



ECOSYSTEMS

Traffic education campaigns and animal-vehicle collisions in Brazil

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Abstract: Educational traffic campaigns aim to alert the population about adoption of behaviors that bring safety and quality in traffic. Animal-vehicle collisions are one of the most visible impacts on roads, and the planning of measures to reduce these collisions is justified for at least three reasons: animal welfare, financial cost, and drivers and passengers' safety. We evaluated whether the impact of animal-vehicle collisions was present in educational traffic campaigns and if campaigns showed any other environmental issues. We analyzed 205 campaigns from state and national traffic departments in Brazil. Although "collision" was the most frequent subject, animal-vehicle collisions only appeared on two campaigns, both portraying domestic animals. The identified environmental issues were "animal-vehicle collision" and "garbage", and most campaigns did not have an environmental focus. We highlighted some directions to include the subject of wildlife-vehicle collisions in traffic campaigns that could raise public awareness and, ultimately, reduce the impact on humans and animals involved in collisions.

Key words: Biodiversity conservation, environmental awareness, traffic education, wildlife roadkill.

INTRODUCTION

Traffic education campaigns are an important educational tool to inform and influence the public on the adoption of safe behaviors, increasing awareness of traffic risks (Friemel & Bonfadelli 2016, Hoekstra & Wegman 2011). These campaigns have shown a positive effect in significantly reducing traffic accidents (Phillips et al. 2011, Vaa et al. 2009) and efficiency in reducing the overconfidence of drivers who underestimate the risks of traffic (Silva et al. 2020). Official traffic departments establish subjects used in the campaigns and execution schedules, especially for vacation periods or extended holidays (Brasil 1997, Lee & Al-Mansour 2020, Vaa et al. 2009). The subjects are mainly related to the safety of road users, such as the relationship between the consumption of

alcohol and traffic accidents, the risks of using cell phones, and the importance of using the seat belt and the car seat (Phillips et al. 2011, Vaa et al. 2009).

Roads bring important benefits to society, as they allow the transportation of people and goods. However, road construction and vehicle traffic pose a threat to biodiversity because they increase wildlife mortality and decrease connectivity and habitat quality (Teixeira et al. 2020, van der Ree et al. 2015). Collisions between vehicles and animals are among the most visible and first impacts to be documented (van der Ree et al. 2011), being also recognized as one of the main direct anthropogenic causes of wildlife fatalities (Hill et al. 2019). Moreover, these collisions also present a life-threatening

risk to the people involved (Abra et al. 2019, Freitas & Barszcz 2015).

Planning measures that reduce these collisions is justified for at least three reasons. First - animal welfare and the threat to wildlife species. Animal welfare issues related to the death of a single animal would be enough for us to think about avoiding collisions. However, some authors show that eight million birds and two million mammals die on highways in Brazil (González-Suárez et al. 2018), which may pose a problem for the persistence of wildlife populations (Fahrig & Rytwinski 2009). Considering the paved highways of the state of São Paulo alone, the most populous Brazilian state, almost 40 thousand large mammals are estimated to die per year (Abra et al. 2021). Second - the financial costs of collisions. In São Paulo, the overall average of animal accident costs was R\$ 21,656.00, and, in the case of accidents involving injured and/or dead people, the average cost was R\$ 67,048.00 (Abra et al. 2019). Such costs include expenses associated with people - such as hospital expenses, costs associated with vehicles - such as material damage, and institutional costs - such as damage to the highway (IPEA 2015). Third - the safety of drivers and passengers. Police reported approximately 2,600 animal accidents per year in São Paulo, and 18.5% of them result in harm to human health (Abra et al. 2019). This problem is also documented in other parts of the globe. In the state of New South Wales, Australia, 33% of animal-vehicle collisions resulted in human injury between 1996 and 2005 (Ramp & Roger 2008). In the United States, roughly 10% of animal accidents result in human injury or death, with a total of 26,000 collisions per year (Huijser et al. 2008).

Even with the existence of mitigation measures that aim to influence the behavior of drivers (such as speed reducers and road signs)

(Hobday & Minstrell 2008), public perception about wildlife collisions remains a critical issue (Lunney 2013). The environmental impact of wildlife fatalities resulting from collisions between vehicles and animals directly reflects on the safety of road users (Abra et al. 2019), becoming also a social issue. Thus, raising awareness about this issue among drivers and passengers becomes essential. Traffic education campaigns developed to raise awareness about the hazards of traffic among a wide public (Vaa et al. 2009) can be a good opportunity to promote environmental awareness about this issue, which is also a public safety concern (Niemi et al. 2013).

