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Does Anticipation Training Affect Drivers' Risk Taking?

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Skill and risk taking are argued to be independent and to require different remedial programs. However, it is possible to contend that skill-based training could be associated with an increase, a decrease, or no change in risk-taking behavior. In 3 experiments, the authors examined the influence of a skill-based training program (hazard perception) on the risk-taking behavior of car drivers (using video-based driving simulations). Experiment 1 demonstrated a decrease in risk taking for novice drivers. In Experiment 2, the authors examined the possibilities that the skills training might operate through either a nonspecific reduction in risk taking or a specific improvement in hazard perception. Evidence supported the latter. These findings were replicated in a more ecological context in Experiment 3, which compared advanced and nonadvanced police drivers.

Keywords: speed, risk taking, training, driving, skill

Many everyday activities, such as driving and sport, involve degrees of both skilled performance and risk-taking behavior. These two components are often seen as independent aspects of performance. For example, in the driving domain, many researchers have drawn a distinction between driving skill and driving style (Elander, West, & French, 1993; Evans, 1991; Summala, 1987). Others use a similar distinction when referring to errors and violations (Reason, 1990; Reason, Manstead, Stradling, Baxter, & Campbell, 1990). *Errors* refer to a skill-based failure in information processing, whereas *violations* refer to risk-taking behavior that involves deliberate infringement of a regulation. It has been proposed that these two dimensions (a) are conceptually distinct, (b) are empirically separate, (c) may have different psychological origins, and (d) may require different remedial interventions (Parker, Reason, Manstead, & Stradling, 1995; Reason et al., 1990). The question of whether these different dimensions require different modes of remediation is of particular interest and was investigated in the present work, in which we examined the effect of a skill-based training program on risk-taking measures.

If skill and risk taking are independent, as argued above, then skill-based training should have no impact on risk taking. However, there are also arguments supporting both alternative possibilities: (a) that skills training may increase risk taking or (b) that skills training may decrease risk taking. The practical consequences of whether skill-based training influences risk taking are of considerable importance. Policymakers may find it possible to support training that decreases risk taking but feel compelled to oppose training that increases it.

The argument for the potential independence of skill and risk taking has already been made (Parker, Reason, et al., 1995; Reason et al., 1990), so we shift our focus to how skill-based training could increase or decrease risk taking. In theory, an increase in risk taking could follow skill-based training as a result of an increase in self-confidence and self-efficacy (an individual's belief in his or her own ability to perform a given task). For example, Kruegar and Dickson (1994) found that perceived self-efficacy was related to greater risk-taking behavior. A practical example of concern over this issue may be observed in discussions of the effect of compulsory skid training (Gregersen & Nyberg, 2003). Rather than the anticipated decrease in the number of accidents after compulsory training, the number of accidents increased. Gregersen and Nyberg (2003) suggested that this result may have emerged through an increase in confidence. Indeed, Gregersen (1996) had demonstrated that practice on a short skid-training course produced no discernible improvement in actual skill, although it did produce a significant increase in confidence. If the increase in confidence was translated into faster speeds or driving in more dangerous situations, then increased accident involvement could readily follow. Horswill, Waylen, and Tofield (2004) found that the more skillful drivers believed themselves to be, the faster they intended to drive. Sufficient concern over this problem was expressed so that when new skid training was designed in Finland, an explicit aim was to avoid an increase in confidence (Katila, Keskinen, Hatakka, & Laapotti, 2004). Although this aim was not successful (there was some increase in confidence), the Finnish system did at

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least avoid an increase in the number of accidents. The aim of reducing the number of skid-related accidents was, however, not successful (Katila et al., 2004). By identifying a route through which skill-based training could increase confidence, which in turn could increase risk taking, the possibility arises that skill-based training is not completely independent of risk taking and that an increase in risk taking is possible.

The alternative is, of course, that skill-based training may decrease risk taking. One potential factor by which skill-based training might decrease risk taking involves knowledge-based risk taking versus ignorance-based risk taking. Clearly, it is possible to engage in an activity with a relatively poor understanding of the potentially risky outcomes. Yates (1992) has argued for two major classes of risk taking, deliberative and nondeliberative, with the distinction being based on the weight assigned by the decision maker to the risk of negative outcome. McKenna and Horswill (in press) have argued that although the risk of a negative outcome may be very much on the minds of researchers and policymakers, it may not be such a key concern of those actually participating in the activity. Indeed, from the participant's perspective, he or she may not be risk taking at all, even though the activity is dangerous. In other words, it is possible to engage in a hazardous activity by failing to detect the hazard. If this is the case, then training in anticipating hazards might improve the anticipation of danger and reduce at least that part of risk taking that was due to ignorance. Anticipation has been found to play an important role in general skilled activity, and differences have been found between novices and experts on a range of domains such as sport (Abernathy, 1987; Rowe & McKenna, 2001), driving (Horswill & McKenna, 2004; McKenna & Horswill, 1999), and anesthesiology (Gaba, Howard, & Small, 1995). In the context of driving, *hazard perception* refers to the ability to read the road and anticipate forthcoming events (Horswill & McKenna, 2004). A training course might then sensitize participants to risk and hence decrease risk taking.

