Digital screen use for a road safety campaign message was not associated with road safety awareness of passers-by: a quasi-experimental study

Abstract

Introduction: Recent evidence suggests fatality risks for cyclists may be increasing in Britain. Understanding how to increase levels of cycling while keeping risk low is paramount. Educating drivers about cyclists may help with road safety, and mass-media messaging is a possible avenue, potentially utilizing digital displays screens in public areas. However, no studies have examined the use of these screens for road safety campaigns. *Methods:* A quasi-experiment was conducted to examine if digital screens may be effective to raise awareness of a campaign message and encourage recall of car drivers. A digital campaign image was selected that encouraged car drivers and cyclists to 'look out for each other,' and stated than 80% of cyclists owned a driving license. Views and knowledge on driver priorities around cyclists were examined before (control) and after campaign exposure (intervention), and tested using regression modelling. *Results:* 364 people were interviewed over five days. Those interviewed on intervention days were more likely to rank 'Look out for cyclists' as being more important compared to those interviewed on control days (OR 1.20), but this was not statistically significant (p=0.355). Those who said they had seen the image did not rank 'Look out for cyclists' higher than those who said they had not seen it (p=0.778). The disparity between reported and displayed percentage of cyclists with a driving license did not differ between intervention and control days, but was 8% higher amongst those who claimed to have seen the image (p=0.026). *Conclusions:* We did not find strong evidence that use of an image on digital screens increased public awareness or recall of a casualty reduction campaign message. Work is needed to investigate the effects of longer-term exposure to road safety images. *Practical applications:* Short-term use of digital signage is not recommended for raising awareness of road safety campaigns.

Keywords

Cyclist; road safety; casualty reduction; car driver behavior and education; digital screens

1 Introduction

Cycling as a means of transport provides health and environmental benefits to those who cycle as well as society as a whole (Mueller et al., 2015). It is anticipated that increasing levels of cycling for travel in the UK would lead to multiple public health improvements and consequent cost savings to the National Health Service (NHS; Jarrett et al. 2012). Improvements would be driven by a reduced prevalence of heart disease, cerebrovascular disease, depression, dementia, and diabetes (Woodcock et al., 2009). These are all conditions for which risk reductions can be achieved by participation in moderate intensity physical activity, typical of that associated with cycling. In addition, there is evidence a 'safety in numbers' phenomenon exists, where a high volume of cyclists is associated with a lower risk of injury due to reduced risk of collisions between cyclists and other road users (Elvik & Bjørnskau, 2017).

There is evidence in England that declines in cycling fatalities have been particularly focused amongst males. The male fatality rate per billion kilometers in England fell significantly from 32.1 (28.5–36.0) in 2007–2009 to 20.8 (18.1–23.9) 2010–2012, whilst the female rate remained largely unchanged (Feleke et al., 2018). Despite this, there is recent evidence that the risk per commuter cyclist may be increasing; after declining by 35.7% between 1991 and 2001, numbers of commuter cyclists killed or seriously injured (KSI) per 1000 commuters increased by 3.6% between 2001 and 2011 (Aldred et al. 2017). Understanding how best to increase levels of cycling while keeping risk of death or injury low is paramount. The UK government launched a call for evidence on this topic in 2018, with the consultation requesting evidence on how road user education can be improved to help support more and safer walking and cycling (Department for Transport, 2018a). The

theory of planned behavior (TPB) proposes that people's intentions and behaviors can be modified by changing their attitudes, perceived social norms, and perceived behavioral control over a given behavior (Ajzen, 1991). Empirically, TPB has been shown to have a moderate to strong effect on changing actual behavior when used in designing behavioral interventions (Steinmetz et al., 2016). Therefore, it is pertinent to consider this theoretical framework in road safety interventions.

