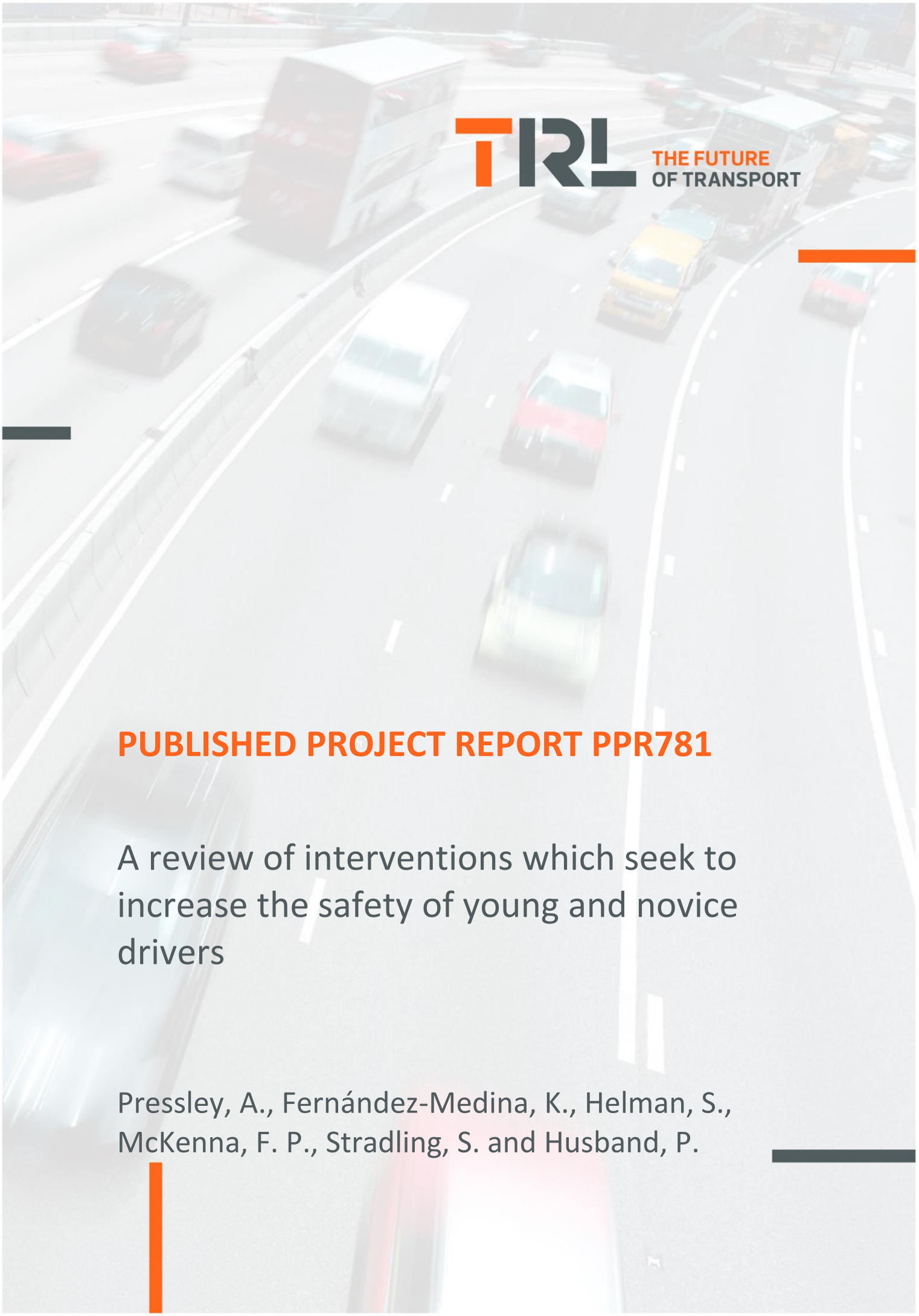

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A review of interventions which seek to increase the safety of young and novice drivers

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The heightened collision risk of newly qualified drivers (especially those who are also young) relative to their driving exposure is well documented in Great Britain and around the world.

Some interventions that seek to reduce this risk do so through licensing systems that maximise maturity and on-road experience before licensure (typically through minimum learning periods) and seek to limit exposure to risky situations such as night time driving and carrying peer-age passengers when solo driving begins.

Some interventions take an alternative approach; broadly, they use a variety of methods (e.g. training, education, technology, engagement with drivers and their social support networks) in attempts to equip learners with the skills, knowledge and attitudes they need to become a safer driver.

In this report, we consider this second type of intervention. The primary objective was to identify, from the available literature, between three and five interventions that have the greatest potential to reduce the collision rates of newly qualified drivers based on existing evidence of efficacy. The scientific literature since 2000 was reviewed for interventions that demonstrated either evidence of effectiveness in terms of reducing collisions (or a risk factor related to collisions), or (where evaluation had not yet been possible) some theoretical plausibility that they may reduce such risk.

The review of the literature found only a small amount of good quality empirical evidence. Nonetheless, a small number of approaches have either shown some effectiveness, or show promise in terms of their theoretical grounding.

A workshop was then held with stakeholders to discuss how these 'most promising' interventions might be implemented, both in an evaluation trial in GB, and in later roll-out (for interventions shown to be effective on the basis of such evaluation). Deliverability was considered in a broad and qualitative sense; detailed examination of the cost-effectiveness of different interventions was beyond the scope of the work. Based on the evidence reviewed and the workshop discussions, there are four intervention types that we recommend are evaluated properly, ideally against collision outcomes, and in a randomised controlled trial in GB, to establish comprehensively their efficacy in reducing the risks to newly qualified drivers. These interventions are:

1. An intervention to engage parents in managing post-test driving in specific risky situations
2. An intervention to engage a range of stakeholders (and utilising a logbook approach) in increasing the amount and breadth of pre-test on-road experience
3. An intervention utilising technology (in-vehicle data recorders or 'telematics') and possibly parents to manage driver behaviour post-test
4. An intervention to train hazard perception skill

All of these interventions can be implemented without legislative changes to mandate their use, although it is anticipated that uptake (and therefore effectiveness) would be greater if they could be built into the licensing system.

Executive Summary

Introduction

The heightened collision risk of newly qualified drivers (especially those who are also young) relative to their exposure to driving is well documented in Great Britain and around the world (Wells et al., 2008; Mayhew, Simpson & Pak, 2003; McCartt, Shabanova & Leaf, 2003; Maycock, 2002; Williams, 1999; Sagberg, 1998; Forsyth, Maycock & Sexton, 1995; Maycock, Lockwood & Lester, 1991). For this reason, the Department for Transport (DfT) has a specific interest in understanding the effectiveness of interventions that attempt to lower the collision and injury risk of this group.

Some interventions, such as graduated licensing systems that entail minimum learning periods and restrictions on night time driving and carrying peer-age passengers when solo driving begins, have been well researched and evaluated (Kinnear et al., 2013; Russell, Vandermeer & Hartling, 2011). This evidence review focuses on less well researched alternative interventions that use a variety of methods (e.g. training, education, technology, engagement with young drivers and their social support networks) in attempts to equip learners and young novice drivers with the skills, knowledge and attitudes they need to become a safer driver[1].

The overall goal of this review was to identify such interventions that might form the basis of future evaluation trials in GB.

Approach

The key tasks undertaken were:

1. A review (from the year 2000 onwards) of pre- and post-test interventions focused on improving the safety of newly qualified drivers, including scoring of quality and consideration of the theoretical underpinning of such interventions and their proposed mechanisms of effect. This was followed by a shortlisting of the most promising interventions (based on evidence of behaviour change and a sound theoretical underpinning) for discussion at a stakeholder workshop
2. Engagement with stakeholders at a workshop held at TRL's Crowthorne office on the 8th November, 2015 to discuss the real-world feasibility of the short-listed interventions against a range of criteria related to implementation[2]

[1] Educational interventions, in the context of this review, are limited to classroom-based educational initiatives targeted specifically at young people, often before they start driving. National Drivers Offenders Retraining Scheme (NDORS) courses, which are targeted educational interventions for drivers that have been caught committing some types of motoring offences, such as speeding, driver alertness or distraction, are not covered by this review.

[2] Participants in the workshop represented the following organisations: Driver & Vehicle Standards Agency (DVSA), The Institute of Advanced Motorists (IAM), RAC Foundation, The Royal Society for the Prevention of Accidents (RoSPA), Chief Fire Officers Association, Road Safety GB, RoadSafe, Driving Instructors Association (DIA), Association of British Insurers (ABI), Approved Driving Instructors National Joint Council, First Car, Parliamentary Advisory Council for Transport Safety (PACTS), Association of Police Chiefs' Council and Transport for London (TfL).

3. The production of a final list of four recommended interventions based on the previous tasks

The review

Almost all interventions are evaluated against outcome measures that seek to serve as 'proxy measures' for collisions and injuries. Even when collision or injury outcomes are included in evaluations the sample sizes achieved are often insufficient to draw any firm conclusions. An assessment of the risk factors targeted by interventions made it possible to consider a range of approaches that were sufficiently recent as to not have been properly evaluated (thus making it possible to include such interventions for discussion at the workshop were they to show sufficient promise based on their theoretical plausibility or the risk factors they were targeting for change).

There were few 'off the shelf' interventions which had been evaluated in multiple studies of high enough quality to consider them for inclusion in the workshop discussions. However, there was a range of interventions and intervention types that tended to focus on plausible risk factors, and through a small number of apparently plausible mechanisms. These mechanisms included parental engagement in the learning to drive process and in post-test driving, the use of in-vehicle data recorders (IVDRs) and other technologies to support various interventions focused on behavioural monitoring, and the training of hazard perception skill.

The literature review did not identify any evaluations of traditional education (i.e. classroom based approaches) or training-based (i.e. behind-the-wheel driver training) interventions that are targeted at young people that had sufficient evidence for effectiveness or sufficient theoretical support (either in the risk factors targeted or their proposed behavioural mechanisms of effect) for having a direct impact on collision outcomes.

Seven evidence-based interventions/intervention types were taken forward for discussion at the workshop. Three of these involved parental engagement specifically, three involved the use of technologies to help promote behavioural change in the pre-test and post-test phases, and one involved hazard perception training. Traditional classroom-based education (which is typically based on a syllabus that seeks to change attitudes towards driving) and behind-the-wheel driver training (such as advanced driving tuition) that are targeted at young people were also included for discussion at the workshop, so that ease of implementation could be assessed against existing provisions.

Workshop findings

Interventions were discussed and rated qualitatively against a set of criteria for implementation in GB. These included the general applicability of each intervention, issues around who would 'own' it, costs, and acceptability to the end user.

None of the interventions discussed were 'ruled out' using any of the criteria. Most were positively received and described as having some key positive and negative aspects.

Discussion at the workshop also focused quite heavily on how the different potential interventions might be best built into the existing licensing process, and how incentives might be needed to maximise market penetration if a voluntary approach is taken (i.e. non-mandatory participation).

Recommendations

Four interventions are recommended for properly controlled scientific evaluation in a future trial in GB. These are the four interventions types supported by a reasonable level of empirical evidence, which target risk factors that are important in contributing to collisions in newly qualified drivers, use viable behavioural change mechanisms to achieve change, and (in the light of workshop discussions) seem feasible in terms of the practicalities of both an evaluation trial and subsequent roll-out. These interventions are outlined below. We would expect all of these interventions to have a chance of demonstrating efficacy in a controlled evaluation trial, and effectiveness in a wider roll-out if mechanisms to ensure sufficient penetration among end users can be found.

An intervention to engage parents in managing post-test driving in specific risky situations

We recommend that an intervention (based on the currently and freely available 'Checkpoints' programme (http://www.saferdrivingforteens.org/) is designed to focus on having parents and guardians set voluntary limits with newly qualified drivers on levels of post-test driving at night, driving with peer-age passengers, and driving in other specific situations. Such an intervention has been evaluated in a number of studies of good quality since its introduction in the USA and has been shown to have positive effects on the risk factors targeted.

An intervention to engage a range of stakeholders (and utilising a logbook approach) in increasing the amount and breadth of pre-test on-road experience

We recommend that an intervention be developed to encourage a greater amount and breadth of pre-test on-road experience. The learning to drive period is by far the easiest period during which to engage with drivers; by utilising input from parents, approved driving instructors (ADIs), the Driver and Vehicle Standards Agency (DVSA) and insurers we would anticipate that much greater amounts of on-road experience than seen now could be achieved with only modest extra effort on behalf of learner drivers. In the absence of formal testing of the effects of specific amounts of practice, a range of researchers have suggested that this approach should aim to increase amounts of experience to around 120 hours (with ADIs and other supervising drivers combined), with a defined set of driving situations covered.

An intervention utilising technology (IVDRs) and possibly parents as well to manage driver behaviour post-test

We recommend that a telematics intervention (either bespoke, or a standards-matched set of commercially-available products) be utilised to provide feedback on key driving behaviour risk factors post-test. Initially, we recommend that behaviours associated with speed choice (e.g. average speed, maximum speeds, speeding events) are chosen as the main triggers for feedback, through a range of mechanisms (e.g. parent involvement, technology-only-involvement) which could be evaluated separately in the trial. It is possible that some other specific, defined risk factors (e.g. seat belt wearing, exposure to risk) could also be targeted.

An intervention to train hazard perception skill

We recommend that a hazard perception training intervention, ideally delivered post-test, is evaluated. As with the recommended IVDR approach to behaviour change a bespoke intervention could be designed using one or more of the range of delivery mechanisms

known to work (for example watching video commentaries from expert drivers, e-learning based training, or on-road hazard perception tuition), or some commercially available products could be used as long as they matched some standards set based on the literature.

Notes on evaluation and later implementation

We recommend that the interventions taken forward are evaluated using a Randomised Control Trial (RCT) design, ideally using collisions as the outcome measure of interest. An RCT of some kind is the only design through which a robust appraisal can be made of the efficacy of each intervention, and causality inferred.

The involvement of those already working in road safety, such as road safety practitioners who already deliver content to young and novice drivers, will be critical to the success of any trial and future legacy. In short, the existing providers of education and training interventions should be seen as future delivery partners, in the trial and for later delivery of any interventions that are shown to be effective.

Finally, we recommend that the way in which incentives are used in later implementation (should a voluntary model of engagement be used) is considered as part of the evaluation trial, so that potential effects on market penetration and overall effectiveness can be assessed. Ideally however, we would expect to see greater effectiveness if the roll-out of successful interventions was mandatory.

1 Introduction

Over 40 years ago, Goldstein (1972) noted that it had been known for several decades that young drivers are over-represented in traffic collisions. In the following decades research established that both age and inexperience play a role in the inflated collision risk of this group (Wells et al., 2008; Mayhew, Simpson & Pak, 2003; McCartt, Shabanova & Leaf, 2003; Maycock, 2002; Williams, 1999; Sagberg, 1998; Forsyth, Maycock & Sexton, 1995; Maycock, Lockwood & Lester, 1991). In short, the younger a driver is when they become fully licensed (all other things being equal) the higher their crash risk, and newly qualified drivers of all ages become safer as they accumulate on-road driving experience. The first six months to a year of driving is the period of highest risk (Wells et al., 2008; Maycock et al., 1991) with some evidence that the first 1,000 miles of solo driving is the period during which risk reduces at the greatest rate (McCartt et al., 2003).

There are a multitude of road safety interventions aimed at young and novice drivers. Some of these are based on licensing conditions (such as minimum learning periods) and restrictions on certain types of driving such as night time driving and the carrying of peer-age passengers. These so-called graduated driver licensing ('GDL') systems have been well researched and have an established evidence base (Kinnear et al., 2013; Russell et al., 2011). Less well researched alternative interventions use a variety of methods (e.g. training, education, technology, engagement with drivers and their social support networks) in attempts to equip learners with the skills, knowledge and attitudes they need to become a safer driver.

There is recognition that those interventions being implemented across GB in attempts to educate, train or otherwise influence the behaviour of young and novice drivers should be based on the best available theory and evidence. Therefore, the purpose of this review was to examine the recent theory and evidence for such young and novice driver interventions that might be taken forward for evaluation in a future large-scale trial[3].

The review prioritised these interventions based on supporting evidence, theoretical plausibility, and feedback from stakeholders on how such interventions might be implemented in GB.

The remainder of this report is structured as follows:

- Section 2 describes the acquisition and evaluation of studies (since 2000) which report evaluations of interventions targeting the safety of young and novice drivers.
- Section 3 is the main results section. This section summarises the evidence for each of the interventions and intervention types identified. The findings of an expert workshop focused on delivery are then described; the workshop was used to assess the ease of implementation of the interventions considered. Finally, a small number of interventions

[3] The review specifically excluded interventions which use a graduated driver licensing (GDL) approach to place specific restrictions on night time driving, the carrying of passengers, and lower blood-alcohol limits for newly qualified drivers. However, interventions that target these risk factors in other ways (for example educating newly qualified drivers about risks of night time driving, or seeking to reduce exposure through voluntary approaches such as parent-teen contracts) were included where found.

that show the most potential in terms of a future research study, based on existing evidence and theory, and based on the outcomes of the workshop, are described.

- Section 4 provides a range of recommendations to support the design and implementation of these interventions and the best practice approaches for evaluating their likely impact on collisions and injuries in newly qualified drivers.

2 Acquiring and evaluating the evidence base

A number of steps were taken to acquire and evaluate relevant literature.

- First, available scientific articles were sourced from the literature.
- Second, these articles were scored for scientific quality, to establish which interventions or approaches had the most evidence of effectiveness or showed the most promise based on their proposed mechanisms of effect.
- Third, given the paucity of evidence for the effectiveness of interventions in impacting the desired 'final' outcome measures of collisions and injuries, the wider road safety and driver behaviour literature was examined[4] to increase understanding of those outcomes (e.g. behaviours, attitudes and other risk factors) that were most reliably linked with collision and injury outcomes. This information was then fed into the final quality scoring for interventions, to provide a shortened list of potential interventions to be considered in more depth.
- Fourth, the manner in which this shortened list of interventions or approaches could be implemented in a GB context was discussed during an expert workshop attended by a range of road safety industry stakeholders.

The methods used in these four stages are described in the following sub-sections.

2.1 Sourcing relevant articles

Search terms were agreed with DfT (see Appendix A for the list of terms) and a search of all relevant literature databases was conducted by TRL's library services. The review included interventions from the year 2000 until the point at which the review was conducted (September 2015). The year 2000 was used as a cut-off to balance project scope with what the project team already knew from the extant literature; the team were certainly aware of the pre-2000 literature (as well as more recent meta-analyses which had relied on this) so it was deemed unnecessary to extend the search to before 2000.

The initial search yielded a total of 402 articles. The list of abstracts[5] was then reviewed to establish the potential relevance of each article in relation to the objectives of the current project; the review sought to identify any study that directly evaluated the impact of any pre- or post-test intervention for young and novice drivers, either on injury or collision outcomes or some other relevant measure (see Section 2.3). The 402 articles were independently assessed for potential relevance by two researchers (AP and KFM) and the results were compared. In cases where there were disagreements, a third researcher (SH) examined the information and made a final decision on whether the article should be included for further consideration.

