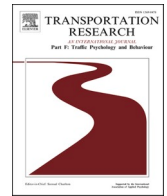




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A cluster randomised controlled trial (cRCT) evaluation of a pre-driver education intervention using the Theory of Planned Behaviour

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ABSTRACT

Road traffic injuries are the leading cause of death of 15–29-year-olds worldwide (World Health Organisation, 2018) making young driver safety a global public health concern. Pre-driver road safety education programmes are popular and commonly delivered with the aim of improving safety amongst this at risk group but have rarely been found to be effective (Kinnear, Lloyd, Helman, Husband, Scoons, Jones et al., 2013). A pre-driver education intervention (DriveFit) was designed and evaluated with a cluster randomised controlled trial (cRCT) using the Theory of Planned Behaviour (TPB) (Ajzen, 1991). The responses of 16–18-year-old students ($n = 437$) from 22 schools/colleges in Devon, UK were analysed and showed that the DriveFit intervention led to some small improvements in risk intentions, attitudes, and other measures, which differed by sub-group. Speed intentions improved immediately post-intervention (T2), whereas a composite measure of all intentions and mobile phone use intentions improved at 8–10 weeks post-intervention (T3). Apart from speed intentions, a trend towards intentions becoming safer at T3 was noted. Mobile phone use and speeding attitudes, a composite measure of attitudes, as well as attitudes to driving violations and perceptions of risk, improved at T2 and T3, with the size of the effect slightly reduced at T3. Participants expressed safe views at baseline (T1), which overall left minimal room for improvement. Whilst previous research has found that education interventions deliver small self-reported effects, that diminish over time (i.e., Poulter and McKenna, 2010), this study finds small, but lasting attitude effects (which diminish in magnitude over time) and a trend towards improving intentions, over and above the control group. The findings provide some guidance on future research to design and evaluate educational interventions for pre- and novice drivers.

1. Introduction

Young driver safety is a key public health concern. A recent World Health Organisation report (World Health Organisation, 2018) stated that road traffic injuries were the leading cause of death amongst 5–29-year-olds. In Great Britain, young drivers between the ages of 17–24 are involved in 24% of all killed and seriously injured (KSI) collisions, despite accounting for a much smaller percentage of all licence holders (7%) (RAC Foundation, 2020).

Jurisdictions throughout the world have sought to put in place robust road safety systems to support the safety of young and novice

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drivers. Several researchers have investigated the possible causal factors responsible for increased risk amongst young and novice drivers. In a critical ecological systems-based review, [Cassarino and Murphy \(2018\)](#) concluded that incomplete development of cognitive skills (i.e., hazard perception, visual scanning, managing distractions) and a greater vulnerability to social influence were particularly important areas of risk for young people. Inexperience, mobile phone distraction, drink driving, and speeding were found to be common causes of road traffic collisions for this age group. Other authors have identified impairment from fatigue as a risk factor for young driver collision risk ([Alvaro, Burnett, Kennedy, Min, McMahon, Barnes et al., 2018](#)).

Approaches to improve young driver safety have typically included some form of education. However, the evidence on the effectiveness of young and novice driver education ([Fisher and Dorn, 2016](#)) and pre-driver education programmes in particular, remains both mixed and limited. [Waylen and McKenna \(2008\)](#) found that young people exhibit several risky driving attitudes ahead of the age that they learn to drive. They argue that given, by age seventeen, attitudes are already well established there is a need to initiate driver education at a younger age to support the development of safe driving attitudes. Most young driver safety interventions typically focus on increasing awareness and knowledge of risk-taking behaviours. Whilst some of these interventions have been found to influence Theory of Planned Behaviour (TPB) ([Ajzen, 1991](#)) components such as attitudes ([Cutello, Hellier, Stander, & Hanoch, 2020a; Burgess, 2011](#)), subjective norms ([Cutello et al., 2020a; Burgess, 2011](#)) perceived behavioural control (PBC) ([Cutello et al., 2020a; Elliott & Armitage, 2009; Poulter & McKenna, 2010; Burgess, 2011](#)) and beliefs ([Cutello et al., 2020a; Poulter & McKenna, 2010; Burgess, 2011](#)), as well as knowledge ([Bojesen & Rayce, 2020; Zask, van Beurden, Brooks, & Dight, 2006](#)), this has not typically translated into lasting behaviour change ([Bojesen & Rayce, 2020; Raftery & Wundersitz, 2011](#)) or direct effects on collision risk ([Helman, Grayson & Parkes, 2010](#)). Instead, short-term benefits are common, including improvements in attitudes to risky driving ([Cutello et al., 2020a](#)) and traffic violations ([Feenstra, Ruiters & Kok, 2014](#)) as well as positive impacts on risk perception and self-efficacy ([Lanning, Melton & Abel, 2018](#)). There have also been several studies reporting no overall effect of educational interventions ([Dale, Scott & Ozakinci, 2017; Markl, 2016](#)) with the potential for unintended outcomes reported in some intervention designs ([Poulter & McKenna, 2010](#)). One of the main criticisms of educational interventions for young people is that they are rarely underpinned with behavioural theory ([Kinnear et al., 2013](#)) and there are few 'off-the-shelf' evaluated and effective provisions available ([Pressley, Fernandez-Medina, Helman, McKenna, Stradling, Husband, 2016](#)). Shortcomings in intervention design could explain the weak and inconsistent findings reported to date.

Some educational interventions rely on fear and/or threat appeals, and questions have been raised about the potential detrimental effects for young and novice drivers. A popular method for delivering fear appeal interventions is with testimonial performances by emergency service workers, bereaved family members and road traffic collision victims. Over recent years, these have been evaluated and either found no effect ([Dale et al., 2017](#)), or small, short term effects ([Cutello et al., 2020a; Poulter & McKenna, 2010](#)). Whilst threat appeals can attract attention ([Lewis, Watson, Tay & White, 2007](#)), this has not been found to reliably translate into improvements in driving behaviour ([Carey, McDermott, & Sarma, 2013](#)). It has also been suggested that threat appeals may provoke an increase in risky behaviours (*Op cit.*). However, threat appeals may have a beneficial impact on behaviour if there is a predominantly female audience, or the intervention is addressing circumstances where there is high susceptibility and high severity conditions requiring one-time only behaviours ([Tannenbaum, Hepler, Zimmerman, Saul & Jacobs, 2015](#)). Given the continuous behaviours associated with at-risk driving behaviour and young males being especially vulnerable to crash involvement compared with females ([Cassarino & Murphy, 2018](#)) threat appeal effects may be diminished in this context. Fear appeals have also been found to be counter-productive for males ([Goldenbeld, Twisk, & Houwing, 2008](#)) leading to defensive reactions such as avoidance of threatening information ([Brown & Locker, 2009](#)), and message rejection ([Hastings & MacFadyen, 2002](#)). Males have also reported being less likely to find threat-based material presented as being applicable to themselves ([Lewis et al., 2007](#)). The mixed picture related to the impact of fear appeal approaches has led some behavioural scientists and health promotion professionals to conclude that threat appeals should be used with caution.

In contrast, positive emotional appeals have been found to show promise in encouraging safety promoting behaviours, with some studies finding them to be more effective than fear appeals at increasing the relevance of and engagement with risk information ([Cutello et al., 2020b](#)). Positive emotional appeals involve the portrayal and modelling of safe driving behaviours and the positive consequences of adhering to that behaviour. This can include humour, with content that encourages empathy, role-modelling, hope and compassion. Based on the available public health research, it has been posited that they may provide an effective persuasive approach for high-risk male drivers ([Lewis, Watson, & White, 2008](#)). A positivistic non-driving focused resilience education programme implemented in Australia, reported a 44% reduction in relative crash involvement amongst young drivers ([Senserrick et al., 2009](#)). Resilience education focuses on building strengths and competencies, by encouraging young people to reflect on their behavioural tendencies, strengths, and weakness, and supports them in developing strategies for coping with risky circumstances, to help young people bounce back from adversity ([Senserrick & Kinnear, 2017](#)). The focus is not only on managing ones' own risk, but also that of peers and friends by looking out for them and promoting safety orientated social norms (*op. cit.*).

There is also the question of how the intervention message is received and processed for maximum effectiveness. Messages that are neither excessively arousing (e.g., fear appeal) or disengaging (e.g., purely factual presentation) have been found to support optimal message processing ([Rhodes, 2017](#)). The active engagement of the audience is one strategy that can be used for maintaining and managing attention ([Markl, 2016](#)). [Cuenen et al. \(2016\)](#) describe how simple energising strategies such as self-activation and social interaction can be used to avoid non-engagement. Active classroom education has been found to be more effective than other methods, through increasing engagement and enhancing cognitive ability ([Michel, Carter III & Varela, 2009; Riaz et al., 2019](#)). [Deighton and Luther \(2007\)](#) note that road safety interventions seem to be more successful when they include active participation and discussion as well personal experiences and reflective thinking and recommend the use of such interactive elements in future interventions.

Workshops can support active learning approaches and are often used within road safety education initiatives. Several workshop

programmes have reported subsequent reductions in collisions (Senserrick et al., 2009), improvements to road safety knowledge and attitudes (Treviño-Siller, Pacheco-Magaña, Bonilla-Fernández, Rueda-Neria, Arenas-Monreal, 2017) and other socio-cognitive variables (Riaz et al., 2019) whereas others have reported no impacts on perceived risks associated with unsafe driving (Glendon, McNally, Jarvis, Chalmers & Salisbury, 2014). Road safety film content is also commonly delivered to this target audience, either alongside workshops (often in the form of a discussion primer) or as stand-alone content. The effects of film content have been found to vary, depending on the nature of the content. For example, a study using fear appeal-based road trauma film content found higher driving speeds post-intervention when compared to participants who had watched a neutral film (Taubman Ben-Ari, Florian & Mikulincer, 2000). Another study by Cutello et al. (2020b), which evaluated an intervention to reduce risky driving behaviours, showed that a positively framed film significantly decreased self-reported risky driving behaviours when delivered in both 2D and virtual reality (VR) formats, although it was especially true in the VR format. In contrast, the fear appeal film, when shown in VR, failed to reduce risky driving behaviours and increased young drivers self-reported risky driving behaviours.