Research in the UK into car driver attitudes and perceived social norms concerning aggressive driving around cyclists suggested that campaigns to reduce the negative attitudes of motorists who do not cycle themselves could reduce such driving behavior and hence potentially impact accident risk (Fruhen & Flin, 2015). Indeed, an Australian study found that drivers who were also cyclists were more likely to have positive attitudes and drive safely around cyclists, and suggested that whilst getting all car drivers cycling would not be a realistic solution, raising awareness of safe driving behaviors around cyclists could help (Johnson et al., 2014). Despite this promise, an evaluation of the Department for Transport's (DfT) 2013 THINK! education campaign, which targeted driver and cyclist awareness and behaviors in England, suggested there was very little change in self-reported driver behavior around cyclists (TNS BMRB 2014). It is unknown if this null finding was due to problems with the campaign messages or limitations in their penetration into driver consciousness due to limited public exposure.

Mass-media campaigns may have potential to change attitudes and therefore improve road safety when used in conjunction with education (Hoekstra & Wegman, 2011), with a meta-analysis of mainly mass-media road safety campaigns finding that the weighted average campaign effect was a 9% reduction in accidents (95% CI -12%, -6%; Phillips et al.,

2011). Channels for this public facing messaging include television, print, radio, websites, social media, road signs and on-vehicle messaging (The Royal Society for the Prevention of Accidents [ROSPA], 2018). The location of such messaging may have an impact on its efficacy, and research suggests that using roadside messaging, such as variable message (matrix) signs (Department for Transport, 2015) and billboards, may have a beneficial effect on speeding (Tay & De Barros, 2010), and a greater impact on accidents than campaigns using other methods (Phillips et al., 2011).

Recently, with the advance of pervasive computing (Davies et al., 2016), the availability of large-scale, digital display screens in public areas away from main highways, commonly used to show news and advertisements, offers the opportunity to communicate information to passers-by. Limited research, however, has been conducted into the efficacy of such digital screens for this purpose. An observational study in a Finnish city (n=37 interviewees) used digital screens to display 'fun facts' about the local area in public spaces, in order to examine how urban areas can be made appealing to the public (Memarovic et al., 2012). The authors found that the screens could be used to successfully communicate new information and to facilitate social interaction between those viewing that information. A small (n=35 interviewees) observational study in a residential area of a Belgian city suggested that public messaging using street infographic signs could increase public knowledge of their local area (Claes & Moere, 2013). The researchers found that 31% people stopped to read the signs, that 20% of these people remembered the exact percentages shown on the sign, whilst 54% remembered the statistics in more general terms. A study using eye tracking technology suggested that although passers-by rarely looked for long, this was often long enough to take on board some information (Dalton et al., 2015). Despite this promise, two other studies suggest that there are still barriers to the

use of digital screens. In a study of public screens in three European cities displaying events, adverts, and other information, researchers found that very few people stopped to view the content (Huang et al., 2008). Authors of a study exploring the use of 11 public displays in a German city (n=91 interviewees) suggest that this may be due to 'display blindness,' whereby the public ignores such displays, as they expect them to be uninteresting (Müller et al., 2009). No studies have examined the use of digital screens for road safety campaigns, and the conflicting findings from existing studies means the efficacy of using digital screens for disseminating mass-media information on road safety to members of the public is unknown.

The English city of Norwich (population 140,353; Office for National Statistics, 2018) has experienced a recent increase in cyclist KSIs, with the rate per 100,000 population increasing from 44.6 in 2007-11 to 58.1 in 2013 (Norfolk County Council, 2015). Norwich has recently adopted a multi-component strategy to increase cycling levels while attempting to reduce cyclists KSIs (Norfolk County Council, 2016). Digital screens, which measure around 70cm high by 40cm wide, were installed at city center bus stops and transport interchanges in Norwich in late 2016, primarily to provide transit-timetabling information. The ease by which the material displayed on the screens could be modified raised their potential for use as part of the city-wide strategy to increase cycling by promoting local events and displaying casualty reduction messaging. The efficacy of such an approach has, however, not been tested, so this article describes quasi-experimental research using the screens to test their impact on awareness, recall, and perceived importance of road safety messaging, of members of the public. The research question was: Are digital display screens a potentially effective way of: (a) raising awareness and (b) encouraging change in perceived importance of a casualty reduction campaign message?