[4] The databases searched were Psychoinfo, ScienceDirect, PubMed, Scirus, SORT (Social Research in Transport Clearinghouse), TRIP (Transport research in progress from the EU area) and SINGLE (System for Information on Grey Literature in Europe). Web searches were also undertaken using Google and Google Scholar.

[5] In some cases the search procedure produced truncated results (i.e. only a short title would be shown). In these cases web resources were used to supplement the information and the process was repeated using the additional information.

The result of the above procedure yielded a total of 120 articles, 106 of which were deemed potentially relevant to the project objectives. There were also 14 articles that were not directly relevant according to the inclusion criterion above but were marked for further investigation as they were thought likely to include references to additional articles. Subsequent investigation of these articles yielded a further 30 references for consideration.

In addition to the process described above, in order to capture potential innovative interventions that had not yet been evaluated or evaluations which had not been published in peer-reviewed publications, a general web-based search was undertaken. A further 30 articles of sufficient potential relevance were identified from this process.

A full review of the 166 (106+30+30) 'potentially relevant' articles was then undertaken to establish which would be taken forward based on a judgement of relevance after reading the full article. In order to be deemed relevant, an article needed to report the *outcome* of an *intervention* i.e. where an intervention had been implemented, evaluated and a change (regardless of the risk factor targeted) had been measured. A total of 52 articles were deemed definitely relevant on the basis of the criteria above, and taken forward for scoring of quality.

2.2 Quality scoring – Adjusted Maryland Scientific Methods Scale

When undertaking a review of the literature for the purpose of establishing the level of evidence for effectiveness, it is important to assess the quality of evidence. As noted in Kinnear et al. (2013), this is because evidence of low quality is of little or no use when attempting to draw formal conclusions about effectiveness. Examples of 'low quality' evidence might include anecdotal accounts, studies that do not adequately control for self-selection bias, or those which have other research design limitations (such as factors other than the intervention that are not properly controlled in the design).

The Adjusted Maryland Scientific Methods Scale (herein referred to as the AMSMS) (Madaleno & Waights, 2015) is a scale which assesses "whether an evaluation provides convincing evidence on likely policy impacts" (p. 2). The scale was originally developed (and adjusted) by the Centre for Local Economic Growth and was intended for the evaluation of scientific work in the economics sector; nonetheless, its core components reflect established and generally accepted principles of scientific quality.

The AMSMS provides two scores (e.g. 5, 3); the first score denotes the strength of a study's *design*, and the second describes the strength of *implementation*. The implementation quality score was not used[6]. A summary of design levels from 1 (least robust) to 5 (most robust) from the AMSMS is shown in Appendix B.

The 52 articles remaining after relevance scoring were scored for quality on the AMSMS by two researchers (AP and KFM) working in parallel to achieve an agreement of the intervention's score. A random sample of scored interventions was selected by a third

[6] It was the intention of the project team that the implementation score would be used to break 'ties' should there be too many interventions for the final list for consideration at the workshop; in practice this was not required.

researcher (SH) to ensure consistency. After discussion, agreement was reached on all articles.

2.3 Further scoring of evidence quality – consideration of risk factors[7]

There were very few 'off the shelf' interventions, and very few interventions or intervention types that had been evaluated against injury or collision outcomes. One practical reason for this may be that very large samples are generally required to evaluate against such outcomes (see Peck, 2011). Large samples can often, in turn, require longer study times (for example to allow time for collision data to accumulate).

The tendency of the literature to rely on other outcomes such as behaviours, attitudes and other risk factors believed (or assumed) to be linked with collisions and injuries necessitated a change of focus in the review, and placed greater importance on consideration of the wider road safety and driver behaviour literature to understand which outcome measures really could be said to act as useful markers of collision or injury risk.

Such outcomes have been described as proxy measures in other fields[8]. While proxy measures are frequently employed in a number of areas of research (e.g. qualifying for a free school meal is often used as a proxy for socio-economic status) there is a need for greater understanding of what makes a good proxy measure in road safety (Wundersitz & Hutchinson, 2012).

Here we propose three criteria that might be used to establish the suitability of proxy measures. The first criterion is practical availability (i.e. can we obtain the necessary raw data to create the proxy measure). Proxy measures will vary in their practical availability with better measures having a high ease of use. A second criterion is the relationship between the proxy measure and the 'final measure' (here road collisions or injuries). Good proxy measures will have a better relationship with the final measure. The third criterion is that interventions should affect the proxy measure in the same way as the final measure. In other words if an intervention improves a good proxy measure then it will improve the final measure.

Clearly the extent to which a proxy measure is theoretically and empirically related to collision involvement or injuries will determine the success of this approach. The multifactorial nature of collision involvement makes the task of providing a good proxy measure challenging, however. If we consider the second criterion which defines the magnitude of the relationship between the proxy measure and the final measure then we find that even for a measure such as driving violations which has one of the strongest relationships with collision involvement (see e.g. De Winter & Dodou, 2010) then the correlation is only of the order of 0.13. Even if we follow the advice of Rosenthal (1990; cited in Horswill & McKenna, 2004) and use the correlation coefficient itself as an indicator

[7] See the reference section for the full list of literature consulted.

[8] Conceptually proxy measures can be thought of as similar to 'surrogate endpoints', which are biomarkers used in medical research in place of clinical endpoints. For example, cholesterol level (biomarker) is often used as a surrogate endpoint for heart attacks (clinical end point).

of how one measure is affected by another, we might expect violations to be explaining around 13% of the variance in collisions at best.

An alternative approach is to consider risk factors[9] which, if changed, would show promise as remedial interventions.

With this in mind, a supplementary literature review (using the same databases and timeframe as the first review) was undertaken in order to identify risk factors in relation to young drivers and their collision risk (the search terms are shown in Appendix A). The outcomes from this search were not subjected to a formal evaluation using the AMSMS scale; it was used as a supplement to the existing subjective judgement and knowledge of the research team regarding which risk factors (either those identified as outcome measures in the first review, or those known from previous research) showed most promise in terms of their link to crash outcomes.

It is worth considering why a formal quantification of the links between the risk factors and collisions was not attempted; in turn, it is worth noting some detail regarding the way in which the subjective ranking that is presented in place of a formal quantification was undertaken. In short the authors know of no common metric (e.g. odds ratio, correlation coefficient) shared in the literature by all of the risk factors considered, which might be used to quantify their links with collision outcomes. Therefore, the main consideration for the subjective ranking was the consistency with which, to the authors' knowledge, each risk factor had been shown to have an association with collisions or injury risk. This is by no means a perfect way to arrive at conclusions regarding the risk factors to prioritise as outcomes for interventions, but in the absence of a robust evidence base, it was the best option available.

The list of risk factors (summarised below[10]) was subjected to lengthy scrutiny during a session which included all members of the project team. The purpose of this session was to use the combined expertise and knowledge of the team to reach a subjectively agreed final list of risk factors rated for their link to collision outcomes. The final list is as follows:

1. Simple risk factors such as age and experience have been known for many years. Crash rate decreases with age of licensure across the age range under investigation here (Maycock et al., 1991). Crash rate also decreases very rapidly with driving experience across the first few months of driving and more slowly thereafter

[9] The term 'proxy measure' is sometimes used to imply that the measure in question can be used as a replacement for the final measure. The low correlation between any single measure and collision/injury outcomes does little to support such an implication. Therefore, in the remainder of this report, we now refer to 'risk factors' rather than 'proxy measures'. Risk factors can be thought of as any measure that is known to be associated with an increased risk of the final measure occurring, with no implication of complete equivalence.

[10] The lay reader may be surprised to see some of the things absent from this list. For example, vehicle handling skills might be expected to be relevant to safety outcomes, but when the evidence base is examined this is found not to be the case (see e.g. Williams & O'Neil, 1974 and Helman et al., 2010 for a summary). The list here, albeit one that was arrived at largely through discussion within the project team, is nonetheless the list we consider appropriate for the purpose (namely, to help understand which are the most promising intervention types from the first review, given the lack of robust evaluations using collision or injury outcomes).

(McCartt et al. 2003; Maycock et al. 1991). On-road experience (amount and type) in the learning phase has also been shown to be associated with a reduction in post-test collisions (Sexton & Grayson, 2010; Gregersen et al., 2000).

2. Night time driving has been noted by Williams (2003) to be a risk factor for young drivers, and has been successfully targeted in GDL programmes (Kinnear et al., 2013; Russell et al., 2011).
3. The presence of peer-age passengers has been shown to be associated with an increase in fatal accident involvement (Chen, Baker, Braver & Li, 2000), and again has been successfully targeted in GDL programmes (Kinnear et al., 2013; Russell et al., 2011).
4. The effect of alcohol is a straightforward risk factor for young drivers. The evidence that alcohol impairs performance and has a detrimental effect on concentration is compelling. Zador et al. (2000) found that, even at levels below the current legal limit, young males (below age 20) are 17 times more likely to be involved in a fatal single vehicle crash than drivers with no alcohol in their system (zero BAC).
5. Driving violations, as measured either by police convictions (Gerbers & Peck, 2003) or through self-report (De Winter & Dodou, 2010), have long been associated with collision involvement and as a consequence are candidates for assessment as key risk factors.
6. Seat belt wearing is known to be lower among some younger drivers (Christmas et al., 2008) and there is an uncontroversial association between seat belt wearing and risk.
7. The use of distracting devices while driving is a known risk factor for crashes. A recent review for the European Commission (TRL, TNO, RappTrans, 2015) estimated that between 10% and 30% of road collisions in the EU have distractions (in general) as a contributory factor. Lansdown (2012) has shown that even though people understand the distractions inherent in engaging with tasks such as using mobile devices while driving, they are still happy to engage in such tasks themselves, and young male drivers are the most likely to do so.
8. The relationship between speed and crash involvement is straightforward and well documented; as speed goes up so does the likelihood of crash involvement (Aarts & van Schagen, 2006; Richter et al., 2006; Finch et al., 1994). In terms of the severity of crashes involving young drivers, it is possible that speed has a multiplier effect when combined with other risk factors (e.g. distractions, peer-age passenger, driving at night etc.). It is also known that when observed unobtrusively on a variety of roads under free flow conditions, younger drivers choose faster speeds (Maycock, Palmer & Buttress, 1999).
9. Close following is another measure that has a simple connection to collision involvement. Close following hampers a driver's opportunity to read the road ahead and reduces the time available to react in the event of a sudden hazard. An observational study by Evans and Wasielewski (1983) found a clear relationship between the following distances that people choose and their crash involvement, and McKenna (2007) found that a video measure of close following was associated with accident involvement (although these studies were not exclusive to young

drivers). In another observational study young people were observed to adopt closer following distances (McKenna et al., 1998).

10. There is a growing literature on hazard perception. In an analysis of young driver crashes Braitman et al. (2008) found that search for and detection of hazards was one of the most common factors. It has been known for some time that hazard perception can be measured (McKenna & Crick, 1994), that it can be trained (McKenna & Crick, 1997), that it is related to accident involvement (Wells et al., 2008; McKenna & Horswill, 1999; Hull & Christie, 1993; Quimby et al., 1986).

Another compelling approach is to consider whether methods designed to change the above risk factors[11] have been successful in reducing collisions and injuries. The power of this argument is that if interventions designed to target these risk factors have been successful in reducing collisions and injuries then it reinforces the relevance of the risk factor. For example, it has been shown that interventions that target extending the learning period, and reducing both night-time driving and driving with peer-age passengers (post-licence) are successful in reducing injuries (Masten et al., 2013).

The introduction of a hazard perception test has also been shown to be associated with accident reduction (Wells et al., 2008). A wide range of engineering and enforcement interventions that target speed choice (Elvik & Vaa, 2004) have been shown to be effective. All of this work reinforces the identification of the relevant risk factors.

The question then arises as to whether there are alternative interventions specifically relevant to newly qualified drivers, which target the risk factors on the above list. This will be addressed in Section 3.

Table 1 summarises the final list of risk factors, in terms of what the desired outcome would be for an intervention targeting that risk factor in newly qualified drivers.

Although no detailed quantitative assessment is made here of the link between each of these risk factors and injury or collision outcomes, it is possible to consider the relative strength and depth of evidence linking each risk factor to these final health measures. In short, the top seven rows in the table contain those risk factors that the authors believe are best supported by the evidence in terms of their link to collisions and injuries. The next three rows contain those risk factors with reasonable links to collisions and injuries, and the final row (attitudes, behavioural intentions) contains the risk factor type with the weakest link (although still of potential value).

[11] There are some measures that have not yet been shown to be successful, despite apparent face validity as predictors of collisions. For example elevated g forces produced by harsh braking or sharp turns, offer themselves as potential risk factors (e.g. Simons-Morton et al., 2013). While such events have a high level of intuitive credibility, this is somewhat dimmed by the wide variety of measures in use by different technology suppliers and insurers, and the uncertainty as to which measures are more or less likely to be successful as indicators of risk.

Another measure that has been targeted for improvement through driver training is broader driving skill. Numerous studies have failed to find any benefit from so-called 'traditional' driver training (Helman et al., 2010).

All of these risk factors are potentially open to change through intervention, and all can be measured.

Table 1: Desirable changes in risk factors targeted by interventions which seek to reduce collisions and injuries in newly qualified drivers

Risk factor change	Rationale
Older age at licensure	Known to be associated with a reduction in risk
Less night time driving	Known to be a particularly risky situation for young and novice drivers from GDL literature
Less driving with peer-age passengers, or fewer peer-age passengers	Known to be a particularly risky situation for young and novice drivers from GDL literature
More supervised on-road experience pre- or post-test	Known to lower collision risk
More seat belt wearing	Uncontroversial association with injury outcomes
Lower levels of drink driving	Uncontroversial association with collision risk
Lower speeds	Uncontroversial association with collision risk and injury outcomes
Higher hazard perception skill	Hazard perception skill is the only driving skill shown to be associated with collision risk over multiple studies
Less close following	Close following has been shown to be associated with collision risk
Less use of distracting devices when driving	Distraction is widely shown to impact on driver attentiveness, which is strongly associated with the chances of missing timely stimuli on the road ahead
Reducing unsafe attitudes and behavioural intentions regarding all of the above	In general it is accepted that safer attitudes and behavioural intentions will be associated somewhat with safer behaviour, and (to a smaller degree) injury and collision outcomes

2.4 Final scoring of evidence for interventions and intervention types

The final stage of scoring the interventions involved the consideration of all previous tasks (sourcing articles, quality scoring, and consideration of risk factors).

After quality assessment, very few of the articles reported discrete 'off the shelf' interventions. Due to this finding, the interventions were first divided by the *type* of intervention in generic terms relating to their key mechanism of engagement e.g. hazard perception, parental engagement, traditional practical training, computer or simulator training, intelligent speed adaptation (see Section 3 for a full review of the interventions that were scored).

Based initially on the judgement of the third author and then through consultation with the remainder of the project team in an internal meeting, the totality of the evidence base in these categories was scored on the following measures:

- Design quality (on the AMSMS)
- Magnitude of impacts seen (small, medium, large)
- Weight of evidence (number of studies with safety improvements, safety disbenefits, or demonstrating no change)
- The outcome measures targeted for change (whether injuries/collisions or risk factors)
- A subjective rating of the plausibility that the behaviour change mechanisms proposed could impact on later behaviour[12]

Based on the final scoring, a list of interventions/intervention types was taken forward for discussion at the expert workshop.

2.5 Expert workshop

The purpose of the workshop was to provide a mechanism by which the interventions with the strongest evidence base could be scrutinised by an eclectic mix of road safety professionals and stakeholders. The workshop did not consider evidence of effectiveness; instead, the workshop focused on a discussion of the list of interventions shown in Table 1. The overall goal was to reduce the list of interventions to the three to five with the greatest potential based on likely effectiveness and a consideration of a range of characteristics that might influence larger scale implementation. Participants were informed that these interventions might be considered for evaluation in a future research study and were therefore asked to consider the practical constraints and issues that might impact on their suitability.

The workshop involved group discussions in which participants discussed each intervention or intervention type on a number of characteristics including: UK applicability, cost, acceptability, ease of implementation, ownership, target audience and other relevant issues (see Appendix C).

Fifteen stakeholders were selected to attend the workshop by TRL and were approved by DfT. Inclusion in the workshop was based on stakeholders' knowledge of:

1. The potential capacity to deliver any interventions selected for further consideration
2. The young driver population, and an ability to provide insights on how those targeted by the interventions might be impacted (for example access to required resources)
3. The young driver challenge, and an ability to give the young driver population a 'voice' in the consideration of interventions

[12] For example an intervention that sought to improve knowledge about a risky behaviour (e.g. driving at night) would be expected to have less chance of changing behaviour than an intervention that sought to provide alternatives to actually engaging in the risky behaviour.

4. The practical constraints and impacts seen in previous interventions

Four representatives attended from DfT (who sat in on the small discussion groups). The workshop was completed in a day.

2.5.1 Workshop output and qualitative assessment of data

Workshop attendees were divided into three small groups of five attendees and a TRL facilitator (with one or two DfT representatives sitting in on each group). The facilitator mediated and encouraged the discussion throughout the session and made detailed notes. In addition to this, participants were asked to complete a short worksheet for each intervention discussed. In this worksheet, participants were asked to consider two main questions in relation to the six key issues discussed in Appendix C:

1. What would be positive about implementing this intervention?
2. What are the possible challenges with implementing this intervention?

The completed sheets (see blank version in Appendix D) were collected at the end of the workshop. These were used by the project team to contextualise and add to the general discussion notes made by the group facilitators. The results are discussed in Section 3.

3 Results

This section summarises the interventions and intervention types found in the literature. Interventions were divided into eight categories, based on the apparent mechanism by which they sought to reach young and novice drivers, and by the risk factor or factors that appeared to be the key focus. It is worth noting that there is some overlap in the categories used, so each intervention was categorised according to what appeared to be its key focus.

For each intervention or intervention type, a paragraph of text and a table is presented. Each paragraph summarises the evidence for the intervention or intervention type, taking into account the final scoring of articles described in Section 2.4. Each corresponding table contains (for each article in that category) the reference, the type of intervention study, a brief summary of the results reported, and the AMSMS score. More detailed information on each of the interventions is provided in Appendix F to Appendix L (e.g. sample size, methodology and timescale).

3.1 Parental engagement to influence exposure to risky driving situations (the Checkpoints Programme)

The Checkpoints Programme is an intervention that involves parental involvement, the purpose of which is primarily to establish boundaries and impose limits on young drivers' exposure to risky driving situations. The programme targets two risk factors (among others) that have a robust evidence base as risk factors for young driver crashes (driving at night and driving with passengers). The literature on this intervention is summarised in Table 2.

The summary of the evaluations conducted on the Checkpoints Programme appear to point to positive outcomes in terms of imposing restrictions on teen driving. Much of the positive evidence base behind this approach is predicated on the basis of parent-teen agreements. A parent-teen agreement is a commitment from both parties to abide by a set of negotiated promises. Whether delivered by parents in isolation or with the support of driving instructors (see Zakrajsek et al., 2009 and Zakrajsek et al. 2013 respectively), positive outcomes are reported in terms of the likelihood of imposing restrictions on teen driving in high risk situations. Furthermore, Simons-Morton et al. (2006b) report significant reductions in the likelihood of having traffic violations after 12 months. An advantage of this approach is that it appears to be effective in limiting behaviours that we know from available evidence are high risk scenarios for young drivers (e.g. driving on weekend nights, on high speed roads, in bad weather, and with teen passengers). It is important to note that *awareness* on the part of the parent of teen driver risk is not the goal here (which could be achieved via a communication-only approach); it is the tangible application of actionable agreements that is believed to result in change.

