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Traffic Crash Involvement: Experiential Driving Knowledge and Stressful Contextual Antecedents

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Researchers have rarely examined stressful environments and psychological characteristics as predictors of driving behavior in the same study. The authors hypothesized that (a) safer drivers more accurately assess physical and emotional traffic hazards and (b) stress and emotional states elevate crash risk. The hypotheses were evaluated with procedural and declarative tacit driving knowledge tests requiring assessment of emotional and contextual hazards and with accident reports describing crash antecedents, including stressful events and environmental conditions. Analyses identified separate driving knowledge factors corresponding to emotional and contextual hazards that were significantly related to the crash criteria. Accident report analyses show that stress significantly elevates at-fault crash risk. The results demonstrate the importance of experiential knowledge acquired without instruction (procedural or tacit knowledge) and provide safety recommendations.

A common, long-standing view of driver safety is that individuals assess their current situation and its associated level of difficulty and use this information to compensate for changes in task or driving difficulty (e.g., Näätänen & Summala, 1974, 1976; Taylor, 1976). According to this view, drivers reduce crash risk by increasing task effort and modifying speed in response to difficult driving conditions. In response to social pressures, traumatic life events, and other motivations, individuals often drive in ways that increase crash (or accident) risk, such as driving at faster speeds, allowing themselves shorter headway distances, and passing other vehicles more frequently. Motivational driver safety models have been formulated to describe driving processes reflecting this common view of driver safety (cf. Blomquist, 1986; Deery, 1999; Gregersen & Bjurulf, 1996; Janssen & Tenkink, 1988; Näätänen & Summala, 1976; Wilde, 1976). These frameworks identify factors influencing driver safety such as environmental conditions, immediate needs, and operator personality and skill, and propose risk assessment mechanisms to maintain safety and regulate driving behaviors.

Ample evidence supports the expectation of these models that crashes are determined by both contextual variables and individual characteristics. Environmental factors, such as road hazards and weather conditions, impact driving safety in the immediate sense, whereas major life events, such as divorce and financial problems, increase crash rates for more extended time periods (Finch & Smith, 1971; McMurray, 1970; Selzer & Vinokur, 1974). Although the stability of at-fault crash rates suggests a role for individual characteristics (Elander, West, & French, 1993), meta-analysis (Arthur, Barrett, & Alexander, 1991) has identified few personality or cognitive variables substantially related to crash rate; as a complex task, driving performance and crash avoidance are unusual because they have only a minor relationship with general intelligence.

Reviews and analyses have noted the criticality of risk assessment to driving safety (Deery, 1999; Evans, 1991, 1993; Gregersen & Bjurulf, 1996; Jonah, 1986) and have demonstrated differences between novice and experienced drivers in risk assessment (Trankle, Gelau, & Metker, 1990). In these formulations, risk assessment has been broadly conceptualized to include identification, assessment, and reaction to driving hazards and risks. According to this view, novice drivers are less able to detect driving hazards, assess the risk associated with specific hazards, and act to mitigate those risks. Although these formulations reflect comparisons of novice and experienced drivers, it is well known that crash risk decreases with experience, and this relationship suggests that high-risk drivers may be less able to recognize and assess risks associated with specific driving hazards. In this study, we sought to develop reliable, experientially based driving knowledge tests and to assess their validity by using crash involvement criteria.

Conceptualizations of Knowledge

Knowledge has often been characterized as either declarative or procedural. Declarative knowledge corresponds to factual knowledge organized in semantic networks that are often explicitly represented, whereas procedural knowledge supports actions and is acquired through repetition. Cognitive learning theories (cf. Ackerman, 1988; Anderson & Lebiere, 1998; Kyllonen & Christal,

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1990; Shiffrin & Schneider, 1977) link declarative and procedural knowledge by proposing that procedural knowledge emerges through repetition from more explicit, declarative representations and supports automatic actions. Reber (1999) provided a different perspective, suggesting that most declarative and procedural knowledge (cf. language acquisition) is implicitly, as opposed to explicitly, learned. Driving is an interesting mix of procedural and declarative knowledge, with much of the very general knowledge explicitly taught in driving school; however, the huge preponderance of knowledge is acquired slowly and incrementally over years of experience.

Conceptualizations of tacit knowledge have much in common with expectations regarding procedural knowledge. The term *tacit knowledge* has roots in works on the philosophy of science (Polanyi, 1966), ecological psychology (Neisser, 1976), and organizational behavior (Schön, 1983). The concept stems from the idea that much knowledge relevant to competent performance (personal or job related) is not openly expressed or stated. Sternberg et al. (2000) proposed that the main characteristics of tacit knowledge are (a) directly related to practical goals people value, (b) procedural in nature and not readily articulated, and (c) generally acquired on one's own and unspoken.

