BEHAVIOURAL ADAPTATION TO MOBILE PHONE LEGISLATION: COULD THERE BE UNINTENDED CONSEQUENCES OF PARTIAL BANS?

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ABSTRACT

Behavioural adaptation refers to unintended changes in behaviour that follow a change to the road transport system. Legal restrictions on handheld mobile phone use may inadvertently encourage some drivers to use more easily concealed forms of electronic communication, such as text-messaging. An observational mobile phone use survey was conducted of vehicles stopped at intersections in the state of Victoria, Australia. The survey aimed to quantify Melbourne drivers' use of hand-held and hands-free phones, as well as their engagement in a range of other non-driving activities that are associated with increased crash risk. Despite legislation prohibiting the use of handheld mobile phones while driving, a significant proportion of drivers (3.4%) were observed engaging in handheld mobile phone use, including text-messaging (1.5%). Conversely, only 1.4 percent of drivers were observed to be communicating via a legally allowed, hands free, device. While the observational survey was not designed to test the behavioural adaptation hypothesis, the results may suggest this possibility; however, further research is required before this can be established.

KEYWORDS

Cell phones, driver distraction, text-messaging, driver behaviour, road safety.

INTRODUCTION

With respect to driver psychology, the expression 'behavioural adaptation' refers to unintended behaviour(s) that arise following a change to the road traffic system [23]. Typically, behaviours that were not intended by the initiators of the change are particularly relevant and, while their effect on road safety can be positive, negative, or neutral, it is usually the negative consequences that are of primary concern. Previous research has demonstrated the propensity for behavioural adaptation as a result of both engineering, and intelligent transportation system (ITS), in-vehicle safety interventions [3].

The form, or manifestation, of behavioural adaptation depends on the nature of the intervention under study. For example, adaptive cruise control (ACC), an enhanced version of conventional cruise control, allows a vehicle to follow another at an appropriate speed and distance by controlling the engine and/or brake, and has been shown to reduce the visual demand of driving [15]. Not surprisingly, behavioural adaptation to ACC is manifest by an increase in drivers' likeliness to engage in secondary tasks while driving [10] and in increased reaction times to a visual hazard perception task [30]. On the other hand, behavioural adaptation to in-vehicle navigation systems that provide route guidance is evidenced by drivers spending significantly less time looking at the road ahead when using a navigation system than when using either a paper map or memorising directions beforehand [1], and in

unexpected traffic congestion on neighbourhood streets (as navigation systems with dynamic route guidance collectively urge drivers to use the same 'alternative routes') [20].

This paper extends the discussion of behavioural adaptation to the mobile phone context, where policy and legislative initiatives are taking place worldwide and, thus, where consideration of behavioural adaptation is germane. Research has conclusively demonstrated that the use of mobile phones while driving can be distracting and can increase the risk of being involved in a collision by up to 400% [5, 19, 24, 29]. One method to effectively minimise driver distraction due to mobile phone use is to ban the use of all mobile phones while driving, including those that are considered 'hands free'. However, due to social, political and economic pressures, this method is not usually a popular option. Instead, a commonly-used and accepted countermeasure is for jurisdictions to enact legislation prohibiting the use of handheld mobile phones, while permitting the use of hands free devices. This option, typically referred to as a "partial ban", offers a relatively non-controversial and easy-to-implement answer to the ever-increasing demands for government to do *something* to limit the dangers associated with mobile phone use while driving. There are many jurisdictions worldwide that have such legislation currently in place, including, for example, seven states in the U.S. and the District of Columbia, all Australian states, several Canadian provinces, and over 40 other countries [7].

Mobile phone providers will argue that phone use is no different from any other distracting activity that drivers might perform [6, 8]. They will further contend that if a jurisdiction bans the use of mobile phones while driving, then it should also ban drivers from eating, drinking, applying makeup, or dealing with children in the rear seat [34]. Mobile phone use, however, usually involves a considerable cognitive component, which is absent or lacking from most other activities [31]. Further, the degree of exposure, in terms of time spent engaged, is significantly greater for mobile phone use compared to other activities, which may take only seconds to perform, and at the driver's discretion [31]. Finally, the argument for banning the use of mobile phones while driving hinges on it being a relatively recent phenomenon in driving history, and one that can easily and effectively be managed by government intervention.