The quality of the studies is high, and weight of evidence suggests that the programme has a positive effect on safety; this is apparent through the influence of the programme on risk factors with plausible connections to collision and injury risk, plus in one study a reduction in traffic violations. The lack of any evidence for actual collision reductions is not unexpected, since sample sizes in studies are all quite limited.

Table 2: Literature relating to parental engagement to influence exposure to risky driving situations[13]

Reference	Type of Intervention	Results Summary	AMSMS score
Zakrajsek et al. (2013)	Parent - Driver Pairs. Improving Parent Management Practices (Checkpoints Programme delivered with support from ADIs)	ADIs enrolled 148 parent-teen pairs (intervention teens (ITs = 99, control = 149)). ITs were more likely to report the use of a 'Parent-Teen Driving Agreement'. ITs were also more likely to report restrictions on driving; with teen passengers, on weekend nights, on high speed roads and in bad weather during the first six months of licensure. No difference in offences or crashes at six months but ITs reported less high risk driving.	5
Zakrajsek et al. (2009)	Parent - Driver Pairs. Improving Parent Management Practices (Checkpoints Programme)	At licensure, compared with parents in the comparison group, treatment parents had increased awareness of teen driving risk and were more likely to have completed a 'Parent-Teen Driving Agreement' and met Checkpoints recommendations for restrictions on teen driving in inclement weather and road types.	5
Simons-Morton et al. (2006a)	Parent - Driver Pairs. Improving Parent Management Practices (Checkpoints Programme delivered with persuasive communications (mail) relating to high risk driving and 'Parent-Teen Driving Agreements')	Families who participated in the Checkpoints Programme reported significantly greater limits on teen driving at licensure, and at **3-** and **6-months** post-licensure. There were no differences in reported risky driving behaviour, violations, or crashes.	5

[13] Please note the AMSMS score shown in Tables 2 – 8 relates to the quality of the study design and does not consider implementation factors or other elements. Table 9 summarises the other things taken into account to arrive at the final list for consideration at the workshop.

Reference	Type of Intervention	Results Summary	AMSMS score
Simons-Morton et al. (2006b)	Parent - Driver Pairs. Improving Parent Management Practices (Checkpoints Programme delivered with persuasive communications (mail) relating to high risk driving and 'Parent-Teen Driving Agreements')	Follow up: By the **12-month** follow up teens in the intervention group were significantly less likely than those in the comparison group to have had a traffic violation.	5
Simons-Morton et al. (2002)	Parent - Driver Pairs. Improving Parent Management Practices (Checkpoints Programme)	Both parents and teens in the intervention group reported significantly greater limits on teen driving at licensure and three months post-licensure.	5

3.2 Literature relating to parental engagement to influence behaviour

This category differs slightly from the 'exposure' category as it focuses on parents taking a stronger role in both the type of practical driving undertaken by the young driver and its monitoring. Two key differences between this and the 'exposure' category (and specifically the Checkpoints Programme) are that there are no restrictions per se placed on the teen driver, and this category seems to be heavily dependent on in vehicle data recorder (IVDR) technologies to enable the parental management[14]. The studies included in this category can be seen in Table 3.

We might also conclude this is a reactive rather than a proactive approach. This is an important distinction to make; the behaviour change mechanism occurs a posteriori (i.e. after the relevant risk factor has occurred), meaning feedback is retrospective. On a separate note – which is also applicable to the 'exposure' category – parental communication style is likely to influence the success of any approach that relies on the parent acting as the 'gatekeeper' or 'enforcer' of teen driving behaviour (for example see Yang et al. 2013).

The overall weight of evidence is high and points to positive outcomes where parental influence is used to monitor and correct the driving behaviour of the teen driver. In all cases where parents are involved the outcomes are positive whether achieved by IVDR only (with parents being given access to a feedback panel) or event triggered video outputs (see Simons-Morton et al., 2013 and McGehee, et al., 2007 respectively). The plausibility of the mechanism is also high based on the positive results reported by the insurance sector where this approach is used (albeit without properly controlled evaluation designs, and with compliance being driven by other penalties and incentives in some instances).

The outcome measures for the interventions listed are unsurprisingly based on reductions in IVDR events. We should exercise some caution in assuming a direct correlation between a reduction in IVDR g-force events[15] and collision involvement. However, the overall mechanism of behaviour change measurement using IVDRs seems plausible. IVDRs are a useful tool to measure driver behaviour objectively; we can therefore have a relatively high confidence in the outcomes reported. There is one caveat to this however, in that there is not currently an agreed set of criteria to establish what 'safe' and 'unsafe' driving is.

The overall design quality of the studies is generally high with randomised control trials employed in five of the studies included. It should be noted that one study reported that providing LED ('red/green/amber') feedback to the driver (without any parental involvement) had no effect on behaviour (Simons-Morton et al. 2013).

[14] In vehicle data recorders are often known colloquially as 'black boxes' and encompass a wide range of systems that collect data on driver and vehicle behaviour and either store it locally or transmit it remotely using mobile communications. Such systems are also increasingly referred to as 'vehicle telematics'.

[15] IVDR g-force 'events' are occasions where vehicle g-forces (e.g. acceleration or deceleration) exceed pre-defined parameters. Typically events are categorised by colour where red = severe, green = acceptable, and amber = less severe. They can be used to trigger video-based recording of the vehicle (both inside and out).

Table 3: Literature relating to parental engagement to influence behaviour

Reference	Type of Intervention	Results Summary	AMSMS score
Taubman et al. (2015)	The study combines data gathered using in-vehicle data recorders from actual driving of parents and their male teen drivers with data collected from self-report questionnaires completed by the young drivers.	Findings indicate that the parents' (especially the fathers') sensation seeking, anxiety, and aggression, as well as their risky driving events rate were positively associated with higher risky driving of the young driver. In addition, parents' involvement in the intervention, either by feedback or by training, led to lower risky driving events rate of young drivers compared to the control group.	3
Peek-Asa et al. (2014)	"Steering Teens Safe" - a parent-focused programme to improve parental communication with teens about safe driving using motivational interviewing techniques in conjunction with 19 safe driving lessons.	Intervention teens ranked their parents' success in talking about driving safety significantly higher than control teens and reported that their parents talked about more topics (non-significant difference). The Risky Driving Score* was significantly (21%) lower in intervention compared to control teens. Interaction between communication quantity and the intervention was examined. Intervention teens who reported more successful communication had a significantly lower (42%) lower Risky Driving Score than control parents with less successful communication. *Respondents reported the number of times in the past three weeks that they performed each driving behaviour (related to each of the four intervention topics), and an overall score was calculated (for this study) as the sum of risky driving behaviours.	5
Farah et al. (2014)	The study examines the utility of providing parents with guidance on how to exercise vigilant care regarding their teens' driving. Driving behaviour was evaluated using data collected by IVDR.	It can be concluded that providing feedback on driving behaviour and parental training in vigilant care significantly improves the driving behaviour of young novice male drivers.	5

Reference	Type of Intervention	Results Summary	AMSMS score
Simons-Morton et al. (2013)	IVDR - Comparison of a) LED feedback to teens (Lights Only) and b) LED feedback with parental access to driver data (Lights Plus). LED feedback was provided in the form of a green light in the absence of a g-force event, a red and green flashing light following an event, and then a red light indicating that footage of the event had been saved.	Results showed a significant decrease in event rates during 13 weeks of feedback for the 'Lights Plus' group, but no change for the 'Lights Only' group. Provision of feedback with possible consequences associated with parents being informed reduced risky driving, whereas immediate feedback to teenagers only did not.	5
Yang et al. (2013)	Different 'Family Communication Patterns' were explored. These were correlated with the frequency of parent-teen discussions and teens' driving safety attitudes.	In families with communication patterns that were laissez-faire, protective, and pluralistic, parents talked to their teens significantly less about safe driving than did parents in families with a consensual communication pattern. Moreover, the frequency of parent-teen communication about safe driving was significantly and positively associated with teen attitudes toward safe driving.	5
Farmer et al. (2010)	Vehicles of 85 teenage drivers were fitted with a device (IVDR) that detected all instances of sudden braking/acceleration, speeding, and non-use of seat belts.	Seat belt use improved when violations were reported to the parent websites, and improved even more when in-vehicle alerts were activated. Consistent reductions in speeding were achieved only when teenagers received alerts about their speeding behaviour, believed their speeding behaviour would not be reported to parents if corrected, and when parents were being notified of such behaviour by report cards.	5

Reference	Type of Intervention	Results Summary	AMSMS score
McGehee et al. (2007)	Pairing a weekly video review (event triggered) and graphical report card giving parents the ability to teach their teens after they begin driving independently.	Preliminary findings suggest that combining this emerging technology with parental weekly review of safety-relevant incidents resulted in a significant decrease in events for the more at-risk teen drivers.	2

3.3 Literature relating to Hazard Perception Training

Interventions were included in this category which sought to teach young drivers to anticipate hazards. The mechanism via which this is achieved varies between the studies considered. The literature related to this intervention type can be seen in Table 4.

Overall, in the studies considered during this review participants showed improvements in their ability to recognise potential hazards relative to control groups. Although the AMSMS score of the interventions listed are lower than in other categories a historical body of comprehensive research exists showing that the skill can be trained and is related to collision risk (see Section 2.3). We also know from historical work that a relatively small number of 'contact' hours can lead to improvements equal to that of a considerable amount of driving experience (McKenna & Crick, 1997). We can also be comfortable that the technical mechanisms for measuring improvements in hazard perception in controlled environments are well established. The magnitude of effects sizes are reasonable and are measured using objective techniques (e.g. anticipation times to defined hazards).

One of the studies considered reported positive outcomes in other risky driving behaviours, namely safer attitudes to close following and to dangerous overtaking, and a decrease in driving related confidence[16] (Isler et al. 2011). In line with this finding McKenna et al. (2006) noted that while it has been argued that skill and risk taking are independent, requiring different remedial measures, they found that a skill based intervention (hazard perception training) did influence risk taking measures.

We know that hazard perception can be taught and measured, and that drivers with better hazard perception skills are less likely to be involved in a collision; we do not yet have a comprehensive demonstration that those drivers who are trained to be better at hazard perception then go on to have fewer crashes[17].

[16] A decrease in driver confidence can be considered to be a positive outcome. For example some driver training programmes which focus on vehicle handling skills may lead to increased risk taking due to learners' inflated level of confidence in their driving skills.

[17] A recent report published while this review was being finalised has found an effect on collisions, in some drivers, of a simple hazard perception training programme. Thomas, Rilea, Blomberg, Peck and Korbelak (2016) have shown that a brief computer-based HP training intervention was able to lower collision rate for male drivers by around 23%, but demonstrated no statistically significant change in collisions for female drivers. More research is clearly needed to confirm these promising results.

Table 4: Literature relating to Hazard Perception Training

Reference	Type of Intervention	Results Summary	AMSMS score
Meir et al. (2014)	Comparison of 3 AAHPT (Act and Anticipate Hazard Perception Training) modes (active, instructional, or hybrid) or a control group. Active members observed video-based traffic scenes and were asked to press a response button each time they detected a hazard. Instructional members underwent a tutorial that included both written material and video-based examples regarding hazard perception. Hybrid members received a condensed theoretical component followed by a succinct active component.	Overall, the active and hybrid modes were more aware of potential hazards relative to the control.	2
Zafian et al. (2014)	Evaluates the effectiveness of a training programme, Road Aware® (RA), at training drivers to scan for hazards in roadway scenarios where the anticipation of a hazard required between one and three glances.	The study's results suggest that RA training was effective in teaching young drivers to anticipate hazards, and that the training effect was even larger for the complex situations requiring more than one glance.	2

Reference	Type of Intervention	Results Summary	AMSMS score
Isler et al. (2011)	Comparison of the effects of training in higher-order driving skills (e.g. perception, motivation, insight) and vehicle handling skill training in relation to on-road driving performance, hazard perception, attitudes to risky driving and driver confidence levels in young, inexperienced drivers.	Participants who received higher-order driving skill training showed a statistically significant improvement in relation to visual search and the composite driving measure. This was accompanied by an improvement in hazard perception, safer attitudes to close following and to dangerous overtaking and a decrease in driving related confidence. Participants who received vehicle handling skill training showed significant improvements in relation to their on-road direction control, speed choice and the composite driving score. However, this group showed no improvement in hazard perception, attitudes to risky driving or driver confidence.	5
Pradhan et al. (2005)	A PC-based Risk Awareness and Perception Training Programme (RAPT) was developed to teach novice drivers about different categories of risky situations likely to be encountered while driving. The format was an interactive multimedia presentation with both plan (i.e., top down) views and perspective views of roadway geometry that illustrated generally risky scenarios along with information about the type of risks and the relevant areas that attention should be allocated to in order to detect the risks.	The ability of the novice drivers to identify risks in static views improved after they completed the training programme. More importantly, the trained novice drivers were significantly more likely to correctly fixate on risk relevant areas in the simulated driving environment than the untrained drivers 3-5 days after training.	2

Reference	Type of Intervention	Results Summary	AMSMS score
Fisher et al. (2006)	RAPT (Risk Awareness and Perception Training Program) uses evidence-based techniques to teach learners to identify risky situations when on the road by transferring knowledge acquired during PC training. It 'encourages deep processing in scenarios where risks are hidden by asking the novice drivers to visualise for themselves where those risks are…'. The goal is to use transfer learning (i.e. where skills obtained can be transferred into a real-world scenario).	Significantly more trained drivers (70%) in the near-transfer scenarios (i.e. situations that resemble the scenarios in training) fixated on areas of the roadway which contained information which could reduce their likelihood of a crash (only 33% of untrained drivers did the same). In the far-transfer scenarios (i.e. scenarios that do not necessarily resemble those used in training but still require application of the general principles learned) differences were smaller between groups, but still remained significant.	5

3.4 Literature relating to the use of in vehicle data recorders (IVDRs) to monitor and manage behaviour

These interventions directly examine the effect of IVDR and feedback types in isolation from other factors (i.e. excluding parental influence). The references in this category can be seen in Table 5.

Few studies were found in this category. The majority of other studies using IVDRs were found to focus on the active involvement of parents, and have been included in that category.

The study undertaken by Bolderdijk et al. (2011) is the one high quality study found that demonstrates the effectiveness of a 'Pay as You Drive' style intervention, based on a number of risk factors such as driving volume (mileage), style (e.g. speed, acceleration, deceleration), as well as other factors (e.g. time of driving). Its inclusion highlights the range of risk factors that can be included in IVDR solutions directly linked to insurance premiums. In particular, the study reports a significant reduction in speeding violations of young drivers.

Table 5: Literature relating to the use of in vehicle data recorders (IVDRs) to monitor and manage behaviour

Reference	Type of Intervention	Results Summary	AMSMS score
Bolderdijk et al. (2011)	'Pay-as-you-drive' PAYD, in combination with GPS devices in policy holders' cars, resulted in changes in participants' insurance premiums based on a multitude of risk factors, including driving volume (mileage) and style (e.g. speed, acceleration, deceleration), as well as other factors (e.g. time of driving).	Analyses showed that, relative to pre- and post-measurement, and to a control group, the introduction of a PAYD insurance fee significantly reduced speed violations of young drivers.	5
Donmez et al. (2008)	A driving simulator study was conducted with 48 participants and 3 conditions: retrospective feedback, combined feedback (both retrospective and concurrent), and no feedback (baseline case).	The feedback conditions (retrospective and combined) resulted in faster response to lead vehicle braking events as depicted by shorter accelerator release times. Moreover, combined feedback also resulted in longer glances to the road. The results suggest that both feedback types have potential to improve immediate driving performance and driver engagement in distractions. Combined feedback holds the most promise for mitigating the effects of distraction from in-vehicle information systems.	2

3.5 Literature relating to education approaches[18]

These interventions examine the effect of education programmes targeted at young people that focus on a range of driving behaviours. This category can be thought of as the closest to what is currently delivered across GB by local authorities and other providers. Such interventions tend to be classroom- or theatre-based, and generally try to target young people before they are exposed to driving by highlighting the potential consequences of risky driving. The references involved can be seen in Table 6.

Overall the quality of the evidence base behind this type of intervention is currently weak to moderate. Very few evaluations were found that scored highly on the AMSMS. The findings from studies included in this review are also relatively inconclusive[19]. Although some studies have reported isolated improvements in certain measures of risk (such as attitudes), the overall evidence base is currently generally low in quality and fails to demonstrate effectiveness.

A range of reviews have failed to find evidence for the effectiveness of such interventions in reducing collisions, and a range of authors have pointed out that the mechanisms posited for safety benefits from those interventions that have been evaluated are not based on sound theoretical behaviour change techniques (see Helman et al., 2010 for a summary of both of these arguments). More worryingly, a number of researchers have also highlighted the issue that some driver education initiatives may lead to an increased risk of crash involvement through plausible delivery mechanisms (Mayhew & Simpson, 2002; Vernick et al., 1999 – see McKenna, 2010 for a review). There is some evidence of this in the literature reviewed in Table 6. For example the study by Glendon et al. (2014) found that participants of a pre-driving education course reported *riskier* attitudes towards unsafe driving behaviours after the course, compared with a control group. Although (as previously noted) such outcome measures may not be good 'proxies' for collisions and injuries, the fact that the course was designed specifically to reduce such risky attitudes means that this result must be seen as a failure. Such findings can be easily explained through such mechanisms as those discussed in McKenna (2010) and Helman et al. (2010); for example there is some evidence that risk can be seen as a reward by some teenage recipients of safety messages in other fields (see McKenna (2010) for a discussion), leading to greater tendency to engage in risky behaviours even when messages about such behaviours explicitly discourage participation.

It should be noted that in line with McKenna (2010) and Helman et al. (2010) the authors of this report do not believe that more traditional educational interventions can never be effective as safety treatments. Rather it is that the interventions need to be based on sound

[18] Educational interventions, in the context of this review, are limited to classroom-based educational initiatives targeted specifically at young people, often before they start driving. National Drivers Offenders Retraining Scheme (NDORS) courses, which are targeted educational interventions for drivers that have been caught committing some types of motoring offences, such as speeding, driver alertness or distraction, are not covered by this review.

[19] An additional challenge is that many locally developed initiatives have not been subject to evaluation. Given the similarity between such initiatives and those larger ones in the wider literature that have been found to be ineffective, this should be a cause for concern.

behaviour change techniques, that evaluation evidence needs to be provided, and that when compared with the other approaches reviewed here (which tend to use stronger mechanisms of engagement focused on stronger risk factors) they lack as much promise for applied evaluation.

We also acknowledge that despite the generally weak evidence base for direct effects on strong safety outcomes, more traditional road safety education approaches may have value in other ways as part of contributing to the wider road safety culture (which may be slow to change over time); they may also demonstrate effectiveness in changing other outcomes which are not directly related to safety but may lead to an indirect safety benefit (for example, as discussed by several authors, as a way of legitimising and therefore facilitating greater use of known effective activities such as speed enforcement).