Considering the environmental issue and the safety of road users, we wondered if the impact of collisions between vehicles and animals is present in the traffic education material used in Brazil. To answer this question, we have analyzed the content of the campaigns developed by the traffic departments. Our objectives were: i) to investigate whether the subject of collisions between vehicles and animals was present in videos from traffic education campaigns, either focusing on environmental issues or the safety of road users; ii) to investigate whether the videos from traffic education campaigns showed environmental issues; iii) to evaluate whether the collisions between vehicles and animals or any other environmental issues were selected by the National Traffic Council (Contran; national department responsible for defining the scope of the campaigns in Brazil). Even if the National Traffic Council does not recognize and require environmental subjects on their resolutions, traffic departments could spread campaigns to alert the population about the wildlife-vehicle collisions as those collisions can result in human injuries and economic damage.

MATERIALS AND METHODS

Data collection

We conducted a quali-quantitative analysis of the educational materials from Brazilian traffic departments. We chose educational campaigns in online video format because it allows dissemination over a large period of time and to a wide audience. The search for educational campaigns was carried out between March 30 and April 10, 2021, on the official pages of traffic departments and official YouTube channels, since the vast majority of the campaigns available on the websites were displayed on this platform. We searched for campaigns from state traffic departments of four Brazilian states (Paraná, Rio Grande do Sul, Santa Catarina, and São Paulo) and the national traffic department. Videos that were published more than once, on very close dates, and had the same content (same audio, scenes, and duration) were excluded from the analysis. However, some very similar campaigns (e.g. campaigns with the same audio but different scenes) were considered since these differences can change the campaign's subject and focus.

Roadmap to the observation of educational campaigns

To standardize the evaluation, we developed a roadmap containing a set of characteristics and information to be observed in the campaigns. Each campaign was watched twice, on different days, to better fill in the information for the same person. Furthermore, in case of doubt as to the presence of a piece of information, the campaigns were paused for inspection and confirmation. The information generated for each campaign contained: a unique campaign identification code, the date of the campaign, the responsible department, present subjects, who was involved (campaigns with collisions), and an access link to the video.

Some campaigns indicated the date of realization in the title, in the description, or during the video. However, when there was no indication of the date, we considered the date of the publication on YouTube as the date of the campaign. For some campaigns, especially those prior to 2011, we were able to identify only the years in which they were released.

Analysis of traffic education campaigns

We identified which subjects were present in the campaigns and when the campaign topic did not fit into the subjects established by official traffic department, we proposed new subjects. We proposed seven themes and categorized the campaigns into them, described below: 1) Traffic Safety (highlights risk attitudes to road users); 2) General awareness (calls attention to safer traffic, without mentioning specific risks); 3) Pedestrian (explicitly warns of pedestrian safety risks); 4) Cyclist (explicitly warns of cyclist safety risks); 5) Environment (warns about problems related to the environment); 6) Equipment and maintenance (calls attention to risks arising from the lack of accessories and/or maintenance); 7) Other topics (subjects that don't fall under the previous categories).

The same subject may have been categorized into more than one theme because the categorization also depended on the focus given to the campaign. For instance, a subject listed on both "Traffic safety" and "Equipment and maintenance" categories indicates that, in some campaigns, it was related to the risk it presents to the user (first category) while, in others, it was related to the lack of equipment and/or maintenance (second category). The campaigns generally presented more than one subject and, if they presented subjects of different themes, they were classified into more than one theme. We analyzed the diversity of

subjects within each theme and the frequency in which the themes appeared.