According to Sternberg (1988, 1997), tacit knowledge is an aspect of practical intelligence enabling individuals to select, shape, and adapt to real-world environments in pursuit of personally valued goals. Tacit knowledge results from the application of information-processing components to practical problems that tend to be poorly defined, context rich, concrete, and personally relevant. Therefore, tacit knowledge reflects practical rather than abstract thinking skills and may be unrelated to general intelligence. This theoretical perspective is unusual, even unique, because it provides a rationale and guidelines to identify performance-related knowledge with low *g* loadings (cf. Schmidt & Hunter, 1993). In the context of vehicular crash research, a perspective providing a negligible theoretical relationship between a driving-knowledge domain and general cognitive aptitude is important because crash involvement and cognitive aptitude have only a minor relationship (Arthur et al., 1991).

We extended this conceptualization in several important ways. First, we recognized that some goals are universally valued (e.g., crash avoidance and self-preservation), whereas the original conceptualization links tacit knowledge to personal goals only. We also recognized that regardless of its importance or declarative or procedural status, poorly specified knowledge cannot be well supported by formal education and is more typically acquired through experience. Second, we acknowledged the utility of cognitive learning perspectives (cf. Anderson & Lebiere, 1998) and allowed for the possibility that some tacit knowledge may have declarative characteristics. Finally, we allowed tacit knowledge to have limited *g* loadings. Table 1 describes these characteristics in detail, reports our conceptual extensions, and summarizes evidence supporting the expectation that non-*g*-loaded, crash-relevant knowledge domains can be identified.

Risk Assessment

We speculated that risk assessment would correspond to an experientially based skill domain with tacit knowledge characteristics on the basis of the following information:

1. Data showing risk assessment improves with experience (Trankle et al., 1990).

2. A review of driver education curricula and traffic safety guidance concluding risk assessment is poorly supported by training programs (Mayhew & Simpson, 1995).

3. Conceptualizations of risk assessment are seen as context dependent and critical to crash avoidance (cf. Deery, 1999; Evans, 1991, 1993; Jonah, 1986).

4. Crash avoidance is recognized as a personally and universally valued goal.

5. A meta-analysis (Arthur et al., 1991) concluding that cognitive aptitude is not substantially related to crash involvement.

These observations imply that crash risk assessment corresponds to a knowledge of factors considered or monitored by safe drivers and this expertise has been primarily self-developed. By specifying knowledge and beliefs differentiating high- and low-risk drivers, this approach has promise of identifying information that could be shared in driving education classes to improve the driving performance of novice and high-risk drivers.

Experiential Driving Knowledge Hypothesis

The expectation that individuals moderate risk in response to ongoing motivations and driving conditions implies that individuals who can more accurately appraise the level of risk associated with a range of driving hazards respond more appropriately and are involved in fewer crashes. To evaluate this hypothesis, we developed two tests to measure risk assessment ability. They described a range of driving situations and required participants to estimate either safe driving speed or crash risk for each situation. The tests obliged participants to consider the impact of environmental factors (e.g., inclement weather and slippery roads) and internal and emotional conditions (e.g., fatigue and stress) on actions (changing speed or assessing risk) they might take.

These experimental driving scales can be described as experiential, primarily procedural, or tacit knowledge tests and were designed to provide information to improve traffic safety. In terms of the procedural–declarative distinction, the Safe Speed Knowledge Test required participants to make judgments that were more task related (of how fast to drive) than the Accident Causation Knowledge Test (of when and where crashes occur). In this sense, the safe speed test was more procedurally oriented than the accident causation test.

Contextual and Emotional Crash Antecedents Hypothesis

The literature suggests that individuals adjust their driving behavior following the assessment or cognitive appraisal of increased or changed crash risk (cf. Blomquist, 1986; Deery, 1999; Gregersen & Bjurulf, 1996; Janssen & Tenkink, 1988; Näätänen & Summala, 1976; Wilde, 1976). Crash involvement has been linked to a variety of road hazards and contextual events, such as family- or financial-related stress, presumably by changing one's current driving situation or influencing a driver's internal or emotional state (McMurray, 1970; Selzer & Vinokur, 1974). However, there

Table 1
Tacit Knowledge (TK) Conceptualization and Supporting Evidence for Its Use in Identification of Driving Knowledge Domains

