\chi^2(5) = 46.33$, $p < .001$. The model in block 1 was able to explain 10.5% of the variance in high/low risk phone users (Nagelkerke's $R^2 = 0.105$), and correctly classified 69.4% of cases. Out of the three navigation applications entered in block 1, only Apple Maps was statistically significant, indicating that using Apple Maps increased the likelihood of being in cluster 2 (the high frequency phone offenders) compared to cluster 1 (odds ratio = 1.879). Both liking/following road policing pages on Facebook and checking these pages were also significant predictors. This result indicates that those who like/follow and check road policing pages on Facebook before they drive are significantly more likely to be in the high frequency phone offender category compared to those who do not check these Facebook pages (odds ratio = 1.724 and 2.614, respectively).

Block 2 of the hierarchal logistic regression was statistically significant, $\chi^2(9) = 95.03$, $p < .001$. The full model, with the inclusion of both block 1 and block 2, was also statistically significant, $\chi^2(14) = 141.36$, $p < .001$. The model with the additional variables entered in block 2 was able to explain 26.9% (Nagelkerke's $R^2 = 0.269$) of the variance and correctly classified 74.7% of cases. Direct punishment was significant, but in the opposite direction than expected. This result means that those who have been caught and punished for illegally using their phone while driving were significantly more likely to be in cluster 2 (high frequency offending) compared to those who have not been caught and punished for the offence (odds ratio = 4.77). Categories 2 to 5 of punishment

Table 4
Descriptives and Cluster Analysis.

Variables	Overall sample		Cluster			Significance	Effect size		
	M	SD	One Low frequency n = 433 M (SD)	Two High frequency n = 185 M (SD)	Predictor Importance	(bootstrap) *p*	Hedge's correction	*t*	*df*
Personal characteristics & driving history									
Age	32.08	16.60	34.83 (18.56)	25.81 (7.79)	0.06	<0.001	0.56	8.5	615.87
Gender (female)	–	–	60%	55%	0	0.209			
Drivers licence* (open)	–	–	54%	32%	0.03	<0.001			
Driving per week	11.79	10.22	10.2 (8.54)	15.58 (12.66)	0.05	<0.001	−0.54	−5.29	258.28
Personal driving behaviour									
Sending messages while driving (hand-held use only)	15.77	23.69	3.3 (6.83)	44.95 (23.47)	0.84	<0.001	−2.96	–23.71	197.44
Taking or sending videos/pictures while driving	11.76	22.92	1.68 (6.37)	35.35 (29.45)	0.49	<0.001	−1.98	−15.4	191.38
Reading messages while driving (hand-held use only)	19.44	26.33	4.90 (8.84)	53.47 (21.9)	1.0	<0.001	−3.45	−29.16	210.1
Talking on the phone (hand-held use only)	14.94	24.16	3.19 (7.97)	42.41 (26.93)	0.65	<0.001	−2.42	−19.44	197.93
Check notifications if you see them (hand-held use only)	22.19	28.12	8.54 (16.35)	53.76 (24.17)	0.63	<0.001	−2.37	–23.28	258.78

Note. *Cluster 1 participants were mostly open licenced drivers (N = 233, 53.8%) followed by P1 (N = 103, 23.8%), then P2 (13.6%) and leaners (N = 38, 8.8%). Cluster 2 drivers were mostly P1 drivers (N = 64, 34.6%), followed by open licenced drivers (N = 59, 31.9%), P2 drivers (N = 41, 22.2%) and then learner drivers (N = 21, 11.4%.

Table 5
Certainty of apprehension and punishment avoidance categories.