Table 6: Literature relating to education approaches

Reference	Type of Intervention	Results Summary	AMSMS score
Glendon et al. (2014)	Year 11 students (age range 16–17 years) - Young drivers. The course comprised six 30-min sessions with up to 30 students per group. Content involved interacting with a seriously injured crash survivor, practical demonstrations of the importance of vehicle and road conditions on reaction time and stopping distance, and interactive workshops on the impacts on driving of alcohol, drugs, and fatigue. It included group discussions about the importance of vehicle safety and regular maintenance. Talks targeted attitudes, awareness, and preparation for the unexpected by eliminating risk, minimizing distractions, and anticipating hazards. A local police presentation covered possible consequences of a driver's choices, including fatalities, crashes, fines, and penalties.	While no changes in attitudes toward unsafe driving were found for the control group, the intervention group reported riskier attitudes toward unsafe driving behaviours from T1 to T2 and T3. No differences were found from T1 to T3 in perceived risk toward unsafe driving for either the intervention or control groups. (T = Time Point)	3

Reference	Type of Intervention	Results Summary	AMSMS score
Brijs et al. (2014)	"On the Road" (OtR). Flemish post-licence driver education programme with a focus on cognitive skills and motivational aspects ('insight programme'). The intervention also seeks to address lower-order procedural skills (emergency braking, seating position and steering wheel handling). The course is delivered over three and a half hours by experienced driving school instructors. It costs €20, is voluntary and those who take part may have the opportunity to receive reductions in their car insurance.	The programme had a small positive effect in relation to speeding (positive effect on descriptive norm, self-efficacy and behavioural intention). However, it had a negative effect on drink driving on some psychological variables. At follow-up, only risk-related knowledge was significantly different between the groups; participants scored higher in the second measurement than in the first. However, there were limitations with matching; groups had a statistically different mean age.	2
Lenné et al. (2011)	To promote safe behaviours between drivers and passengers. The aim of the training is to teach teamwork and communication skills.	Headway distances (measured in a simulator environment) were significantly larger in the training group when compared to the control group. However, measures of speed and vehicle control did not differ between both groups. Trained passengers also emitted significantly fewer unsafe comments (though there was no significant difference between groups for emitted safe comments).	5
Burkett et al. (2010)	"Drive Alive" Pilot Programme. A 'theory-based' programme building on highway safety. The focus is on increasing seat belt use among teen drivers and is delivered in high schools.	The results showed increased seatbelt use by 23%. However, as this was an observational study, data cannot be matched to individuals and hence the study cannot assess individual's changes in behaviours. No personal variables were collected, just counts.	2

Reference	Type of Intervention	Results Summary	AMSMS score
Lang et al. (2010)	Development of a two-hour facilitated discussion group aimed to help learner drivers develop safe driving-related attitudes, increase their awareness of the risks novice drivers face and equip them with risk mitigation strategies.	Significant short term changes towards safer attitudes were observed for some driving-related attitudes, subjective norms and behavioural intentions. Participants' self-efficacy ratings did, however, not change significantly.	2
Senserrick et al. (2009)	Participants completed a detailed questionnaire and consented to data linkage in 2003–2004. Questionnaire items included year of participation in two specific education programs: a 1-day workshop-only programme focusing on driving risks ("driver-focused") and a whole-of-community programme also including a 1-day workshop but also longer term follow-up activities and a broader focus on reducing risk-taking and building resilience ("resilience-focused"). Survey data were subsequently linked to police-reported crash and offense data for 1996–2005. Poisson regression models that adjusted for multiple confounders were created to explore offences and crashes as a driver (dichotomised as 0 vs 1) after programme participation.	Offences did not differ between groups; however, whereas the driver-focused programme was not associated with reduced crash risk, the resilience-focused programme was associated with a 44% reduced relative risk for crash (0.56 [95% confidence interval: 0.34–0.93]). The large effect size observed and complementary findings from a comparable randomised, controlled trial in the United States suggest programs that focus more generally on reducing risks and building resilience have the potential to reduce crashes.	2

Reference	Type of Intervention	Results Summary	AMSMS score
Henk et al. (2008)	"Teens in the Driving Seat" (http://www.t-driver.com/) - Peer-to-Peer driver education and awareness programme. Content: 1) driving at night; 2) distractions (primarily in the form of other teen passengers and cell phones/texting); 3) speeding; 4) not wearing a seat belt; and 5) alcohol use.	Data gathered to date indicates that teens involved in the TDS Programme: 1) have improved levels of awareness (40 to 200+ percent) related to the top risks faced by teen drivers; 2) exhibit higher seat belt usage rates (+11 percent overall); and 3) exhibit lower usage of wireless devices while driving (30 percent less).	3
King et al. (2008)	"You hold the Key" (YHTK). The purpose of the intervention is to increase safe driving and passenger behaviours for teens between 15 and 19. It is a 10-week school-based programme. It includes safety education, cooperative learning, role playing, videos and presentations from experts. The programme focuses on behaviours such as drink-driving, distractions, seatbelts, passengers, resistance skills and strategies to reduce crashes.	YHTK was associated with significant immediate and long–term improvements in teen seatbelt use, safe driving, and perceived confidence in preventing drunk driving.	2

Reference	Type of Intervention	Results Summary	AMSMS score
Molina et al. (2007)	One-day training programme. Measurement of the impact of the training programme focused on the participants' self-evaluation and self-reporting of some driving behaviour indicators related to accident risk.	Data analysis showed a change in the expected direction in the scale related to the skills for careful driving, but not for the other four scales considered. The results of the experiment show that using a one day driver safety course, it is possible to change some of the drivers' evaluations connected to safe driving style into safe direction. The follow-up period was exceptionally long (9 months) and the design (randomly divided experimental and control groups with before and after measurements) was reliable.	5
Simpson et al. (2002)	"DRIVE" pre-driver education package. The BBC produced six 10 minute television programmes shown as the series ‘Drive with Alexei Sayle’. Support materials consisted of a Teacher/Student Support Booklet which contained four student tasks for each of the six modules, guidance notes for the teachers, and a self-help booklet for individual use.	An evaluation of the effects of DRIVE amongst students in schools and colleges using questionnaire surveys showed that DRIVE improved both students’ knowledge of driving safety and their attitudes towards driving. Students who had participated in DRIVE obtained significantly higher scores on questions about driving safety and were also more likely to rate driving as dangerous after the course than those students who had not taken the course.	3

Reference	Type of Intervention	Results Summary	AMSMS score
Nolén et al. (2002)	PILOT - Further education of young drivers to motivate them to use larger safety margins in traffic. One-day course (four different types).	The test group did understand the message in the education and considered themselves influenced as car drivers two years after the course. The education also had positive long-term effects on self-reported use of a seat belt, distance-keeping and overtaking, perceived ability to drive with safety margins and to attitudes/beliefs regarding seat belts and safety margins of young drivers. The results are consistent with the focus of the education and hopefully the results are positive from a traffic safety perspective. However, empirical evidence is still missing of the effects on driver behaviour in traffic and on accident involvement.	2
Senserrick et al. (2001)	The Skilled Drivers Of Australia driver-training programme. A one day programme developed for 18-25 year-olds.	After the Skilled Drivers training programme, participants reported low levels of dangerous driving behaviours (as measured by DBQ), and greater awareness and sensitivity to the risk of having a collision or a near miss.	2
Carcar et al. (2001)	Evaluation and comparison of the effectiveness of a pre vs. a post licence classroom based educational programme for young drivers. This was done over four studies.	Overall no evidence was found to support the pre-driver intervention, and some support was found for the post driver intervention. However, not all studies employed the same measures which may limit comparison (only two of the studies involved previously validated scales).	2

3.6 Literature relating to practical (in-car) training

This category contains studies which examine the effect of practical training such as Advanced Driving, approaches to enhance driver skill, and training based on conventional learning to drive practices (i.e. in-car training with driving instructors). The references in this category can be seen in Table 7.

As with educational approaches, the current evidence base for the effectiveness of 'traditional' practical driver training suffers from a lack of consistency of positive effects and a range of reasons to believe that the mechanisms proposed by some interventions are not based on robust theory (see Helman et al., 2010 for a summary).

Even some so-called 'innovative' approaches have not proven successful. For example a study by Helman et al. (2013) examined an innovative in-car 'coaching' approach based on the outputs and recommendations of the large European HERMES project (HERMES, 2010). The study found some evidence for an overall treatment effect, but with some outcomes being positive and some negative in terms of their impact on safety.

Positive findings from some studies must be balanced against some indications of safety disbenefits in other studies. The magnitudes of effects seen are generally small even if some positive outcomes are observed, and they are generally only seen on outcomes with little sound link to collisions and injuries. We can be confident of the small effect sizes because there have been numerous high quality research studies employing RCT methods that have arrived at similar conclusions (see Helman et al., 2010, for a recent summary of these earlier reviews). It must also be noted that there is almost no support for the theoretical mechanisms of behaviour change relating to practical in-car training (Helman et al., 2010).

Small-scale evaluations of advanced driving coaching systems have shown beneficial effects on some outcomes (e.g. measures such as situation awareness, or application of those techniques that have been taught) where the intervention involves the delivery of the advanced driving syllabus (see Stanton et al., 2007). It is challenging to extrapolate the findings from this study specifically to young drivers due to the wide age profile of participants recruited for the study, and the range of other limitations of the study design (for example the self-selecting nature of the comparison group). Furthermore, advanced driving organisations have historically found it difficult to recruit young drivers into what are essentially membership groups, thus making it difficult to examine the behavioural effect of advanced driver training on large cohorts of statistically high risk drivers. It is also important to note that the benefits associated with membership (e.g. lower insurance) of these organisations are limited to those outside of the greatest risk segments (typically 23 years upwards) which may, in part, account for this phenomenon.

As noted in the section on more traditional road safety education, the authors believe that behind-the-wheel training has value as part of a wider approach to improving road safety culture (and it is certainly necessary for people to gain access to driving). Nonetheless, when compared with the evidence base for the other approaches considered in this review, it does not seem to show as much promise for further applied evaluation.

Table 7: Literature relating to practical (in-car) training

Reference	Type of Intervention/Study	Results Summary	AMSMS score
Helman et al. (2013)	"The learning to drive evaluation project"	When considered as a whole, the findings did suggest the presence of a pattern in the data consistent with there being an overall (although not statistically significant) treatment effect. However this pattern was not consistent with a clear safety improvement since some comparisons showed indications of safety benefits, and others indications of safety disbenefits.	4
Stanton et al. (2007)	Evaluation of an Advanced Driver Coaching System (IAM)	The results suggest that advanced driver coaching using the IPSGA (Information, Position, Speed, Gear, Acceleration) system had a beneficial effect. Treatment drivers improved their situational awareness, driving skills and reduced attributions of external locus of control.	3

3.7 Literature relating to PC or simulator training

These are interventions where simulators or PCs are used for training drivers on a range of risk factors. The references involved can be seen in Table 8.

As with hazard perception training, the broad picture appears to show evidence of improvements in the risk factors targeted using this delivery mechanism but the overall magnitude of effects are low and there is a much weaker conceptual link, and empirical link, between the outcome measures that tend to be used and collisions.

The design quality of the studies is high probably due in part to the practical ease of setting-up experimental studies using PCs or simulators. The risk factors targeted by the literature found focused on driver distraction, possibly because of the proliferation of portable electronic devices that are leading to a renewed focus in road safety on distraction as a wider risk factor for collisions (TRL et al., 2015).

Horrey et al. (2009) report a decline in self-reported willingness to engage in distracting activities and increased perceived risk relative to a control group whose self-reported behaviour did not change. Regan et al. (2000) showed a deferred benefit from CD-ROM training after 4 weeks with a reduction in mean speed relative to the control (although no differences were recorded between groups at the start of the study). The follow up also noted that participants drove closer to the posted speed limit and performed relatively better in a reaction time task. The studies examined appear to show some positive behaviour change using a relatively small engagement time-scale, for example one-hour PC training and approximately 15 minutes in studies conducted by Pradhan et al. (2011) and Horrey et al. (2009) respectively.

The use of simulators as a training mechanism is challenging due to their scarcity but the use of PCs as a delivery mechanism is highly appealing from a practical point of view (for example, the ability of the majority of young drivers to access PCs either at home or through public access facilities). This could involve some form of e-learning which we would expect to be accessible for the majority of the target audience (either at home or via a public facility), and an overlap with hazard perception (i.e. as a mechanism by which hazard perception training can be delivered) may be desirable.

Table 8: Literature relating to PC or simulator training

Reference	Type of Intervention	Results Summary	AMSMS score
Pradhan et al. (2011)	Forward Concentration and Attention Learning (FOCAL) - A one-hour PC-based training using error learning to train drivers in driving-related attention maintenance techniques.	The FOCAL trained group showed significantly fewer glances away from the roadway that were more than 2 seconds.	5
Horrey et al. (2009)	The training offered an interactive training module aimed at improving driver decision-making regarding distracting tasks. The training included information and general facts about distraction, video demos, training in a technique for dealing with distraction, and demos of using this techniques with added commentary. The training seeks to promote and develop metacognitive strategies. The training used in the study took 12 to 14 minutes to complete.	The participants in the experimental group showed a decline in self-reported willingness to engage in distracting activities and an increased perceived risk. Ratings from drivers in the control group did not change. However, no driving data was collected before the intervention and hence no comparison can be made pre/post for the same individuals.	5
Regan et al. (2000)	DriveSmart training (CD ROM training) - The training includes elements of insight training: optimism, commentary driving; prediction; and situation awareness. The main instruction strategy is incremental transfer learning.	Entrance and exit drives: at the start, no differences were found in mean speed in the control vs. treatment groups. However, at the exit drive (4 weeks after training) the control group drove significantly faster than the experimental group. At the post follow-up, participants in the treatment group drove closer to the posted speed limits, and performed relatively better than controls in the reaction time task.	3

3.8 Interventions discussed at the stakeholder workshop

The list of interventions discussed during the stakeholder workshop was developed based on the results from the literature review and team discussions about other potential approaches that might have theoretical support, but which may not have empirical support due to their recent introduction (the 'smartphone app' to act as an electronic logbook for encouraging on-road pre-test practice falls into this category).

Table 9 outlines how the different intervention categories were rated overall according to a consideration of the quantity and quality of the studies (taking into account the AMSMS score), the overall consistency of evidence, the quality of the risk factors, and the plausibility of the mechanisms of behaviour change proposed. It was not possible to quantify all of these measures because of the heterogeneity in the literature regarding the precise outcomes used; therefore the scoring is in some cases qualitative.

Table 9: Overall ratings of the intervention categories

Description	No. of studies	Quality (scores)	Consistency of the evidence	Quality of risk factors	Plausibility of mechanisms of behaviour change
3.1 Parental engagement to influence exposure to risky driving situations (the Checkpoints Programme)	5	All scored the maximum (5, 5, 5, 5, 5)	All show positive effects	Good – mostly self-reported behaviours relating to night time and with-passenger driving	Good. Reduction in risk exposure has been shown to reduce crashes
3.2 Literature relating to parental engagement to influence behaviour	7	Generally high (5, 5, 5, 5, 5, 3, 2)	All show positive effects	Variable – some self-report specific behaviours with high validity such as speed choice and seatbelt wearing. Some related to IVDR measures such as g-forces.	Generally accepted to be good – changes in actual behaviour through parental monitoring have a good chance to decrease crashes
3.3 Literature relating to Hazard Perception Training	5	Medium (5, 5, 2, 2, 2)	All show positive effects	Good – hazard perception score (measured in various ways) supplemented in some cases by risk-attitude measures	Good – changes in hazard perception ability should improve safety – hazard perception ability previously related to collision risk

Description	No. of studies	Quality (scores)	Consistency of the evidence	Quality of risk factors	Plausibility of mechanisms of behaviour change
3.4 Literature relating to the use of In Vehicle Data Recorders (IVDRs) to monitor and manage behaviour	2	Medium (5, 2)	Both show positive effects	Good. In one case speed choice, and in another case reducing distraction effects.	Good – monitoring and providing feedback should be effective at changing behaviour
3.5 Literature relating to education approaches	13	Generally low (5, 5, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2)	Mostly positive effects but two studies show negative effects and two show none	Varied – some observed behaviour but many measures were related to attitudes	Weak – educational interventions provide little in the way of ongoing monitoring or management of behaviour; this coupled with poorly-defined mechanism by which they may influence actual behaviour make plausibility low
3.6 Literature relating to practical (in-car) training	2	Medium (4, 3)	Varied – one study shows mixed effects (some positive some negative), one shows positive	Varied but generally weak – subjective ratings and self-report attitudes/intentions	Medium – in car training should have more relevance to safety outcomes but dosage is small

Description	No. of studies	Quality (scores)	Consistency of the evidence	Quality of risk factors	Plausibility of mechanisms of behaviour change
3.7 Literature relating to PC or simulator training	3	Generally high (5, 5, 3)	All show positive effects	Varied – some self-report intentions, some simulator measures of glance, some speed behaviour	Medium – using e-learning or simulation to deliver training seems plausible, but unknown dosage requirements. May be better suited to include as potential delivery mechanism for other risk factors?

Based on the totality of ratings in Table 9, it is clear that the interventions described in Sections 3.1-3.4 (and to a lesser extent 3.7) score the highest.

Given the lack of any well-defined 'off the shelf' interventions (except perhaps the Checkpoints Programme) it was necessary to combine some of the above categories with others that emerged through a consideration of other known 'innovative' approaches (through discussions within the project team) and also taking into account variation within the categories themselves (for example whether to use telematics with or without parental involvement, which is a variant within the telematics category). This resulted in a list of seven interventions for proposed discussion at the workshop, derived from the five best scoring categories in Table 9.

Table 10 presents the interventions and intervention categories discussed at the workshop as well as a short description of what each is designed to do in terms of the desired change in specific risk factors.

As noted above none of the shortlisted interventions were 'off the shelf' products (other than the Checkpoints programme), and therefore the descriptions of interventions are based on general principles derived from the literature review and from the judgement of the team.

Table 10: List of interventions for discussion at stakeholder workshop

Type	Intervention	What intervention is designed to do
Parent/ guardian involvement	The Checkpoints programme	Mainly focused on reducing exposure to high risk situations such as driving at night and carrying peer age passengers
	Parent/guardian-led pre-test or post-test on-road practice	Increase on-road practice (pre-test or post-test)
	Parent/guardian involvement in coaching behavior	Improve behaviour on several risk factors related to behaviour (seat belt use, speeds, distraction etc.)
Behavioural monitoring + feedback	Telematics feedback and sharing information with parents/guardians (simple – e.g. online access to colour-coded IVDR feedback, or complex – e.g. online access to event triggered video information)	Improving driving style, and potentially reducing exposure to high risk situations such as driving at night
	Telematics feedback without parental involvement	Improving driving style, and potentially reducing exposure to high risk driving situations such as driving at night
	Smartphone app to encourage and monitor increased pre-test on-road practice	Increase pre-test on-road practice (with driving instructors, or with other supervising drivers)
Cognitive skills	Hazard perception training	Increase hazard perception skill

In addition, the categories 'classroom- or theatre-based driver education' and 'behind the wheel driver training' were included for discussion. Although almost none of the evidence identified through the review (or historically) pointed toward the effectiveness of either of these types of intervention in reducing collision risk, it was seen as important to give attendees the opportunity to evaluate the delivery capacity for these categories of interventions along with those interventions that the review found to have stronger evidence for effectiveness; this also gave the research team the opportunity to confirm that stakeholders were not aware of additional evaluations or evidence in these categories unknown to the research team.