Analysis of the subjects defined by the National Traffic Council

Six resolutions of the National Traffic Council (Contran) defining the subjects of the campaigns were available for consultation, effective in the years 2007 and 2017 to 2021 (Brasil 2007, 2017, 2018, 2019, 2020a, b). The resolutions of the years 2007 and 2021 were not used for comparing the subjects because we did not find campaigns matching their period of validity. We analyzed the subjects defined in the resolutions to identify whether they were incorporated into the educational campaigns of the state and national transit departments we evaluated. This comparison allows us to assess whether the absence of any subject from the educational campaigns – such as, for example, animal-vehicle collisions – can be caused by a lack of demand by the responsible department. Furthermore, we can evaluate whether the educational campaigns encompass subjects beyond those defined in the resolutions, thus allowing the suggestion of subjects to be included in the campaigns. To do this, we have separated the campaign subjects according to the validity periods of the resolutions and checked, separately for the state and national departments, whether the subjects were contemplated in the campaigns and whether the campaigns presented subjects that are absent in the resolutions. For these comparisons, although subjects are defined monthly, we used all the subjects defined in each resolution for the period it covered, as there is uncertainty as to the campaign creation date – which is not necessarily the date of its publication on YouTube. Using the full period of the resolution, it is possible to assess thoroughly whether the determined subjects are present in the campaigns published in that period. For this

comparison, we considered campaigns reprised in different years as independent campaigns, since we understand that they were selected to be used again to stress that subject in that period.

RESULTS

Traffic education campaigns

We analyzed 205 educational campaigns from state and national traffic departments. Of these, 55 were from the National Traffic Department while 150 were from the state departments, 71 from the state of Paraná, 43 from the state of São Paulo, 30 from the state of Rio Grande do Sul, and six from the state of Santa Catarina. The period of the campaigns covered the years 1999 to 2020. Among the state departments, the available campaigns have dates after 2010, and all campaigns before this period (1999 to 2009) are from the national traffic department. The months with the highest number of campaigns were May and December, with 52 and 34 campaigns respectively. The complete information of the analyzed campaigns is detailed and contained in the Supplementary Material – Table SI.

We identified 45 subjects in the 205 analyzed campaigns, with “collision” being the most frequent subject (present in 63 campaigns) (Figure 1 - only subjects that appear in more than 10 campaigns are displayed). When campaigns presented collisions, those involved in them were: cars (92%), trucks (17%), people and motorcycles (14% each), buses (13%), buildings (10%), bicycles (8%), and animals (3%). The frequency in which the themes appeared in the campaigns varied greatly, with “Traffic safety” being the most frequent (58%), and “Cyclist” and “Environment” being the least frequent (2% each) (Figure 2).