Previous research has shown that it is not only the physical manipulation of a mobile phone that can be distracting, but the cognitive component as well [9, 14]. An argument against the banning of handheld mobile phones while permitting the use of hands free devices is that it may convey the message that it is safe to drive while talking on a hands free mobile phone, which is not, in fact, the case [5]. Another possibility is that it might encourage drivers to engage in other forms of more easily concealed electronic communication like text-messaging when they might otherwise refrain.

Drivers may demonstrate behavioural adaptation to partial bans on mobile phone use by choosing to engage in these other forms of electronic communication that are less obvious to an outside observer or police officer. The possibility is even more likely if enforcement of the partial ban is not taken seriously or perceived as unreliable or unlikely, and/or if public opinion is not in support of the legislation.

Text-messaging is an increasingly popular communication feature of mobile telephones, and its prevalence is particularly high among adolescents and young adults [36]. Because of its increased availability and popularity, text-messaging among drivers is one of the latest road safety concerns. Although few studies have experimentally assessed the effects of text-

messaging on driving performance, those that have, have found that it seriously impairs most measures of driving performance, including lateral control, responses to traffic signs [17, 39], and braking response time [18, 39]. Further, survey studies have found that up to 88 percent of drivers admit to text-messaging while driving [25, 27, 33, 37], and that teens themselves report text-messaging to be the most distracting activity in which they engage while driving [21, 27].

The state of Victoria, Australia is unusual compared to many other jurisdictions internationally in that it has had legislation restricting the use of handheld mobile phones while driving in place since at least 1966[1]. As of December 1999, Victoria revised its traffic regulations to implement the national Australian Road Rules (ARRs), which were agreed to be adopted in substance by all Australian states and territories. ARR 300 prohibits a driver (except the driver of a police or emergency vehicle) from "using a handheld mobile phone while the vehicle is moving, or is stationary but not parked, unless exempted under another law of jurisdiction" [26].

The effectiveness of legal restrictions on a given behaviour depends on a number of factors, including whether the restriction is reliably enforced by police, whether the public perceives any resulting penalty for violating the restriction as serious, and whether the public opinion is in support of the restriction. If any or all of these factors are not present, the unwanted behaviour may not be suppressed. Saturation of the Australian mobile telephone market has been reached [2]; however, expansion in mobile phone usage options, such as text-messaging for example, continues to occur. It is interesting to note that, in Victoria, the number of penalty notices for using handheld mobile phones while driving has more than tripled since the year 2000 and, despite market saturation, has increased steadily from 2004 to 2009 (C, Golebiowski, personal communication, August 11, 2009) (Figure 1). Whether the increase in the number of penalty notices over recent years reflects increased phone use or increased enforcement is not known; however, it does demonstrate that many Victorian drivers still engage in handheld phone use while driving despite the legislation, which includes "texting" and "using any other function on your phone".

The purpose of this paper is to consider the potential influences of behavioural adaptation in the context of mobile phone use. In doing this, we draw on data collected in a 2009 study by Young, Rudin-Brown and Lenné [38], which aimed to establish the prevalence of handheld *vs.* hands free mobile phone use in a metropolitan centre (greater Melbourne) in Victoria, Australia. The purpose of the 2009 study was not to assess behavioural adaptation. However, for the purposes of the present discussion on behavioural adaptation, it provides a relevant data set for examination. It was hypothesised that, if legislation prohibiting the use of handheld devices while driving was resulting in behavioural adaptation in some drivers, a significant percentage of drivers would be observed using phone options that are easily concealed from police, such as text-messaging and using the phone in loudspeaker mode. Further, this proportion would be comparatively larger than that of drivers observed to be engaging in more obvious mobile phone behaviour, such as talking into a handset. A secondary objective of the current paper is to investigate possible driver and situational factors that are associated with these mobile phone-related behaviours, and may play a role in whether a driver is likely to display behavioural adaptation in this form.

[1] Regulation 153(1) of Victoria's Motor Car Regulations (1966) states "Except with the approval of the Chief Commissioner the driver of a motor car shall not while the motor car is in motion use any telephone microphone or any other similar instrument or apparatus in such motor car".