3.9 Results from the workshop

This section summarises the responses elicited from the workshop participants. As many similarities were found between interventions employing the same key mechanism of delivery the sections start by highlighting the key positive and negative attributes discussed for each intervention type at this high level of description (for example all interventions that primarily focused on parent/guardian involvement – the leftmost column in Table 10). Specific elements discussed for individual interventions or intervention types are also discussed (e.g. parent/guardian-led pre-test or post-test on-road practice – the middle column in Table 10).

3.9.1 Overview

There were a number of overall messages that arose from workshop attendees that seemed to remain constant regardless of the type of intervention. These messages primarily relate to applicability, need for further development, the risk of a self-selection bias, and the role of incentives.

In terms of applicability to the UK context, almost all interventions were viewed as being applicable, and generally speaking stakeholders could see a benefit to the application of the interventions discussed with UK drivers. Only the Checkpoints programme was subject to some disagreement on the applicability issue (perhaps given its status as the only 'off the shelf' intervention meaning that it could be readily identified as originating from a specific jurisdiction).

The costs involved in the development and application of these interventions were believed to be acceptable. However, it is noteworthy that stakeholders believed most of the interventions (except possibly hazard perception and education/training initiatives) would likely be privately funded (i.e. either by parents or the private sector).

The standout point that seemed to relate to all interventions was the belief that these required further development. This was somewhat expected as most interventions presented (except the Checkpoints programme) were 'templates' of interventions rather than an 'off the shelf' solution. Similarly, none of the listed interventions were considered to be stand-alone; many stakeholders believed that combining these or other interventions would be desirable for the most successful outcome.

The issue of a possible self-selection bias was also a common topic of discussion among groups. Most interventions (in their current form) were perceived as likely to fail to reach all

those who would benefit, in the absence of legislation to ensure that newly qualified drivers were obliged to undertake them[20].

3.9.2 Parent/guardian involvement

Stakeholders in the workshop were generally in agreement that increased parental involvement would make a positive contribution to the safety of young drivers. Some stakeholders also believed that increased involvement and responsibility from parents in the learning to drive experience would result in lower implementation costs of interventions from authorities as parents take on the role of educating and training. The fact that many parents provide finance and access to a car was seen as a powerful negotiating factor in encouraging conformity to exposure restrictions and in promoting uptake of supervised on-road practice.

However, a number of challenges were identified in relation to strategies requiring parental involvement. The main challenges or limitations foreseen related to the difficulty in obtaining parental/guardian buy-in (issues such as time commitment were discussed) as well as the relative capability of parents to deliver appropriate driver training and coaching[21]. The high possibility for a selection bias was discussed and so there was concern that only those teens that were naturally less risky (for example because they had parents willing to provide support during the learning process) would be involved in such interventions. There was also consensus from participants that insurance premiums were inappropriately high on the basis of accident risk under supervised conditions. This might be a barrier for learners seeking to increase on-road experience.

Therefore, communication with parents (and ways of getting buy in) were seen as crucial for the success of these approaches, as well as teen buy in (and/or acceptance) as this could also be a potential barrier.

Overall, parental involvement was seen as positive but the challenges in delivering these interventions appropriately were considered by some to be considerable, but not insurmountable. Table 11 summarises the positive and negative points made about parent/guardian involvement approaches overall.

Sections 3.9.2.1 through 3.9.3.1 then discuss the main positive features and challenges/ barriers discussed by workshop attendees for the individual intervention approaches within the 'parental involvement' super-category.

[20] This issue is returned to in the later section on recommendations. For any later trial of effectiveness the point around incentives may be irrelevant, since if a trial is undertaken incentives can be built into the experimental design. However, the nature of any eventual, implemented intervention, it would be necessary to consider how it would be ensured that the intervention reached all those young and novice drivers who would be expected to benefit from its effects.

[21] It should be noted that the stakeholders mentioning this may not have been aware that on-road practice does not appear to require 'coaching' or any other specific approach to have an impact on collisions – see Gregersen et al. (2000).

Table 11: Summary of positive and negative points made by workshop attendees regarding 'parent/guardian involvement' approaches

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	Generally, parental involvement was considered viable in a UK context	No significant challenges were raised (some potential barriers are discussed below)
Cost	Low cost	Cost not considered to be a significant challenge
Acceptability	Positive providing buy-in can be obtained	Some parents may not wish to take on the responsibility of supporting a young driver (may feel it is the role of the ADI)
Ease of implementation	Easy to implement (at national/ governmental level) Parental role should allow for some control over the implementation of restrictions	Difficult to get parents' buy-in and/or to maintain commitment longer term Parents may not see themselves as part of the learning process
Ownership	Parents take on some responsibility	Would require a structure to be developed
Target audience	Positive for those with engaged parents	Limited target audience (younger, and more affluent, still living at home, supportive parents)
Any other relevant issues	Increased parental involvement is always positive	Possible need to train parents

3.9.2.1 The Checkpoints programme

Low cost and ease of implementation were key positive attributes of this type of intervention. Two potential limitations were discussed, one being a limited target audience (the youngest new drivers or those living at home) and the other whether the intervention (in its current form) would be applicable to the UK context. Table 12 summarises these points.

Table 12: Summary of positive and negative points made by workshop attendees regarding the Checkpoints programme

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	N/A	Issues with applicability to the UK context (currently a US-only based intervention so some potential challenges in a UK context)
Cost	Low cost	Cost not considered to be a significant challenge
Acceptability	Clear rationale behind the restrictions	May unnecessarily restrict safe drivers (e.g. those during the evenings)
Ease of implementation	Relatively easy to implement/ encourage participation	Reliant on good parent-teen relationships
Ownership	Positive for those with engaged parents	Limited target audience (younger, and more affluent, still living at home, supportive parents)
Target audience	Positive providing there is an adequate support mechanism	Level of support from a parent/ guardian
Any other relevant issues	Centrally owned. No requirement for external involvement	No guarantee that when restrictions are lifted that the young driver is ready (if no training has been given)

3.9.2.2 Parent/guardian-led pre-test or post-test on-road practice

This intervention was generally positively viewed in that stakeholders were aware of the positive impact of increased practice. The fact that learners are perceived as being keen on obtaining on-road practice (at least at the pre-licencing stage) was mentioned as something that could encourage uptake. Stakeholders noted that if partners or spouses were also made part of the process, this could reach a wider audience of novice drivers (i.e. not solely those who still have close links with parents). Challenges related to the possible need to engage with ADIs, and the increased time commitment for parents. Table 13 summarises these points.

Table 13: Summary of positive and negative points made by workshop attendees regarding parent/guardian-led on-road practice

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	Generally speaking, parental involvement was seen as being viable in a UK context	No significant challenges were identified (some potential barriers are discussed below)
Cost	Low cost	Cost not considered to be a significant challenge
Acceptability	Pre-test practice likely to be more welcome than post-test Learners are keen on obtaining practice	No significant challenges were raised in terms of acceptability
Ease of implementation	Relatively straightforward to implement	May require additional engagement/buy in from ADIs Increased time commitment from parents required
Ownership	Someone other than the parent could also be involved in this intervention	Parents may not be willing to engage/have the necessary skills to do so
Target audience	Seen as a sensible approach for young/new drivers	May favour those with supportive parents (self-selection bias) May not reach those that are higher risk
Any other relevant issues	Could appeal to wider audience if this dynamic could also include partners/spouses	Cost of insurance Possible need to train parents

3.9.2.3 Parent/guardian involvement in coaching behaviour

Interventions involving coaching from parents/guardians received similar criticisms as the above (Section 3.9.2.2); however, a major concern in this particular area related to the parent/guardian's ability to deliver appropriate coaching. Some attendees believed that parental training would need to be provided and that care should be taken to ensure appropriate guidance was offered to parents undertaking this role. Table 14 summarises these points.

Table 14: Summary of positive and negative points made by workshop attendees regarding parent/guardian-led coaching of behaviour

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	Similar responses to other parent/guardian led interventions	Similar responses to other parent/guardian led interventions
Cost	N/A	Cost not considered a significant barrier
Acceptability	Parental involvement seen as positive in general	General challenges around involving parents (as discussed elsewhere)
Ease of implementation	N/A	Salient issue about parent ability to take on the role and the potential need for training of parents
Ownership	Parent/guardian ownership	Will probably require some support mechanism (e.g. training/information)
Target audience	Parents considered a viable mechanism to achieve change	May favour those with supportive parents May not reach those that are higher risk
Any other relevant issues	Could start at early age Could include life coaching more generally Could benefit other areas of family/life	Similar issues around suitability/ experience/knowledge of parents

3.9.3 Behavioural monitoring and feedback through telematics

These types of interventions were perceived positively, and the topic of telematics as a viable tool for improving driver behaviour was discussed in relation to many of the interventions proposed during the workshop. The approach was viewed by some as a platform for accessing drivers and obtaining data. It was also viewed as a potential means for assessing the allocation of incentives to drivers who exhibit safer behaviours.

The issues of ownership of data, and development of optimal models of driver behaviour were discussed in some detail. It was believed that as the market is moving very quickly, insurance companies should have ownership of the development of driver behaviour models as they would be able to see the opportunities and implement more quickly than

government. However, one option discussed (which could follow from a trial) was that government could evaluate and regulate such a model and then make it available as best practice to be used by commercial organisations[22]. Table 15 shows the positive and negative points made about these approaches overall, and Sections 3.9.3.1 and 3.9.3.2 discuss individual approaches within this category.

Table 15: Summary of positive and negative points made by workshop attendees regarding behavioural monitoring and feedback

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	General consensus around the potential use of telematics for positive behaviour change	Broad issues around data protection (outlined below)
Cost	Collaboration with insurance companies could reduce the overall cost	Cost was not considered a significant challenge based on insurance company involvement
Acceptability	Telematics is seen as a robust measurement tool	Parents/young drivers may not know that police can use telematics data if a collision occurs. How are data used/shared? Needs to be encouraged in a positive way
Ease of implementation	Easy to implement	Not necessarily an intervention, rather a means for delivering and encouraging use of other interventions (e.g. the effects of hazard training on driving style could be examined through data) Challenges around data usage, data protection, opt-outs and general understanding of the data collected Installation and/or policy costs Challenges with uptake and continued engagement
Ownership	Could involve commercial suppliers who are more flexible to demand	Questions around ownership of data/intellectual property

[22] A word of caution here is that is that such an approach might reduce opportunities for commercial advantage and competition between insurers. Insurers have suggested that government intervention should focus on setting minimum standards for telematics data quality but not being prescriptive about how data are used and to what outcome (Tong et al., 2015)

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Target audience	No significant comments	Questions around telematics and some more risky young drivers
Any other relevant issues	Driving difficulties backed by concrete data are harder to dispute Parents would be interested to know young driver's performance	Monitoring the use of feedback Technical issue with accurately linking driver behaviour to speed

3.9.3.1 Telematics with parental feedback and sharing information with parents/guardians

Generally, this intervention was believed to be promising in terms of the use of telematics data, particularly if this could be supported by incentives from insurance companies. Similarly, stakeholders believed that this intervention (much like those discussed in Section 3.9.2) has the benefit of engaging parents in the learning to drive process.

However, limitations were highlighted regarding the reliance on parents and as such there was concern that this intervention may only appeal to those teens with a good relationship with their parents/guardians (self-selection); it may also only be applicable to those young drivers who are still living at or close to home.

The general acceptability by the young driver was also questioned; many stakeholders believed that it might be difficult to obtain buy in from learners as they may not want parents to have access to information about their driving. Table 16 shows the positive and negative points made by attendees during the workshop.

Table 16: Summary of positive and negative points made by workshop attendees regarding telematics with parental feedback

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	General consensus around the potential use of telematics and parents as a positive behaviour change mechanism	Applicability may be limited (younger/living at home)
Cost	Insurance sector involvement	Cost was not considered a significant challenge based on insurance company involvement
Acceptability	Combining telematics and parental influence appears to be a viable way of changing behaviour	Acceptability by young drivers may be low Data privacy etc.
Ease of implementation	Opportunities for incentivising may help increase uptake	See other comments around data protection, data usage etc.
Ownership	Insurance sector involvement with a road safety 'plug in'	Knowledge sharing between insurers may be a barrier
Target audience	No significant comments were raised	Some drivers may value their privacy over participation
Any other relevant issues	Engaging parents seen as positive	Similar issues around parental ability/knowledge/training

3.9.3.2 Telematics feedback without parental involvement

The technology involved in this intervention was viewed positively. This particular method of delivery (i.e. without parental involvement) was perceived as being likely to be more acceptable to young drivers, and applicable to a wider age range (as it does not rely on parental support). Table 17 shows the positive and negative points made by attendees during the workshop.

Table 17: Summary of positive and negative points made by workshop attendees regarding telematics without parental feedback

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	Similar comments to those on telematics in general	Limited impact of the intervention without parental involvement
Cost	Less costly as no parental training required	Similar comments to other telematics-based interventions
Acceptability	Young drivers may be more likely to participate if their parents are not involved	Parents may wish to have access to feedback
Ease of implementation	No significant differences to other telematics-based interventions	No significant differences to other telematics-based interventions
Ownership	Insurance sector led	Knowledge sharing between insurers may be a barrier
Target audience	More likely to be accepted by young drivers Applicable to wider age range	Questions around effectiveness of this type of intervention
Any other relevant issues	No other significant issues raised	No other significant issues raised

3.9.3.3 Smartphone app to encourage and monitor increased pre-test on-road practice

The idea of a smartphone app to prompt more pre-test practice was the least well received intervention from the list. While some stakeholders believed that apps are a good way of engaging with younger people, others suggested that apps are not always effective. Another issue was related to security and ensuring that data logged (for example, in terms of practice hours) was accurate. Ultimately, it was believed that if the app was to be used effectively and consistently by young drivers, this would have to be a requirement of the learning to drive process and potentially require buy in from ADIs. Table 18 summarises these points.

Table 18: Summary of positive and negative points made by workshop attendees regarding smartphone app to encourage and monitor increased pre-test on-road practice

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	Accessible to young drivers (technology is a 'norm' for them)	No significant challenges identified
Cost	Low cost once the technology has been developed	No significant cost challenges raised
Acceptability	Appeals to young drivers	No significant acceptability concerns raised
Ease of implementation	An electronic log book Effective means of engaging with young drivers	Would have to be careful how it is implemented so that it does not encourage negative behaviours
Ownership	Likely to involve private industry	Issues around intellectual property
Target audience	The target audience are familiar with the technology	Danger that young drivers might use the app on the move
Any other relevant issues	Easy to develop/many already on the market Useful platform to circulate other relevant information Possible link with driver behaviour data Could be accessible by parents, driving instructors and the young driver as a 'log'	Many stakeholders believed this is not a viable intervention Security – how to ensure data logged is accurate (i.e. can a young driver cheat if there are incentives?)

3.9.4 Hazard perception training

Hazard perception training was the intervention viewed most positively. This is likely to relate to the fact that hazard perception skill has already proven to have an effective link to safety outcomes, and is included in the current licensing system (in the form of a test).

The main challenges raised by attendees related to choosing the right media through which to deliver the training and providing guidance to those who would potentially be involved in this process. Uptake was one of the main negative issues relating to this intervention. Table 19 summarises these points.

Table 19: Summary of positive and negative points made by workshop attendees regarding hazard perception training

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	The target audience are familiar with it given it is already part of the existing test	No significant challenges raised
Cost	Low cost (if self-financed)	Some discussion around the high development costs
Acceptability	Proven to be important for safety; industry is comfortable with it Reinforcement of the skills drivers have acquired during the driving test process	Might be seen as duplicating the existing HP test component
Ease of implementation	Easy to implement (e-learning)	Challenges in encouraging uptake, particularly post-test Need to select/develop the appropriate training
Ownership	Involvement of the DVSA	No significant challenges raised
Target audience	Relatively easy to obtain coverage of large number of drivers	Self-selecting participation if based on voluntary mechanism
Any other relevant issues	Could appeal to wider audience if this dynamic could also include partners/spouses	”Clicking a mouse is different to pushing a pedal” Danger that it is seen as a “hoop for drivers to jump through”

3.9.5 Behind-the-wheel driver training

Stakeholders were keen to explore the possibility of developing effective training and education for young drivers, but there was general acceptance that those current models and approaches that have been evaluated have not yet been demonstrated to be effective. Although training can be wide reaching and applicable to a large segment of the driver population, it was believed that costs and the lack of evidence base are important issues. Table 20 summarises these points.

Table 20: Summary of positive and negative points made by workshop attendees regarding behind-the-wheel training

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	Applicable to all drivers	Limited resources available to reach all drivers
Cost	No significant comments made	Costs could be prohibitive May need to incentivise participation
Acceptability	No significant comments made	Challenges in obtaining buy-in from insurers
Ease of implementation	Could begin at a younger age (pre license)	Need for trainers with the right skills High time commitment
Ownership	No significant comments made	Identifying who is ultimately responsible for the syllabus
Target audience	Could target risky drivers/those using risky roads/certain demographics	No significant challenges raised
Any other relevant issues	Could provide more experience to drivers Could include motorway driving and driving at night, for example	Lack of existing evidence of effectiveness May favour motor enthusiasts Targets driver skill. May not change attitudes

3.9.6 Classroom or other road safety education

As with behind-the-wheel training, stakeholders were aware of the current lack of evaluation evidence for the effectiveness of road safety education initiatives which target young people in directly influencing collision rates, but were keen to ensure education is not completely removed from the young driver experience. However, a number of key issues were highlighted including the need for development and delivery of consistent messages. Table 21 summarises these points.

Table 21: Summary of positive and negative points made by workshop attendees regarding educational approaches

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability	It is already being done by some organisations	Challenges around ensuring consistency
Cost	Low cost (possible sponsorship opportunities)	Some considered this to be an expensive intervention type
Acceptability	Captive audience if delivered in an educational setting	If in school time, students may not be completely engaged
Ease of implementation	Not easy to implement in a consistent and comprehensive way	Would require access to schools and currently not part of curriculum Could be challenging to get into the curriculum
Ownership	Could be embedded into the curriculum	What standards would those providing the training abide by? Challenges with regulation
Target audience	Potentially wide reaching	Time commitment
Any other relevant issues	Life skills can be taught from early age Can be delivered with peers	Messages need to be consistent Lack of existing evidence of effectiveness

3.9.7 Workshop outcomes discussion

The sections above highlight the key discussion points during the workshop. Most interventions were positively received. A number of challenges to the effective delivery or 'reach' of these were noted at a practical level, but no interventions were 'ruled out' on the basis of such limitations.

Hazard perception training was probably the best received intervention in that stakeholders seemed to be confident in the validity of such an intervention and its capability to deliver positive results; this may be related to its links with the current driving curriculum. Although challenges were identified, these were fairly limited and considered to be resolvable.

Interventions involving telematics were also well received and viewed as having an important role to play in the improvement of young driver safety. The issues of uptake and data protection were discussed at length.