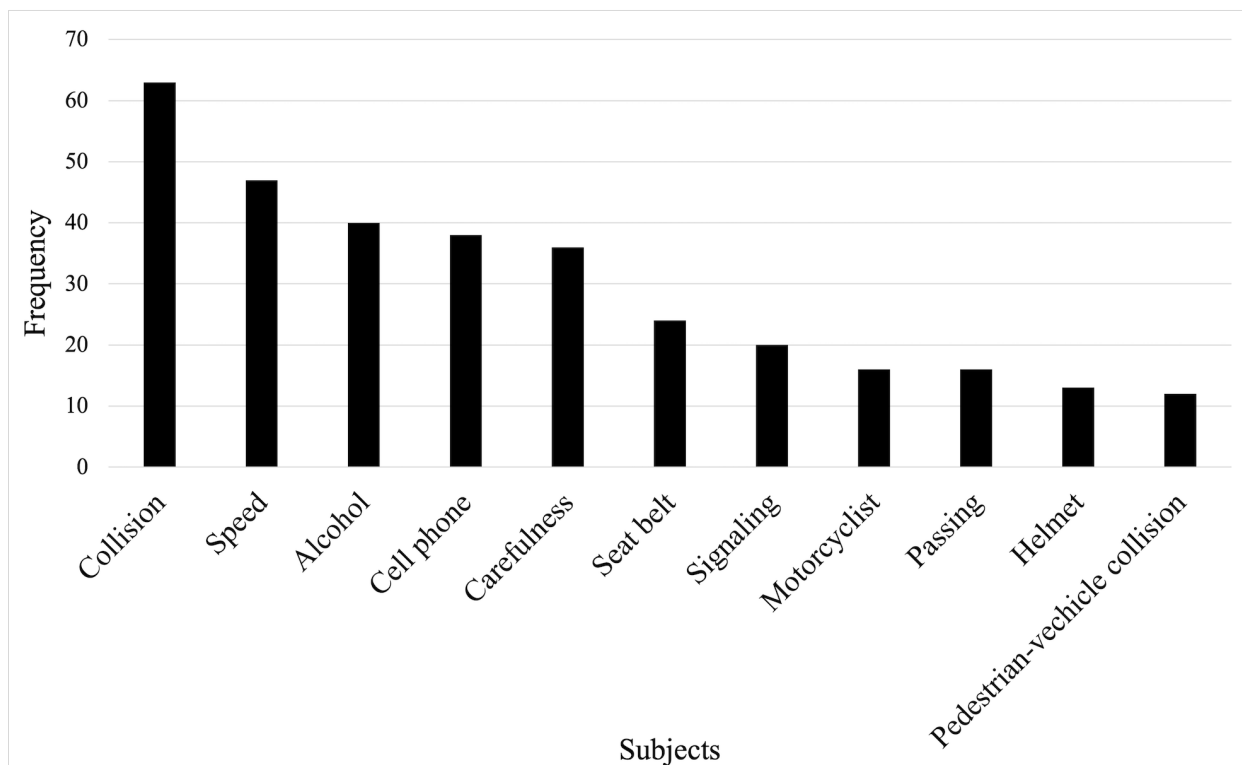


Figure 1. Frequency of subjects in analyzed campaigns. Subjects present in less than 10 videos were not included for a better visualization.

The number of subjects categorized in each theme ranged from two (under “Environment”) to 25 (under “Traffic safety”) (Table I), and their frequency within themes also showed considerable variation (Supplementary Material Figure S1). In the theme “Traffic safety” (139 campaigns), the subjects that appeared most in the campaigns were: collision (41%), speed (34%), and alcohol (29%). In “General awareness” (49 campaigns), the subject “carefulness” was the most present (61%). In the theme “Equipment and maintenance” (15 campaigns), “helmet” was the most frequent subject (60%). In “Pedestrian” (17 campaigns), the most frequent subject was “pedestrian-vehicle collision” (59%), while in “Other themes” (12 campaigns), the subject “institutional advertising” was the most frequent (50%). The theme “Cyclist” (4 campaigns) had two subjects with the same frequency: “cyclist” and “bike path” (50% each). In “Environment”

(4 campaigns), the only two subjects (“animal-vehicle collisions” and “garbage”) had the same frequency (50%).

Environmental issues in traffic education campaigns

The campaigns under the theme “Environment” had only two subjects identified (“animal-vehicle collision” and “garbage”), each one appearing twice (Table I). Both campaigns with the subject “animal-vehicle collision” concerned only domestic animals. One of them highlights speeding and the impossibility of braking in time to avoid colliding with a cow. The other, however, aimed to draw attention to the incorrect transportation of pet animals without a seat belt, being the collision with a dog a consequence of letting it loose in the car. Regarding campaigns with the subject “garbage”, one of them was aimed at the possibility of accidents from a soda