Previous research, then, demonstrates a lack of consensus about how pre-driver education can best be designed and delivered to improve young driver safety. Interventions have frequently been delivered in a non-scientific way, often designed by road safety professionals based on prevailing beliefs about what works, with evaluations - where they are run - often being poorly conducted, not controlling for the quality of the programmes assessed. The failure to systematically evaluate interventions means that previous research has not been built on to develop a robust evidence base (Lonerio & Mayhew, 2010). The present study aims to empirically evaluate the effectiveness of a newly designed positively framed education programme called 'DriveFit'. The Theory of Planned Behaviour (TPB) (Ajzen, 1991) was used as the theoretical basis for the design and evaluation of the intervention, as recommended by previous studies (Poulter & McKenna, 2010). The TPB is based on the premise that attitudes, subjective norms, and perceived behavioural control, shape an individual's behavioural intentions and behaviours. It is one of the most commonly applied theories in psychosocial interventions for health promotion (Solomon & Cavanaugh, 2015), with demonstrable effects on achieving positive health outcomes (Webb, Joseph, Yardley & Michie, 2010) including within road safety (e.g., Stead, Tagg, MacKintosh & Eadie, 2005).

Four hypotheses were tested:

1. Compared with baseline (T1), DriveFit improves self-reported intentions towards road safety amongst 16–18-year-old pre-drivers and newly qualified drivers immediately after delivery (T2) compared to a no-treatment wait list control group;
2. Compared with T1, DriveFit improves self-reported intentions towards road safety amongst 16–18-year-old pre-drivers and newly qualified drivers 8–10 weeks after delivery (T3) compared to a no-treatment wait list control group;
3. Compared with T1, DriveFit improves self-reported socio-cognitive measures (attitudes, subjective norms, and perceived behavioural control), perception of risk, attitudes towards driving violations, driver coping and efficacy amongst 16–18-year-old pre-drivers and newly qualified drivers at T2 when compared to a no-treatment wait list control group; and
4. Compared with T1, DriveFit improves self-reported positive socio-cognitive measures (attitudes, subjective norms and perceived behavioural control), perception of risk, attitudes to driving violations, driver coping and efficacy amongst 16–18-year-old pre-drivers and newly qualified drivers at T3 when compared to a no-treatment wait list control group.

2. Method

2.1. Design of DriveFit

Considering previous studies on intervention effectiveness, the DriveFit intervention was designed to consist of a 40-minute film delivered in the classroom followed by a 45-minute online facilitated workshop within 2-weeks of the film. The two-part approach adopted aimed to extend the duration of the intervention, given concerns raised by previous research about the importance of intervention dosage (Glendon et al., 2014; Kinnear, Pressley, Posner & Jenkins, 2017; Markl, 2016; Poulter & McKenna, 2010).

The film was designed with reference to the Theory of Planned Behaviour (TPB) (Ajzen, 1991), made use of Behaviour Change Techniques (BCTs) (Michie et al., 2013), and was piloted with the target audience. The overall logic model for the intervention reflected that, in the short term, the intervention sought to change attitudes, subjective norms and perceived behavioural control to result in safer passenger and driver intentions. The film used a talk show style interview format where expert guests provided information, demonstrations, and tips about how pre-, learner and newly qualified drivers can best manage the learning to drive process as well as the risky driving behaviours associated with speeding, tiredness, mobile phone use and intoxicated driving (drink and drug driving)¹. The film content for each of the topics addressed was informed through an analysis of the behavioural, normative and control beliefs of the target audience, elicited through an evaluation of the literature, focus group discussions with the target group and an observation of existing provisions. For example, the film addressed, amongst others, various speeding beliefs: driving at the speed limit makes it easier to detect hazards and uses less fuel (Elliott & Armitage, 2009) (Behavioural beliefs); speeding is disapproved of by the police and attracts citations (Rowe et al., 2016) (Normative beliefs); and the importance of and process for selecting a safe speed

¹ DriveFit film clip <https://vimeo.com/686692595/f72523ab34>.

(Fylan, personal communication about NDORS Speed awareness course content, February 24th, 2021) (Control beliefs). The film employed a total of 16 BCTs² from the 93-item hierarchically clustered techniques Behaviour Change Technique taxonomy (Michie et al., 2013), 11 of which had been identified by previous research as high potential BCTs for this target audience (Fylan, 2017; Sullman, 2017). BCTs are “Observable, replicable and irreducible component[s] of an intervention designed to alter or redirect causal processes that regulate behaviour” (Michie et al., 2013, p.82). Historically, a lack of standard BCT definitions has affected BCT identification and replication of intervention effectiveness (Abraham & Michie, 2008).

The workshop that followed the film used the ORID (Objective; Reflective; Interpretive and Decisional) framework (ICA-UK, 2014) to encourage the participants to remember the film and extract relevant learning for their own personal situations. The workshops were delivered by one of two commissioned professional facilitators (one accredited with the International Association of Facilitators, with over 40 years’ experience and the other working at this standard with over 4 years’ experience), who delivered the 45-minute workshop to a pre-defined protocol, with a random sample of workshops observed by the researcher to check fidelity. The facilitators were experts in facilitation, rather than road safety and were supported by the study researcher before and after workshop sessions to address any subject matter issues raised. The 45-minute workshop was delivered in four parts: an introduction and warm-up, remembering and reviewing the DriveFit film, personal action planning and concluding with a summary of the discussion and participants completing the post-intervention survey. For the introduction, participants were given information on the format for the session, to increase engagement during the workshop participants were introduced to the Mentimeter voting tool and then asked to submit their answers to a warm-up poll about their learning to drive stage. This was followed by a review of what participants remembered about the DriveFit film using an all class Mentimeter poll, a paired student discussion with post-discussion feedback reported to the facilitator and peers, followed by a class discussion and a facilitator led review of the key film themes. Participants reviewed how easy or difficult they expected to find the take up the actions promoted by the DriveFit film (e.g., Managing my driving speed) and identified scenarios they were most likely to find themselves in. The situations that they scored as easy or difficult to deal with were then discussed amongst their peers. The participants reflected on these situations and considered what actions they could take, what barriers they might face and what ‘if-then’ implementation intention plans they could apply to these situations, supported with worked examples (Box, 2021a). The participants were then invited to commit to their if-then plans / implementation intentions by completing a DriveFit postcard for them to retain. Implementation intentions were employed based on previous research showing that behavioural intentions result in desired behaviours in both broader public health (Gollwitzer, 1999; Gollwitzer & Sheeran, 2006; Sheeran & Orbell, 1999; Webb & Sheeran, 2006), and road safety outcomes (Brewster, Elliott & Kelly, 2015), as well as it having been recommended for trialling in pre-driver interventions (Cuenen, Brijs, Brijs, Van Vlierden, Daniels & Wets, 2016; Poulter & McKenna, 2010). Brewster et al. (2015) tested the effects of implementation intentions, supported by volitional help sheets, in the context of drivers’ speeding behaviours and found that implementation intentions were effective at reducing speeding, by reducing the effect of habit and allowing drivers to behave in accordance with their goal intentions. This was found to be particularly the case where attitudes were relatively safe at baseline. A website (<https://www.drivefit.info>) was also available to support the programme and provide additional information to students, parents, and guardians.

2.2. Design and procedure

To evaluate the DriveFit programme, a school/college-based cluster randomised controlled trial (cRCT) was conducted within government-funded, non-free paying (state), all-ability, co-educational schools/colleges in Devon, UK. cRCTs are an ideal research design for evaluating the effectiveness of educational interventions delivered in school and college settings and is a research design commonly applied within the medical research field. To date only one other study evaluating young and novice driver education (Bojesen & Rayce, 2020) has employed this robust research design. The protocol for the trial was developed, delivered, and reported on in accordance with CONSORT 2010 guidelines (Schulz, Altman, & Moher, 2010) and Standard Protocol Items: Recommendations for Intervention Trials (SPIRIT) guidance (Chan, Tetzlaff, Gotzsche, Krleza-Jeric, Hrobjartsson, Mann et al., 2013) and the study was retrospectively registered with the ISRCTN (Box, 2021b). Ethical approval for the study was gained from the Cranfield University Research Ethics Committee (CURES/3733/2018) and all data for the study was collected and managed in line with GDPR requirements.

Fifty-six government-funded, non-free paying (state), all-ability, co-educational schools/colleges with a mixture of socioeconomic status, representative of county level variability, were invited to take part in the study. Head teachers, sixth form and college leaders from all eligible schools were sent an invitation letter and school information sheet with details of how to take part in the trial in July 2021. Participating schools and colleges were offered a £200 cash incentive for taking part in the trial.

Documents describing the study procedures (e.g., student recruitment and consent, measurements³) including an electronic link to an information video describing the PdTWER project⁴ can be found online. A follow-up email to each school/college was sent to confirm their involvement or to secure their consent to participate if a response had not yet been received. Up to ninety participants

² 1.1 Goal setting (behaviour), 1.2 Problem solving, 1.4 Action planning, 1.9 Commitment, 2.3, Self-monitoring of behaviour, 3.1 Social support (unspecified), 3.2 Social support (practical), 4.1 Instruction on how to perform the behaviour, 4.2 Information about antecedents, 5.1 Information about health consequences, 5.3 Information about social and environmental consequences, 5.5 Anticipated regret, 6.1 Demonstration of the behaviour, 6.3 Information about others’ approval, 7.1 Prompts/cues, 9.1 Credible source.

³ https://www.racfoundation.org/wp-content/uploads/School-I-College-information-sheet_Study-4-Devon.pdf.

⁴ <https://www.racfoundation.org/wp-content/uploads/PdTWER-School-and-college-trial-recruitment-Study-4-Devon.mp4>.

(16–18 years) in 40 participating schools/colleges were eligible to participate in study measurements. To estimate the required sample size an online calculator (Kohn & Senyak, 2021), with results based on Donner, Birkett & Buck (1981), was used to establish the number of participants per group required within a standard randomised controlled trial, adjusted for a cRCT using the following parameters: Power = 80%, significance level = 5%, SD = 1.1 based on a review of Poulter and McKenna (2010) (Range: 1.28–1.68; M = 1.46) and other evaluation surveys run as an earlier part of this research study programme (Range: 0.6–1.45; M = 1.01), with an intraclass correlation coefficient of 0.05 (Cohen, 1988; Hutchison, 2009; Hutchison & Styles, 2010; Lin, Strong, Scott, Broström, Pakpour & Webb, 2018) and average cluster size = 60 (two classes within each school). Students received a participant information sheet and consent form to complete before taking part in the online baseline (T1) and post-intervention surveys (T2 and T3). Participants were informed that they could discontinue all or any part of the study (either or both measurements and intervention) at any time, up until two-months post-intervention, with no impact on their education.