2 Material and methods

2.1 Research design

This research took a quasi-experimental approach (Robson 2011). An image from the UK Department for Transport 'Think Cyclist' national road safety campaign, 'Let's look out for each other' (Figure 1) (Department for Transport, 2012), was displayed on digital screens at bus shelters on St Stephens Street (a major shopping and transport interchange street in central Norwich) on two intervention days (Wednesday 7 and Friday 9 February 2018). The image was specifically chosen as it was credible, being a real campaign image, and had not been used for six years prior to the experiment and had not previously been used on public displays in Norwich. The 'Think Cyclist' national road safety campaign sought to raise awareness about cyclists. It aimed to change the 'them and us' attitude between cyclists and motorists (Department for Transport, 2012), which may lead to negative attitudes towards cyclists and increase their risk of accident (Fruhen & Flin, 2015; Johnson et al., 2014), thereby targeting the first construct of the theory of planned behavior. The DfT chose to do this by highlighting that the two groups have more in common than they might think, which it illustrated by stating that 80% of cyclists also held driving licenses.

Three control days were used where no image was displayed in the week prior to the intervention (Wednesday 31 January, Thursday 1 February and Tuesday 6 February 2018). Only weekdays were selected to provide comparable context for the intervention and control periods. The weather was cold but largely dry during the study period. A comparison was made of public responses to an intercept survey on intervention and control days to determine the potential impact of the images. A quasi-experimental design was used as it was not possible to randomize days into control or intervention groups.

Figure 1. The image used for the experiment

On both intervention and control days, a street intercept survey was undertaken at times between 11:30 and 18:00 on the streets concurrently hosting the signs, by a team of nine researchers, whereby the next person passing each researcher was asked to participate. Therefore, all participants had the opportunity to see the image prior to being interviewed. Participants were given a list of five statements and asked to rank them in terms of their view of what the participant felt it was most important for car drivers to do around cyclists on the road. This was chosen to align with the message on the image. The statements were 'Look out for cyclists' (the main message on the image), and four other statements taken from the Highway Code; 'Be patient with learner drivers,' 'Do not consume alcohol,' 'Do not

use mobile phones,' and 'Stick to the speed limit.' The statement that participants selected as most important was ranked as one, through to the least important which was recorded as five. It is known that the order in which a list of items is presented is likely to influence response and therefore introduce bias (Vriens et al., 2017). Therefore, the order of the statements was randomized for each researcher. Participants were also asked what percentage of cyclists they thought had a driving license, information that was also given on the image, to test their recall of a statistic, a potentially simpler element of the campaign message.

It was hypothesized that mode of travel into the city and having seen the campaign image before elsewhere might influence participant responses. Participants were therefore asked how they travelled into the city center (which mode/s of travel were used: bus, train, bicycle, car, foot, taxi or other) and if and where they had seen the 'Let's look out for each other' image (after being shown the printed image on A4 paper). Respondent age group and gender were observed by the researcher. The interview question sheet is included as an appendix.

In addition to the interviews, members of the research team observed passers-by at one digital screen for around an hour on each intervention day, and at different times during the day. Each researcher recorded how many people passed but did not look at the image, how many glanced at the image but did not clearly read it, and how many appeared to read the display.

2.2 Data analyses

All statistical analyses were carried out using the Stata 13.1 package (Stata Corp 2015). Descriptive analyses were undertaken to compare outcomes intervention and control days. The Mann-Whitney (two-sample Wilcoxon rank-sum) equality test was used to compare the ranking of the statement 'Look out for cyclists' between those unexposed (control days) and exposed (intervention days) to the image. The test was also used to calculate a probability that the statement would be given a higher rank of importance by those interviewed on intervention rather than control days (using the 'porder' function in Stata's ranksum command). The chi-square test of independence was used to see if there was a difference in the number of respondents reporting the number of cyclists who owned a driving license as 80% (the value on the image) between intervention and control days.