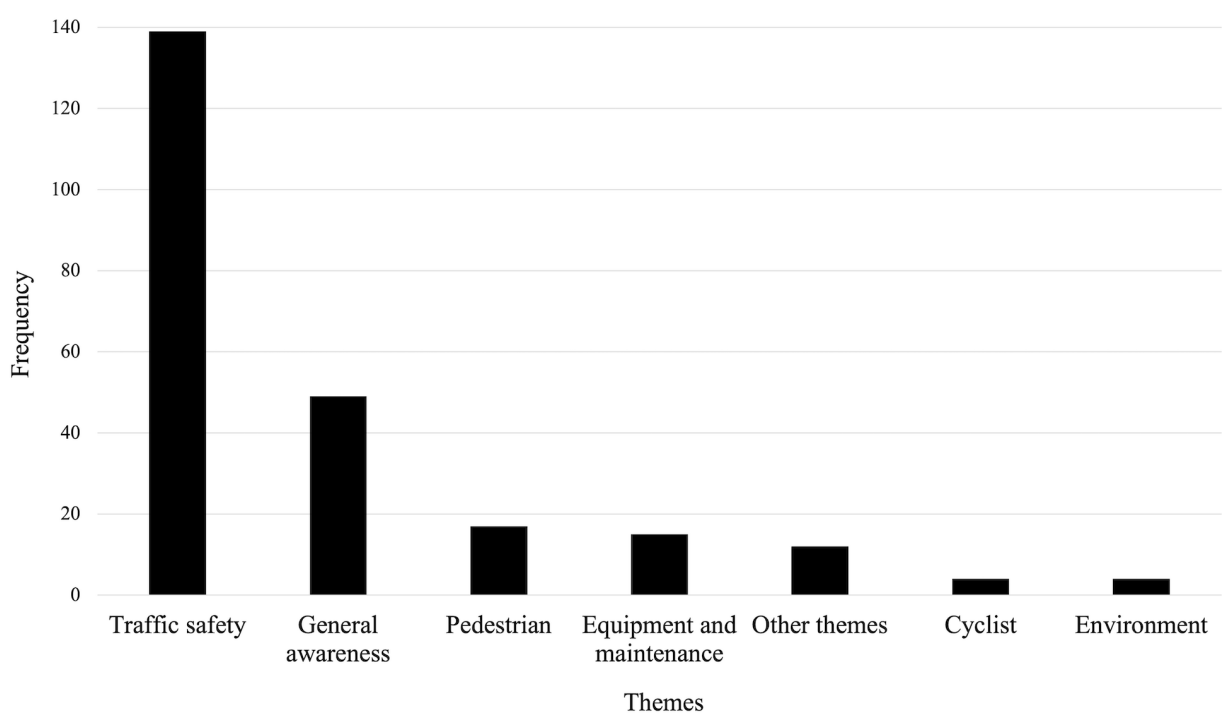


Figure 2. Frequency of themes in the analyzed campaigns. One or more themes were used to describe the same campaign.

can throw out the window, only mentioning environmental conservation in a sentence towards the end. The other one, though, raised awareness in defense of the environment and was carried out in partnership with the national environmental agency (IBAMA - Brazilian Institute of Environment and Renewable Natural Resources).

Subjects defined by resolutions of the National Traffic Council (Contran)

The resolutions were drawn up by representatives of different bodies that make up Contran, such as some ministries and the National Agency for Land Transport (ANTT). Among the present ministries, we highlight the Ministry of Education, absent in 2021, and the Ministry of the Environment, present in the resolutions of 2007, 2017, and 2018. In the four analyzed resolutions, 20 subjects were identified (Table SII), of which 14 were present in the educational campaigns of state and national departments.

No environmental issues were present among the subjects established in the resolutions. The educational campaigns of the state and national departments presented subjects that were not defined in any of the Contran’s resolutions we analyzed.

DISCUSSION

Our results show that environmental issues are not frequent in the educational campaigns from state and national transit departments, nor are they in the resolutions of the National Traffic Council in Brazil. In all the campaigns we evaluated, the only issues identified under the theme “Environment” were “animal-vehicle collision” and “garbage”. Although collisions between vehicles and animals directly affect the safety of road users (Abra et al. 2019), this subject is not highlighted in campaigns with collisions. In addition to animals appearing only in two campaigns, these were domestic animals

Table I. Categorized subjects in each theme. Some subjects were included in different themes.

Themes	Identified subjects	
Traffic safety	Road verge	Excess load
	Alcohol	Road lighting
	Animal-vehicle collision	Throwing objects
	Pedestrian-vehicle collision	Hands on the wheel
	Coasting	Motorcyclist
	Trucker	Signaling
	Cell phone	Sleepiness
	Cyclist	Transportation of domestic animals
	Seat belt	
	Collision	Pedestrians crossing
	Wrong-way driving	Passing
	Safe distance	Drug use
	Improper parking	Speed
General awareness	Horn	Information
	Collision	
	Carefulness	Traffic laws
	Lack of attention	Signaling
	Kindness	Victim aid
Pedestrian	Pedestrian trampling	Pedestrian
	Crosswalk	Pedestrians crossing
Cyclist	Cyclist	Headphones
	Bike path	
Environment	Animal-vehicle collision	Garbage
Equipment and maintenance	Car seat	Road lighting
	Helmet	Maintenance
	Protective equipment	Signaling
Other themes	No car day	Pandemic
	Institutional advertising	Report

in both cases, which may not allow the public to reflect on the impacts on wildlife.