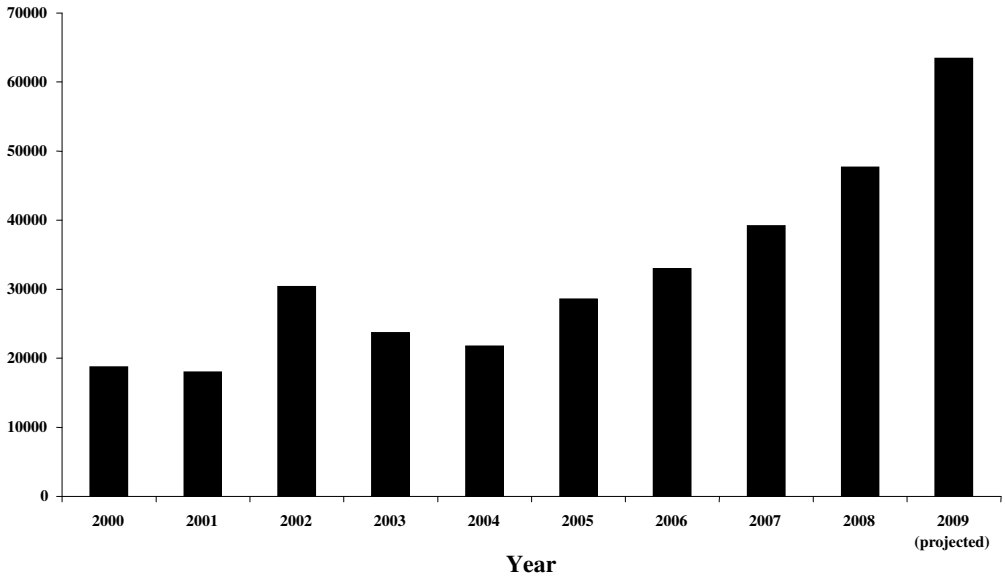

Figure 1 – Number of penalty notices for using handheld mobile phone while driving issued in Victoria from 1 Jan 2000 to 31 July 2009.

METHOD

Three sites were selected for the study, one in the Melbourne central business district (CBD) and two at suburban sites with different socio-economic profiles. All sites a) comprised an intersection with traffic lights, b) were located in a 60km/h speed zone, c) allowed clear visibility for observers, d) excluded features that might interfere with observations, including trees and construction work, and e) excluded features that might risk the safety of the observers, such as narrow pedestrian paths and/or nature strips. The decision to use these inclusion criteria was based on their effectiveness in previous MUARC observational studies [35].

Procedure

Roadside observations were conducted in May, 2009. All three sites were surveyed on six separate occasions between the hours of 8:00 am and 5:30 pm. Observation times were selected to provide a mix of morning *vs.* afternoon, peak *vs.* non-peak, and weekday *vs.* weekend traffic times. Each observation session lasted one hour, to yield a total of 18 hours of observations.

Data at each site were collected by three trained observers, who screened all vehicles that were stopped at the intersection, recorded basic driver and vehicle details, as well as whether the driver was using a handheld or hands free phone. Observers were able to position themselves directly beside the vehicles, and typically had a clear view of drivers' hands and lap. Driver engagement in mobile phone use was only recorded in cases where the observer had a clear view of the driver and their interaction with the telephone. Hands free phone use was judged if a driver was wearing an earpiece or portable mobile phone headset, and/or was talking in a manner that appeared to be one side of a conversation. Registration plate and any other details that could identify the vehicle or driver were not recorded. Observations were made of all vehicle types (except motorcycles) in a single direction of traffic flow, and all lanes except the right turning lane were screened.

The suitability of the sites and data collection method was pilot tested in one, one-hour observation period prior to the main data collection period. Inter-observer reliability was assessed by having all three observers record details from the same vehicles during two of the observation periods and comparing the data. Further details of the methods used in the study can be found in [38].

Data analysis

The dependent variable of interest was phone activity (talking—handheld; talking—hands free; talking—loudspeaker mode; dialling/answering; holding phone (but not talking/texting); text-messaging; or unknown). To examine whether certain driver and situational characteristics were associated with driver engagement in the most common phone activities, four binary logistic regression models were fitted, including one for each of the three most common phone activities, plus one for all phone activities combined. Predictor variables included in the regression models were: estimated driver age, gender, and time-of-week (weekday *vs.* weekend), and were chosen based on previous research [32, 40, 41] demonstrating an association with driver phone use.