Ordinal logistic regression, with the participants' 1-5 rank score given for 'Look out for cyclists' forming the outcome category, was used to examine the association between the participant-selected rank of importance of the statement 'Look out for cyclists' and exposure to the campaign image on an intervention versus control day. Odds ratios were computed, representing the odds that 'Look out for cyclists' was given a higher (more important) ranking. Differences between intervention and control days were tested by the introduction of a binary dummy variable into the model, which was set to the value of 1 for intervention and 0 for control days. The ranking of the five statements was reversed coded so that that a higher value equaled a higher importance (i.e., the value was set to 5 for those respondents who selected 'Look out for cyclists' first). Covariates of gender, age, mode of travel into the city, and whether respondents claimed to have seen the image before were added into the model to test if any potential intervention effects were robust to these factors.

Linear regression was used to investigate if exposure to the campaign image resulted in participants more accurately reporting the number of cyclists who owned a driving license. The outcome variable was the absolute difference between the percentage quoted by each participant and 80 (the value displayed on the image). Exposure was measured by the inclusion of the dummy variable into the model, and covariates of gender, age, mode of travel into the city, and whether respondents claimed to have seen the image before were again adjusted for.

2.3 Ethical approval

Approval for this study was granted by the Faculty of Medicine and Health Sciences Research Ethics Committee at UEA (reference number 2016/17 15SE).

2.4 Informed consent

The respondent received a verbal introduction to the project at the start of the intercept survey as follows: 'Norfolk County Council are asking people in the city about road safety today. I have four questions to ask you. We are not collecting any personal information. Your responses will not be shared with any organizations outside Norfolk County Council and the University of East Anglia who are analyzing findings.'

3 Results

A total of 6,271 members of the public were observed over two days when the digital screens were displaying the image. Of these, 5,636 (89.9%) did not appear to look at the

image, 454 (7.2%) appeared to glance at it, and 181 (2.9%) appeared to read it. In total, 364 participants were interviewed on five separate days; 145 when the screens were not displaying the image (control days), and 219 when they were (intervention days). Of the intercept interview participants, 53% were female, while 37% were estimated to be 16-24 years old, 40% 25-65 years, and 23% over 65 years. Regarding mode of travel into the city, 58% arrived by bus, 20% by car or taxi, 18% on foot, 5% by bicycle, and 1% by train.

In total, 51 (14.0%) of those interviewed reported that they thought they had previously seen the campaign image that was being displayed at the time of interview. On an intervention day, this figure was slightly higher (15.1%) than a control day (12.4%), although this difference was not statistically significant (p=0.475). Over one third (36.5%) of people reporting having seen the image could not recall where they had seen it. Of those that could, 19.2% said they had seen it on one of the bus screens, 9.6% said they had seen it on a bus, 7.7% on television, and 5.8% at college. Others suggested they had seen the image at the hospital, the police station, at work, on a website, in the newspaper, on the roadside, the back of a van, in another non-specific location in the city or in a different country.

Of those interviewed on intervention days, 21.5% of participants ranked 'Look out for cyclists' as the most or second most important thing drivers can do (Figure 2). This compared to 20.7% interviewed on control days. This difference was not statistically significant (p=0.481). The Mann-Whitney test suggested that those interviewed on intervention days were 53% more likely to assign a higher rank to the statement 'Look out for cyclists' (mean 2.6, median 2) than on control days (mean 2.5, median 2), although again

this difference was not statistically significant (U = 14857.5, p=0.280). Those who said they had seen the image did not rank 'Look out for cyclists' higher than those who said they had not seen it (p=0.778).