	N	%
Certainty of Apprehension		
0%	25	4%
1–25%	143	23%
26–50%	159	25.6%
51–75%	118	19%
76–100%	176	28.3%
Missing	1	0.2%
Punishment Avoidance		
0%	127	20.4%
1–25%	138	22.2%
26–50%	136	21.9%
51–75%	116	18.6%
76–100%	84	13.5%
Missing	21	3.4%

avoidance were also significant predictors, indicating that those who rated their confidence of avoiding police detection for MPUD between 26 and 100% were significantly more likely to be in cluster 2 compared to those who rated their confidence in avoiding detection as 0. Drivers' perceived certainty of apprehension was not a significant predictor.

4. General discussion

This study provides an important starting point for addressing the large gap in the literature in relation to the impact of punishment avoidance technologies on engagement in illegal MPUD. To obtain an in depth understanding of the issue, first a qualitative study with police officers was conducted to understand how these technologies impact enforcement of the MPUD law. Next, a quantitative study was conducted to obtain an understanding of how the use of the punishment avoidance technologies impacts experiences with punishment avoidance and MPUD from a driver's perspective. Overall, the findings demonstrate the complexity of the impact of punishment avoidance technologies on

Table 6
Hierarchal binary logistic regression predicting being in a low frequency or high frequency MPUD category.

	B	SE	Wald	p	OR	95% CI OR Lower	Upper
Block 1							
Waze	−0.379	0.297	1.624	0.203	0.685	0.382	1.226
Google Maps	−0.013	0.194	0.005	0.945	0.987	0.674	1.444
Apple Maps	0.631	0.195	10.421	0.001	1.879	1.281	2.756
Follow/like road policing pages on Facebook	0.544	0.269	4.095	0.043	1.724	1.017	2.921
Check Facebook road policing pages before driving	0.961	0.305	9.927	0.002	2.614	1.438	4.753
Block 2							
Direct Punishment	1.562	0.366	18.231	<0.001	4.768	2.328	9.765
Certainty			13.775	0.008			
Certainty (1)	−0.228	0.583	0.154	0.695	0.796	0.254	2.493
Certainty (2)	−0.312	0.588	0.282	0.595	0.732	0.231	2.316
Certainty (3)	0.689	0.592	1.354	0.245	1.992	0.624	6.355
Certainty (4)	0.053	0.595	0.008	0.929	1.055	0.329	3.384
Punishment avoidance			45.977	<0.001			
Punishment avoidance (1)	0.765	0.395	3.742	0.053	2.148	0.99	4.663
Punishment avoidance (2)	1.824	0.39	21.829	<0.001	6.196	2.883	13.318
Punishment avoidance (3)	2.417	0.406	35.517	<0.001	11.209	5.063	24.818
Punishment avoidance (4)	1.919	0.427	20.217	<0.001	6.817	2.953	15.737

MPUD. It was reported in Study 1 that the technologies can be used as an additional tool to promote enforcement activities. Nevertheless, the technologies can also be used as a tool to avoid being caught illegally using their phone while driving, as Study 2 identified that frequent offenders were more likely to report using Facebook police location pages/groups and Apple maps than non-frequent offenders. However, the use of Waze and Google maps did not predict membership in the high-frequency phone offender group. Ultimately, it is suggested that whether the technology impacts the behaviour is dependent on the way the driver uses the technology. The results from this study have important implications for policy, practice, and future research.

4.1. Study 1

In Study 1, a diverse range of viewpoints emerged from police officers regarding the use of punishment avoidance technologies and their impact on enforcement of the MPUD law. These findings are explained through the lens of deterrence theory below to provide a deeper understanding of the responses. First, it is necessary to come back to general deterrence and specific deterrence in interpreting the present findings. Some of the responses from the police officers suggest that punishment avoidance technologies may increase general deterrence for MPUD (and in some cases, might extend to other traffic offences such as speeding). This is because the use of the technology can increase drivers' exposure to enforcement practices, thereby increasing perceptions of apprehension certainty. Previous research has suggested that increased exposure to enforcement can further promote deterrence (Koper et al., 2013; Tay, 2005). Notably, this study offers a unique insight into indirect exposure to enforcement through the punishment avoidance technologies. The indirect exposure also has the unique ability to contribute to misperceptions about the location and duration of enforcement practices, whereby some drivers may believe that enforcement is present in specific locations when that is not the case, which could contribute to more compliance in those areas without the resource expenditure.