Although “garbage” has not received an environmental focus in one of the two campaigns in which it was present, its presence is important

because it can make people rethink - due to the chances of causing an accident - their attitudes about throwing garbage on the roads. These attitudes may be related to the presence of animals on or near the road verge. Some small

animals end up dying trapped in bottles or other objects thrown from vehicles (Moates 2018). Furthermore, the garbage accumulated on the roads attracts animals seeking food, augmenting the number of collisions between vehicles and wildlife (Hill et al. 2021). Other issues that could be included in the theme “Environment”, such as the emission of pollutants and noise produced by vehicles - which are present in the Brazilian Traffic Code (Brasil 1997) and the handout of the driver training course (Bastos 2020) - are not represented in the traffic education campaigns we evaluated. Since our work was very time-consuming, we had the limitation of not covering all the Brazilian states. In our data 27% campaigns are from the National Department, 52% are from the state departments from the south region (Paraná, Santa Catarina and Rio Grande do Sul), and 21% are from the most populous state in Brazil (São Paulo). Those states represent part of three biomes in Brazil: Atlantic Forest, Cerrado, and Pampa. However, even though we did not have any representation of any department from Pantanal, Amazonia, and Caatinga biomes, we expected that our findings might be representative of other regions in Brazil as we also evaluated national campaigns which are broadcast nationwide.

There are two possible reasons why environmental issues are almost absent from traffic campaigns. The first reason is that these issues are not listed in any of the available resolutions from the National Traffic Council among those that must be present in the campaigns (Brasil 2007, 2017, 2018, 2019, 2020a, b), although the Ministry of the Environment is responsible for drawing up half of the resolutions, causing traffic departments not to include the subject in their campaigns. However, even with the absence of the subject “animal-vehicle collision”, the national department conducted a campaign that contained this subject. This leads

us to the second reason: lack of knowledge of the subject or interest of some traffic departments to include in their campaigns environmental issues focusing not only on the risks to human health but also on environmental conservation. Traffic departments and environmental agencies have different perspectives on problems and solutions to road impacts (Sullivan & Messmer 2003), and collaboration between them is important to achieve greater awareness of safe practices in traffic for both humans and animals (Kioko et al. 2015). One of the campaigns of the theme “Environment” evaluated in this work can be an example of this collaboration since it was carried out in a partnership between the national traffic department and a national environmental agency. It highlights the environmental problems of throwing garbage on the roads and also mentions the risk of accidents that arises from this action.

Regarding the impact of collisions between vehicles and animals, we can use awareness to generate knowledge of this social issue and enable the development of safe practices in traffic (Silva 2013). One way of raising awareness is to mention in educational campaigns at least two reasons to mitigate this impact that reflect directly on humans: the financial cost of collisions and the safety of drivers and passengers. Campaigns that draw attention to the medical expenses and repair costs of vehicles resulting from collisions with animals can be most effective in changing traffic behaviors as drivers who were involved in deer-collisions were worried most about costs (Marcoux & Riley 2010). Furthermore, health risks from accidents can be highlighted, since they range from minor injuries to fatalities, with motorcyclists being the most involved in fatal collisions (Wilkins et al. 2019, Abra et al. 2019). Moreover, it is important to stress that some accidents involving wild animals result

in a high percentage of serious injuries and human deaths (Freitas & Barszcz 2015, Huijser et al. 2008, Seiler 2005). We can also use animal welfare and biodiversity conservation to include the subject in the campaigns, as a way of raising awareness of the public about the impacts on the fauna. Using a personal element that is close to the target audience can increase the chances of the campaign message being transmitted (Vaa et al. 2009), and the presence of domestic animals in campaigns can work in such a way. However, campaigns should contain not only domestic animals, but also wildlife, in order to promote an environmental consideration that can help reduce impacts and fatalities caused to animals and, consequently, aid the conservation of wild animals. Combining the financial and safety issues with the environmental theme allows traffic departments to address different problems with the same campaign.

Educational campaigns are effective in reducing traffic accidents, with alcohol and speed campaigns contributing the most to this (Phillips et al. 2011). Speeding is one of the main causes of collisions with animals cited by drivers (Sássi et al. 2012), so, the association of these two subjects in traffic campaigns may have good chances of warning about these collisions. Therefore, since the effects of campaigns are greater in the short term, these subjects should be stressed from time to time (Phillips et al. 2011). Furthermore, the use of different campaign styles can cover a larger audience (such as emotive or shocking campaigns), as the effect of the styles varies between different groups of people (Silva et al. 2020).