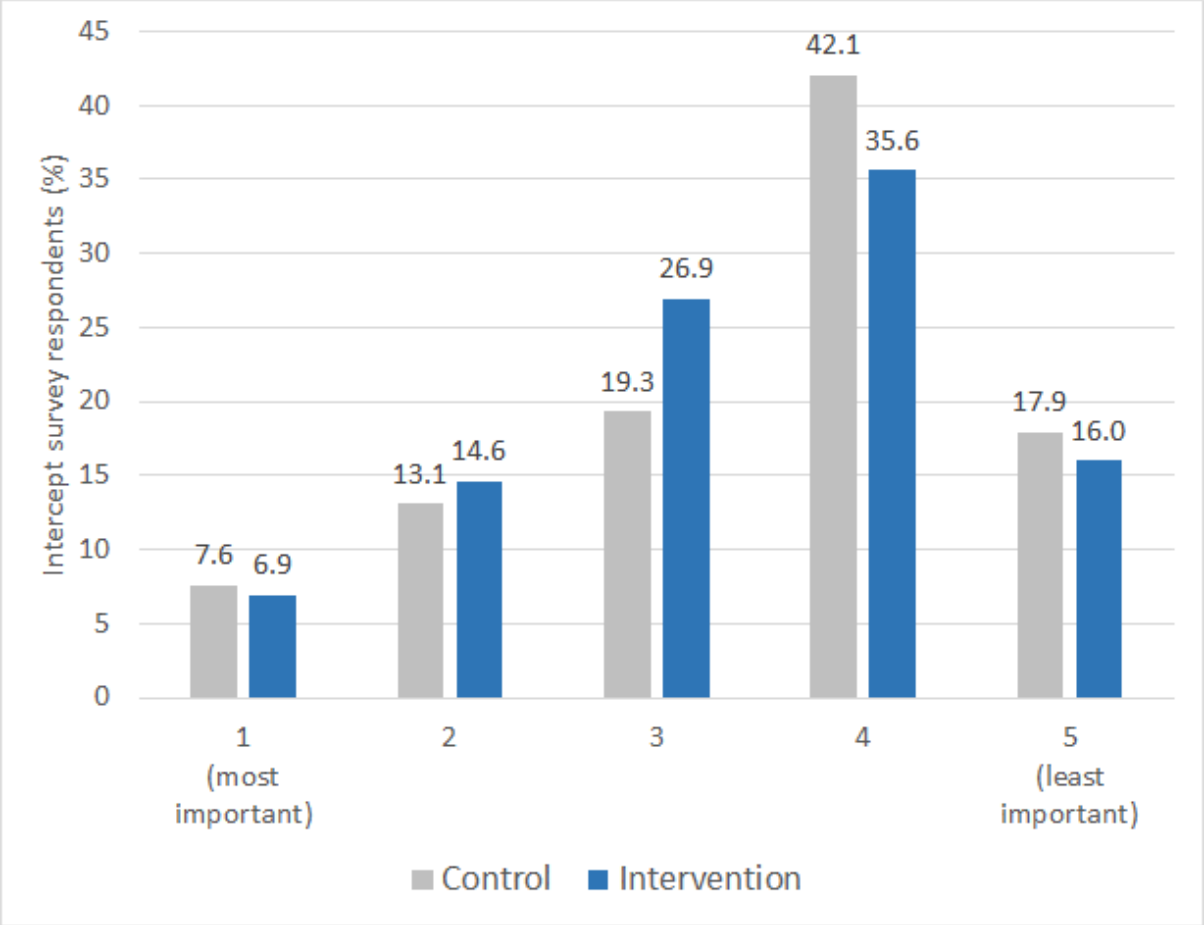

Figure 2. The perceived importance (rank) of the statement 'Look out for cyclists' of those interviewed during control and intervention days. Percentages are shown.

In total, 34 (9.3%) participants in the intercept survey correctly said that 80% of cyclists held driving licenses, and 103 (28.5%) reported a value within 10% of this. A slighter higher

percentage gave the correct value on an intervention day versus control day (10.1% vs. 8.3%), and if they reported having seen the image previously (9.8% vs. 9.3%). Neither of these differences were statistically significant (p=0.570 and p=0.902, respectively).