The use of punishment avoidance technologies may also influence specific deterrence. While it is unlikely that the technology would increase specific deterrence by influencing recidivist offending, the results from this study identified that the technology may instead decrease specific deterrence by influencing drivers' experiences with direct punishment avoidance. Stafford and Warr (1993) identified that specific deterrence involves both direct experiences with punishment and also direct experiences with punishment avoidance. As some police officers discussed, technology may be used to avoid detection of the offence in specific areas, resulting in drivers engaging in the behaviour in other locations. This may allow drivers to experience punishment avoidance more often (i.e. using their phone while driving without being caught and punished for the offence). Previous road safety deterrence literature has consistently found that experiencing punishment avoidance is one of the most salient predictors of continued engagement in offending behaviour (Freeman et al., 2021; Szogi et al., 2017; Truelove et al., 2019; Watling et al., 2010). Therefore, it can be suggested that if this technology has been used to allow drivers to avoid punishment, those drivers may continue to frequently engage in the risky behaviour. Further, while these direct experiences of punishment avoidance are likely to impact behaviour, it should also be acknowledged that drivers may be made aware of indirect experiences of punishment avoidance via other users of the technology. Based on Stafford and Warr's (1993) reconceptualised deterrence theory, it can be suggested that drivers who view these indirect experiences of punishment avoidance may be more likely to engage in the offending behaviour themselves (however, this relationship would not be as strong as the relationship between direct punishment avoidance and engagement in the behaviour; Stafford & Warr, 1993). While there are fewer opportunities to share punishment avoidance experiences on the navigation applications (Waze does have a chat function), it is more likely that users would share stories of punishment avoidance on the Facebook groups and pages due to the nature of this technology.

These findings come back to the central tenet of deterrence theory: the perceived certainty of being apprehended for the offence. It has been identified that experiences of direct and indirect punishment avoidance may lower an individual's perception of the certainty of being apprehended for an offence (Stafford & Warr, 1993; Truelove et al., 2021). Therefore, if drivers are experiencing direct or indirect punishment avoidance for MPUD via the technologies, their perceived certainty of being caught may be lowered. Conversely, as discussed above, if drivers are exposed to enforcement more regularly via the technology, their perceptions of the certainty of being apprehended may instead increase. However, suppose a driver's perceived certainty of being apprehended for an offence was higher due to the use of the applications. In that case, an outstanding question remains as to how these perceptions fluctuate. It is well established in the deterrence literature that perceptions of the certainty of being apprehended for an offence can fluctuate over time, depending on experiences with punishment and punishment avoidance (Minor & Harry, 1982; Saltzman et al., 1982; Truelove et al., 2020). For example, if a driver is aware that there are enforcement practices occurring at a specific location, their perceptions of the certainty of being apprehended for the offence in that area may be high. However, once the driver passes that location, their perceptions of the certainty of being apprehended may be lowered to some extent. The extent to which these perceptions would be lowered remains an outstanding question for future research.

The way in which a driver perceives the certainty of being apprehended for an offence also needs to be considered in the context of how accurate they believe the punishment avoidance technology is. It was mentioned in the interviews that the technologies would not be able to capture all enforcement activities. Specifically, it was suggested that the locations of cameras would be more likely to be displayed on the technology, while police enforcement activities would be less likely to be reported. With this reasoning, if drivers believed that the punishment avoidance technologies were not accurate (and additional enforcement activities may be present but not reported), it may be possible that drivers perceived certainty of being apprehended would not be substantially lowered after being exposed to enforcement locations via the technology. However, this would also be dependent on how certain they believe their chance of being caught is outside of the known locations. Previous research has identified that, on average, drivers perceive that their chance of being caught using a hand-held phone while driving are low, and consequently enforcement is not a significant deterrent (Kaviani et al., 2020; Truelove et al., 2019; 2021). Oviedo-Trespalacios et al. (2020) explain that mobile phone tasks can be easily shortened or delayed which potentially reduce drivers' perceived risk of being detected by road rule enforcement. Therefore, it may be suggested that, even if drivers believed that there are some enforcement practices that are not captured on the technology, their chance of being caught would still be low.