Involving parents/guardians in the learning to drive process was generally considered a positive step forward. However important challenges were noted. First, increasing requirements for driving practice could put additional strains on parents' finances (including personal time) and possibly on parent-teen relationships. Second, not all parents want to (or

believe they should) be involved in their children's learning to drive. It was noted that communication with parents (and ways of getting buy-in, through appropriate marketing) may be crucial for the success of these approaches. Similarly, the success of such approaches is likely to require the development of guidance that can aid parents as they take a more central role in the learning to drive process.

Ownership is also likely to be a challenge, and it is noteworthy that with the possible exception of telematics approaches (that could be owned by insurance companies), there was no real agreement on who should own individual interventions. Without a clear development and financial model to support the roll out of such interventions, it will be challenging to ensure an appropriate delivery method is employed and also, to measure the outcomes.

The need for appropriate incentives was also mentioned as a key issue for many if not all interventions. Much discussion centred on whether interventions could be adequately incentivised if they were not part of the licensing system (i.e. mandatory), although alternatives such as insurance discounts for well-evidenced interventions were discussed.

These points about ownership and incentives may not be relevant until evidence for actual effectiveness is obtained in a future evaluation trial; if one or more interventions can be shown to be effective at reducing collision and injury outcomes in an adequately robust and properly controlled trial, decisions regarding the best way of ensuring that as many drivers are exposed to such interventions can be made on a case by case basis and (crucially) can be based on some objective evidence of the safety benefits that may accrue.

4 Discussion and recommendations

The purpose of this review was to identify young and novice driver interventions that might be taken forward for evaluation in a trial in GB.

Before drawing conclusions, it is worth reiterating the manner in which the review eventually arrived at the list of 'best chance' interventions for discussion with stakeholders regarding actual implementation.

In short, there are almost no 'off-the-shelf' interventions that have been properly evaluated and found to be effective in directly reducing collision risk. A cursory glance at the largest group of interventions (these include traditional education and training approaches) that are currently in circulation and which target young people reveals some room for improvement. There are some interventions being delivered in GB that have been evaluated to some degree and found to be either ineffective or only moderately effective in changing short term attitudes, and even then only in very weak evaluation designs (see for example Kinnear et al., 2013 for a review of pre-driver interventions). There are a number of so-called 'innovative' interventions that have not yet been evaluated properly, but for which no plausible mechanism of effectiveness can be identified. There are novel approaches undertaken by insurers, for which commercial confidence exists but which again lack any support from rigorous and independent review.

Part of the reason for the apparent ineffectiveness of traditional training and educational approaches as direct treatments for crash reduction has been discussed before at length (e.g. Kinnear et al., 2013; McKenna, 2010; Helman et al., 2010). One of the key challenges is that such interventions do not target relevant risk factors; driving skill, knowledge, attitudes and other measures with 'intuitive appeal' are offered as potential outcomes of merit but when the theoretical plausibility of such outcomes as genuine indicators of later collision risk is examined, none has yet been found (McKenna, 2010). As noted previously in this report, the current lack of evidence for effectiveness for traditional training and education approaches as direct treatments for crash reduction does not mean that such interventions have no value; however, on the basis of the evidence reviewed here we believe that there are other interventions that show greater promise for trialling in GB[23]. These are interventions that target more promising risk factors (objective behaviours known to increase risk of collision and injury such as speed, night time driving, driving with peer-age passengers, and hazard perception skill), through more comprehensive mechanisms of engagement with young drivers.

Such interventions are finding their way into the literature, and into practice. Again very few off-the-shelf interventions have been evaluated in more than a small number of studies. Nonetheless through a consideration of risk factors, and through linking different interventions into categories depending on those risk factors targeted and the manner in which they are to be targeted, it was possible to draw up a list of seven broad approaches for discussion.

[23] It is imperative that any new interventions, whatever their focus, should be evaluated in properly controlled studies against their intended outcomes. This includes new training and education approaches which target known risk factors using behaviour change theory and techniques.

The previous sections in this report have outlined the methods taken to review the literature, the way in which research has been scored for quality, and the way in which the workshop opened up discussion of pertinent points regarding implementation of any future initiatives of the types discussed. In the coming sub-sections we discuss what we consider to be the four 'best chance of success' approaches that ought to be taken forward in any future evaluation trial (based on the literature review and workshop findings). Given the paucity of off-the-shelf products (and limitations noted regarding the one that was found), we have given these interventions names that reflect their intended mechanisms of engagement and effect. They are:

1. An intervention to engage parents in managing post-test driving in specific risky situations
2. An intervention to engage a range of stakeholders (and utilising a logbook approach) in increasing the amount and breadth of pre-test on-road experience
3. An intervention utilising technology (IVDRs) and possibly parents to manage driver behaviour post-test
4. An intervention to train hazard perception skill

In the sections below we describe these interventions and then in Section 4.5 and Section 4.6 we outline the ways in which any evaluation trial would be best undertaken, including some discussion of those stakeholders who might be involved in the delivery of interventions and the likely design, incentives and sample sizes required. We also touch on longer term considerations for implementation after any evaluation trial (assuming effectiveness can be demonstrated) although ultimately such issues would also need to be included as part of any evaluation, and explored once the interventions themselves are better defined. A summary of the four recommendations in the form of logic maps can be found in Appendix E. The logic maps are intended to summarise the main objectives of the intervention, the required inputs and outputs, and the outcomes.

4.1 Intervention to manage post-test driving in specific risky situations through parent-driver contracts

The one 'off the shelf' intervention which seemed to show the most promise is the Checkpoints Programme (http://www.saferdrivingforteens.org/). This programme is freely available, and provides content through the World Wide Web for parents[24] to use in helping their newly qualified driver manage the risks faced in early licensed driving, among other things.

One core component of Checkpoints is a 'parent-teen' driving agreement that sets out agreed limitations on driving in the dark, with peer-age passengers, in different weather conditions, and on different types of roads over the first few months of solo-driving. The programme gets its name from the fact that the parent and newly-qualified driver agree 'checkpoints' at which such limitations are gradually relaxed.

[24] We use the word 'parent' here to mean 'parent or other person who is able to act as a supervising driver for the newly qualified driver'.

We recommend that Checkpoints be used as the starting point for an intervention that focuses on risk factors such as these. It will be necessary to slightly change the materials for the GB context (for example, Checkpoints is currently administered in US states which have GDL restrictions) but the basic approach could be rolled out in an evaluation trial relatively easily.

A limitation of such an approach will be that it will only be relevant to newly qualified drivers who have access to someone who can fulfil the 'parent' role. This should be a substantial number of newly qualified drivers (although not all) since parents do play a role in the learning to drive process for many learners (even if this is only helping to pay for driving lessons and test costs).

4.2 Intervention to increase the amount and breadth of pre-test on-road experience

A number of studies have shown that increasing amounts (and breadth) of on-road experience before licensure can decrease post-licence collision risk. Although post-licence experience also has beneficial effects, the findings of the workshop and the existing set-up of the GB licensing system (a clearly defined learning period after which unlimited solo driving is permitted) point to the pre-licence period as being most suitable as the focus of any additional supervised practice. The vast majority of learner drivers already engage with an approved driving instructor (ADI) for driving lessons, and many also have supervised practice with parents. The harnessing of these two groups of stakeholders, along with the Driver and Vehicle Standards Agency (DVSA) and other stakeholders such as the insurance industry, in increasing supervised on-road practice during the learning stage would have a good chance of increasing safety.

Previous approaches to this issue in Sweden and in Australia have focused on the amount of supervised on-road practice, with around 120 hours being agreed as a sensible target at which to aim (Kinnear et al., 2013; Scott-Parker, Watson, King & Hyde, 2012). Current work for the DVSA is examining changes to the driving test which are designed to encourage a wider range of pre-test on-road experience, in line with previous findings that seem to suggest this is beneficial (Sexton & Grayson, 2010).

We recommend that an intervention designed to increase pre-test practice should seek to achieve both of these aims.

The importance of engaging with all stakeholders mentioned above to ensure that the intervention can be properly delivered and evaluated cannot be overstated. Without buy-in from ADIs and from parents, the two main mechanisms of achieving on-road practice will be missing. Insurers would be expected to lower premiums to enable more supervised practice pre-test. DVSA would be expected to already be prepared for such an approach, given their historical work around logbooks.

A logbook of some kind to suggest and monitor driving types and amounts of practice in each (preferably using a range of engagement methods such as apps and paper-and-pencil approaches) should be utilised to enable the whole approach.

A limitation of such an approach will be that it will only appeal to those learners who actually want (or can be persuaded) to have more practice. The 'self-certified' nature of the

records would also need to be addressed, although experience from Australia has suggested that such an approach is workable without widespread 'cheating' (e.g. Watson & King, 2012).

4.3 Intervention to manage post-test driving behaviour through technology

The availability and cost of IVDR technology that can record the way that a vehicle is being used has been changing rapidly. This means that risk factors such as speed choice, g-forces, and when the vehicle is driven are now readily available. Instrumental feedback through rewards and penalties implemented either by insurance companies or parents are also readily available. For example, insurance companies operating with telematics can reward behaviours such as compliance with speed limits. The extent to which these external forces might undermine intrinsic motivation has been offered as a concern. In other words the control of behaviour may be located in the reward rather than from some personal motivation. The argument then is that when the reward disappears then so also does the improvement in behaviour. There is some evidence that this occurs for telematics specifically (e.g. Bolderdijk, Knockaert, Steg & Verhoef, 2011 demonstrated that monetary incentives delivered significant reductions in speeding that were not maintained when the incentive was removed). In a more general systematic review and meta-analysis of health-related behaviours it was found that health behaviour did dissipate when the incentive was removed (Mantzari et al., 2015). Given the specific high risk that new drivers face in the first few months of driving it should be clear that this limitation is not critical to the effectiveness of such an intervention; even if such an approach only targets the first few months of driving, this is the period during which the greatest safety benefit is to be gained.

We recommend one of two approaches for this intervention. Either a telematics intervention developed independently from commercial telematics-based insurance products, or a standard set of features (e.g. mechanisms of feedback, criteria for feedback thresholds) should be outlined and a range of commercial providers engaged to deliver within this standard. There are advantages and disadvantages to both, but in either case the design of the system (or standard) should be relatively straightforward, drawing on what is known from the literature reviewed in this study and from what is known more widely about behavioural change.

The main limitations of such an approach are twofold. First (as is the case with other approaches) it might be that such a system would only have the chance of engaging a sub-set of newly qualified drivers (those who might wish to access such technology, or in the cases where parental engagement is required, those who have access to such support). Second, an argument could be made that telematics-based insurance is already becoming so prevalent as to effectively be a background trend effect that would need to be controlled in such a study; this might have implications for the first approach (bespoke system) especially.

4.4 Intervention to train hazard perception skill

Hazard perception skill is the only driving skill that has been shown to be related to collision risk across a number of studies (Horswill & McKenna, 2004). Several studies have also shown that it can be trained using a range of methods (watching commentary drives, on-road tuition, discussion group settings, e-learning) and the manner in which materials and training approaches should be designed is reasonably well understood.

We recommend that a hazard perception intervention is evaluated using one of two approaches. Either a bespoke training intervention could be designed and evaluated specifically, or a standard for hazard perception training could be defined and commercial suppliers then invited to provide interventions for evaluation that meet this standard. The latter approach has the benefit of encouraging some commercial competitiveness that may deliver greater innovation. We also recommend that the intervention be delivered to drivers late in the learning to drive process, or just after passing the practical test. The reason for this is that currently in GB, the hazard perception test taken as part of the theory test is already providing a motivation for learner drivers to train themselves in the skill before the theory test is taken (typically early in the learning to drive process – see Helman, McKenna, McWhirter, Lloyd & Kinnear, 2013). Therefore prompting more training later in the learning to drive process seems more likely to complement the existing provision. There will be implications for further implementation that follow from this decision.

4.5 Notes on evaluation

We recommend any evaluation of the shortlisted interventions should aim to apply the principles and research methods of a randomised control trial (RCT). Although other methods are used in some studies reviewed these result in much lower scores of quality on scales such as the AMSMS. There is also a precedent for using RCT approaches – for example we note the use of this approach in the DVSA's 'Transforming the Driving Test' trial being undertaken by TRL at the time of writing.

The AMSMS guide summarises the main components of a RCT that would achieve the maximum *method* score (5) (see Madaleno & Waights, 2015, pp. 5-6):

- Random assignment to either the treatment or the control group. Programme applicants may be pre-screened on eligibility requirements[25]
- A lottery (computer randomisation) assigns a percentage of the eligible applicants (usually 50%) to the control group and the remainder to the treatment group(s)
- Baseline data are collected (either from an existing data source or from a bespoke baseline survey)
- After treatment is applied, data are collected sometime after (again, either from an existing data source or from a bespoke baseline survey)[26]

Furthermore, the same guide suggests three ways that a RCT can achieve the maximum *implementation* score (5) (see pp. 6-7):

- Randomisation is successful. If randomisation is successful, tests (for example 'balancing tests') should show no significant differences between the two groups.

[25] In this case this might include the option of parental/guardian involvement, willingness to participate in a 'black-box' study (which will involve some form of vehicle monitoring), access to online facilities (online HP training), familiarity with smartphone apps, and so on.

[26] In all cases, we recommend that the final outcome measures used are collisions (either self-reported or if possible through some objective measure such as event data recorders or other forms of in vehicle data recorder).

- Attrition must be carefully addressed. Attrition occurs when individuals drop out from the study (e.g. do not complete the intervention or do not provide follow up data).
- Contamination must not be an issue. In order for the control group to be a suitable comparator, it must not in any way be exposed to the intervention.

Defensible applications of both of sets of criteria would result in a combined score of '5,5'.

It should also be noted that an RCT design, using collisions as the outcome measure, does not need to be prohibitively expensive. The actual sample size required is dependent on the variability in the outcome measure, the baseline, and the size of effect that the trial needs to be designed to detect (at a given level of statistical power – 80% is the accepted standard). A sample size of as low as 1,000 per group may be sufficient to detect large (say 25%) reductions in first year crashes for this group. If risk factors are instead used as outcomes (in this case amount of driving in times and circumstances of risk, amount of on-road practice, speed or similar measures from telematics devices, or hazard perception skill) the sample sizes required in the treatment and control groups would potentially be smaller again (precise estimations would require that effect sizes, exact measures used, and other elements of trial design were specified before a calculation were undertaken).

We recommend if a multi-design intervention research study were to be commissioned, the DfT and other partner organisations should keep the amount of publicity (regarding the details of those interventions being tested) to a minimum in order to reduce the cross- and within- intervention contamination effects.

4.6 Notes on incentives and implementation

During the evaluation of interventions, incentives will be needed to prompt participation, since by definition all research participation is voluntary. One of the challenges with incentivising participation is separating the effect of the intervention from the effect of the incentive structure. It will be important to have a research design that can overcome the various sources of bias that can arise.

In the context of actual roll-out it is important to distinguish between voluntary and non-voluntary approaches. If the desired outcome is to achieve 100% coverage for young and novice drivers for any interventions found to be successful in reducing collisions, changes to the process of licence acquisition and supporting policy will be required. For example, if the hazard perception training intervention is found to be successful, it might be desirable to introduce it as a mandatory training stage that must be completed (but not necessarily pass/fail) within a short time of passing the practical test.

Alternatively a voluntary approach could be adopted. However, any such approach is likely to result in a self-selection bias at implementation with drivers who are predisposed towards reducing their personal risk opting for the interventions.

In either case, the use of participant incentives is likely to form part of the overall intervention. The goal of incentives with a voluntary approach would be to off-set barriers to participation and similarly overcome apathy towards the intervention. In the case of the non-voluntary approach, incentives might be used to offset any additional costs incurred as a result of the mandatory component.

The use of incentives in both cases needs to have sufficient flexibility as not all young drivers will find the same incentive attractive. It is especially important in the voluntary case. Put simply, we must not be seduced by the notion that a voluntary-based 'one size fits all' approach will reach every segment of the young driver population, even with some incentives. It is often assumed that young drivers exhibit homogeneous tastes, preferences and behaviours and can be treated as such. This may not be the case. It is possible that applying this logic will limit the uptake and thus the effectiveness of any young driver intervention.

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Appendix A Search terms

Search terms used in the review of literature regarding **pre-/post-test driver interventions**

Key terms	**Intervention type** (**AND** terms entered separately)	**Type of study**
Driv* AND (one further term at a time, in order) Teenage* New Inexper* Pre-test/Pre Under 17/U17 Young Novice Post-test/Post Learner / Learn*	Intervention Risk perception Behav* Attitud* Knowledge Skills Training Test* Educat* Publicity Communicat* Campaign Program* Crash OR collision AND prevention / prevent* OR reduction / reduc* Fatal* OR injur* AND prevention / prevent* OR reduction / reduc* Parent* Simulat* Game* App* Feedback e-learning Classroom Lesson Technolog* Learn* Insurance Restrict* Guidance Safety Experience	Evaluat* Effect* Trial RCT Test Compar* Analys* Survey

Search terms used in the review of literature regarding risk factors and collision/injury outcomes.

Key terms	AND	AND
Collision OR injury OR Accident OR Crash	Link OR association OR relation* OR connection OR predict* OR correlat* OR associat*	Delay* AND licence* OR On-Road experience OR On-road practice OR On-road learning OR Speed OR hazard perception OR night time/ evening driv* OR passenger* OR close follow* OR Tailgat* OR violat* OR citation* OR fine* OR convict* OR distrac* OR behav* OR attit* OR prox* OR surrogate*

Appendix B Adjusted Maryland Scientific Methods Scale (AMSMS) – design score

Level 1: Either (a) a cross-sectional comparison of treated groups with untreated groups, or (b) a before-and-after comparison of treated group, without an untreated comparison group.

Level 2: Use of adequate control variables and either (a) a cross-sectional comparison of treated groups with untreated groups, or (b) a before-and-after comparison of treated group, without an untreated comparison group.

Level 3: Comparison of outcomes in treated group after an intervention, with outcomes in the treated group before the intervention, and a comparison group used to provide a counterfactual (e.g. difference in difference).

Level 4: Quasi-randomness in treatment is exploited, so that it can be credibly held that treatment and control groups differ only in their exposure to the random allocation of treatment.

Level 5: Reserved for research designs that involve explicit randomisation into treatment and control groups, with Randomised Control Trials (RCTs) providing the definitive example.

Appendix C Implementation considerations (workshop)

1) UK applicability: Is there any known reason to rule out an intervention because it lacks applicability to the GB context?

2) Cost: Is it affordable to GB and to end users? What is the cost model?

3) Acceptability: Is there any known acceptability issue, either for those charged with its delivery, other stakeholders (such as the media or road safety charities), policy-makers, or end users?

4) Ease of implementation: Can we deliver it in GB? Would we need new structures/tools to do so?

5) Ownership: Who will be responsible/take ownership for the delivery of the intervention? Will any partnerships need to be formed? Who will need to be involved?

6) Target Audience: Is it likely to appeal to some but not all young drivers? Might it be accessible to only sub-groups?

7) Any other relevant issues: Are you aware of any other advantages or disadvantages, in terms of delivery?