When covariates of gender, age, mode of travel into the city, and whether respondents claimed to have seen the image before were adjusted for using the ordinal logistic model (Table 1). Those interviewed on intervention days were 20% more likely to rank 'Look out for cyclists' as being more important compared to those interviewed on control days, (OR 1.20, 95% CI 0.82, 1.76) although this difference remained non-significant (p=0.355). Those who claimed to have seen the image previously were 4% more likely to give the statement 'Look out for cyclists' a higher rank of importance (OR 1.04 95% CI 0.60, 1.80), although this was not statistically significant (p=0.891). There were a low number of people reporting having seen the image before (n=51), and there was no evidence that this was more likely on intervention compared to control days in the model (p=0.167).

	Odds ratio	95% CI		Sig
Intervention day (ref = control day)	1.20	0.82	1.76	0.355
Seen the image before	1.04	0.60	1.80	0.891
Male	0.80	0.55	1.16	0.240
Age category (ref = 16-24 years)	1.00			
25-65 years	1.20	0.78	1.84	0.397
Over 65 years	0.91	0.55	1.51	0.721
Mode of travel: bus (ref = car, bicycle, walk, taxi or train)	1.01	0.68	1.48	0.978

Table 1. Ordinal logistic regression predicting the ranking of the statement 'Look out for cyclists' as the most important thing car drivers can do (n=364). *(NOTE: a value of 5 equals the highest rank).*

Linear regression suggested that exposure to the image on an intervention day did not decrease the difference between participant reporting of the percentage of cyclists who they thought held a driving license and the value of 80% displayed on the image. After adjustment for the covariates of age, gender, mode of travel into the city, and whether respondents claimed to have seen the image before (Table 2), the disparity between the value given and 80 was actually 1.58 (95% CI -3.39, 6.55) percentage points greater on intervention compared to control days, although this was not statistically significant

(p=0.532). In this model, the difference between reported and true value was actually 7.96 (95% CI 0.96, 14.96) percentage points greater for those who claimed to have seen the image before compared to those who did not, and this was statistically significant (p=0.026).

	Coef.	95% CI		Sig
Intervention day (ref = control day)	1.58	-3.39	6.55	0.532
Seen the image before	7.96	0.96	14.96	0.026
Male	1.23	-3.61	6.08	0.617
Age category (ref = 16-24 years)	1.00			
25-65 years	0.88	-4.73	6.49	0.757
Over 65 years	6.91	0.49	13.33	0.035
Mode of travel: bus (ref = car, bicycle, walk, taxi or train)	-5.13	-10.19	-0.07	0.047
Intercept	-31.54	-37.89	-25.19	<0.001

Table 2. Linear regression predicting percentage difference between respondents' answer and the value of 80% for the number of cyclists holding a driving license (n=362).

4 Discussion

We did not find strong evidence that exposure to a particular image on digital screens increased public awareness, changed perceived importance, or encouraged recall of a casualty reduction campaign message. Whilst intercept survey participants on intervention as opposed to control days rated the importance of car drivers looking out for cyclists slightly more highly than other road safety priorities, differences were not statistically significant. Further, those on intervention days were not more likely to correctly report the percentage value displayed on the image, and the disparity between the displayed value and response provided was actually greater amongst those who reported having seen the image before, after they were shown it during the survey. The observational component of the study suggested that passers-by largely ignored the messaging on the screens, as found in a previous study (Müller et al., 2009). This concurs with the findings of a study in three European cities (Huang et al., 2008), but contrasts with a Belgian study which found nearly a third of people stopped to read street infographic signs (Claes & Moere, 2013).

Comparisons are difficult, as the context of each of the previous studies is undoubtedly different, with the screens and signs varying in location, messaging, size, and purpose. Nevertheless, the findings from our quasi-experimental design suggest that the use of public facing messaging and mass media as a communication tool may not raise awareness of a road safety campaign or associated messaging. It may be that the location of the screens, at bus shelters, was not the most suitable for conveying road safety information, and that passers-by may have only thought the information displayed here suitable for bus users.

However, it is noted that as around 74% of the population have driving licenses (Department for Transport, 2018b), bus users are likely to be or have been car drivers too.