Following recruitment, T1 survey measurements were taken in September 2021 (see section 2.3), after which participating schools/colleges were randomised to control (no-treatment wait list control) and intervention (DriveFit) groups through stratified randomisation, based on the percentage of disadvantaged students (below and above participating school/college median calculated from data accessed from gov.uk for the number of disadvantaged students completing study within each school/college⁵) and type of educational establishment (school or college). Randomisation was stratified by these variables given the evidence of differential road safety outcomes by both education type (e.g., Riaz et al., 2019) and disadvantage (e.g., Christie, Kimberlee, Lyons, Towner, & Ward, 2008). Randomisation lists for each stratum were prepared in Excel using random number generation for allocation by an employed trials advisor independent from the study management team who had previous cRCT trial expertise. Randomisation took place after T1 measurements were complete to ensure schools and participants were unaware of their group allocation at T1. Following randomisation, it was not possible to blind participants to randomised allocation as the intervention schools were aware that they were receiving an intervention and the researcher was aware of intervention groups whilst conducting the analysis. The control groups ran under wait list control conditions and received no-treatment or 'usual care' during survey data collection. Following the completion of the trial, the control groups were offered part of the intervention (film only) to watch within their classrooms. The trial was delivered between November 2021 and January 2022.

2.3. Dependent measures

The questionnaire administered to evaluate the intervention consisted of five sections. The first included socio-demographic questions about gender, age and ethnicity as well as school/college attendance, form tutor information and first and surname details for survey matching purposes (matched in R, version 4.1.2, with the 'RecordLinkage' package, version 0.4–12.1).

The second section included questions about participants learning to drive stage, hours and months of driving practice achieved/expected before taking their driving test, actual/planned supervising driver type and the number of cars/van available for use within the household. The subsequent sections included the intention, attitude and other survey measures which are outlined in the sections that follow.

In addition to participant data collection at baseline (T1), data was collected immediately after the workshop (T2) and 8–10 weeks after intervention delivery (T3). The primary outcome measurement for evaluating DriveFit was follow-up at T2 and T3 adjusted for T1 in self-reported intentions related to mobile phone use whilst driving (INT_MOB), drink driving (INT_ALCO), driving whilst tired (INT_FATIGUE) and speeding (INT_SPEED) as well as a composite all intentions measures (INT_ALL) (See Annex A1). These items were adapted from standardised Theory of Planned Behaviour (TPB) measures (Conner & Sparks, 2005; Rowe et al., 2016). Cronbach alpha scores were calculated to ensure that the items were measuring the same construct (See: Annex A1). For all measures, a Cronbach's alpha of 0.65 or higher was considered satisfactory for data clustering (Field, 2013). All survey items were coded so that lower scores indicated safer intentions. The composite measure for INT_ALL, excluded the INT_ALCO measure, as this measure experienced floor effects and was therefore not considered appropriate to include within the composite measure of intention.

The secondary outcome measurement for evaluating DriveFit was follow-up at T2 and T3 adjusted for T1 in self-reported attitudes related to mobile phone use whilst driving (ATT_MOB), drink driving (ATT_ALCO), driving whilst tired (ATT_FATIGUE) and speeding (ATT_SPEED) as well as a composite all attitudes measure (ATT_ALL) with drink driving responses excluded from the composite attitude measure for the same reasons as outlined for the composite intention score.

Self-reported TPB measures for subjective norms (SNORM) and perceived behavioural control (PBC) items related to speeding were also measured and analysed in the same way, as were responses to four other standardised survey sets: an adapted perception of risk scale (P_RISK) (Glendon et al., 2014; Ivers et al., 2009); the Attitudes to Driving Violations Scale (ADVS) (West & Hall, 1997); four measures adapted from the task-focused items on the Driver Coping Questionnaire (DCQ) Scale (Matthews, Desmond, Joyner, Carcary, & Gilliland, 1996) and an adapted efficacy measure (EFF) for pre-drivers (Ford, Weissbein, Smith, Gully & Salas, 1998). The intervention group were also asked questions to assess their cognitive (POS_COG_FILM and POS_COG_WRKSH) and emotional (NEG_EMO_FILM and NEG_EMO_WRKSH) response to the programme, using measures devised by Cuenen et al. (2016). Emotional response was evaluated to assess whether the programme was received as intended (i.e., not evoking fear). The face validity of the programme (FCVALD) was also tested through adapting six item measures previously used for the assessment of the Safe Drive Stay Alive testimonial interventions delivered in Surrey and Greater Manchester, UK (Road Safety Analysis, 2015). Participants were asked to provide

⁵ <https://www.find-school-performance-data.service.gov.uk/#SearchSchools> <https://www.find-school-performance-data.service.gov.uk/#SearchSchoolshttps://www.find-school-performance-data.service.gov.uk/#SearchSchools>

any further comments about the DriveFit intervention and select whether they would like to take part in a focus group to discuss their views on and experiences of DriveFit.

In addition, a process evaluation was conducted to examine the action model for the DriveFit programme. Process evaluations are “used to monitor and document programme implementation to aid in understanding the relationship between specific programme elements and outcomes” (p.134) (Saunders, Evans, & Joshi, 2005). The process evaluation questions used within the study emulated those depicted in Saunders et al (2005) process-evaluation plan to assess the implementation of a targeted health promotion intervention. They have also been developed with reference to Medical Research Council guidance for conducting process evaluations of complex interventions (Moore, Audrey, Barker, Bond, Bonell, Hardeman et al., 2015).

2.4. Analysis

Generalized Estimating Equations (GEE) is a method for modelling longitudinal or clustered data and is typically used to model non-normal data. It is “a marginal model that allows for the effect of explanatory variables on the outcome and correlation between observations to be modelled separately. The treatment group coefficient from the model represents the average difference between the treatment and control groups” (p.111) (Campbell & Walters, 2014). The responses to the survey measures at T2 and T3 were compared between intervention and control groups using GEE, with adjustments made for T1 values for all measures. GEE estimates the regression coefficients for marginal models (Liang & Zeger, 1986) and a working correlation matrix is specified to model the correlation between individuals within clusters. An estimate of the intervention effect, 95% CI and p value was calculated. The analysis was run in SPSS version 28.

The GEE model applied used Gamma with log link to account for the positively skewed data, with the following parameters: Condition (Control, Intervention); T1 value of the outcome (included as a covariate in the model to understand the impact of condition on measure, after controlling for measure values reported at T1); Gender (Male, Female); Age (16, 17, 18+); Driving Stage (I have passed my test or are currently learning, Learning in the next 12 months – 5 years, Maybe learning at some point – never learning); Ethnicity (White, Non-white); Education type (College, School); School/college disadvantage level (Below median, Above median); the number of cars in a household (Low: 0–1 cars, Medium: 2–3 cars, High: 4–5+ cars) and time between survey completion (T1_T2: 3–4 weeks; 5–6 weeks; 7–8 weeks; 9–10 weeks; 11–12 weeks; Over 12 weeks and T1_T3: 11–12 weeks; 13–14 weeks; 15–16 weeks; 17–18 weeks; over 19 weeks). Control variables were selected based on evidence of their impact on road safety outcomes (i.e., Age and gender, (Rhodes & Pivik, 2011); driving stage (Roman, Poulter, Barker, Mckenna, & Rowe, 2015; Waylen & McKenna, 2008); ethnicity

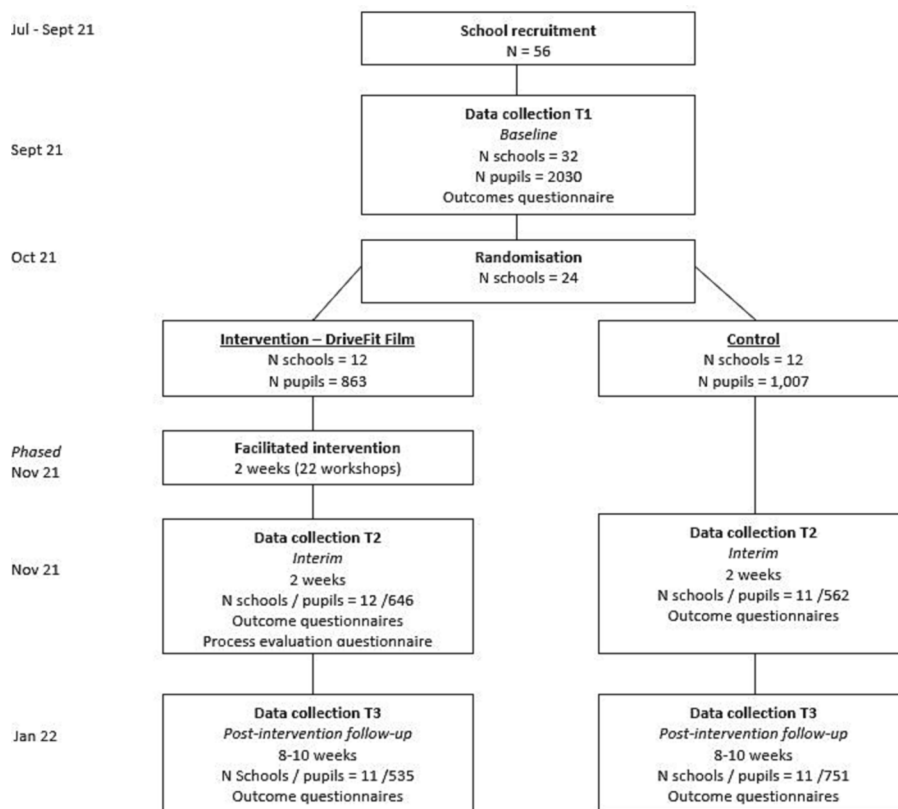


Fig. 1. Measurement sessions for DriveFit cRCT.

(Boufous et al., 2010; Christie et al., 2008); education type (Riaz et al., 2019); disadvantage (Christie et al., 2008) and number of cars in the household as a proxy for socioeconomic status (Chen et al., 2010)). Time was also included in the model to account for variations in survey response times at T2 and T3.

The GEE models included a subject variable (school ID) which assumes that observations in separate clusters (schools/colleges) are independent, and that observations within a cluster (school/college) may be correlated. An exchangeable correlation structure was applied, which assumes all pairs of responses within a subject (school/college) are equally correlated. Participants with a missing value of the outcome at T3 follow-up were excluded from the analysis at T2 and T3. Sub-group analysis by prespecified moderators (Gender, Education type and School/college level deprivation) was performed. The interaction between randomised group and each moderator was also stratified if the interaction was $p < 0.05$, with the intervention effect (difference between intervention and control, and 95% CI) estimated (i.e., model values, rather than raw means) for each sub-group.

To establish whether there were any significant differences between the control and intervention groups or by survey response, a two-way ANOVA was conducted to examine the effects of condition (Intervention/control) and response (T1 only/T1-T3 responses) at T1 for all survey scale items. A chi-square analysis was also conducted to establish whether there were any significant differences, by condition or response for the categorical socio-demographic variables. Finally, ANOVAs were conducted on the final dataset of responses (connected participant data at T1, T2 and T3), to establish whether there was any difference in response by socio-demographic groups at T1.