RESULTS

Number of screened vehicles

A total of 5,813 vehicles were screened across the 18 hours of observations, including those observation sessions where inter-observer reliability was assessed. Table 1 presents the number of vehicles screened at each observation site and time.

Table 1 - Number of vehicles screened at each site and observation time

Time	Site			
	CBD	**Suburb 1**	**Suburb 2**	**TOTAL**
8-9am	336	160*	403	899
10-11am	330	353	334	1017
2-3pm	346	339	332	1017
4.30-5.30pm	399	92*	389	880
10-11am (weekend)	277	337	344	958
2-3pm (weekend)	328	346	368	1042
TOTAL	2016	1627	2170	**5813**

* Denotes times when the inter-observer reliability was assessed.

Inter-observer reliability

Inter-observer reliability was determined by calculating the single measure intraclass correlation coefficient (ICC), which is an index of the extent to which two or more observers are in agreement. As a general rule, correlation values from 0.40 to 0.59 are considered moderate, 0.60 to 0.79, good, and 0.80 and above, excellent.

The inter-observer reliability in all categories was excellent ('gender ICC' = 1.00; 'phone activity ICC' = .959; 'driver age ICC' = .807, estimated using three broad age groups [under 30, 30-50, over 50]).

Mobile phone use

Across all observation periods, a total of 292 (5%) of the 5813 drivers screened were observed using a mobile phone in some manner. Figure 2 presents the proportion of drivers who were observed to be engaged in each of the six possible mobile phone activities (0.2% of observed phone activities were recorded as "unknown"). Text messaging (including both reading and writing) was the most common observed phone activity, with 1.5 percent of all drivers engaged in this task, followed by talking on a handheld phone (1.3%) and talking hands free (into a headset) (1.1%).