Gregersen and Nyberg (2003) considered the conditions under which training might increase or decrease risk taking. They were examining the effects of two early training programs in Norway, of which one resulted in an increase in accident involvement (skid training) and the other resulted in a decrease in accident involvement (training for driving in the dark). They speculated that the differences occurred as a function of the method of training. The skid training involved drivers mastering simple exercises and potentially creating unrealistically positive perceptions of driving skill, which could lead to increased risk taking. In contrast, the training for driving in the dark was designed to demonstrate the dangers and problems of nighttime driving and therefore might lead to a decrease in risk taking.

Experiment 1

Our aim in Experiment 1 was to examine the effect of hazard anticipation training on risk-taking behavior. McKenna and Crick (1994) found that anticipation in driving could be significantly improved by training in the laboratory using video simulation techniques. They showed that novice drivers could be improved to the level of experienced drivers within 4 hr of training. Training in simulators has also been shown to improve skills in other domains, such as sports. For example, Todorov, Shadmehr, and Bizzi (1997) found that a virtual reality simulation of a table tennis task with augmented feedback was a more efficient training tool than traditional techniques were.

One method of training involves the generation of a verbal commentary. Under certain conditions, concurrent verbal protocols have been found to improve task performance in a number of different domains (Berry, 1990). For example, Ahlum-Heath and Di Vesta (1986) found that participants who were instructed to verbalize their thought processes when solving the Tower of Hanoi puzzle performed better than those who did not. Within the driving field, this method is called a *commentary drive*.

We used the commentary drive technique in the present study to train novice drivers in hazard anticipation. We measured drivers' risk-taking behavior using a range of established laboratory tests. The tests included video simulation measures of speed choice (Horswill & McKenna, 1999a), following distance, and gap acceptance (Horswill & McKenna, 1999b), as well as questionnaire inventories of driving violations (Parker, Reason, et al., 1995) and speeding (French, West, Elander, & Wilding, 1993).

As noted earlier, it is possible to justify all three alternative hypotheses, namely, that training might (a) increase risk-taking behavior, (b) decrease risk-taking behavior, or (c) have no significant effect on risk-taking behavior.

Method

Participants

Ninety-one participants were recruited from within the University of Reading. All had full driving licenses and had passed the U.K. driving test up to a maximum of 3 years previously. There were 57 men and 34 women with an average age of 18.9 years ($SD = 1.00$) and an average yearly driving mileage of 3,670 miles ($SD = 3{,}417$; in kilometers, $M = 5{,}906$, $SD = 5{,}467$). Participants obtained their driving license an average of 1.5 years before the study ($SD = 0.82$).

Measures

The equipment consisted of a computer-based digital video system, with a second computer recording response latencies where appropriate. Video stimuli were displayed on a 42.5-cm (17-in.) monitor, and participants were positioned approximately 75 cm from the screen. The second computer was synchronized to the digital video sequences via a timed signal. Details of each of the driving measures are given below. Reliabilities for the measures are given in Table 1.

Questionnaire measure of speeding. This was a three-item inventory of speeding behavior (French et al., 1993; West, French, Kemp, & Elander, 1993) that has been found to predict both accident involvement and observed speed on the road. An additional study found that the speeding inventory possessed a high retest reliability after a 2-year interim (West, Elander, & French, 1991). In the present study, we changed the wording of the questionnaire to ask people about their expected behavior in the future, as we were interested in behavior after the training (the original wording of the questionnaire was retrospective). The items were as follows: "In the future, how often do you expect to (a) exceed the 70 mile per hour (113 km/h) speed limit during a motorway journey, (b) drive fast, and (c) exceed the speed limit in built-up areas?" Drivers responded to all three questions on 6-point scales, which ranged from 0 = *never or very infrequently* to 5 = *very frequently or always*. The speed questionnaire score was an average of drivers' responses to the three questions (overall score range from 0 to 5).

Questionnaire measure of driving violations. This was an eight-item questionnaire relating to drivers' propensity to commit driving violations (Parker, Reason, et al., 1995). Responses were made on a 6-point frequency

Table 1
Means, Standard Deviations, and Intercorrelations for Risk-Taking Measures

Measure	*M*	*SD*	Cronbach's α	1	2	3	4	5	6	7
1. Motorway speed (mph)	77.07	7.64	—[a]	—						
2. Questionnaire speed	2.59	1.06	.77	.69**	—					
3. Video speed (mph)	5.53	3.72	.60	.53**	.55**	—				
4. Violations questionnaire	0.69	0.44	.70	.47**	.64**	.47**	—			
5. Normal following distance (s)	13.11	4.07	.94	−.18	.10	.07	.20	—		
6. Uncomfortably close distance (s)	20.97	3.11	.96	−.01	.15	.17	.29**	.75**	—	
7. Gap acceptance	119.28	58.25	.88[b]	.05	.07	.24*	.29**	.11	.02	—

Note. mph = miles per hour.
[a] Because this is a one-item measure, Cronbach's alpha cannot be calculated.
[b] Because the items are dichotomous, the Kuder–Richardson Formula 20 statistic is reported instead.
* $p < .05$. ** $p < .01$.

scale ranging from 0 = *never* to 5 = *nearly all the time*. As with the speed questionnaire, we modified the wording to ask about expected behavior in the future. The items were as follows:

> In the future, how often would you expect to do each of the following?
>
> (a) Drive especially close to the car in front as a signal to its driver to go faster or get out of the way;
> (b) Become impatient with a slow driver in the outer lane and overtake on the inside;
> (c) Cross a junction knowing that the traffic lights have already turned against you;
> (d) Angered by another driver's behavior, you give chase with the intention of giving him/her a piece of your mind;
> (e) Disregard the speed limits late at night or very early in the morning;
> (f) Drive even though you realize you may be over the legal blood-alcohol limit;
> (g) Have an aversion to a particular class of road user, and indicate your hostility by whatever means you can;
> (h) Get involved in unofficial "races" with other drivers.