However, the effectiveness of educational campaigns in reducing collisions may not be straightforward, but it may occur indirectly due to a greater awareness of the subject, as is the case of road signs, which can be used to warn about the severity of the impacts caused

by collisions (Seburn & McCurdy-Adams 2020, Huijser et al. 2015). People who are more environmentally conscious care more about environmental issues, seeking to minimize the impact of their actions (Kollmuss & Agyeman 2002). Therefore, the presence of environmental issues in the campaigns may result in people trying to reduce their direct impact on fauna and demanding from authorities mitigating measures to make roads safer against collisions, thus saving animal and human lives. Safe roads are also of interest to the State and road concessionaires since they are responsible for paying compensation in cases of accidents with animals on Brazilian highways (Abra et al. 2019). Moreover, educational campaigns should not be thought of as alternatives to other mitigating measures, but complementary to them (Seiler et al. 2016), since the effect of campaigns on the behavior of drivers can vary according to the intimacy and immediacy of the message (Vaa et al. 2009).

The messages used to underpin educational campaigns on this subject should address both sides of collisions – animal and human – in order to raise awareness of the environmental problem without giving the impression that the drivers must put themselves at risk to save the animal. Since collisions are often unanticipated, it is interesting to think of messages that make drivers reduce the rate of encounter with animals and increase their carefulness in some specific locations. In this sense, messages such as: “Avoid night driving: animals are more active at night” can be used, indicating that there is less chance of encountering an animal during the day, and “You are going through an area with a higher risk of animal-vehicle collision”, signaling hotspot locations or near protected areas. Moreover, the addition of a wild animal in campaigns, such as the capybara – one of the wild animals that most causes serious accidents

in Brazil (Freitas & Barszcz 2015, Huijser et al. 2013), can call attention to the environmental problem.

The inclusion of the subject “wildlife-vehicle collisions” in the traffic campaigns could be an institutional collaboration. The national traffic department, responsible for defining the scope of the campaigns, could receive collaboration from other agents to identify the subjects that should be added. For example, with the participation of the Ministry of the Environment in the National Traffic Council, subjects that focus on environmental issues can also be defined as scope for the campaigns, as occurs in other countries (WildlifeVictoria 2020, DCI 2015, Niemi et al. 2013, Sullivan & Messmer 2003). Also, transportation users can demand some information that they are concerned about, and researchers can help to identify the locations where roadkills are concentrated and the main animal groups involved in collisions. The road concessionaires could fund some campaigns to try to avoid some financial costs due to victim compensation.

In conclusion, the evaluation of the educational campaigns from the state and national traffic departments allowed us to conclude that the subject of collisions between vehicles and animals is virtually absent from these campaigns in Brazil, even though it represents a safety risk to humans and results in lawsuits and financial loss. The subjects defined in the resolutions of the National Traffic Council do not include environmental issues. The inclusion of this environmental theme in traffic education is important so that road users - given the economic and health issues involved - may know the subject, and, from this, incorporate environmental concern into their reality, benefiting both humans and animals.

Acknowledgments

We would like to thank Eunice Kindel and Mariana Labão Catapani for their suggestions in a previous version of this manuscript which helped us to improve it; to Fernanda Zimmermann Teixeira and Andreas Kindel to our discussions and inspiration for this study. Bibiana Terra Dasoler is funded with a scholarship by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) under grant number 141090/2020-0. Larissa Oliveira Gonçalves is supported by the USP Sustainability Program (USPSusten) of the Superintendence of Environmental Management of the University of São Paulo.

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Both authors contributed to the study conception and design. Material preparation and data collection were performed by Bibiana Terra Dasoler. Analysis was done by Bibiana Terra Dasoler and Larissa Oliveira Gonçalves. The first draft of the manuscript was written by Bibiana Terra Dasoler and Larissa Oliveira Gonçalves commented on previous versions of the manuscript. Both authors read and approved the final manuscript.



SUPPLEMENTARY MATERIAL

Figure S1.
Tables SI, SII.

How to cite

DASOLER BT & GONÇALVES LO. 2023. Traffic education campaigns and animal-vehicle collisions in Brazil. *An Acad Bras Cienc* 95: e20220404. DOI 10.1590/0001-3765202320220404.

Manuscript received on May 5, 2022;
accepted for publication on December 27, 2022

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