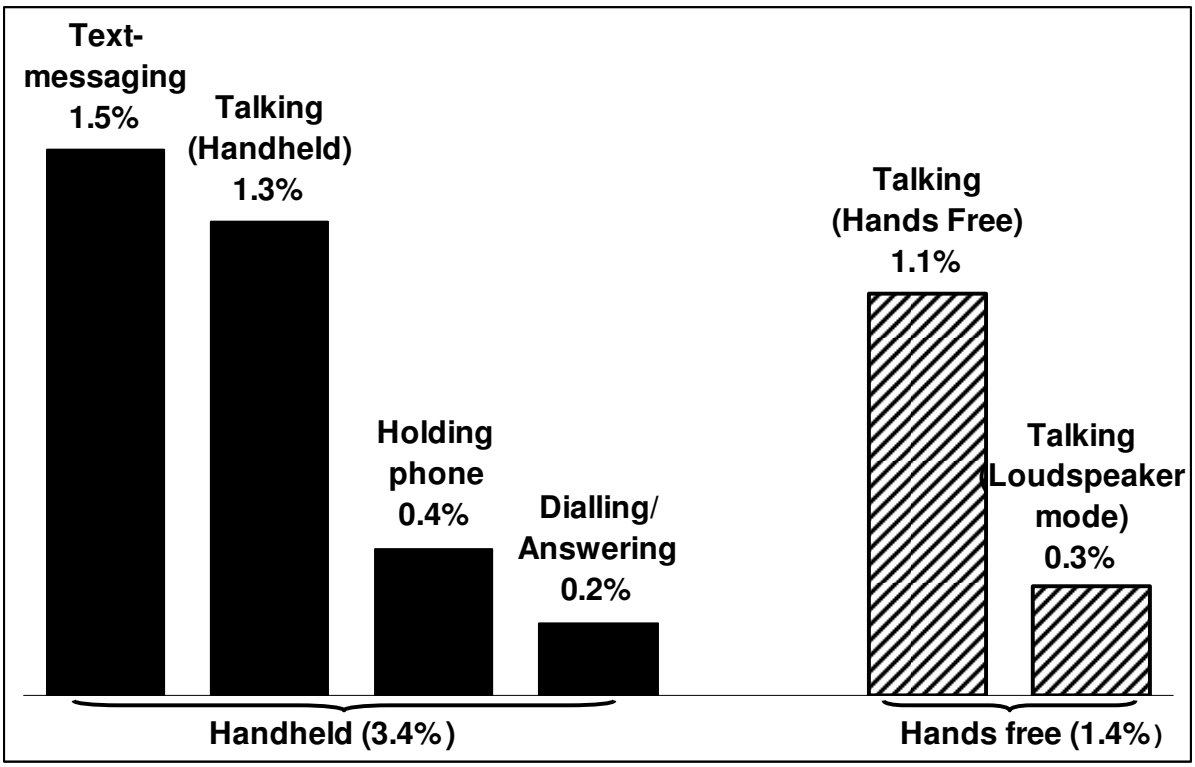

Figure 2 – Proportion of drivers observed to be engaged in handheld *vs.* hands free mobile phone activities

Characteristics associated with mobile phone use

To examine the characteristics associated with different mobile phone activities while driving, four binary logistic regressions were fitted using driver age, gender, and time-of-week (weekday *vs.* weekend) as predictor variables.

All mobile phone activities combined. The overall analysis was significantly predictive of the factors associated with whether a driver was observed to be performing any sort of mobile phone activity, $\chi^2(5)=44.619$, $p<.001$. After controlling for gender and time-of-week, driver age was found to be significantly associated with whether a driver was observed to be using a mobile phone. More specifically, compared to drivers aged more than 50 years, drivers aged less than 30 years were four times as likely, and drivers aged 30-50 years were 2.5 times as likely, to be observed using a mobile phone. Similarly, after controlling for gender and driver age, time-of-week was found to be significantly associated with whether a driver was observed to be using a mobile phone; drivers were one and a half times as likely to be observed using a mobile phone during the week, compared to the weekend.

Text-messaging. The overall analysis was significantly predictive of the factors associated with whether a driver was observed to be text-messaging, $\chi^2(5)=40.126$, $p<.001$. After controlling for gender and time-of-week, driver age was found to be significantly associated with whether a driver was observed to be text-messaging. More specifically, compared to drivers aged more than 50 years, drivers aged less than 30 years were five times as likely, and drivers aged 30-50 years were twice as likely, to be observed text-messaging. Similarly, after controlling for gender and driver age, time-of-week was found to be significantly associated with whether a driver was observed to be text-messaging; drivers were over three times as likely to be observed text-messaging during the week, compared to the weekend.

Talking—handheld. The overall analysis was significantly predictive of the factors associated with whether a driver was observed to be talking on a handheld mobile phone, $\chi^2(5)=16.038$, $p<.01$. After controlling for gender and time-of-week, only driver age was found to be significantly associated with whether a driver was observed to be talking on a handheld phone. More specifically, drivers aged under 30 years, as well as drivers aged 30-50 years, were more than six times as likely to be observed talking on a handheld mobile phone than were drivers aged over 50 years.

Talking—hands free. The overall analysis was not significantly predictive of factors associated with whether a driver was observed to be talking on a hands free mobile phone.

DISCUSSION

With regards to the frequency of phone use, the results show that, despite legislation in place restricting it, the use of handheld mobile phones by drivers in Victoria, Australia continues to be popular, with 3.4 percent of observed drivers using these devices. The most commonly observed handheld mobile phone activity was text-messaging (1.5% of drivers), followed by talking on a handheld phone (1.3%). Only 1.4% of drivers were observed talking on a legally allowed hands free phone.

The rate of observed driver handheld mobile phone use is similar to those found in previous observational surveys of jurisdictions within the United States and Canada where this practice is also banned. For example, one year after the introduction of handheld phone bans in the U.S. state of New York and the District of Columbia, usage rates of handheld phones among drivers were 2.1% and 4.0%, respectively [22, 23]. Likewise, handheld phone use in the Canadian province of Newfoundland and Labrador, where legislation has been in place since 2003, was observed to be 1.2% in 2006 (rural sites) and 5.4% in 2007 (urban sites) [4].

Logistic regression analyses performed on the three most common mobile phone activities, as well as all phone activities combined, revealed two variables, driver age and time-of-week, that were predictive of whether a driver was observed to be engaged in mobile phone use while driving. The odds of a driver aged less than 50 years being engaged in any form of mobile phone use were more than 2.5 times that of a driver aged over 50 years. Similarly, the same relationship between driver age and the likelihood of text-messaging while driving was also observed. Finally, the odds of a driver under age 50 being observed talking on a handheld phone compared to one who is over 50 were even greater at more than six-fold. The collective finding that mobile phones are more likely to be used by younger drivers than by older drivers is consistent with much of the previous research in this area [13, 16, 25, 32].