3. Results

3.1. Descriptives

A total of 2030 participants from 32 schools/colleges returned a questionnaire at T1, following an initial request to participate in the study being sent to a total of 56 schools/colleges. The measurement sessions for the DriveFit cRCT are outlined in Fig. 1 below.

Only 24 of the 32 schools/colleges that had responded at T1 were eligible to progress in the trial (i.e., 8 schools/colleges returned < 30 student responses at T1 and were excluded from the trial). Following survey matching across the study period (T1-T3, using surname and school/college attendance), valid data was collected for 437 participants from 22 schools/colleges (Control: $n = 210$, DriveFit: $n = 227$). This represents a significant drop out rate, due to school/college level (i.e., teacher) and student motivation to complete all three surveys so that responses from individuals could be joined across all three measurement periods. The intervention was delivered remotely (i.e., by pre-recorded film and online workshop), and was therefore reliant on schools/college teachers to promote survey completion amongst students. The last survey for the intervention group (T3) was completed at the end of the facilitated workshop, prompted by the facilitator. The trial was delivered during a testing time for schools/colleges (e.g., catch-up learning following Covid lockdowns and Covid related absences from the classroom), which was also a contributory factor in response rates and school level drop-out. Survey length may also have been a contributory factor in response rates. The descriptive features of the sample are described in Table 1.

The Chi-square tests for association that were conducted to determine differences in the proportion of socio-demographic categorical variables for 1) control participants at T1 only and T3; 2) intervention participants at T1 only and T3; 3) T3 responses for control and intervention groups found some differences in group characteristics, with some groups not being well represented within the final T3 data analysis (i.e., T1 only and valid T3 control responses: education type $X^2(1, 1007) = 10.97, p < .001$) and disadvantage level (i.e., above or below median school level disadvantage) $X^2(1, 1007) = 4.34, p = .037$). The GEE analysis method employed in this study controls for socio-demographic factors and considers any variation in sample characteristics and does not present limitations for

Table 1
Descriptive statistics of participants in randomised controlled trial.

		Control group	Intervention
<i>n</i> schools/colleges		11	11
<i>n</i> participants		210	227
Age (SD)		16.24 (0.49)	16.36 (0.60)
Gender	Male (%)	99 (47.2)	79 (34.8)
	Female (%)	104 (49.5)	143 (63.0)
	Unknown (%)	7 (3.3)	5 (2.2)
Driving stage	Passed test or currently learning (%)	29 (13.8)	35 (15.4)
	Learning in the next 12 mnths – 5 yrs	163 (77.6)	164 (72.2)
	Maybe learning at some point or never learning	18 (8.6)	28 (12.3)
No. household cars	Low (0–1 cars)	51 (24.3)	56 (24.7)
	Medium (2–3 cars)	146 (69.5)	135 (59.5)
	High (4–5 + cars)	13 (6.2)	36 (15.9)
Ethnicity	White	194 (92.4)	212 (93.4)
	Non-white	12 (5.7)	11 (4.8)
	Unknown (%)	4 (1.9)	4 (1.8)
Education type	College	107 (51.0)	139 (61.2)
	School	103 (49.0)	88 (38.8)
Disadvantage level	Below median	147 (70.0)	82 (36.1)
	Above median	63 (30.0)	145 (63.9)

the interpretation of the GEE results. At T1, both intervention and control groups were largely road safety supportive (See Table 2).

A two-way ANOVA was conducted to assess whether there was any difference in the responses at T1 for those participants that had responded at all timepoints. The results show that for INT_ALL ($F(1,1785) = 4.171, p = .041, \eta_p^2 = 0.002$), INT_MOB ($F(1,1785) = 4.372, p = .037, \eta_p^2 = 0.002$), INT_ALCO ($F(1,1785) = 3.796, p = .052, \eta_p^2 = 0.002$) and PBC ($F(1,1785) = 7.591, p = .006, \eta_p^2 = 0.004$) there was a statistically significant difference between the survey responses received at T1 by those participants who completed the T1 survey only and those who completed the surveys for all measurement periods. This indicates that participants who completed the survey at all measurement periods, had safer views on some measures, in comparison to those who discontinued involvement in the study at T1. This has been taken account in the interpretation of the results.

One-way ANOVAs were also conducted to establish whether there was any difference in the responses (for respondents providing data at all timepoints) at T1 by sub-groups. Across the majority of measures a main effect of gender was found, with females reporting safer road safety intentions, attitudes and other responses than males (e.g., INT_MOB, $F(1,421) = 13.070, p < .001, \eta_p^2 = 0.030$). However, there were some measures (i.e., INT_ALCO, INT_FATIGUE, PBC and EFF) where there was no statistical difference at T1 between males and females (e.g., INT_FATIGUE, $F(1,421) = 1.930, p = .165, \eta_p^2 = 0.005$). There was no differential effect by age (e.g., INT_ALL, $F(2,431) = 0.507, p = .603, \eta_p^2 = 0.002$), ethnicity (e.g., ATT_SPEED, $F(1,419) = 0.415, p = .520, \eta_p^2 = 0.001$), education type (e.g., PBC, $F(1,426) = 0.002, p = .961, \eta_p^2 = 0.000$) or disadvantage level (e.g. INT_FATIGUE, $F(1,432) = 0.035, p = .851, \eta_p^2 = 0.000$) at T1. A differential effect by driving stage was found for several of the measures (i.e., INT_ALCO, ATT_ALL, ATT_MOB, ATT_ALCO, ATT_FATIGUE, PBC). Where there was a differential effect, the safest responses were provided by respondents closer to licensure (i.e., having passed their test/learning to drive). The only variation to this was found for PBC ($F(1,425) = 9.784, p < .001, \eta_p^2 = 0.044$), where those who were planning to learn to drive in the next 12 months – 5 years, provided a safer response (i.e., more control) than those that had already passed their driving test/were currently learning to drive and those that were maybe/never learning to drive. A differential effect by the number of household cars was found for INT_ALCO ($F(2,431) = 3.816, p = .023, \eta_p^2 = 0.017$), where responses were least safe for those in low car ownership households and the most safe for those in medium car ownership households. Given car ownership had been used in this study as a proxy for SES and lower SES has been associated with increased relative crash risk (e.g., Chen et al., 2010), this finding contributes to the evidence base about the types of risk behaviours that certain sub-groups maybe at greater risk from engaging in.

3.2. GEE results

3.2.1. Intentions

The GEE model outputs (See Fig. 2) show that DriveFit had a small beneficial effect on speed intentions at T2 and on the composite measure of all intentions and mobile phone intentions at T3, when compared to the control condition. The intervention speed intentions effect at T2 (Intervention vs control difference: $B = -0.052$ with CI -0.101, -0.004, $p = .036$) equates to a 1/20th of a scale point improvement in speed intentions. Mobile phone intention at T3, the largest improvement noted ($B = -0.086$ with CI -0.157, -0.015, $p = .018$) equates to a 1/12th of a scale point improvement in mobile phone use intentions. As outlined in Table 2, it should be noted that for all measures, participants provided largely safe responses at T1, meaning that there was minimal room for improvement, which may in part explain the modest improvement in scores. Apart from speed intentions, there is a trend towards intentions becoming safer at T3 than at T2.

Post-hoc exploratory analyses were run to investigate sub-group differences. The results show that the programme had a beneficial effect for females for all significant condition outcomes (T2_INT_SPEED: $B = -0.063$ with CI -0.101, -0.025, $p = .001$; T3_INT_MOB: $B = -0.140$ with CI -0.231, -0.048, $p = .003$; T3_INT_ALL: $B = -0.103$ with CI -0.157, -0.049, $p = .002$).

Table 2

Reliability and mean scores for socio-cognitive behavioural variables drawn from the Theory of Planned Behaviour and other measures, at T1 for control and intervention groups.

Variable	Cronbach's α	Control group ($n = 209^a$) Mean (SD) T1	Intervention group ($n = 225^a$) Mean (SD) T1
INT_ALL	0.80	1.80 (0.72)	1.75 (0.83)
INT_MOB	0.87	1.39 (1.29)	1.44 (0.89)
INT_ALCO	0.88	1.08 (1.08)	1.10 (0.48)
INT_FATIGUE	0.81	2.08 (2.07)	2.00 (1.14)
INT_SPEED	0.90	1.91 (1.91) ^b	1.80 (1.12) [*]
ATT_ALL	0.91	1.61 (0.60)	1.55 (0.76)
ATT_MOB	0.82	1.36 (0.56)	1.39 (0.77)
ATT_ALCO	0.73	1.11 (0.35)	1.15 (0.59)
ATT_FATIGUE	0.88	1.71 (0.76)	1.65 (0.84)
ATT_SPEED	0.90	1.77 (0.95) ^b	1.60 (0.96) [*]
PBC	–	1.98 (1.51) ^b	2.04 (1.76) [*]
SNORM	0.77	1.46 (0.81) ^b	1.52 (1.03) [*]
ADVS	0.66	17.77 (3.35) ^b	17.27 (3.60) [*]
P_RISK	0.68	17.78 (2.78) ^c	17.74 (3.15) ^{**}
DCQ	0.84	8.03 (4.11) ^c	7.97 (4.36) ^{**}
EFF	–	1.63 (1.14) ^d	1.78 (1.31) ^{***}

^a Unless otherwise specified ^b $n = 206$ ^c $n = 204$ ^d $n = 199$ ^{*} $n = 222$ ^{**} $n = 221$ ^{***} $n = 219$.