Taken together, these findings highlight the complexity of the impact of punishment avoidance technologies, such that it cannot be ascertained whether these technologies are good or bad for road safety. Instead, it is recognised that this technology may promote exposure to enforcement and can be an additional enforcement tool, while also allowing drivers to avoid punishment for the behaviour or serving as a form of distraction. Consequently, it can be suggested that the way this technology impacts offending behaviour may be dependent on how it is used by a driver and may vary depending on the population of interest (e.g., frequent versus non-frequent offenders).

4.2. Study 2

In study 2, drivers who were classified into the high-frequency phone offender category were younger, consisted of more provisional licence drivers, reported driving more frequently and engaged in MPUD more frequently than the low-frequency phone offender group. These findings

are consistent with previous research that has identified significant associations between these demographic factors and more frequent MPUD (Oviedo-Trespalacios et al., 2017; Young et al., 2010). Checking notifications and reading messages were the most common hand-held MPUD, whereas taking or sending videos/pictures and talking on the phone were the least common. These results are consistent with previous findings on self-reported engagement in MPUD (e.g., Gauld et al., 2017; George et al., 2018; Tian & Robinson, 2017; Truelove et al., 2021; Oviedo-Trespalacios et al., 2019).

It was identified that the use of Google maps and Waze did not predict cluster membership, while the use of Apple maps, *liking/following* Facebook police location sites and *checking* these Facebook police location sites did predict being in the high frequency MPUD cluster. Results identified that 'checking' behaviours were more strongly predictive of group membership than 'liking/following' behaviours. This suggests that how participants are using these pages/group is more important than if they use them at all. Particularly, drivers who are actively monitoring the content of the groups show associations with their own MPUD. This finding aligns with a recent study that looked at police location community usage among drug takers (Mills et al., 2022). More specifically, this study found there was no difference in reports of drug driving between those who used the sites and did not use the sites, however, those who used the sites for avoiding Roadside Drug Testing reported greater past offending, as well as greater intentions to offend in the future compared to those who used the sites for other purposes (Mills et al., 2022). Meanwhile, the greater use of apple maps, but not Waze or Google maps, among the high frequency phone offender group is a surprising finding. Notably, Apple maps do not specify the type of traffic enforcement camera that is displayed, instead a yellow symbol with a picture of a camera is displayed on the map, which may be interpreted as any type of traffic enforcement camera (e.g., speed camera, red light camera or mobile phone detection camera). However, it should be acknowledged that there are distinguishable physical differences in these types of cameras that drivers can identify. Specifically, mobile phone detection cameras are positioned higher than speed cameras and are angled to enable them to capture images inside of the vehicle. Therefore, it may be suggested that the camera symbol on Apple maps can notify a driver that there is a traffic enforcement camera in the vicinity, which can lead to the driver more actively scanning the environment for the camera, and when they see it, they will be able to identify the type of camera. Another factor to consider is that younger drivers (16–24 years) are more likely to use Apple phones, whereas in older age groups, Android phones are more commonly used (Statista, 2019), which may also help explain this finding. This is supported by the descriptive statistics from this study, that found younger drivers were significantly more likely to use Apple maps than older drivers. Meanwhile, the non-significant difference in Google maps use between high and low frequency MPUD offenders may be due to the fact that this application is the most downloaded navigation application (Statista, 2022b) and may be used more frequently for the purpose of directions rather than avoiding traffic enforcement cameras. Nevertheless, drivers will be notified of the location of these traffic enforcement cameras regardless of their intentions behind using the application, highlighting the necessity of understanding if the use of these applications may impact offending behaviour. As this paper was more exploratory in nature, the reason why Apple maps was significantly different between the high and low frequency offender groups, and the use of Google maps was not, cannot be clearly ascertained and needs to be examined in more detail in future research.