The driving violations score was the mean of drivers' responses to the eight items (overall score range from 0 to 5). The driving violations questionnaire has been found to predict accident involvement (Parker, Reason, et al., 1995). In addition, a high level of correspondence between this questionnaire (as a subsection in a larger driving behavior questionnaire) and observed driving behavior on a 40-km test route has been reported (Rolls, Hall, Ingham, & McDonald, 1991).

The video speed test. Participants watched digital video footage of seven traffic scenes taken from the point of view of the driver. For each scene, they had to judge to what extent they would be going faster or slower than the vehicle in the video if they were driving (Horswill & McKenna, 1999a). Answers were recorded on a response sheet. For example, if a participant would have been driving 10 miles per hour (16 km/hr) faster than the vehicle in the video for a particular scene, they would write down "+10." The measure was an average of responses across the seven scenes in miles per hour. This test has been shown to predict speed-related accidents as well as relating to driver age (young drivers chose faster speeds) and gender (women chose slower speeds) in a way consistent with data from observational studies (see Horswill & McKenna, 1999a, for details).

The close following video test. This test involved participants viewing a film in which the camera car gradually approached the back of a car on a motorway (Horswill & McKenna, 1999b). Participants were required to press a response button once when they reached the distance at which they would normally follow a car and then a second time at the distance at which they felt uncomfortably close. Participants were given a practice run, and then the scene was repeated four times. The two measures (normal following distance and uncomfortably close following distance) were both means of the relevant responses (time in milliseconds from the beginning of the scenes) over the four trials. This test has been found to replicate gender differences in observed following behavior (men drive closer to the car in front of them than do women, see Horswill, 1994, for details). Also, both measures were found to cluster with an alternative laboratory measure of close following (using photographic animations) in a principal components analysis of 15 different measures of driver attitudes and behavior (see Horswill & Helman, 2003, for details).

The gap acceptance video test. Participants watched a film of a T junction from the point of view of someone waiting to turn left from a side road into the main stream of traffic (the film was of a U.K. road situation where people drive on the left side of the road). The camera was positioned as if looking through the driver's right-hand window at the oncoming traffic (Horswill & McKenna, 1999b). Participants were required to press a response button for any gap in the oncoming traffic that they would be willing to drive their cars into. Twenty-four gaps were monitored, and the computer registered any button press within the time frame of each gap. Participants were given a demonstration, and the entire video sequence was 5.5 min long. The gaps were ranked in order of perceived acceptability (as defined by the proportion of participants who accepted them), and a gap acceptance score was calculated for participants by summing the ranks of the gaps they chose to accept. This gave a weighted score (ranging from 0 if no gaps were accepted to 300 if every gap was accepted) such that those who accepted the most risky gaps received inflated scores (as these gaps would have the highest rankings) and those who only accepted less risky gaps received low scores (as these gaps would have the lowest rankings). This test was found to differentiate between accident-free drivers and drivers with two or more accidents (Horswill & McKenna, 1998). Also, this measure clustered with an alternative laboratory measure of gap acceptance (using photographic animations), as well as 2 measures of overtaking propensity, in a principal components analysis of 15 different measures of driver attitudes and behavior (see Horswill & Helman, 2003, for details).

The hazard perception video test. This test involved participants viewing roadway scenes on video and pressing the response button whenever they perceived something that might turn into a dangerous situation (Horswill & McKenna, 2004; McKenna & Crick, 1994). A *dangerous situation* was defined as one in which the participant considered there to be a possibility of an accident or a near accident. For example, in one scene, a cyclist is riding along the side of the road toward the camera car. He can be seen from some distance away. He then crosses the road directly in the path of the camera car, which is forced to slow to avoid a collision. Participants received a 1.5-min practice scene, after which they read the instructions a second time and then performed the main test, which was 3.5 min long. Eight hazardous situations were monitored. Participants' reaction times to each of these hazards were recorded and averaged to give an overall hazard response measure (response times were in seconds from a defined start point before the beginning of each incident). When participants missed a hazard altogether, they were assigned a maximum reaction time for that hazard (the time after which the hazard presented on the video was no longer present). This was designed to penalize respondents who missed hazards without forfeiting the rest of their data. The hazard perception test (see Horswill & McKenna, 2004, for a review) has been found to discriminate among novice drivers, experienced drivers, and expert drivers (McKenna & Crick, 1994) and can predict accident involvement (McKenna & Horswill, 1999).

Motorway speed question. Participants were asked to estimate at what speed (in miles per hour) they would drive at when they next traveled on a three-lane motorway under specified conditions (McKenna & Myers, 1995).