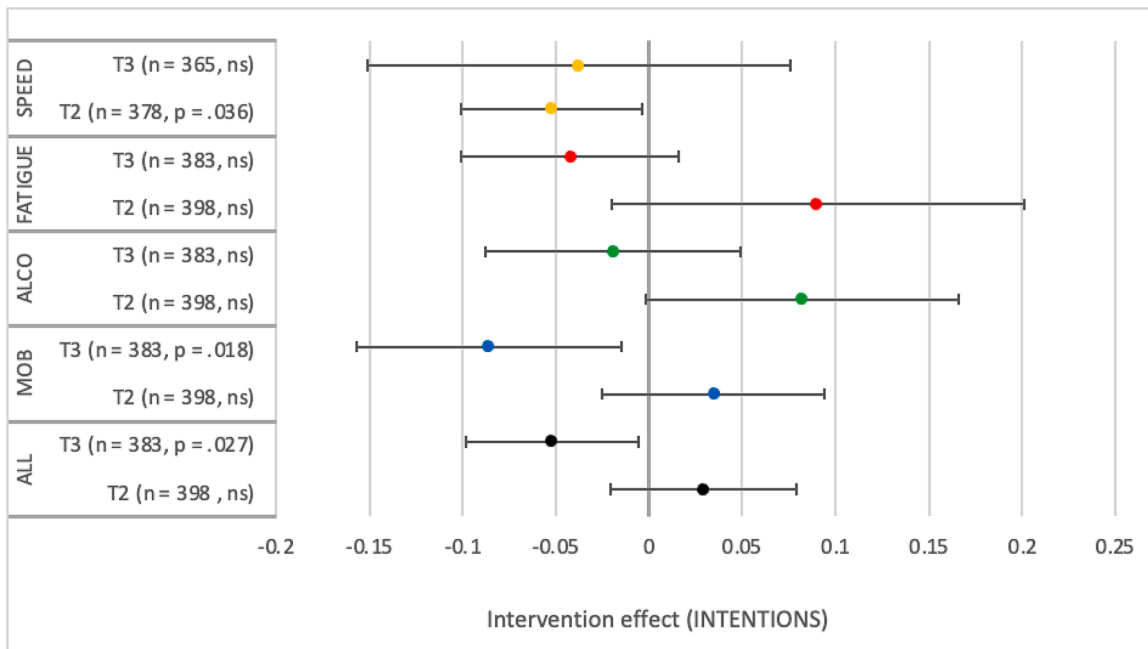


Fig. 2. Intervention effect on intention outcomes presented as T1-adjusted difference to control, with 95% Confidence Intervals.

3.2.2. Attitudes

The effect of DriveFit on attitudes was found to be greater than for that of intentions. Significant beneficial effects were seen at T2 and T3 for mobile phone use and speeding attitudes as well as for the composite measure of all attitudes, with the magnitude of the effects diminishing slightly between T2 and T3. A significant beneficial effect on fatigue attitudes was found at T2, but this was not significant at T3. In contrast, a significant beneficial effect for drink driving attitudes was found at T3, but not at T2 (See Fig. 3). DriveFit had the largest beneficial effect at T2 on mobile phone attitudes ($B = -0.206$ with CI $-0.261, -0.150, p < .001$) and the composite measure of all attitudes ($B = -0.168$ with CI $-0.217, -0.118, p < .001$).

The post-hoc exploratory analyses run for these measures indicates that DriveFit typically had a greater beneficial effect for

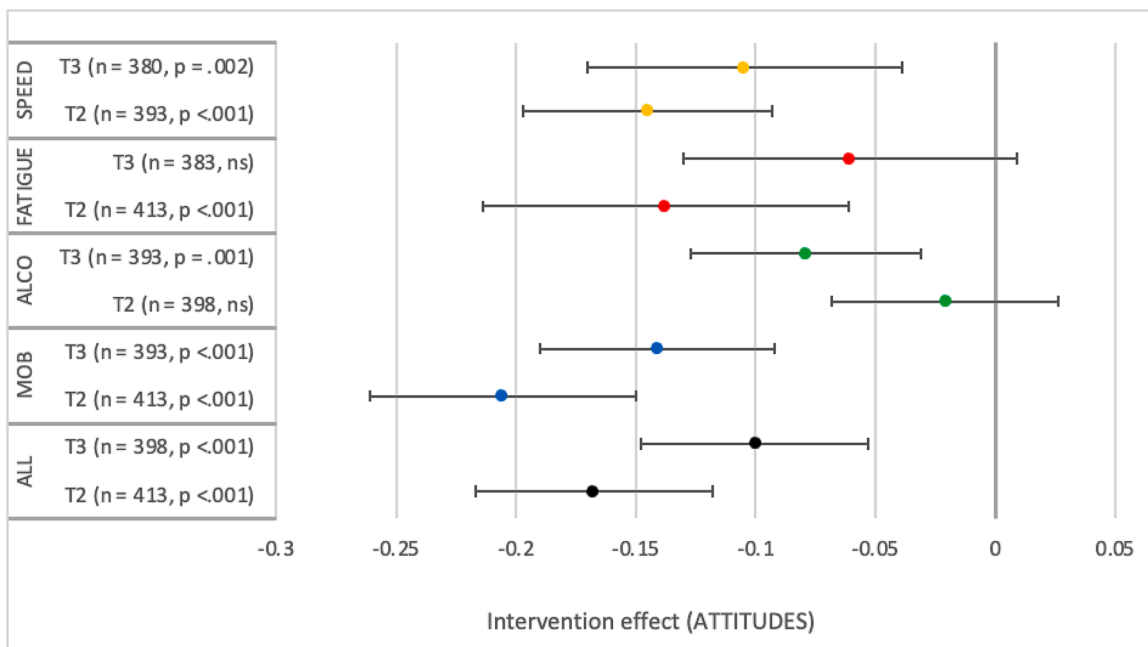


Fig. 3. Intervention effect on attitude outcomes presented as T1-adjusted difference to control, with 95% Confidence Intervals.

females, than for males (i.e., T2_ATT_ALL- Female: $B = -0.218$ with CI $-0.253, -0.182, p = .000$, Male: $B = -0.102$ with CI $-0.194, -0.010, p = .029$), apart from for mobile phone use attitudes and drink driving attitudes where there was a similar order of magnitude effect for males and females at T3 for mobile phone use (Female: $B = -0.145$ with CI $-0.236, -0.054, p < .001$, Male: $B = -0.153$ with CI $-0.277, -0.029, p = .015$) and greater effects for males for drink driving attitudes (Female: $B = 0.070$ with CI $-0.109, -0.032, p < .001$, Male: $B = -0.116$ with CI $-0.196, -0.036, p = .004$). It is however interesting to note that the intervention did have a beneficial effect for males for several of the attitude measures (i.e., T2_ATT_ALL, T2_ATT_MOB, T3_ATT_MOB and T3_ATT_ALCO).

Some differential effects by education type were found, with beneficial intervention effects for school participants for all attitudes (T2: $B = -0.097$ with CI $-0.139, -0.055, p < .001$, T3: $B = -0.119$ with CI $-0.198, -0.040, p = .003$), mobile phone use (T2: $B = -0.095$ with CI $-0.151, -0.038, p = .001$ and T3: $B = -0.145$ with CI $-0.229, -0.062, p < .001$), fatigue (T2: $B = -0.120$ with CI $-0.185, -0.056, p < .001$) and alcohol (T3: $B = -0.078$ with CI $-0.119, -0.036, p < .001$), whereas there were less significant effects found for college students, but where they were found they were greater or similar to those for school students (i.e., T2_ATT_MOB: $B = -0.195$ with CI $-0.239, -0.152, p = .000$ and T3_ATT_MOB: $B = -0.104$ with CI $-0.195, -0.012, p = .027$ and T3_ATT_ALCO: $B = -0.087$ with CI $-0.161, -0.014, p = .020$).

Some further differential effects were found by disadvantage level, with beneficial intervention effects found for participants from below median disadvantage educational institutions for all attitudes (T2: $B = -0.169$ with CI $-0.253, -0.084, p < .001$, T3: $B = -0.075$ with CI $-0.129, -0.021, p = .006$), mobile attitudes (T2: $B = -0.176$ with CI $-0.261, -0.091, p < .001$, T3: $B = -0.129$ with CI $-0.199, -0.060, p < .001$), alcohol attitudes (T3: $B = -0.115$ with CI $-0.159, -0.072, p < .001$), fatigue attitudes (T2: $B = -0.203$ with CI $-0.294, -0.112, p < .001$) and speed attitudes (T2: $B = -0.165$ with CI $-0.285, -0.044, p = .008$, T3: $B = -0.081$ with CI $-0.161, -0.001, p = .047$). Some lesser beneficial effects were also found for those from above median disadvantage education institutions, but these were confined to effects immediately after the intervention at T2 for all attitudes ($B = -0.105$ with CI $-0.127, -0.084, p = .000$), fatigue attitudes ($B = -0.144$ with CI $-0.258, -0.031, p = .013$) and speed attitudes ($B = -0.144$ with CI $-0.212, -0.077, p < .001$).

3.2.3. Other measures

DriveFit had some significant beneficial effects on the other measures included within the survey. Beneficial effects of the intervention were seen at both T2 and T3 for perceptions of risk (P_RISK) and attitudes to driving violations (ADVS), with effects remaining significant, but diminishing in magnitude at T3 (See Fig. 4). There was a beneficial effect on the measure of subjective norms (SNORM) and driver coping (DCQ) at T2. The largest effect at T2 was for driver coping ($B = -0.131$ with CI $-0.223, -0.038, p = .005$), and for perception of risk ($B = -0.064$ with CI $-0.98, -0.030, p < .001$) at T3.

The post-hoc exploratory analyses found that there was a beneficial impact of the intervention for females on attitudes to driving violations (ADVS) (T2: $B = -0.108$ with CI $-0.150, -0.066, p < .001$, T3: $B = -0.068$ with CI $-0.102, -0.034, p < .001$) and perception of risk (P_RISK) (T2: $B = -0.135$ with CI $-0.155, -0.115, p = .000$; T3: $B = -0.055$ with CI $-0.088, -0.023, p < .001$). For males, there was a beneficial effect of the intervention on P_RISK at both time points (T2: $B = -0.081$ with CI $-0.130, -0.032, p = .001$; T3: $B = -0.078$ with CI $-0.156, -0.001, p = .050$), but no beneficial effect on ADVS. In addition, there was a benefit at T2 of the intervention on female subjective norms (SNORM) ($B = -0.087$, with CI $-0.141, -0.033, p = .002$) and driver coping (DCQ) ($B = -0.206$, with CI $-0.276, -0.137, p = .001$), which was not found at T3. A disbenefit of the intervention on perceived behavioural control (PBC) was found for males ($B = 0.312$, with CI $0.104, 0.519, p = .003$), college students ($B = 0.137$, with CI $0.005, 0.269, p = .042$) and students from above median