Despite Waze having the potential to display locations of mobile phone detection cameras while driving more accurately than Apple maps and Google maps, as well as having the additional function of displaying the location of police enforcement activities, it is noteworthy that there was no significant difference in the use of this application between the high frequency and low frequency MPUD offenders. However, it may be suggested that the non-significant result may at least partially be due to the small number of participants (N = 71, 11%) who reported using this application. Nevertheless, the lower uptake of Waze suggests that this application may not currently be widely used for avoiding punishment among MPUD offenders. Posting of police and traffic enforcement camera locations is user based, so limited users may in turn mean that the application would not be able to accurately report all traffic enforcement activities. This is supported by the findings of study 1, where police officers reported that the applications are unlikely to be completely accurate. Though, as it has been identified that there is a sub-group of drivers that use the punishment avoidance technology of Facebook police location sites to drug drive and avoid being detected (Mills et al., 2022), it can be suggested that future research is required to examine if there is a sub-group of drivers that are using the Waze application to avoid being caught for using their phone while driving (and possibly other road rule violations).

After controlling for the use of the punishment avoidance technologies, the deterrence variables revealed that the legal sanctions had limited impact on engagement in MPUD. Consistent with past research on this offending behaviour (Truelove et al., 2019, 2021), punishment avoidance emerged as a significant predictor of the high-risk group. Offending without punishment can lead one to the perception that being caught is unlikely, and thus they continue to engage in the behaviour. While previous research has acknowledged that concealing the phone while driving has been used as a method to avoid being caught and punished for violating this rule (Gauld, et al., 2014; Truelove et al., 2021), this study identified that the use of technologies, such as Facebook police location pages and navigation applications with the functions that shows traffic enforcement cameras (and police enforcement locations in the case of Waze), can also be used as a technique to avoid punishment. However, as identified in study 1, it was also noted that the use of these technologies may conversely increase drivers' perceptions of the certainty of being apprehended for the offence, as drivers may be made more aware of enforcement practices. Reportedly, misinformation and the potential for drivers to believe that the enforcement initiative is still in place after it has ended may also influence these higher perceptions of the certainty of being apprehended for the offence. However, this study found that there was no significant difference in the perceived certainty of being apprehended between high frequency and low frequency phone offenders. This is consistent with previous research on the general impact of legal sanctions on MPUD (Kaviani et al., 2020; Truelove et al., 2019, 2021) and suggests that drivers have consistently low perceived chances of being caught using a phone while driving, regardless of their experiences of engaging in the offence or their use of punishment avoidance technologies. This may also help explain the low uptake of the Waze application; if drivers believe they have a low chance of being apprehended for illegally using a phone while driving, they may not seek out the use of technologies to help them avoid being caught. Longitudinal studies are needed to determine if drivers' perceived certainty of being apprehended for using a phone while driving can increase after exposure to these technologies, or if the use of the technologies can increase drivers' experiences with avoiding punishment and subsequently lower their perceived chance of being caught. Meanwhile, direct punishment was also a significant predictor of membership in the high frequency MPUD group, however in the opposite direction than expected, such that high-frequency phone offenders were more likely to have reported receiving a punishment for the offence. This is consistent with an emboldening effect, where this data is capturing drivers who are more committed to their offending behaviour and are more likely to continue engaging in this behaviour in the future (Allen et al., 2015; Piquero & Pograsky, 2002; Watson, 2004).