Procedure

Participants were randomly assigned to either a trained ($n = 46$) or an untrained group ($n = 45$). The trained group was required to watch a 21-min video of various road and traffic situations as filmed from the point of view of the driver, with a recorded commentary supplied by an instructor from a police driver training program. The commentary referred to potentially hazardous events and how to identify them. It was edited to remove any direct references to risk taking. Participants in the trained group were told that they would be trained and then have to perform a series of tests of driving that would include a test of hazard perception skill. They were asked to watch the video while taking note of what the driving instructor was saying. The untrained group watched the same video of road scenes but with the recorded commentary removed and with no instructions.

Participants in both conditions then performed the four video simulation tests of driving behavior (close following, gap acceptance, speed, and hazard perception) and then completed a questionnaire that included the questionnaire measure of speeding, the driving violations measure, and the motorway speed question. There was also a question involving drivers' self-perceived personal skill (Svenson, 1981): "How skillful do you think you are compared with the average driver?" Participants responded on an 11-point scale (from 0 = *much less skillful* to 10 = *much more skillful*, where the midpoint was labeled *average*). In addition, questions about each participant's age, gender, number of years driving, mileage, and accident involvement over the previous 3 years were included in the questionnaire. The testing session lasted 50 min, after which participants were debriefed and paid £6 (approximately $10.50).

Results

We used an alpha level of .05 to determine statistical significance. Cohen's d, f, and w were used to indicate effect sizes, where d values of 0.50 and 0.80, f values of 0.25 and 0.40, and w values of 0.300 and 0.500 refer to medium and large effect sizes, respectively (Cohen, 1992).

There were no significant differences between the trained and untrained groups in age, $t(77.16) = 0.72$, *ns*, $d = 0.15$; years elapsed since the driving test was passed, $t(82.31) = 0.86$, *ns*, $d = 0.18$ (the fractional degrees of freedom are due to the use of Welch's t test, because a Levene's test indicated that group variances were not homogeneous); gender, $\chi^2(1, N = 91) = 0.12$, *ns*, $w = .001$; or mileage, $t(89) = 0.19$, *ns*, $d = 0.04$. Participants who received anticipation training responded significantly faster on the hazard perception test than did those in the untrained group, indicating that there was a training effect, $t(89) = 3.60$, $p < .01$, $d = 0.75$. As there were high correlations between a number of the risk-taking measures (see Table 1), we decided to combine some of the measures to simplify the analysis. We combined both following distance measures to form one variable given the correlation between them (we calculated the mean of each measure's z score). We also combined all the speed measures (the video speed test, the motorway speed question, and the questionnaire measure of speeding) with the driving violations questionnaire in the same way, again given the significant intercorrelations. The correlations between the composite violations and speed measure, following distance composite measure, and the gap acceptance measure are given in Table 2. The results of univariate tests are presented in Table 3 and revealed that the trained group took significantly less risk on the violations and speed measure (with a medium effect size of $f = 0.25$) and the gap acceptance measure (with a small to medium effect size of $f = 0.21$). The mean rating of self-perceived skill for the trained group ($M = 6.52$, $SD = 1.44$) was not significantly different from the mean rating of the untrained group ($M = 6.76$, $SD = 1.25$), $t(89) = 0.83$, *ns*, $d = 0.17$, despite having reasonable power (.76) to detect a medium effect size.

Discussion

In contrast to Williams and O'Neill (1974), who found that increased skill appeared to be associated with increased risk taking, the present results indicated that skill acquisition, in the form of anticipation training, significantly decreased drivers' risk-taking propensity. It is clear that any change in risk taking after training could have an important effect on the efficacy of training. For example, Katila, Keskinen, and Hatakka (1996), reflecting on the ineffectiveness of skid training, have argued that increases in perceived skill may have resulted in increased risk taking and hence undermined the training benefit. More generally, the failure of many driver training programs (Brown, Groeger, & Biehl, 1987; Lund & Williams, 1985) might occur through an increase in risk taking operating through trainees' inflated rating of their own driving skill. In the present case, training in hazard perception was associated with no significant increase in self-rated driving skill (means were in the opposite direction), although there was a significant improvement in anticipation skill. The element of risk perception is one difference between hazard anticipation training and other types of driver skills training: Anticipation training involves explicit emphasis on the early detection of potential risks.

Experiment 2

It is possible that the effect of the anticipation training observed in Experiment 1 operated through a general sensitization to risk

Table 2
Correlations Between the Violations and Speed Measure, the Following Distance Measure, and the Gap Acceptance Measure

Measure	Violations and speed	Following distance	Gap acceptance
Violations and speed	—		
Following distance	.13	—	
Gap acceptance	.22*	.12	—

* $p < .05$.

Table 3
Unadjusted Group Means for Experiment 1 (z Scores)

Risk measure	Trained group	Untrained group	*MS*	*MSE*	*F*	Cohen's *f*
Violations and speed	−0.19	0.20	3.65	.64	5.69*	0.25
Close following	−0.16	0.17	2.54	.87	2.92†	0.18
Gap acceptance	−0.21	0.21	4.02	.97	4.02*	0.21

Note. $df = 1, 88$.
† $p > .05$. * $p < .05$.

taking. In other words, the training may have heightened risk awareness in general and produced a nonspecific reduction in risk taking regardless of the level of hazard present. Alternatively, the training may operate through a specific improvement in the ability to detect hazards. To distinguish between these possibilities, we created a new speed test in which participants were asked to choose their speeds in scenarios that either contained or did not contain an explicit hazard. If anticipation training was creating a nonspecific reduction in risk taking, then an equivalent speed reduction should be observed in both hazardous and nonhazardous scenes. Alternatively, if anticipation training operates through a specific improvement in the ability to detect hazards, then an interaction should be observed such that there would be a greater speed reduction in the scenes with an explicit hazard present.