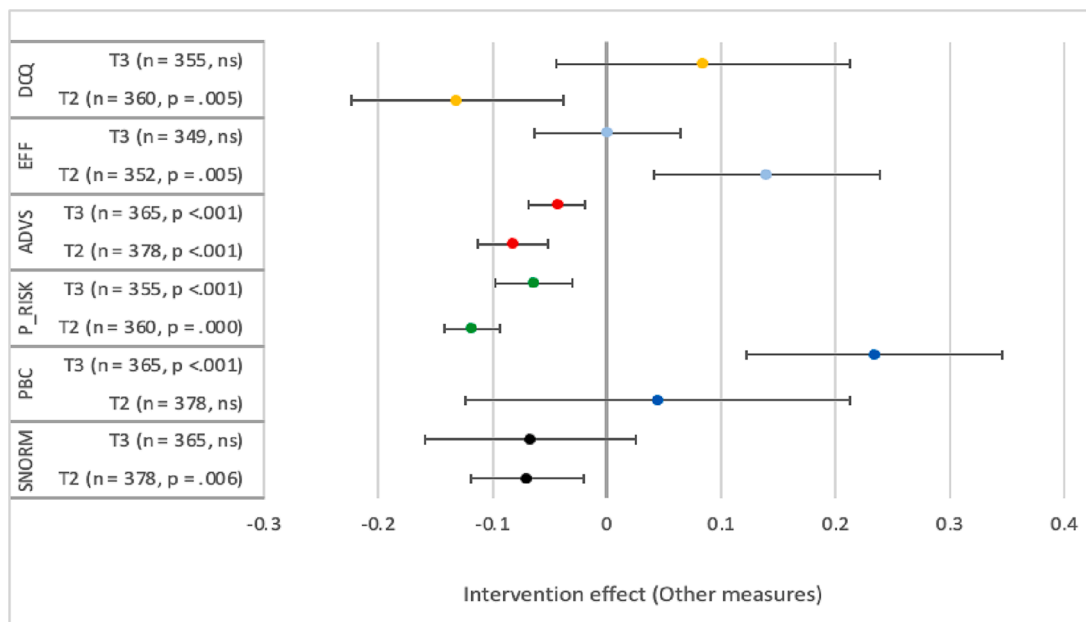


Fig. 4. Intervention effect on other outcomes presented as T1-adjusted difference to control, with 95% Confidence Intervals.

level disadvantage educational settings ($B = 0.525$, with CI $-0.612, 0.952$, $p = .000$), and a disbenefit for efficacy (EFF) was found for the same group, excluding college students (Males: $B = 0.234$, with CI $0.052, 0.416$, $p = .012$; Above median disadvantage: $B = 0.237$, with CI $0.043, 0.430$, $p = .017$).

Differences in intervention effect by educational setting was also found. There was a greater beneficial effect on ADVS for participants from colleges than schools at T2 (College: $B = -0.147$, with CI $-0.179, -0.115$, $p = .000$, School: $B = -0.044$, with CI $-0.067, -0.021$, $p < .001$) and a beneficial effect on P_RISK for college participants at T2 and T3 (T2: $B = -0.153$, with CI $-0.192, -0.114$, $p < .001$, T3: $B = -0.083$, with CI $-0.138, -0.028$, $p = .003$), whereas the lower effect for schools (T2: $B = -0.094$, with CI $-0.123, -0.064$, $p < .001$) was not present at T3. There was a beneficial effect of the intervention on DCQ for school participants at T2 ($B = -0.084$, with CI $-0.158, -0.010$, $p = .025$), but no detectable effect for college participants.

A benefit of the intervention for participants from below median disadvantage educational settings was also observed for the following measures: ADVS (T2: $B = -0.096$, with CI $-0.131, -0.061$, $p < .001$, T3: T2: $B = -0.037$, with CI $-0.086, -0.008$, $p = .012$); P_RISK (T2: $B = -0.117$, with CI $-0.178, -0.057$, $p < .001$, T3: T2: $B = -0.074$, with CI $-0.131, -0.016$, $p = .012$) and DCQ (T2: $B = -0.178$, with CI $-0.333, -0.024$, $p = .024$).

3.3. Process evaluation

Overall, the intervention was implemented as intended. All school and participant recruitment procedures set out within the trial protocol were adhered to as part of the study recruitment. The Vimeo viewing analytics indicate that the DriveFit film was watched by the participating schools and colleges as set out in the trial protocol (i.e., up to 2 weeks before online workshop delivery) which was further confirmed by the facilitator logbook entries. As a result of Covid absences, there were a few cases, reported by students and teachers (via survey feedback) where the film had not been watched by some individual students ahead of the workshop. A random sample of workshops ($n = 11$) were observed by the researcher, all of which were delivered by the facilitators to protocol. A degree of variation of delivery, in terms of class level discussion, was introduced through individual teacher participation and interest levels, which was noted as part of the workshop observations and was also raised by the two workshop facilitators in their feedback interviews conducted following the completion of all DriveFit workshops. Both the film and the workshops prompted students to review the <https://www.drivefit.info> website to review further information about the subjects discussed during the intervention. The website analytics show low levels of traffic ($n = 254$) during and immediately after the delivery of the programme between Nov 21 and Jan 22, which indicates that this information source, originally intended for parent/guardian information, was not well used. On average, participants agreed that there was a positive cognitive benefit of the DriveFit film and workshop, with slightly higher levels of agreement about the film (See Fig. 5). They also disagreed that the intervention had a negative emotional effect (See Fig. 6). In terms of the face validity (FCVALD) of the programme, on average participants agreed that the DriveFit programme was beneficial (See Fig. 7).

Two-way ANOVAs conducted to examine the effects of gender and education type on all cognitive and emotional measures, found that there was a main effect of gender for the cognitive scores of the DriveFit film ($F(1,177) = 10.86$, $p = .002$, $\eta_p^2 = 0.054$) and workshop ($F(1,177) = 5.28$, $p = .023$, $\eta_p^2 = 0.029$), with females rating both the film and workshop as having greater positive cognitive value than males. A main effect of education type was also found for the cognitive scores of the DriveFit film ($F(1,177) = 17.07$, $p < .001$, $\eta_p^2 = 0.074$) and workshop ($F(1,177) = 7.40$, $p = .007$, $\eta_p^2 = 0.040$) indicating that college students found the intervention to be slightly more useful, important, credible, interesting, and informative than school participants (See Figs. 8 and 9, where lower scores represent stronger agreement with the cognitive value of the intervention).

A main effect of gender was also found for the negative emotion scores for the DriveFit film (NEG_EMO_FILM) ($F(1,177) = 7.51$, $p < .001$, $\eta_p^2 = 0.066$) and workshop (NEG_EMO_WRKSHP) ($F(1,177) = 5.21$, $p = .024$, $\eta_p^2 = 0.029$).

A main effect of education was also found for the film ($F(1,177) = 8.46$, $p = .004$, $\eta_p^2 = 0.046$) and the workshop ($F(1,177) = 20.75$, $p < .001$, $\eta_p^2 = 0.105$). These results indicate that males and school students found the intervention to be less shocking, worrying and

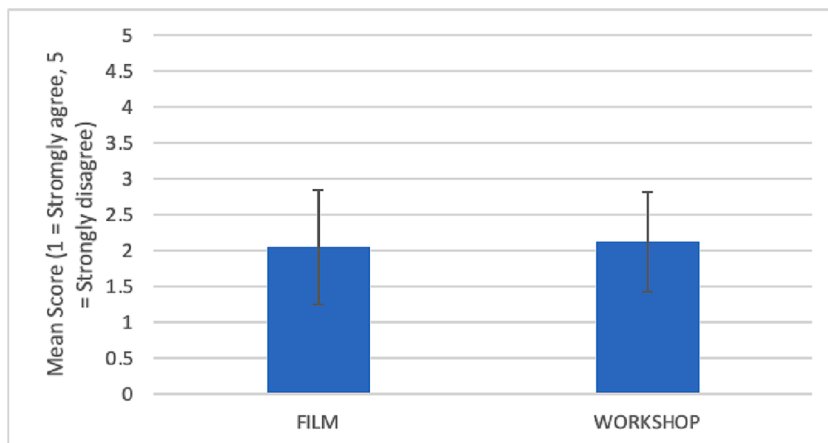


Fig. 5. Positive cognitive response to DriveFit film and workshop ($n = 186$).

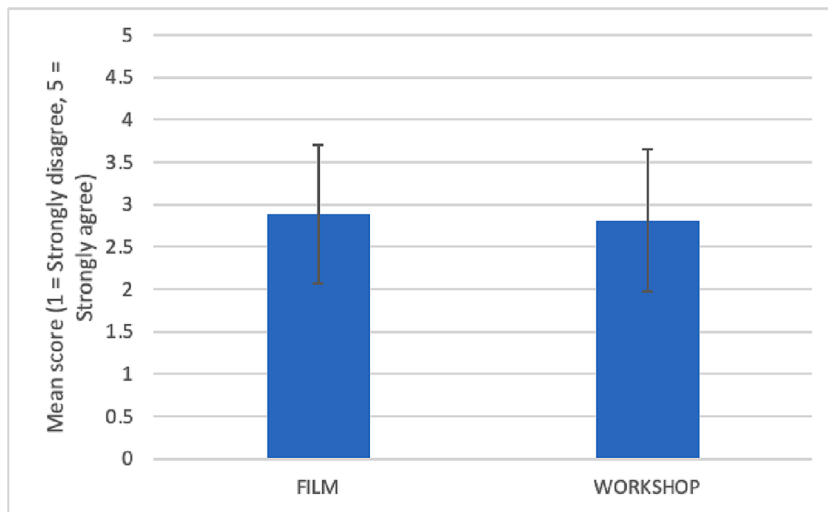


Fig. 6. Negative emotional response to DriveFit film and workshop ($n = 186$).

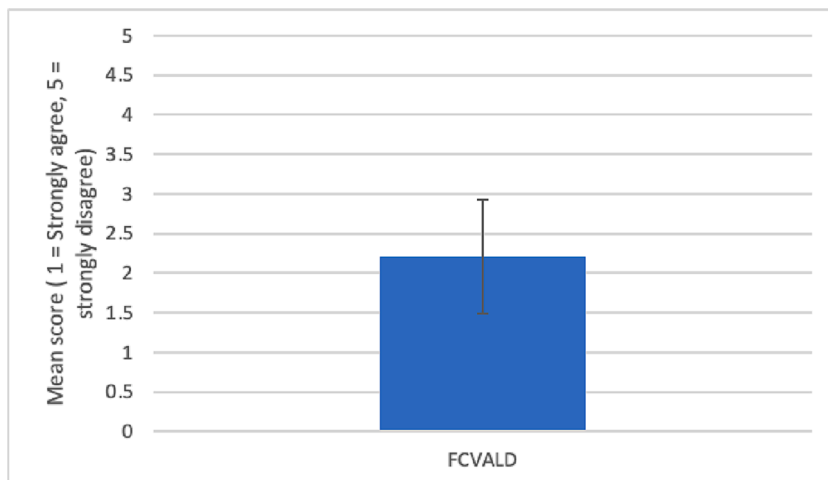


Fig. 7. Face Validity of DriveFit intervention ($n = 186$).

frightening than females and college students (See Figs. 10 and 11).