Appendix D Worksheet used in workshop

Characteristics	What would be positive about implementing this intervention?	What are the possible challenges with implementing this intervention?
Applicability		
Cost		
Acceptability		
Ease of implementation		
Ownership		
Target audience		
Any other relevant issues		

Appendix E Logic Maps

Objectives: Intervention to manage post-test driving in specific risky situations through parent-driver contracts	Inputs	Outputs	Outcomes
Reduce the *post-test* exposure of young drivers to risky situations (i.e. unsupervised driving in higher-risk driving scenarios)	Design a 'restriction matrix' based on evidence of risk factors (e.g. road type, carrying peer age passengers, driving at night) and time-based removal of restrictions	A 'Checkpoints' learner-driver 'restriction matrix'. Justification of the risk factors and the associated restrictions	Taking a pro-active approach to protect young drivers from risky situations (OR) Reduce the exposure of young drivers to scenarios that have shown to be precursors to collisions
Encourage parent-driver driving agreements	Review the evidence base on parent-learner communication styles Parent-driver engagement expertise	A 'best practice' manual for engaging with and supporting the young driver and how to get the most out of the programme (i.e. a 'how to' of establishing boundaries and imposing limits on young drivers)	Increased likelihood of complying to the 'restriction matrix' which in turn will reduce exposure to risk (AND/OR) Increased likelihood of the driver complying to the 'restriction matrix' due to positive parental involvement (/) influence and commitment

Objectives: Intervention to manage post-test driving in specific risky situations through parent-driver contracts	Inputs	Outputs	Outcomes
Promote the programme (and its benefits) and provide ongoing support for both parent and driver	Design a website (using the 'Checkpoints' model as a template - web design support required and possible app support) Design a supporting communication strategy (using the 'Checkpoints' model as a template – multi channel communications (e.g. email, SMS, post) support required)	A website containing supporting information (such as sample parent-learner agreements, the 'restriction matrix', young driver risk factors and the benefits of participation). If technology is also to be involved, apps could also be used to track journeys and then prompt drivers to later add information about these journeys (for example, passengers) A series of integrated communications that are relevant and timely for different stages of the programme ('direct marketing' to the parent and the young driver)	Improved understanding of the components of (and rationale behind) the intervention by the parent and young driver (which in turn will increase the likelihood of maintaining commitment to the intervention) Ongoing reminders are likely to reinforce the importance of the intervention (and the 'message' behind it) and prevent a 'relapse' from the programme

Objectives: Intervention to increase the amount and breadth of pre-test on-road experience	Inputs	Outputs	Outcomes
Encourage supervising drivers to engage in more *pre-test* supervised driving	Agreement (through a review of the evidence) of the target number of hours (there is general agreement that 120 hours would reduce the likelihood of collision involvement)	Agreement and justification of the number of hours supervised driving to be undertaken	
Expose drivers to risky situations (i.e. unsupervised driving in higher-risk driving scenarios) in a relatively controlled way	A review of higher-risk scenarios (e.g. driving at night, rural roads, driving in poor weather) that should be included during the supervised drives	A checklist of scenarios that should be undertaken by the learner/supervising driver before taking the driving test	Preparing drivers for high-risk scenarios i.e. 'controlled exposure to risk' rather than 'reducing exposure to risk' as described in the Checkpoints category
Design and promote a mechanism by which the minimum hours and higher-risk scenarios can be recorded	Input from the DVSA and ADI to ensure the mechanism is fit for purpose (possibly a mobile app (permits interactive monitoring and feedback but potentially less accessible to some groups and incurs more development costs - could be easy to 'cheat') or a log-book (would not permit interactive feedback but is more accessible and cheaper)	A mechanism for supervising drivers and ADI to record supervised hours and higher-risk scenarios driven	Potentially increases the likelihood of completing the recommended number of hours/scenarios driven Provides a mechanism for incentivising/rewarding engagement with the intervention

Objectives: Intervention to increase the amount and breadth of pre-test on-road experience	Inputs	Outputs	Outcomes
Stakeholder engagement (four main stakeholders)	• Parent • Learner • Driving Instructors • DVSA	'Buy-in' from the parent: they will endeavour to provide the supervisory support 'Buy-in' from the learner: they will engage with their supervising driver Support from a driving instructor to both of the above groups High level support from the DVSA	'Buy-in' (parent/learner/ADI) increases the likelihood of completing the recommended number of hours/ scenarios driven Support from the DVSA adds credibility to the intervention
Promote the overall 'minimum hours' proposition and provide ongoing support for both parent and learner	Design of a website interface (with support from a web design agency)	Website containing supporting information (e.g. on the driving scenarios and justification of the minimum number of hours)	Provides the rationale and justification for the intervention which in turn may increase the levels of engagement/ participation

Objectives: Intervention to manage post-test driving behaviour through technology	Inputs	Outputs	Outcomes
Design a *post-test* bespoke IVDR	Technical support from telematics specialists and driving organisations	A fit for purpose IVDR that accurately captures negative driving 'events' (excessive braking, cornering g-forces) and LED in-car feedback (typically 'red/amber/green' type feedback) Measurement of speed (compared with a database of posted speed limits) would provide information on the frequency of speed violations, and would be the preferred option given that g-force based measures (specifically, the boundaries for what is 'safe' and 'unsafe' have not been properly standardised)	
Design a feedback mechanism	Depending on the feedback mechanism; either web-based specialists (i.e. feedback in the form of a driver panel) or event data capture (i.e. video footage), or both	An online feedback mechanism that can be used as part of a parent-driver intervention	An online facility

Objectives: Intervention to manage post-test driving behaviour through technology	Inputs	Outputs	Outcomes
Engage with a range of commercial providers (likely to be commercial insurance providers) to offer support for this intervention	Support from the provider to offer hardware and software solutions to support the intervention	A suite of tools that form the technical support mechanism for use during the intervention	
Provide feedback to a supervising driver based on negative driving events	Dynamic inputs based on the driving behaviour of the young driver as measured by the above device	Feedback provided to the parent via the mechanisms outlined above	

Objectives: Intervention to train hazard perception skill	Inputs	Outputs	Outcomes
Design a bespoke hazard perception test	Review and design the method of training (watching commentary drives, on-road tuition, discussion group settings, e-learning etc.)	A hazard perception test to be used either pre- or post-test	Improvements in hazard perception skill (ability to spot potential hazards)
Engage with a hazard perception test provider	Review and design the method of training (as above)	A hazard perception test to be used either pre- or post-test	
Stakeholder engagement (two main stakeholders)	• DfT • DVSA	High level support from the DVSA to implement the hazard perception test (if deployed as a compulsory component of the driving test syllabus)	
Promote the hazard perception intervention to the end-user and other stakeholders	Design of supporting information	Modification of existing DVSA DfT communications relating to components of the driving test	

Appendix F Literature relating to parental engagement to influence exposure to risky driving situations (Checkpoints) (Full)

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Zakrajsek et al. (2013) / US	Increasing parent involvement/ reducing teen drivers' exposure to risky driving situations/Parent-Teen Driving Agreements (PTDA) (Checkpoints Programme delivered with support from ADIs)	148 parent-teen pairs. Intervention teens (ITs) = 99, Control group pairs = 49	Eight ADIs delivered a face-to-face driver education session to parent-teen pairs including: a video, persuasive messages, discussion and PTDA initiation	Teens completed four surveys: baseline, licensure, and 3- and 6-months post-licensure	Up to 9 months	ITs were more likely to report the use of a PTDA. ITs were also more likely to report restrictions on driving; with teen passengers, on weekend nights, on high speed roads and in bad weather during the first six months of licensure. No difference in offences or crashes at six months but ITs reported less high risk driving	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Zakrajsek et al. (2009) / US	Increasing parent involvement/ reducing teen drivers' exposure to risky driving situations/Parent-Teen Driving Agreements (PTDA) (Checkpoints Programme)	231 parent-teen pairs. Treatment group pairs = 117, Control group pairs = 114	Health educators delivered a 30-minute session to parent-teen pairs including: a video, facilitated completion of a PTDA and polling of parents on their intended driving restrictions. Approx. 1 week prior to licensure, pairs were mailed anther copy of the PTDA and a 1 page newsletter to reinforce the key messages and to encourage pairs to complete a PTDA	Parents and teens completed two surveys: baseline and licensure. Teens also completed surveys at 3- and 6- months post-licensure	Up to 9 months	At licensure, compared with parents in the comparison group, treatment parents had increased awareness of teen driving risk and were more likely to have completed a PTDA and met Checkpoints recommendations for restrictions on teen driving in inclement weather and road types. Teen reports of parental restrictions that met the level of Checkpoints Program recommendations were lower than the parent reports and there were fewer intervention effects	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Simons-Morton et al. (2006a) / US	Increasing parent involvement/ reducing teen drivers' exposure to risky driving situations/Parent-Teen Driving Agreements (PTDA) (Checkpoints Programme delivered with persuasive communications (mail) relating to high risk driving and PTDAs)	4295 parent-teen pairs. Treatment group pairs = 2140, Control group pairs = 2155	Intervention families received by mail the Checkpoints Program materials, including a video, a series of newsletters delivered one every month or so, and a PTDA	Parents and teens in both groups completed 25-minute telephone surveys about teen driving at permit (baseline), licensure, and three months, six months, and 12 months after licensure	Up to 12 months post licensure	Families who participated in the Checkpoints Programme reported significantly greater limits on teen driving at licensure, and at 3- and 6-months post-licensure. There were no differences in reported risky driving behaviour, violations, or crashes	5
Simons-Morton et al. (2006b) / US	12 month follow up of the Simons-Morton et al. (2006a) study	See above	See above	See above	Up to 12 month post licensure	By the 12-month follow up teens in the intervention group were significantly less likely than those in the comparison group to have had a traffic violation. However, no treatment group effect was found for crashes	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Simons-Morton et al. (2002) / US	Increasing parent involvement/ reducing teen drivers' exposure to risky driving situations/Parent-Teen Driving Agreements (PTDA) (Checkpoints Programme delivered with persuasive communications (mail) relating to high risk driving and PTDAs)	264 parent-teen pairs. Treatment group pairs = 125, Control group pairs = 139	Intervention families received by mail the Checkpoints Program materials, including a video, a series of newsletters, and a PTDA	Parents and teens in both groups completed telephone interviews at baseline, licensure, and three months post-licensure	Up to 3 months post licensure	Both parents and teens in the intervention group reported significantly greater limits on teen driving at licensure and three months post-licensure	5

Appendix G Literature relating to parental engagement to influence behaviour (Full)

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Taubman et al. (2015) / Israel	Effect of parents' personality, attitude, and behaviour on young male drivers during their solo driving	121 young male drivers between 17 and 21.5 years of age and their parents (extracted from 242 families participating in a wider scope longitudinal study)	The young male drivers and the families received different type of feedback according to four schemes: (i) no feedback or training provided to either the young drivers or their parents; (ii) feedback provided only to the young drivers; (iii) feedback provided to both the young drivers and their parents; (iv) feedback provided to both the young drivers and their parents, and program provided to their parents with a focus on parental guidance/training	The young male driver's driving behaviour was recorded over the course of 12 months using an IVDR; at least one of his parents' driving behaviour was recorded over the same period of time; the young male driver completed two questionnaires focusing on family and peer dynamics; both of his parents completed three personality questionnaires concentrating on sensation seeking, anxiety, and aggression	Analysis of the data between the 9 and 12 month post licensure period	Findings indicate that the parents' (especially the fathers') sensation seeking, anxiety, and aggression, as well as their risky driving events rate were positively associated with higher risky driving of the young driver. In addition, parents' involvement in the intervention, either by feedback or by training, led to lower risky driving events rate of young drivers compared to the control group	3

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Peek-Asa et al. (2014) / US	Evaluation of "Steering Teens Safe" - A parent-focused programme to improve parental communication with teens about safe driving using motivational interviewing techniques in conjunction with 19 safe driving lessons	145 parent-teen pairs. Treatment group pairs = 70, Control group pairs = 75	Parents received a workbook that identified nineteen safety lessons divided into four topics: Basic safety principles (take driving seriously, seat belt use, distraction, impaired driving, being a safe passenger); Safe Driving Skills (traffic signals, safe speeds, changing lanes, following too closely, communicating with other vehicles, and turning); Rural Driving (2-lane roads, gravel roads, uncontrolled intersections, trucks and farm equipment), and Special Situations (bad weather, animals, emergency vehicles,	Parent and teen baseline surveys and teen surveys filled out one- and six-months post-licensure. Participants completed the Risky Driving Inventory (adapted to reflect the specific goals of the intervention) which captured the number of times in the last three weeks they performed each risky behaviour	Up to 6 months post licensure	Intervention teens ranked their parents' success in talking about driving safety significantly higher than control teens and reported that their parents talked about more topics (non-significant difference). The Risky Driving Score* was significantly (21%) lower in intervention compared to control teens. Interaction between communication quantity and the intervention was examined. Intervention teens who reported more successful communication had a significantly lower (42%) lower Risky Driving Score than control parents with less successful communication. *Respondents reported	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			work zones). Each lesson included talking points and instructed parents to talk about, demonstrate, and supervise their teen in the lesson. Techniques from motivational interviewing (use of open-ended questions, affirmations, reflective listening, summarizing, rolling with resistance, and reframing) were taught to parents (via a 45 minute face-to-face session, a DVD demonstrating sample parent-teen conversations and laminated cards summarizing the techniques). Parents also received three 30-minute follow-up			the number of times in the past three weeks that they performed each driving behaviour (related to each of the four intervention topics), and an overall score was calculated as the sum of risky driving behaviors	

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			phone calls to provide additional intervention support to help them effectively communicate with their teens				
Farah et al. (2014) / Israel	To examine the potential of various feedback forms on driving to affect young male drivers' behaviour and to mitigate the transition from accompanied to solo driving. The study examines also the utility of providing parents with guidance on how to exercise vigilant care regarding their teens' driving	217 family-teen pairs. Family feedback pairs =55, Parental training pairs = 54, Individual feedback pairs = 53, Control group pairs = 55	The families were randomly allocated into 4 groups: (1) Family feedback: In which all the members of the family were exposed to feedback on their own driving and on that of the other family members;(2) Parental training: in which in addition to the family feedback, parents received personal guidance on ways to enhance vigilant care regarding their sons' driving; (3) Individual feedback: In which family members received feedback only	IVDR measurement of family-teen pairs	The first year of driving (three months of accompanied driving and the following nine months of solo driving)	Providing feedback on driving behaviour and parental training in vigilant care significantly improves the driving behaviour of young novice male drivers. The study also showed that: (1) the Parental training group recorded significantly lower events rates (−29%) compared to the Control group during the solo period; (2) although directed mainly at the novice drivers, the intervention positively affected also the behaviour of parents, with both fathers and mothers in the Parental	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			on their own driving behaviour (and were not exposed to the data on other family members); (4) Control: Group that received no feedback at all			training group improving their driving (by −23% for both fathers and mothers) and mothers improving it also in the Family feedback group (by −30%). Thus, the intervention has broader impact effect beside the targeted population	
Simons-Morton et al. (2013) / US	Comparison of a) LED feedback to teens (Lights Only) and b) LED feedback with parental access to driver data (Lights Plus).	88 parent-teen pairs. LED feedback to teens (Lights Only) = 43, LED feedback with parental access to driver data (Lights Plus) = 45	Parent-teen pairs were randomised to one of two groups: (1) immediate feedback to teens (Lights Only); or (2) immediate feedback to teens plus family access to event videos and ranking of the teen relative to other teenage drivers (Lights Plus). LED feedback was provided in the form of a green light in the absence of a g-force event, a red and green flashing light	IVDR measurement of teen driving	2 weeks of baseline data collection and 13 weeks of feedback	Results showed a significant decrease in event rates for the 'Lights Plus' group, but no change for the 'Lights Only' group. Provision of feedback with possible consequences associated with parents being informed reduced risky driving, whereas immediate feedback to teenagers only did not	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			following an event, and then a red light indicating that footage of the event had been saved				
Yang et al. (2013) / US	The effect of 'Family Communication Patterns' on teen attitudes towards safe driving	163 parent - teen pairs	Family Communication Patterns' were divided into four types: pluralistic, protective, consensual, and laissez-faire. These were correlated with the frequency of parent-teen discussions and teens' driving safety attitudes	Parent/Teen communication patterns vs self-reported attitudes toward safe driving	Specific time data not available	In families with communication patterns that were laissez-faire, protective, and pluralistic, parents talked to their teens significantly less about safe driving than did parents in families with a consensual communication pattern. Moreover, the frequency of parent-teen communication about safe driving was significantly and positively associated with teen attitudes toward safe driving	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Farmer et al. (2010) / US	To determine if teenage driving behaviour improves when a monitoring and feedback device is installed in the teen's vehicle	84 teenage drivers. Group 1 = 22, Group 2 = 20, Group 3 = 21, Group 4, 21 (control group).	Participants were assigned randomly to one of four research groups: Group 1: Vehicle monitoring with in-vehicle alert and immediate website notification (alert and web), Group 2: Vehicle monitoring with in-vehicle alert and conditional website notification (alert then web), Group 3: Vehicle monitoring with website notification but no in vehicle alert (web only), Group 4: Vehicle monitoring with no in-vehicle alert and no website access (control group)	IVDR measurement of teen driving	2 weeks of baseline data collection, 20 weeks of feedback, and 2 weeks of post-treatment 'blind' data collection	Seat belt use improved when violations were reported to the parent websites, and improved even more when in-vehicle alerts were activated. Consistent reductions in speeding were achieved only when teenagers received alerts about their speeding behaviour, believed their speeding behaviour would not be reported to parents if corrected, and when parents were being notified of such behaviour by report cards	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
McGehee et al. (2007) / US	Pairing a weekly video review (event triggered) and graphical report card giving parents the ability to teach their teens after they begin driving independently	25 parent-teen pairs	Participants' vehicles were equipped with an event-triggered video device, designed to capture 20-sec clips of the forward and cabin views whenever the vehicle exceeded lateral or forward threshold accelerations. Feedback was provided in the form of a weekly video review and graphical report card	IVDR and video feedback	9 weeks of baseline data collection, 40 weeks of feedback and 9 weeks of post-treatment 'blind' data collection	This research shows that an event-triggered video system, paired with feedback in the form of a weekly graphical report card and video review, can reduce unsafe driving behaviours when reviewed by teens and their parents. These results suggest that incorporating both the video and parental involvement in driver training can significantly reduce the number of unsafe driving events of newly licensed teens	2

Appendix H Literature relating to Hazard Perception Training (Full)

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Meir et al. (2014) / Israel	Comparison of 3 AAHPT (Act and Anticipate Hazard Perception Training) modes (active, instructional, or hybrid) or a control group	Sixty-one participants, 21 experienced drivers (23- to 29-year olds with an average of 8 years of driving experience) and 40 young novice drivers (17- to 18-year-olds with an average of 1.7 months of driving experience) with a maximum driving license time of 3 months	Active members observed video-based traffic scenes and were asked to press a response button each time they detected a hazard. Instructional members underwent a tutorial that included both written material and video-based examples regarding hazard perception. Hybrid members received a condensed theoretical component followed by a succinct active component	Young novice drivers underwent 2 sessions: (1) a hazard perception training session (or control) that lasted for an hour and a half and (2) approximately one week later, a hazard perception testing session that lasted for an hour. Experienced drivers underwent only the testing session. Each young novice driver was allocated into one of 4 conditions: active, instructional, hybrid, or control. The control group was presented with a tutorial	Either one and half hours plus one hour one week later (novice drivers) or a one hour testing session (experienced drivers)	Overall, the active and hybrid modes were more aware of potential hazards relative to the control	2