Method

Participants

One hundred forty-five drivers with full driving licenses participated in the study. There were 88 men and 57 women with an average age of 19.17 years ($SD = 1.13$) and an average yearly mileage of 4,237 miles ($SD =$ 4,837; in kilometers, $M = 6{,}818$, $SD = 7{,}723$). All had passed the U.K. driving test within the previous 4 years (an average of 1.8 years, $SD =$ 0.76, had elapsed since their test). Participants were recruited from within the University of Reading.

Measure

A new video speed test was constructed that was based on the paradigm used in Experiment 1. Six pairs of new scenes were filmed. Each pair of scenes consisted of a traffic scene with a potential driving hazard and the same traffic scene but with the hazard removed. Vehicle speeds, weather conditions, and other factors were kept as similar as possible within each pair of scenes. Examples of the hazards used include a car emerging from a partially concealed driveway and parked cars blocking the drivers' view around a bend. The locations and vehicles were all different from those presented in the training footage. The 12 scenes were then edited together with 6 scenes from the original video speed test in an order designed to distract attention from the fact that some scenes were paired. The instructions for the new video speed test were the same as those given in Experiment 1.

Procedure

Participants viewed the video speed test footage on a video projector. Participants were tested in groups, although their responses were individual and anonymous (participants could not confer and could not see other people's responses). Each group was randomly assigned to either the trained or the untrained condition. The procedures for training and for the untrained controls were the same as those in Experiment 1.

After the training, participants in both conditions completed the revised video speed test. We announced the number of each scene as it occurred to ensure participants did not lose their place on the response sheets. When the speed test was finished, participants were required to fill in a questionnaire that included questions about demographic details and driving history. The testing session took about 40 min, after which participants were debriefed and paid £6 (approximately $10.50).

Results

There were no significant differences between the trained and untrained groups in age, $t(143) = 1.41$, *ns*, $d = 0.24$; gender, $\chi^2(1, N = 145) = 0.61$, *ns*, $w = .005$; mileage, $t(142) = 0.66$, *ns*, $d = 0.11$; or years elapsed since the driving test was passed, $t(142) = 1.79$, *ns*, $d = 0.31$. The mean of the speed scores for the six hazardous scenes and the mean of the speed scores for the six corresponding less hazardous scenes were calculated. The results of a 2 (trained vs. not trained) × 2 (hazardous scenes vs. less hazardous scenes) analysis of variance (ANOVA) with repeated measures on the last factor are given in Table 4. Although the main effects of both training and level of hazard were significant (with medium to large effects of $f = 0.34$ and $f = 0.73$, respectively), more critically, the predicted interaction was also significant (with a large effect size of $f = 0.44$). As can be seen in Figure 1, the nature of the interaction is that for those drivers who were trained, the speed reduction was greater for the hazardous scenes than for the less hazardous scenes.

Discussion

Two contrasting interpretations of the training effect were considered: one in which the training produced a nonspecific reduction in risk taking and the other in which the training effect operated through a specific ability to detect hazards. The significant interaction between the training manipulation and the level of hazard was not consistent with the nonspecific reduction in risk taking. Those who were trained must have been able to identify the hazardous situations to produce a differential reduction in their speed choices.

The results of this experiment verify that the anticipation training is not merely sensitizing drivers to safety. The differential effect on speed choice observed implies that participants had learned to identify hazardous situations and were only choosing

Table 4
Analysis of Variance Results for Experiment 2

Main and interaction effects	*MS*	*MSE*	*F*	Cohen's *f*
Trained vs. untrained	16.32	17.05	16.32**	0.34
Hazardous vs. less hazardous scenes	325.95	3.97	82.02**	0.73
Scene × Training interaction	105.44	3.97	26.53**	0.44

Note. $df = 1, 143$. The dependent variable was speed choice.
** $p < .01$.

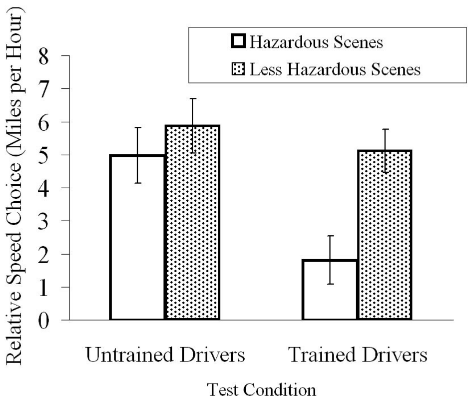

Figure 1. Mean speed choice for the trained versus the untrained group for both hazardous and less hazardous scenes (error bars denote 95% confidence limits).

slower speeds when they had identified a more hazardous situation. This evidence strengthens the claim that anticipation skills can be improved within a very short time span using video simulation.