A further two-way ANOVA was conducted to examine the effects of gender and education on face validity scores (FCVALD). A main effect of gender was found ($F(1, 177) = 10.385, p = .002, \eta_p^2 = 0.055$). This indicates that females agreed more strongly than males that the DriveFit programme had provided benefits and/or impacted on their driving behaviours (See Fig. 12).

4. Discussion and conclusions

This study found significant beneficial effects of the DriveFit programme on 9 out of 16 study measures at T2 (INT_SPEED, ATT_ALL, ATT_MOB, ATT_FATIGUE, ATT_SPEED, SNORM, P_RISK, ADVS, DCQ) and 8 out of 16 study measures at T3 (INT_MOB, INT_ALL, ATT_ALL, ATT_MOB, ATT_ALCO, ATT_SPEED, P_RISK, ADVS), with the largest beneficial effects on attitudes. Where significant attitude effects were still detectable at T3 (ATT_ALL, ATT_MOB, ATT_SPEED), these were reduced in magnitude. In contrast, for study intention measures (apart from INT_SPEED) there was a trend towards intentions becoming safer at T3 than at T2, with the mobile phone use and composite intention measure showing beneficial effects of the intervention, over and above control at T3. Whilst previous research has found that education interventions deliver small self-reported effects, that diminish over time (i.e., Poulter and McKenna, 2010), this study finds small, but lasting attitude effects (which diminish in magnitude over time) and a trend towards improving intentions, over and above the control group, over time. Given this intervention was only measured up to the 8–10 weeks post-intervention point (T3), the longer-term effects are not known. The DriveFit intervention evaluated here is also different to other evaluated pre-driver interventions as it is designed based on the TPB and is positively framed. There is evidence that fear appeal

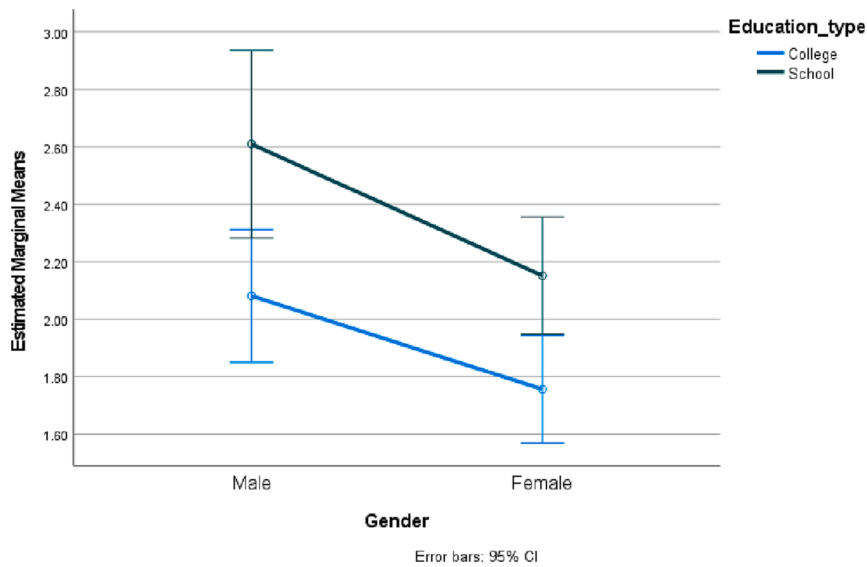


Fig. 8. Estimated Marginal Means of POS_COG_FILM by gender and education.

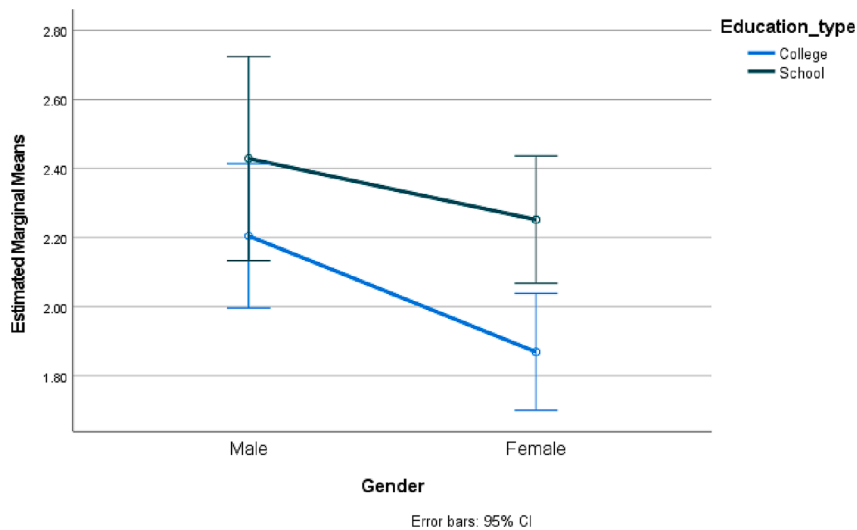


Fig. 9. Estimated Marginal Means of POS_COG_WRKSH by gender and education.

interventions, such as that evaluated by Poulter and McKenna (2010), can have relatively weak, but reliable effects on attitudes, intentions and behaviours (Witte & Allen, 2000). In contrast to previous findings, consistent attitude improvements were seen across the majority of the attitude measures and intentions trended towards improving over time, suggesting that there may be a more positive outcome for positively framed educational interventions, with follow-up workshop components.

The greatest effect of DriveFit, both for intentions and attitudes, was found for mobile phone use and fatigue. This finding is important because young and novice drivers have been found to underestimate the risks associated with driving whilst using a mobile phone (Cazzulino, Burke, Muller, Arbogast, & Upperman, 2014), and this is a behaviour that significantly reduces driving performance and increases crash risk (Caird, Willness, & Scialfa, 2008). Social pressures, other life demands (i.e., studying or work) as well as biological changes have been found to lead to sleep deprivation amongst adolescents, which increases their risk of sleep related collisions (Carskadon & Acebo, 2002; Millman, 2005). Whilst the intervention effects for these risks are small (possibly due to the safe attitudes presented at baseline, and therefore less potential for improvement), this evidence of risk attitude change is informative for the development of future interventions. These findings add to the existing literature, as several studies to date have not been able to break down the effect of interventions on multiple risk behaviours (i.e., Poulter and McKenna, 2010 which focuses solely on speeding behaviours).

The DriveFit intervention also had a beneficial effect on subjective norms at T2, but not at T3. Previous studies have also found

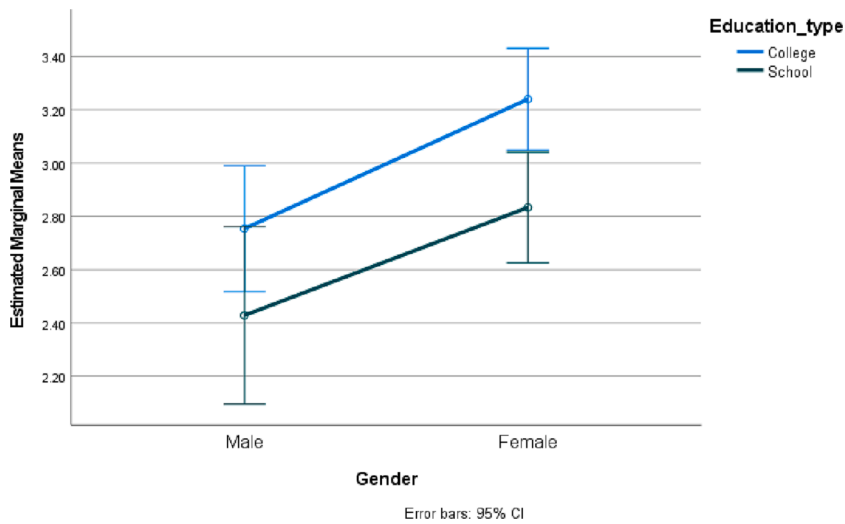


Fig. 10. Estimated Marginal Means of NEG_EMO_FILM by gender and education.

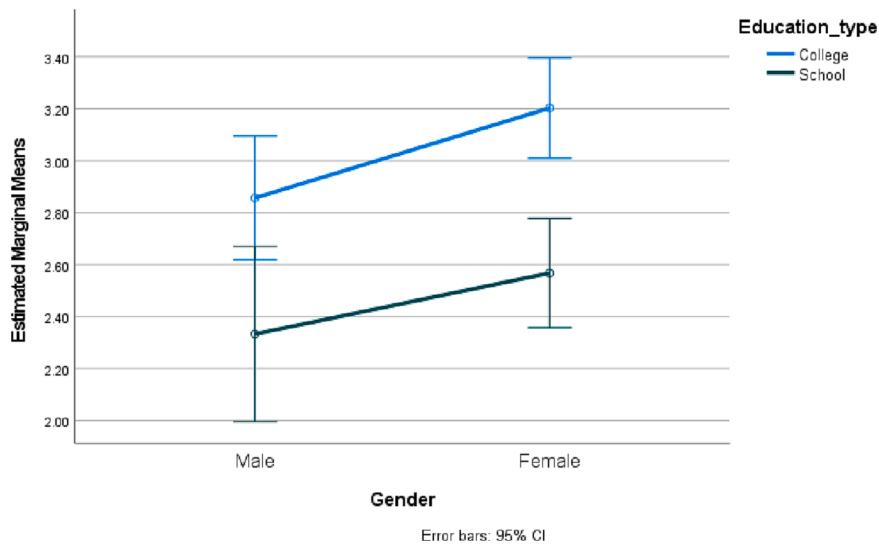


Fig. 11. Estimated Marginal Means of NEG_EMO_WORKSHOP by gender and education.

intervention induced beneficial changes in subjective norms (Cutello et al., 2020a; Poulter & McKenna, 2010; Burgess, 2011) immediately post-intervention. Post-hoc sub-group analysis has found subjective norm benefits for females, but not males. Burgess (2011) in their intervention analysis found that males’ behavioural intentions was mainly due to more appropriate attitudes towards road safety post-intervention, as opposed to changes in perceived subjective norms, whereas females seemed to be influenced to a greater extent by perceived behavioural control and changes in attitudes due to changes in perceived subjective norms. For future studies, further consideration should be given to how longer lasting impacts on subjective norms can be achieved through interventions delivered to this target audience, potentially through delivering interventions that consider the social environment of parents and peers (Cassarino & Murphy, 2018).