4.3. Practical implications

The findings from these studies have a number of important practical implications that need to be considered. Given the new implementation of mobile phone detection cameras in various jurisdictions, it is

suggested that the punishment avoidance technologies have the potential to increase drivers' experiences with avoiding punishment for phone use while driving and limit the effectiveness of these cameras. The results from this study suggest that some of these technologies are more likely to be used by frequent phone offenders, yet updates to the technology can be made to make mobile phone enforcement locations more accessible to users (e.g., making it easier for users to share the locations of mobile phone detection cameras). As such, behaviour change programs that are based on deterrence need to be informed of these punishment avoidance technologies and the impact they can have on offending behaviour. Considering the number of resources that are used in these programs, overlooking how the use of the punishment avoidance technologies can impact such programs can be considered a significant oversight. Furthermore, it can be suggested that navigation applications (such as Google maps and Apple maps) should avoid implementing updates that will specify the type of enforcement camera that is present, as well as the location of police enforcement activities, as this may make it easier for drivers to avoid being caught and punished for using their phone while driving. This is especially pertinent in the current environment given the increasing implementation of mobile phone detection cameras in numerous jurisdictions worldwide. Ultimately, there is a need to advocate to governments and stakeholders to regulate the functions that are available on these technologies to limit drivers' opportunities to avoid being detected illegally using a phone while driving. However, it is acknowledged that as technology continues to evolve, new opportunities for sharing enforcement activities can continue to arise. Therefore, the results from study 1 provide an additional solution that can be considered. Specifically, police officers identified that the use of the technologies can promote exposure to enforcement practices, which may increase some drivers' perceptions of the certainty of being caught for the offence. To save resources, the technology can even be used as a tool to promote deterrence. When enforcement locations are specific, offenders may be more likely to avoid detection. Therefore, the technology could instead have a general alert to say that there may be enforcement in this area. Further, the technology could provide misleading information (i.e., falsely notifying users that there is an enforcement operation in place) or make drivers believe that the enforcement initiative is present for a longer period of time. It has been found that when covert speed cameras were changed to overt speed cameras that were accompied by warning signs stating 'hidden camera may operate', speeding and speed related crashes significantly reduced on all 100 km/hr roads (Keal et al., 2001; 2002). This provides further support for utilising the technology to promote deterrence more generally. If the use of these punishment avoidance technologies will remain and continue to evolve, it can be considered important to continue to monitor the impact they have on offending behaviour and utilise them as an additional tool in the prevention of MPUD.

4.4. Limitations and future directions

As this was a preliminary study, there are a number of limitations and areas for future research that need to be addressed. First, both study 1 and study 2 consisted of self-report data, therefore factors such as self-report bias need to be considered. Further, this study was conducted in the Australian state of Queensland, which needs to be acknowledged in the generalisability of the results. Study 2 consisted of a preliminary investigation to determine if the use of the punishment avoidance technologies and deterrence factors were significantly different between low-frequency and high-frequency MPUD offenders. While this study provided an initial understanding of the issue, there is still a wide array of research that is needed in this area to focus on factors such as 1) why are drivers choosing to use or not use these technologies, and 2) of those drivers that use the technology, how are they using it. Future research is also needed to explore the sub-group of drivers that are using the technology with the intentions of avoiding being caught and punished for the offence. For instance, those with prior offences may be more motivated to use such sites to avoid further penalties. These areas for future research also have applicability for offences beyond MPUD.

4.5. Conclusion

This paper provided an initial understanding of how punishment avoidance technologies impact engagement in MPUD. It was identified that, out of the technologies analysed in this project, Facebook police location pages are the most likely to be used by high-frequency MPUD offenders. Importantly, it was also recognised that the technology is not limited to allowing drivers to avoid being caught and punished for the offence. Instead, the technology also has the potential to increase drivers' perceptions of enforcement practices, while using fewer resources. The findings have important practical implications and numerous directions for future research in the area.

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CRediT authorship contribution statement

Verity Truelove: Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Kayla Stefanidis:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Data curation. **Laura Mills:** Writing – review & editing, Writing – original draft, Formal analysis. **Oscar Oviedo-Trespalacios:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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