Although motivational accounts may, in general, be difficult to discount, this type of explanation is not consistent with the finding that the effect of training interacts with the presence of hazards, nor is it consistent with the finding that it is highly specific components of training programs that improve performance. McKenna and Crick (1997) compared hazard perception training programs with and without an anticipation component and found that only the former was effective.

In Experiments 1 and 2, the training was administered immediately prior to the tests. This raises the practical question of whether the training is likely to have a longer term effect. There is some evidence that this may be the case. First, unpublished data from McKenna's laboratory (McKenna & Farrand, 1999) indicated that the effects of the specific hazard perception training used in Experiments 1 and 2 did extend beyond the immediate testing session (improvements in hazard perception test score were found a week later). Also, McKenna and Crick (1994) found that individuals who were given advanced driver training involving hazard perception (using verbal commentary techniques) improved significantly in their scores in the hazard perception test when the pre- and posttraining tests were approximately 9 months apart. However, the question remains as to whether the pattern of effects observed in Experiment 2 generalizes to long-term anticipation training. This was investigated in Experiment 3.

Experiment 3

Given that Experiments 1 and 2 involved laboratory-based training of hazard perception, one question of interest was whether the pattern of results found generalized to a more ecologically valid situation. Would the same pattern of results emerge when using a more naturalistic training regime? To address this question, we considered the effect of advanced police training. Previously, McKenna and Crick (1994) have found that advanced police training was associated with faster hazard perception reaction times.

Our aim in Experiment 3 was to determine whether the pattern of results found in Experiment 2 could be replicated when comparing advanced police drivers with nonadvanced police drivers. If so, this would suggest that our findings were not an artifact of either our training procedure or our novice driver sample and do hold when transferred to a more ecologically valid setting.

In the present study, we also asked participants to rate the scenes for the level of hazard they considered to be present. We expected the advanced group to rate the hazardous scenes as proportionally more dangerous than their less hazardous counterparts, when compared with the ratings of the nonadvanced group.

Method

Participants

The sample consisted of 87 serving male U.K. police officers, all of whom had passed the U.K. driving test. An insufficient number of female police officers were recruited to allow gender to be counterbalanced between the groups, so data from these women were not used. Two participants were removed from the sample before analysis (1 had been a driving instructor in his previous career and 1 had taken a civilian advanced driving course). Police driver training operates at three levels: basic, standard, and advanced. Of the 85 individuals remaining in the data set, 30 were probationer constables (who had not undergone any police driver training courses), 3 were drivers who had passed the basic U.K. police driver training course, 3 were drivers who had passed the standard U.K. police driver training course, and 49 were drivers who had passed the advanced U.K. police driver training course. To pass the advanced course, police officers had to undergo 4 weeks of training, which involved a combination of theoretical and practical assessment and incorporated on-road training to develop skills in hazard perception. This on-road training involved officers producing a verbal commentary on what they were attending to while driving (the commentary used to train novice drivers in Experiments 1 and 2 was generated by an advanced police driving instructor). The 49 advanced police drivers had passed the U.K. driving test an average of 21.10 years before this study ($SD = 6.72$). Their average age was 39.42 years ($SD = 6.60$) and average annual mileage was 27,686 miles ($SD = 13,076$; in kilometers, $M = 44,298$, $SD = 20,922$).

The 36 nonadvanced police officers (including those who had completed the basic and standard police driver training) had passed their U.K. driving test an average of 9.72 years before the study ($SD = 6.40$). Their average age was 28.22 years ($SD = 6.87$) and their average annual mileage was 15,003 miles ($SD = 9,393$; in kilometers, $M = 24,005$, $SD = 15,029$).

Procedure

Testing took place either in U.K. police training centers or in U.K. police traffic departments. All participants completed the new video speed test using the driving scenes and procedure detailed in Experiment 2, where they were tested in groups using a video projector, but their responses were individual and anonymous. They were told to estimate their preferred speeds relative to the video when driving their own private vehicle off duty. When the speed test was finished, participants completed a questionnaire that included questions about demographic details and driving history, as well as a number of behavioral and attitudinal questions that were not analyzed as part of the present study. Participants were then asked to watch the same video speed test again. This time, they were asked to rate the degree of hazard in each scene, on a scale of 1 (*extremely hazardous*) to 11 (*not at all hazardous*). Once this had been completed, each participant put his response sheets and questionnaire into an unmarked envelope, which was collected by the experimenter. This was to reassure them of the anonymity of their responses.

Results

In terms of basic background characteristics, there were significant differences between the advanced and nonadvanced drivers for age, $t(82) = 7.56$, $p < .01$, $d = 1.67$; years since passing the U.K. driving test, $t(83) = 7.87$, $p < .01$, $d = 1.73$; and mileage, $t(82.97) = 5.20$, $p < .01$, $d = 1.09$ (the fractional degrees of freedom are due to the use of Welch's t test, because a Levene's test indicated that group variances were not homogeneous). As in Experiment 2, we calculated the mean of the speed scores for the six hazardous scenes and the mean of speed scores for the six corresponding less hazardous scenes. A repeated-measures two-way ANOVA was carried out (see Table 5). The first independent variable was whether participants were advanced police drivers or nonadvanced police drivers. The second independent variable was whether the scenes contained explicit hazards. The dependent variable was participants' mean speed choice.