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
				regarding generic road safety issues, unrelated to hazard perception. Participants observed 58 HP test movies, randomly presented, and actively responded by pressing a response button each time they detected a hazard. The presentation and response technique was similar to the one in the active mode but the content was different			

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Zafian et al. (2014) / US	Evaluates the effectiveness of a training programme, Road Aware® (RA), at training drivers to scan for hazards in roadway scenarios where the anticipation of a hazard required between one and three glances	48 participants (allocation data not available)	Simulator study	Participants drove 18 scenarios on a simulator while their eye movements were recorded	Completed within 1 day (exact information not available)	The study's results suggest that RA training was effective in teaching young drivers to anticipate hazards, and that the training effect was even larger for the complex situations requiring more than one glance	2
Isler et al. (2011) / New Zealand	Comparison of the effects of training in higher-order driving skills (e.g. perception, motivation, insight) and vehicle handling skill training in relation to on-road driving performance,	Thirty-six young drivers (23 males and 13 females, average age 16.3 years), mostly on a restricted NZ driver licence, participated in a Driver Training Research camp	Participants were randomly allocated to one of three equally sized groups according to the type of driving skill training (5 days) they received: higher-order, vehicle handling or control (no training).	Professional driver assessors conducted a comprehensive driving assessment before (Baseline) and after the training (Post Training). At both time points, participants also carried out a computerised hazard perception task, and completed self-	5 days	Participants who received higher-order driving skill training showed a statistically significant improvement in relation to visual search and the composite driving measure. This was accompanied by an improvement in hazard perception, safer attitudes to close	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
	hazard perception, attitudes to risky driving and driver confidence levels in young, inexperienced drivers			report questionnaires to assess attitudes to risky driving and driver confidence		following and to dangerous overtaking and a decrease in driving related confidence. Participants who received vehicle handling skill training showed significant improvements in relation to their on-road direction control, speed choice and the composite driving score. However, this group showed no improvement in hazard perception, attitudes to risky driving or driver confidence	
Pradhan et al. (2005) / US	A PC-based Risk Awareness and Perception Training Programme (RAPT) was developed to teach novice drivers about different categories of	Twelve treatment drivers (six males and six females) - mean age (16.72), 12 control	PC/Simulator study - The format was an interactive multimedia presentation with both plan (i.e., top down) views and perspective views of roadway geometry that illustrated generally	Head and eye movements tracked	PC Training + 3 - 5 days post treatment simulator evaluation	The ability of the novice drivers to identify risks in static views improved after they completed the training programme. More importantly, the trained novice drivers were significantly more likely to correctly fixate on risk relevant areas in the simulated driving	2

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
	risky situations likely to be encountered while driving		risky scenarios along with information about the type of risks and the relevant areas that attention should be allocated to in order to detect the risks			environment than the untrained drivers 3-5 days after training	
Fisher et al. (2006) / US	A PC-based Risk Awareness and Perception Training Programme (RAPT)	Treatment = 24, Control = 24	PC/Simulator study - A PC based program designed to teach drivers to recognise risks	Eye movements tracked	PC Training + 3 - 5 days post treatment simulator evaluation	Significantly more trained drivers (70%) in the near-transfer scenarios (i.e. situations that resemble the scenarios in training) fixated on areas of the roadway which contained information which could reduce their likelihood of a crash (only 33% of untrained drivers did the same). In the far-transfer scenarios (i.e. scenarios that do not necessarily resemble those used in training but still require application of the	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
						general principles learned) differences were smaller between groups, but still remained significant	

Appendix I Literature relating to the use of In Vehicle Data Recorders (IVDRs) to monitor and manage behaviour

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Bolderdijk et al. (2011) / Netherlands	Examining the effect of a PAYD insurance scheme on speed violations of young drivers	PAYD incentive group = 100, Control group = 41	The experiment comprised four phases, pre-measurement, intervention phase 1, intervention phase 2, and post-measurement, each phase lasting two months	Driving speed monitored through GPS technology	Up to one year	Relative to pre- and post-measurement, and to a control group, the introduction of a PAYD insurance fee significantly reduced speed violations of young drivers	5
Donmez et al. (2008) / US	To assess the effects of retrospective and combined retrospective and concurrent feedback on driver performance and engagement in distracting activities	48 participants between the ages of 18 - 21 (female = 23, male = 25) with at least one year of driving experience	A driving simulator study was conducted with three conditions: retrospective feedback, combined feedback (both retrospective and concurrent), and no feedback (baseline case)	Simulator Study	Participants completed one practice drive in addition to four experimental drives (each approxi-mately 7 min)	The feedback conditions (retrospective and combined) resulted in faster response to lead vehicle braking events as depicted by shorter accelerator release times. Moreover, combined feedback also resulted in longer glances to the road. The results suggest that both feedback types have potential to improve	2

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
						immediate driving performance and driver engagement in distractions. Combined feedback holds the most promise for mitigating the effects of distraction from in-vehicle information systems	

Appendix J Literature relating to educational approaches (Full)

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Glendon et al. (2014) / Australia	Education (Classroom)	Treatment = 133 (60 female, 73 male), Control group = 172 (69 female, 103 male)	The course involved interacting with a seriously injured crash survivor, practical demonstrations of the importance of vehicle and road conditions on reaction time and stopping distance, and interactive workshops on the impacts on driving of alcohol, drugs, and fatigue. It included group discussions about the importance of vehicle safety and regular maintenance. Talks targeted attitudes, awareness, and preparation for the	Self-reported questionnaire prior to the program (T1), immediately after the program (T2), and at 6-week follow-up (T3)	The course comprised six 30-min sessions with up to 30 students per group	While no changes in attitudes toward unsafe driving were found for the control group, the intervention group reported riskier attitudes toward unsafe driving behaviours from T1 to T2 and T3. No differences were found from T1 to T3 in perceived risk toward unsafe driving for either the intervention or control groups. (T = Time Point)	3

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			unexpected by eliminating risk, minimizing distractions, and anticipating hazards. A local police presentation covered possible consequences of a driver's choices, including fatalities, crashes, fines, and penalties				
Brijs et al. (2014) / Belgium	"On the Road" (OtR). Flemish post-licence driver education programme with a focus on cognitive skills and motivational aspects ('insight programme')	366 participants (231 female, 135 male)	The course was delivered over three and a half hours by experienced driving school instructors. It costs €20, is voluntary and those who take part may have the opportunity to receive reductions in their car	Self-reported questionnaire pre - post (2 month follow-up) intervention	Three and a half hours (combined classroom education and on-road training)	The programme had a small positive effect in relation to speeding (positive effect on descriptive norm, self-efficacy and behavioural intention). However, it had a negative effect on drink driving on some psychological variables. At follow-up, only risk-related knowledge was significantly different between the groups;	2

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			insurance			participants scored higher in the second measurement than in the first. However, there were limitations with matching; groups had a statistically different mean age	
Lenné et al. (2011) / Australia	Teamwork and communication skills training (in a simulator environment)	31 pairs of friends randomly assigned to treatment or control	A training program was developed based upon elements of existing team training programs. Those in the training condition received a two hour facilitated training session 1-2 weeks before the driving task. Driver and passenger pairs operated a driving simulator through scenarios designed to	Self-reported questionnaire pre - post (2 month follow-up) intervention, hazard response, driver behaviour and communication between pairs were measured	Two hours	Compared to the untrained group the trained participants exhibited a larger following distance, reduced speed significantly when faced with an unexpected hazard on the road, and exhibited more safe communications. However, measures of speed and vehicle control did not differ between both groups. Trained passengers also emitted significantly fewer unsafe comments	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			measure aspects of safe driving behaviour and hazard response. Communications between driver and passenger were also measured			(though there was no significant difference between groups for emitted safe comments)	
Burkett et al. (2010) / US	"Drive Alive" Pilot Programme	One rural high school	A 'theory-based' programme building on highway safety. The focus is on increasing seat belt use among teen drivers and is delivered in high schools. The intervention also used incentives/ enforcement/ Education and Media campaigns	Surveys/Direct observation	38 month period	The average seat belt use at the high school increased 23.3% after the education/awareness intervention	2
Lang et al. (2010) / UK	Safe driving discussion group	Four sessions, 35 (20 female, 15 male)	Development of a two-hour facilitated	A questionnaire predominantly comprising Theory of	Two hours	Significant short term changes towards safer attitudes were observed	2

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			discussion group aimed to help learner drivers develop safe driving-related attitudes, increase their awareness of the risks novice drivers face and equip them with risk mitigation strategies	Planned Behaviour items was administered before and immediately after participation in the discussion group to test for short term changes in participant attitudes. Additional qualitative measures included process observation by an independent TRL researcher and a feedback round with participants after each pilot as well as an in-depth interview with the group facilitator after each pilot		for some driving-related attitudes, subjective norms and behavioural intentions. Participants' self-efficacy ratings did, however, not change significantly	

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Senserrick et al. (2009) / US	Education Programme	20,822 first-year drivers aged 17 to 24 in New South Wales (NSW), Australia	2 specific education programs: a 1-day workshop-only program focusing on driving risks ("driver-focused") and a whole-of-community program also including a 1-day workshop but also longer term follow-up activities and a broader focus on reducing risk-taking and building resilience ("resilience-focused")	Pre - Post surveys. Data were subsequently linked to police-reported crash and offence data for 1996–2005	One day workshop	Offences did not differ between groups; however, whereas the driver-focused program was not associated with reduced crash risk, the resilience-focused program was associated with a 44% reduced relative risk for crash. The large effect size observed and complementary findings from a comparable randomised, controlled trial in the United States suggest programs that focus more generally on reducing risks and building resilience have the potential to reduce crashes	2

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Henk et al. (2008) / US	"Teens in the Driving Seat" (http://www.t-driver.com/) - Peer-to-Peer driver education and awareness programme	Approximately 50 high schools (approximately 67,000 high school students in Texas)	Peer-to-Peer driver education and awareness program. Content: 1) driving at night; 2) distractions (primarily in the form of other teen passengers and cell phones/texting); 3) speeding; 4) not wearing a seat belt; and 5) alcohol use	Surveys to measure awareness (n = 2,939)/Direct observation	One day course	Data gathered to date indicates that teens involved in the TDS Programme: 1) have improved levels of awareness (40 to 200+ percent) related to the top risks faced by teen drivers; 2) exhibit higher seat belt usage rates (+11 percent overall); and 3) exhibit lower usage of wireless devices while driving (30 percent less)	3
King et al. (2008) / US	"You hold the Key" (YHTK)	1, 365 high school students (specific info on control/ treatment not provided)	A school–based program consisting of safety promotion education, cooperative learning, student–oriented discussion, interactive lessons, student–led role–plays, prevention videos,	Surveys (n = 1,339 pretest–posttest matches)	10-week school-based programme	YHTK was associated with significant immediate and long–term improvements in teen seatbelt use, safe driving, and perceived confidence in preventing drunk driving	2

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			and presentations from safety experts				
Molina et al. (2007) / Spain	Training Programme	238 participants. Treatment = 124, Control = 114	RACC's training program adopted the classic combination of three training sessions: track experiences (simulated driving scenarios) , on-road feedback drives (20 mins), and group discussion	Surveys (up to 9 months post-treatment)	One day course	Data analysis showed a change in the expected direction in the scale related to the skills for careful driving, but not for the other four scales considered. The results of the experiment show that using a one day driver safety course, it is possible to change some of the drivers' evaluations connected to safe driving style into safe direction	5
Simpson et al. (2002) / UK	"DRIVE" pre-driver education package	1187 participants. Treatment = 546, Control = 641	The BBC produced six 10 minute television programmes shown as the series 'Drive with Alexei Sayle'. Support materials consisted of a	Pre - Post surveys with participants	The course length was dependent on the school but 1 hours' worth of material was provided	An evaluation of the effects of DRIVE amongst students in schools and colleges using questionnaire surveys showed that DRIVE improved both students' knowledge of driving safety and their	3

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
			Teacher/Student Support Booklet which contained four student tasks for each of the six modules, guidance notes for the teachers, and a self-help booklet for individual use			attitudes towards driving. Students who had participated in DRIVE obtained significantly higher scores on questions about driving safety and were also more likely to rate driving as dangerous after the course than those students who had not taken the course	
Nolén et al. (2002) / Sweden	Driver Training Programme	2305 participants. Treatment = 1502, Control 803	The pilot project used further education of young drivers to motivate them to use larger safety margins in traffic. The education was "insight-oriented" and focused on larger safety margins	Pre - Post surveys with participants	One day course (four different types)	The test group did understand the message in the education and considered themselves influenced as car drivers two years after the course. The education also had positive long-term effects on self-reported use of a seat belt, distance-keeping and overtaking, perceived ability to drive with safety	2

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
						margins and to attitudes/beliefs regarding seat belts and safety margins of young drivers. The results are consistent with the focus of the education and hopefully the results are positive from a traffic safety perspective. However, empirical evidence is still missing of the effects on driver behaviour in traffic and on accident involvement	

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Senserrick et al. (2001) / Australia	The Skilled Drivers Of Australia driver-training program. A one day program developed for 18-25 year-olds	220 young drivers participated in the study, though most were female (specific info on control/ treatment not provided)	A driver-training program that aimed to provide greater insight and awareness of potential risks when driving, thereby targeting issues of over-confidence rather than traditional advanced driving skills	The final sample was composed of 149 participants (i.e. those who competed all three questionnaires - time 1 = enrolment in program, Time 2= prior to course commencement/ participation, time 3= following course participation). Note at Time 3, both participants in the experimental and control groups had undertaken the program	One day course	After Skilled Drivers training program, participants reported low levels of dangerous driving behaviours (as measured by DBQ), participants also reported greater awareness and sensitivity to the risk of having a collision or near misses	2

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Carcar et al. (2001) / UK	Classroom based educational program	219 (291 male, 232 female)	The aim of the project was to assess three forms of driver training that included an assessment of the efficacy of two classroom-based intervention programmes designed to bring about change in the self-reported driving behaviour of new drivers	Self-reported beliefs, attitudes and intentions toward driving. These were measured via TPB (Theory of Planned Behaviour) elements, knowledge-related questions, Driving Skills Inventory, Attitude to Driving Violations Scale	Part 1 - Pre-driver education, Part 2 - Post-test driver intervention 1, Part 3 - Post-test driver intervention 2	Overall no evidence was found to support the pre-driver intervention, and some support was found for the post driver intervention. However, not all studies employed the same measures which may limit comparison (only two of the studies involved previously validated scales)	2

Appendix K Literature relating to practical in-car training (Full)

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Helman et al. (2013) / UK	"The learning to drive evaluation project"	203 participants, 106 treatment, 97 control	Comparison of a new driving syllabus (treatment group), and the existing approach to learning to drive (control group)	Pre- post quantitative methods (measuring learner drivers' attitudes and behavioural tendencies)	2 years	When considered as a whole, the findings did suggest the presence of a pattern in the data consistent with there being an overall (although not statistically significant) treatment effect. However this pattern was not consistent with a clear safety improvement since some comparisons showed indications of safety benefits, and others indications of safety disbenefits	4

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Stanton et al. (2007) / UK	Evaluation of an Advanced Driver Coaching System (IAM)	75 drivers, (21 female, 54 male), the cohort were between 23 - 65 (mean age of 44), 25 participants per group	Driver Coaching in IPSGA (Information, Position, Speed, Gear, Acceleration) approach to driving (Treatment Group), Accompanied (Control Group 1), Time (Control Group 2)	Driver assessments	8 weeks (one session per week)	The results suggest that advanced driver coaching using the IPSGA system had a beneficial effect. Treatment drivers improved their situational awareness, driving skills and reduced attributions of external locus of control	3

Appendix L Literature relating to PC or simulator training (Full)

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Pradhan et al. (2011) / US	PC-based training programme (FOrward Concentration and Attention Learning, FOCAL)	37 participants, FOCAL training group = 19 (10 males, 9 females), Control group = 18 (11 males, 7 females)	Four hazard perception training modules (PC-based)	Eye movement tracker/on-road test	1 hour training session	The FOCAL trained group showed significantly fewer glances away from the roadway that were more than 2 seconds	5
Horrey et al. (2009) / US	Computer-based training module on distracted driving	40 participants, Treatment = 20, Control = 20 (21 males and 19 females)	Training included information and general facts about distraction, video demos, training in a technique for dealing with distraction, and demos of using this techniques with added commentary	Pre - Post questionnaire plus one month follow-up questionnaire	12 - 14 minutes training session (plus one month follow up)	The participants in the experimental group showed a decline in self-reported willingness to engage in distracting activities and an increased perceived risk. Ratings from drivers in the control group did not change. However, no driving data was collected before the intervention and hence no comparison can be made pre/post for the same individuals	5

Reference/ Country	Type of Intervention	Sample Size	Method	Data Collection	Time Period	Results Summary	AMSMS Score
Regan et al. (2000) / Australia	DriveSmart training (CD ROM training)	103 participants, 52 Treatment = 52, Control = 51	Training included elements of insight training: optimism, commentary driving; prediction; and situation awareness	Simulator (full cabin)	7 sessions spanning a 9 week period (session 7 occurred 4 weeks after the final training session)	Entrance and exit drives: at the start, no differences were found in mean speed in the control vs. treatment groups. However, at the exit drive (4 weeks after training) the control group drove significantly faster than the experimental group. At the post follow-up, participants in the treatment group drove closer to the posted speed limits, and performed relatively better than controls in the reaction time task	3

A review of interventions which seek to increase the safety of young and novice drivers

Young and novice drivers are over-represented in traffic collisions. A range of educational and training approaches, and approaches based on technology and other innovations, have been used to try and improve safety for this group. What is not clear is which of these approaches are the most effective, or show the most promise for further evaluation in GB.

The scientific literature since 2000 was therefore reviewed for interventions that demonstrated either evidence of effectiveness in terms of reducing collisions (or a risk factor related to collisions), or (where evaluation had not yet been possible) some theoretical plausibility that they may reduce such risk.

Seven interventions/intervention types were taken forward for discussion at a stakeholder workshop attended by a range of road safety professionals. The feasibility of taking such interventions forward for larger scale evaluation in GB was discussed.

Based on the evidence review and the workshop discussions, there are four intervention types that we recommend are evaluated using a large scale trial to establish their efficacy in reducing the collision risk in young and novice drivers. These interventions are: 1) An intervention to engage parents in managing post-test driving in specific risky situations, 2) An intervention to engage a range of stakeholders (and utilising a logbook approach) in increasing the amount and breadth of pre-test on-road experience, 3) An intervention utilising technology (in-vehicle data recorders or 'telematics') and possibly parents to manage driver behaviour post-test, and, 4) An intervention to train hazard perception skill.

Other titles from this subject area

PPR746	The battle for attention: driver distraction – a review of recent research and knowledge. N Kinnear and A Stevens, 2015.
PPR673	Novice drivers - evidence review and evaluation. N Kinnear, L Lloyd, S Helman, P Husband, J Scoons, S Jones, S Stradling, F McKenna, and J Broughton, 2013.
PPR590	A segmentation of novice drivers in Great Britain: Factors associated with intention to take advanced driver training. N Kinnear, S Helman, L Walter, 2011.
INS005	How can we produce safer new drivers? A review of the effects of experience, training, and limiting exposure on the collision risk of new drivers. S Helman, G Grayson, A Parkes 2010.

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