Logistic regression analysis also revealed time-of-week as a significant predictor of mobile phone use while driving. Drivers were one and a half times more likely to use a mobile phone, and over three times more likely to be text-messaging, on a weekday compared to a weekend. This finding may be related to a higher proportion of calls made on weekdays being work-related, and including added pressures to communicate while in transit.

Although inconclusive, results support the hypothesis that, faced with a restriction on mobile phone use while driving, some people may demonstrate behavioural adaptation by choosing to use other phone options that are easy to implement while at the same time easy to conceal. Use of a hands free phone while driving necessitates the purchase and installation of extra components, and its set-up consumes additional, pre-trip time. Added to drivers' perception that enforcement of the mobile phone ban in Victoria is not taken seriously and/or is not reliable [37], these reasons may combine to allow for the development of behavioural adaptation, in terms of an increase in the performance of more 'clandestine' mobile phone activities, such as text-messaging.

Research studies that attempt to investigate factors that contribute to the expression of behavioural adaptation in drivers are typically fraught with a number of limitations. The present survey study was no different, and these limitations are acknowledged. It is often difficult to discern which effects, if any, are the result of behavioural adaptation, and which are simply the consequent direct effects on behaviour. For example, were observed drivers in the present study engaging in text-messaging because it is an activity that is more easily concealed than talking into a handheld mobile phone, or were they text-messaging simply because it is their preferred method of electronic communication? Similarly, did they choose to text-message because they believed the associated charges to be less expensive than those related to regular voice calls? In order to conduct a true test of the behavioural adaptation hypothesis, it would be necessary to compare the prevalence of text-messaging in drivers between jurisdictions with and without bans on handheld phone use that are similar on most other characteristics. Unfortunately, this is currently not possible as, at the time of publication, no other reports of text-messaging prevalence in other jurisdictions exist. An ideal comparison for the data would be, for example, the relative prevalence of text-messaging while driving in a metropolitan centre in New Zealand, where the use of handheld mobile phones while driving has never been banned[2].

Another possible explanation for the high rate of observed handheld phone use in the present study could be related to the average age of the Victorian vehicle fleet, which is generally older than those of jurisdictions with less temperate climates. The observational survey [38]

[2] Since the writing of this manuscript, New Zealand enacted its own partial ban on handheld phones (Road User Amendment Rule 2009) that took effect on 1 November 2009.

found that drivers of newer vehicles (2000 – present) were 2.1 times more likely to be using a hands free phone than drivers of pre-model year 2000 vehicles. It is possible that newer vehicles are better equipped than old vehicles to accommodate hands free phone equipment and that, as older vehicles are replaced, the proportion of Victorian drivers using hands free, as opposed to handheld, phones will increase.

A limitation of observational surveys in general is their tendency to collect behavioural data in situations that are easy to observe, such as in the present case, during daylight hours and when the vehicle is stopped. Thus, observed results may be overestimates of mobile phone use in all vehicles (i.e., those that are stopped as well as those that are in motion). Indeed, in a recent survey [37], over 90 percent of drivers reported that they were more likely to engage in distracting activities when stopped at traffic lights. But it remains possible, and even likely, that the rates of mobile phone use seen in the present study reflect the increased functionality of mobile phones that has developed in recent years. This functionality may inadvertently encourage drivers to use their mobile phones in handheld mode; for example, text-messaging, accessing emails or the Internet for maps or directions.

In conclusion, the present study quantified the rate of driver engagement in mobile phone use at targeted sites within Melbourne, Australia, and is one of the first to report the prevalence of text-messaging among drivers. These data are invaluable for further defining, targeting and evaluating potential driver distraction countermeasures. Given that vehicles and electronic communication technologies are constantly evolving, it is recommended that regular surveys be conducted to gauge future trends in mobile phone and other technology usage over time. It is also recommended that road safety policy makers carefully consider any potential unintended consequences of legal countermeasures to distracted driving, such as partial bans on mobile phone use while driving, when considering their merits *vs.* their costs. Where possible, results from carefully controlled experimental studies should be used to support these countermeasures.

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