The main effect of advanced versus nonadvanced police training was significant, as was the main effect of hazardous versus less hazardous scenes. There was also a significant interaction between the advanced training and hazardous versus less hazardous scene variables. The means are displayed in Figure 2 and the ANOVA statistics are shown in Table 5.

Participants' ratings of the level of hazard in each of the scenes were then analyzed. Levine's tests revealed a violation of the homogeneity of variance assumption across the two groups for the hazards ratings. This violation was found to be eliminated by performing a logarithmic transform on the hazard ratings, and so the ANOVA was done on the transformed ratings instead (see Table 6). The main effect of advanced versus nonadvanced police training was significant, as was the main effect of hazardous versus less hazardous scenes. There was also a significant interaction between the advanced training variable and hazardous versus less hazardous scene variable. The group mean ratings (not transformed) are displayed in Figure 3.

Discussion

The advanced police drivers chose proportionally slower speeds in more hazardous situations than did the nonadvanced police drivers. This replicated the interaction found in Experiment 2, despite the very considerable differences between the two studies. In particular, the participants in Experiment 3 were vastly more experienced than those in Experiment 2. In addition, not only was the type of training different, but also the extent of the training and the opportunities to implement the training were much greater in Experiment 3 than in Experiment 2. Despite these differences, drivers who had received anticipation training selectively modified their speeds in the presence of hazards.

In the present study, it was not possible to match the driver experience of the advanced police drivers with the experience of the nonadvanced drivers because in the real-world scenario, there is a natural confound of experience with training. McKenna and Crick (1997) found that both advanced driver training and experience affected hazard perception skill, so in the present study, it was not possible to judge which of the two factors was most important. However, Experiment 2 indicated that training alone can generate the effects seen.

The ratings of the level of hazard present in the video scenes produced a similar pattern of findings to drivers' speed choice. Compared with the nonadvanced drivers, advanced drivers rated the hazardous scenes as being significantly more dangerous than the less hazardous scenes. This supports the idea that it is drivers' ability to perceive hazards that is influencing their speed choice rather than advanced drivers being more cautious in general.

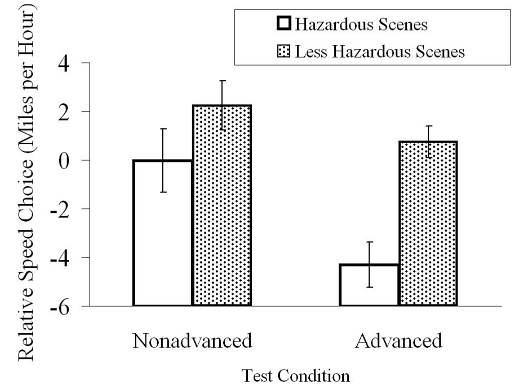

Figure 2. Mean speed choice for the nonadvanced versus the advanced police drivers for both hazardous and less hazardous scenes (error bars denote 95% confidence limits).

Table 5
Analysis of Variance Results for Experiment 3

Main and interaction effects	*MS*	*MSE*	*F*	Cohen's *f*
Advanced vs. nonadvanced training	347.26	14.78	23.52**	0.53
Hazardous vs. less hazardous scenes	558.89	4.22	132.40**	1.26
Scene × Advanced Training interaction	80.39	4.22	19.05**	0.48

Note. $df = 1, 83$. The dependent variable was speed choice.
** $p < .01$.

Table 6
Analysis of Variance Results for Experiment 3

Main and interaction effect	*MS*	*MSE*	*F*	Cohen's *f*
Advanced vs. nonadvanced training	0.51	0.03	17.02**	0.46
Hazardous vs. less hazardous scenes	1.61	0.05	296.27**	1.90
Scene × Advanced Training interaction	0.11	0.05	19.55**	0.49

Note. $df = 1, 82$. The dependent variable was the hazard ratings of video scenes (transformed).
** $p < .01$.

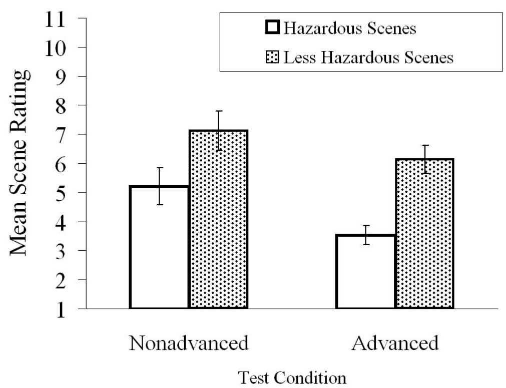

Figure 3. Mean ratings of hazardousness of the hazardous and less hazardous scenes (not transformed) by advanced and nonadvanced police drivers (error bars denote 95% confidence limits). Scene ratings ranged from 1 to 11, with lower numbers indicating more hazardous scenes.

Although it is possible to argue that the main effect of the advanced versus nonadvanced group was due to differences in age (or experience) such that older (more experienced) drivers choose slower speeds, the interaction between advanced versus nonadvanced and hazardous versus less hazardous scenes cannot be explained in this way. Instead, the results support the hypothesis that the speed choice of drivers is influenced by their ability to recognize hazardous situations, which in turn is determined by training and experience.