In addition, the DriveFit intervention also had a beneficial effect on driver coping immediately post-intervention. The Driver Coping Questionnaire (DCQ) captures how people cope with the stress of driving and includes several dimensions (confrontive coping, task focused, emotion focused, reappraisal and avoidance). The adapted survey used for this study focused on future task focused coping such as efforts to drive safely when demands are high (i.e., slowing down and being more vigilant). A consistent relationship between the Driver Stress Inventory and DCQ scales have been established (Matthews, Desmond, Joyner, Carcary & Gilliland, 1997; Dorn, 2021), suggesting that coping mediates the associations between driver stress vulnerability and stress outcomes. Task focused coping has been positively correlated with alertness and hazard monitoring, suggesting that drivers who focus on the problem appear to direct their efforts towards the task itself by adopting rational strategies such as information seeking, taking precautions, and

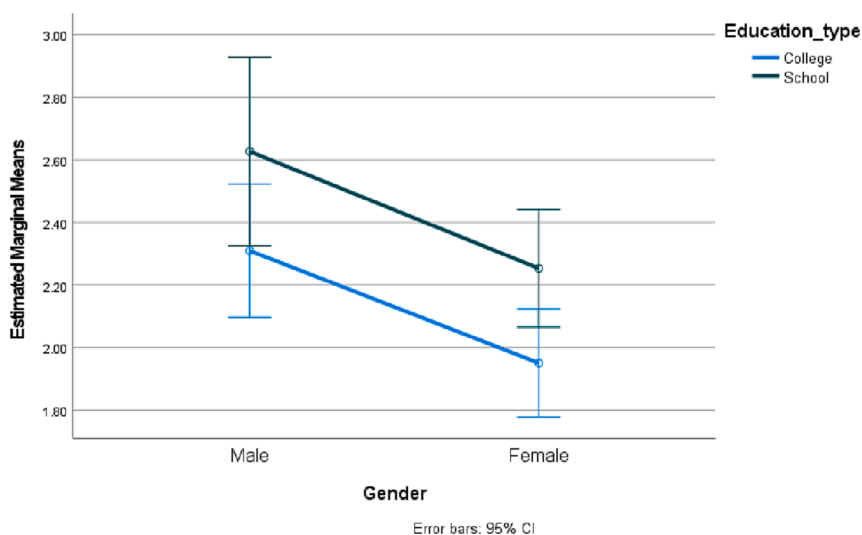


Fig. 12. Estimated Marginal Means of FCVALD by gender and education.

making plans. The small, but detectable improvement in driver coping at T2 did not last until T3, suggesting that consideration should be given to how DriveFit could promote longer lasting coping strategies.

A beneficial intervention effect for perception of risk was also found at T2, and to a lesser extent at T3. “*Risk perception refers to the subjective experience of risk in potential traffic hazards*” (Deery, 1999, p.226) and has been found to relate to risky driving behaviour (Hatfield & Fernandes, 2009). This study found gender differences in perception of risk at T1, with females rating driving situations as less safe than males (also reported by Farrand and McKenna, 2001) as well as an overall intervention effect, which was not seen in the evaluation of a negatively framed testimonial education programme by Glendon et al. (2014). The present intervention differs from others by being theoretically based and positively framed with a focus on developing plans to manage behaviours. Whilst it is not possible to ascertain what component of DriveFit achieved beneficial risk perception effects, when others have not, there several potential differences that could have had an influence. These include a different focus, content, emotional tone, and active learning approach compared with previous interventions.

Similar beneficial intervention effects were also seen for attitudes towards driving violations at T2, and to a lesser extent at T3. In their paper on the role of personality and attitudes in traffic collision risk West and Hall (1997) found that drivers with higher levels of social deviance and more positive attitudes to driving violations (ADVS) sped more and self-reported a greater number of collisions. Consequently, they suggested that ADVS had value as an indicator of collision liability and for identifying risky drivers. Whilst DriveFit had a beneficial effect on ADVS scores overall, the sub-group analysis identified that this overall finding only applied to females, not males and further research is needed to establish how best to target interventions to influence this at-risk group.

Two disbenefits of the intervention were noted for the efficacy and perceived behavioural control measures at T3. Two potential explanations are proposed. Firstly, both measures consisted of one survey item only (See Annex A1). Whilst it is feasible that the intervention led to participants feeling less confident (EFF) and in control (PBC), it is also possible that the survey item did not reliably measure the outcome. Secondly, further analysis of the findings from certain sub-groups showed that males and those from above median level disadvantage educational establishments reported feeling less confident, as well as less in control (with less control also applicable to college participants). Previous research has found that inaccurate self-assessment of driving skills amongst males may be a contributory factor to young male collision rates (Martinussen, Møller, & Prato, 2017). It is therefore feasible that a more realistic assessment of confidence and control may be a beneficial educational outcome for interventions targeting young males, although further investigation is required.

Taking the results together, a clear differential intervention effect by gender and educational setting can be seen, which has also been reported by other studies (Cuenen et al., 2016; Riaz et al., 2019). Evaluations to date have typically found greater beneficial intervention effects for females (Burgess, 2011; King, Vidourek, Love, Wegley, & Alles-White, 2008) and a minority have also found beneficial effects for males (e.g., Cuenen et al., 2016), particularly those with less safe T1 measures providing more opportunity for improvement. The effect of programmes by gender has not been explicitly evaluated by many studies (Feenstra et al., 2014; Markl, 2016), but overall, where sub-group analysis has been conducted, there appears to be a consensus that females present safer attitudes and intentions than males at T1 (Riaz et al., 2019). Within this study females presented safer at T1 than males for most measures and the beneficial effects of the DriveFit intervention were typically found to be more frequent and stronger for females than males. However, beneficial intervention effects were found for males, the most consistent being T2 and T3 effects on perceptions of risk and mobile phone use attitudes. Males were found to have less safe PBC and EFF responses at T3, which differs from previous study findings (e.g., Cuenen et al., 2016). Both the PBC and EFF measures in this study consisted of only one survey item (due to a lack of internal consistency for measured PBC items and the use of a single EFF measure), which makes this finding both less robust and reliable. It is possible that highlighting the importance of taking control of managing road risks in the DriveFit intervention may have led males to

make more realistic assessments of their PBC and EFF post-intervention but given the lack of corroboration of this finding in existing research, this anomaly is most likely a result of survey item reliability issues. The finding does however indicate that exploring intervention effects on male PBC and EFF is an important area of investigation for future studies. Whilst there was no overall differential effect on T1 measures by education type, a differential beneficial effect of DriveFit was found for school students for some of the measures, which again highlights the importance of both evaluating sub-group effects and adjusting intervention content and delivery to better suit the needs of specific target groups.

Considering the process evaluation outcomes, it is interesting to note that participants rated the DriveFit intervention to be cognitively engaging and beneficial with no strong negative emotional effects. Comparing these results to [Cuenen et al. \(2016\)](#) (who used the same scale to evaluate the cognitive and emotional response of students to a victim testimonial intervention delivered in high schools), some differences and similarities arise. In their study, students rated the testimonial intervention as delivering strong cognitive value and negative emotional effect, a variance which may be accounted for by the different delivery styles of DriveFit and a testimonial performance. However, it is interesting to note that both studies found females to have rated the cognitive and negative emotional effects of the interventions higher than males. Unlike the findings of [Cuenen et al. \(2016\)](#), there was a differential cognitive impact of DriveFit by education type, with college students rating its value higher than that of school students. This research therefore adds to a body of comparable literature about how educational interventions are received by the target audience, which is vitally important for future studies to build upon to maximise effectiveness.

Based on these study findings, there are various ways that the impact of educational interventions may be improved. Whilst the intervention was designed with reference to existing evidence, as well as qualitative research with the target audience, the film and workshop delivery may have benefited from involving more peer age participants, as previous research has found peer-to-peer education to support beneficial road safety outcomes (e.g., [Eyler, Bradley, Goldzweig, Schlundt, & Jurez, 2010](#)). The workshops were facilitated online, and this format may not have had the same impact on intentions and attitudes compared with that of a classroom-based in-person group discussion. It is not known what specific features of the intervention (i.e., film and/or workshop) had the greatest impact on the results. Further work is required to ascertain whether there is an effect of different delivery formats. [Cuenen et al. \(2016\)](#) emphasises the importance of understanding the impact of separate components of interventions, such as presentations and workshops. It is also possible that the duration of the intervention period was not sufficient to change intentions and attitudes. Future research may need to investigate the effect of different intervention delivery periods. It is likely that short-term interventions will have a less pronounced effect on pre-driver intentions and attitudes. Revisiting original intervention content with new materials has been found to boost road safety attitudes ([O'Brien, Carey, & Fuller, 2002](#)), similarly, further work is required to develop DriveFit to extend the intervention period. A phased approach is recommended to extend the initial positive benefits with the use of follow-up positively framed messages to motivate and maintain safe behaviour post-licensure. Without regular DriveFit follow-up road safety messages during the early months of driving, the benefits of the intervention may wane as it competes with the influences that young people experience in day-to-day life.

Several limitations of the study should be noted. Firstly, despite a purposive sampling of schools with varied socioeconomic status, participants may not be entirely representative of the wider population in the UK. The final sample size is somewhat small and the statistical power of the analysis to detect an effect is reduced with an increased risk of a Type II error. This drop out may have been reduced with a shorter survey. It is recommended that future studies ensure that evaluation surveys focus on most important variables only to maximise response rates. Secondly, one of the difficulties with drawing firm conclusions from these findings are that there are known limitations associated with self-reported methods ([Hessing, Elffers, & Weigel, 1988](#)) including poor reliability ([Af Wählberg & Dorn, 2015](#)), socially desirable responding and common method variance ([Wählberg, Dorn, & Kline, 2010](#)). One way to overcome the limitation of self-report methods would have been to use in-vehicle data recording measures to assess actual driving behaviours such as speed. Whilst this approach has been used to evaluate young driver interventions ([Tapp, Pressley, Baugh, & White, 2013](#)) it would have involved excluding pre-drivers from the present research. Despite the limitations, self-report survey data provides important information about precursors to behaviour and previous research has found that under certain conditions (i.e., anonymity and no associated response consequences) self-report surveys provide acceptable levels of validity ([Zhao et al., 2006](#)) which can be corroborated using other sources of data ([Taubman - Ben-Ari, 2010](#)). A major strength of this study has been the rigorous evaluation of a positively framed intervention programme underpinned by the Theory of Planned Behaviour ([Ajzen, 1991](#)) and Behaviour Change Techniques ([Michie et al., 2013](#)) using a cRCT design, which has been supported by national delivery partners. This study adds to the growing body of literature on pre-driver education effectiveness and identifies important areas of further research.

CRedit authorship contribution statement

Elizabeth Box: Conceptualization, Methodology, Software, Formal analysis, Investigation, Writing – original draft, Visualization, Project administration, Funding acquisition. **Lisa Dorn:** Supervision, Writing – review & editing.

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.

Data availability

Data will be made available on request. The decision to share will be based on the purpose of the data request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.trf.2023.03.001>.

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