Indeed, it may be that personal communication and targeted messaging via avenues such as social media might be the best way to influence driver behavior and reduce accidents (Phillips et al., 2011).

In terms of the strengths of this study, it is noted that previous studies seem to have studied small numbers of respondents, whereas we were able to observe and interview a large number of individuals. This was facilitated by a large team of nine researchers, working across different days and times of the week to enable studying a variety of respondents in a quasi-experimental study. Despite the statistical power that this brings, the majority of our associations did not reach statistical significance. Having a control, something not adopted by other studies, allowed us to capture any effects of the counterfactual.

There are a number of limitations to the research. The image used was one from an historical road safety campaign, and it was possible that some respondents may have previously seen it, even though it had not been promoted locally. Despite this, 14% of participants in the intercept survey reported having previously seen the image, although these individuals were actually poorer at estimating the value displayed on the image than those who said they had not seen it. It may be that some of these participants had falsely reported having seen the image because of desirability bias, or confused it with another similar image. Those who had seen the image may not have recalled the statistic correctly due to the text in the image being too long or too small, or they may not have felt it was not relevant to the message. While the study was quasi-experimental in nature, with a control group, pragmatic considerations meant that the dates for the intercept survey could not be

randomly allocated, which raises the possibility of confounding associated with differences between the intervention and control periods. While interviewers were continuously interviewing while on the street, the survey took place in a busy locality and it is likely that only a small percentage of those passing were intercepted. This may result in selection bias, whereby those interviewed may not be representative of the wider population. This experiment was conducted over just five days, and the null findings in this research may in part be due to the fact that repeated exposure over a longer time period may be important to communicating a particular message (Wakefield et al., 2010; Schmidt & Eisend, 2015). Having the image displayed over a number of intervention weeks or months may have shown bigger differences, although this may have made it more difficult to identify individuals who had not been exposed to the image. Finally, we were not able to ascertain the impact of the campaign image on change in attitudes, intentions, or behavior for which a longitudinal study would be necessary.

5 Conclusions

The results do not suggest that short-term exposure to a casualty reduction campaign image on digital screens increases public awareness of the campaign message. Although digital displays are attractive due to their flexibility, the more transitory nature of digital images may reduce their utility in road safety campaigns compared to papers posters, which are likely to stay visible for longer. In the context of our null findings, more experimental work is needed to investigate the effects of longer-term exposure to road safety images.

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7 Declarations of interest

None

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9 Appendix: Interviewer question sheet

Norfolk County Council are asking people in the city about road safety today. I have four questions to ask you. We are not collecting any personal information. Your responses will not be shared with any organisations outside Norfolk County Council and the University of East Anglia who are analysing findings.

1. Please could you tell me how you got into the city centre today?
   [*tick all methods used in the answer matrix – bus, train, bicycle, car, foot, taxi. Specify any other modes stated.*]

2. Please would you tell me what percentage of cyclists you think hold a driving licence? [*note the percentage in the matrix*]

3. Here are five statements about things drivers could do, and I want to ask you how important you think each is [*present respondent with list of five statements*].

   Firstly, which do you think is the **most** important thing for drivers to do? [*mark this as number 1 in the matrix*].

   And which is second? [*mark as 2*]. And next? [*mark as 3*] And next? [*mark as 4*]
   - Be patient with learner drivers
   - Look out for cyclists
   - Stick to the speed limit
   - Not use mobile phones
   - Not consume alcohol

   [*make a note of any additional comments in the matrix*]

4. a) Have you seen the following image before? [*show respondent the image, printed on A4, and tick Yes or No*]

   b) If yes, do you know where? [*record the answer*]

5. [*Note the respondent's gender in the matrix, ticking Male or Female. Leave blank if not sure*]

6. [*Note the respondent's estimated age in the matrix, ticking 16-24, 25-65 or 65+*]

Thank you for your time. Are you still happy to give your consent for your data to be used? No personal data has been collected or used by us, so are you happy that you will not be able to withdraw from the study?