General Discussion

The present studies demonstrate that certain types of skills training can influence drivers' risk-taking behavior. After hazard perception training, a reduction in risk taking was observed. As was noted in the introduction and as has recently been repeated by Mayew and Simpson (2002), there is a view that adverse effects of skills training may emerge through associated overconfidence. No significant change in confidence was observed in the present studies. The results were not due to a generalized sensitization to risk as is illustrated by the fact that the choice to reduce speed is particular to hazardous scenes. A motivational account of hazard perception training might be expected to produce drivers who were more sensitive to risk in general and hence would reduce speed equally in hazardous and nonhazardous scenes—a result that was not observed. The same pattern of results was observed to be associated with the operation of an existing advanced police training program. Overall, it appears that a skill-based training program can influence risk taking.

The present results occur against a background in which there is a clear conceptual and empirical distinction between skill and risk taking (Parker, Reason, et al., 1995; Reason et al., 1990). For example, using self-report measures, Åberg and Rimmo (1998) found that violation-based risk-taking items loaded on a factor orthogonal to factors relating to error. Similarly, using video-based driving simulator measures, McKenna and Horswill (1997) found that items from a test of hazard perception skill loaded exclusively onto a factor orthogonal to factors relating to risk taking.

Given this distinction, why should a skill-based training program have an effect on risk-taking behavior? One potential explanation is as follows. Yates (1992) argued that implicit in the term *risk taking* is the idea that the behavior is deliberative, in the sense that the risk taker consciously assesses the risk and contemplates the decision to act. However, he also noted that the extent to which risk taking should be considered deliberative is an empirical question. In other words, when considering a risk-taking behavior such as speed choice, it is possible that the behavior is not only a function of deliberate risk taking but may also reflect the failure to appreciate the level of danger at hand. If drivers fail to detect hazards and are therefore unaware of the risk that may be present, then they have less reason to decrease their speed. In light of this argument, training drivers in hazard anticipation skills may well be expected to have some impact on risk taking. Although Reason et al.'s (1990) proposal that different remedial interventions are required to reduce skill-based errors and risk-taking violations may remain in large part correct, it is now clear that positive interventions to reduce risk taking based on skill-based training are nonetheless possible.

Additional issues worth considering are the correlations between skill and risk taking on the one hand with accident involvement on the other. One influential position is that it is only risk-taking violations and not skill-based errors that correlate with accident involvement (Lawton & Parker, 1998; Lawton, Parker, Stradling, & Manstead, 1997; Parker, Reason, et al., 1995). Although it is uncontroversial to say that risk-taking violations correlate with accidents (see Little, 1966, for a review of early work), the correlation between skill-based errors and accident involvement is more contentious. For example, a number of studies have found an empirical relationship between self-reported driving errors and accident involvement (Parker, West, Stradling, & Manstead, 1995; Rimmo & Åberg, 1999), and others have found a relationship between performance measures of hazard-perception skill and accident involvement (Hull & Christie, 1993; McKenna & Horswill, 1999; Pelz & Krupat, 1974; Quimby, Maycock, Carter, Dixon, & Wall, 1986).

One partial explanation of this apparent inconsistency concerns the methods used for investigation. The conclusion that there is no relationship between skill-based errors and accident involvement may be related to the use of self-report questionnaires. It is possible that self-reports are a more effective measure of deliberative acts such as violations than of nondeliberative acts such as errors. In examining the self-report items that have been used, it is clear that it is not possible to engage in the violations without explicit knowledge, because this is a criterion for the self-report violations. However, it is possible to commit some of the errors without any knowledge of doing so. For example, consider the following item in which you, as the driver, "nearly hit a cyclist who has come up on your inside." It is entirely possible to commit this error without being aware of it, and if one has no knowledge of the driving error, how can one report it? Under these circumstances, it is possible that the self-report error measure simply has lower external validity than does the self-report violation measure, thus artificially weakening the correlation between errors and accidents.

Another potential explanation relates to the type of driving skill under consideration. For example, it can be argued that vehicle control skills have little relationship with accident involvement. For instance, Jonah, Dawson, and Bragg (1981) found that a test of motorcycle-control skills failed to discriminate between accident-involved and accident-free motorcyclists. Indeed, the motorcyclists who performed best in this test of vehicle control were young men, who represent the group with the highest accident risk (Jonah & Dawson, 1979). Katila et al. (2004) found that compulsory skid training in Finland had no overall effect on subsequent accident involvement, even when controlling for exposure and despite a large sample size ($N = 30{,}616$). In contrast, as has already been noted, a different type of skill, hazard perception, has been found to relate to accident involvement. The proposal then is that there are different components of skill and that each must be examined before a conclusion is reached on the general relationship between skill and accident involvement. There is probably enough information to reject the proposal that all skill improvement will reduce accident involvement. However, we argue that there is not enough information to support the proposal that no skill improvement will improve accident involvement.

In summary, we have shown that a specific type of skill training can influence risk taking, even though skills and risk taking are regarded as being independent of one another. The reduced risk taking was demonstrated and the effects replicated in a more ecologically valid context using police drivers, thus demonstrating the generality of the findings. From the perception of road safety, hazard anticipation training appears to offer the dual benefit of improving drivers' hazard perception while also decreasing their risk taking.

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