Quality	Conceptualization and description	Proposed domain: Risk assessment
Generally acquired on one's own; unspoken	TK is conceptually linked to personal experience rather than formal instruction (cf. Sternberg, 1997). Individuals often are unaware of the TK underlying their actions. Experientially based, TK may be acquired in the absence of environmental conditions such as formal training, designed to support its acquisition.	Linked to experience (Trankle et al., 1990) and is poorly trained (Mayhew & Simpson, 1995).
Procedural in nature; not readily articulated	TK is typically conceptualized as specific to particular situations or classes of situations. It often takes the form of "knowing how" rather than "knowing that" and it is "intimately related to action" (Sternberg, 1997). TK is procedural in most aspects, critical to performance, and may guide behavior without being readily available to conscious introspection. Research on expert knowledge is consistent with this conceptualization. Experts draw on a well-developed repertoire of knowledge in responding to problems (Scribner, 1986), yet this knowledge tends to be procedural and operates without focal awareness (Chi, Glaser, & Farr, 1988). Following conceptualizations of procedural knowledge (Anderson & Lebiere, 1998) and implicit learning (Reber, 1999), we describe TK as primarily procedural but acknowledge it can be declarative. Consequently, TK tests may assess declarative as well as procedural knowledge.	Characterized as context dependent and critical to crash avoidance (cf. Deery, 1999; Evans, 1991, 1993; Jonah, 1986). The safe speed test (how much to slow down) was designed to be more procedural, and the accident causation (where crashes occur) test was designed to be more declarative.
Directly related to practical goals people value	TK has practical goal-oriented value to the individual (Sternberg et al., 2000). It reflects the structure of the individual situations or classes of situations more closely than it does the structure of formal, disciplinary knowledge (Groen & Patel, 1988). The more highly valued a goal and the more directly the knowledge supports goal attainment, the more useful is the TK. Although training programs can be designed efficiently to teach general knowledge, it is often difficult for formal training to develop knowledge detailed enough to handle individual situations, intimately related to action, and of practical personal value. We acknowledge that some goals are universally valued although the relevant knowledge may not have been specified or explicitly taught.	Supports crash avoidance, which is recognized as universally valued by conventional wisdom.
Minimal *g* loading	A unique aspect of Sternberg's (1997) conceptualization is that TK reflects practical intelligence and results from application of information components to poorly defined, context-rich, and personally relevant practical problems; thus, acquired TK reflects practical rather than abstract thinking skills and may be unrelated to *g*. We relax or interpret this characteristic to include domains with minimal *g* loadings.	Crash avoidance has low *g* loading (Arthur, Barrett, & Alexander, 1991).

appear to be little data linking crash involvement to either self-reported stress level or to scales assessing major life-event occurrence. We hypothesized that a driver's internal or emotional state would correlate with crash involvement because some drivers would not recognize the inherent danger of such situations and take appropriate corrective actions. To evaluate this second hypothesis, participants completed a self-report measure to describe the context surrounding crashes they had experienced. The measure contained items addressing the presence of disruptive personal and emotional events and of more frequently studied road hazards.

Method

Participants

U.S. Army Safety Center (USASC) data were used to identify 127 enlisted soldiers involved in either personal or work-related auto accidents.

These 127 individuals and an additional 273 soldiers, matched on rank and gender but not involved in accidents reported in the USASC database, participated in the study. We requested a greater number of matched soldiers ($n = 273$) to participate because the USASC database typically includes only traffic crashes impacting work duties, and consistent with our expectations, many of the matched soldiers reported crashes not listed in the USASC database. Agreement between the database and self-report measure was 76.4%. An additional 151 soldiers completed the accident survey form; thus, some measures and associated analyses reflect responses from 551 participants. The primarily midlevel enlisted personnel were 85% male with a mean age of 26.91 years ($SD = 6.03$). Of the 62% White, 25% Black, and 13% Hispanic sample, 46% were married.

Experiential Driving Knowledge Tests

Safe speed test. The Safe Speed Knowledge Test presented a scenario of an individual driving a safe car under optimal conditions (see Appendix A). The participants indicated how much a driver should slow down to ensure safety in 14 driving conditions. Ten items referenced environmental factors (e.g., heavy traffic, snow, or rain), three items referenced internal or affective states (e.g., stress or illness), and one item referenced both an internal state and an environmental factor (i.e., anger and light rain). Participants responded on a Likert scale, ranging from *slow down 20 miles per hour (mph)* to *maintain same speed 0 mph.*

Accident causation test. The Accident Causation Knowledge Test required individuals to estimate the percentage of major accidents involving 14 potential risk conditions (see Appendix B). These conditions referenced a variety of environmental factors (e.g., road condition and weather), as well as characteristics specific to the driver (e.g., age and stress). Participants responded on a Likert scale ranging from 0% to 100%.

Cognitive Aptitude

We obtained Armed Forces Qualification Test (AFQT) scores from Army personnel records and used them to estimate general cognitive aptitude. The AFQT is the military's operational measure of cognitive aptitude, and AFQT scores are obtained by applying unit weights to tests of Arithmetic Reasoning, Mathematics Knowledge, and Verbal. The Verbal test is double weighted and reflects performance on the Word Knowledge and Paragraph Comprehension scales. The AFQT distribution for the participants was elevated and range restricted in comparison to the civilian population. The observed mean was 56.8 versus a theoretical mean of 50.00, and the standard deviation was 19.8 versus an expected value of 28.78.

Accident Report Form

The participants completed a self-report measure, the Accident Report Form, to describe traffic crashes during the previous 5 years. The Accident Report Form was intended to identify the conditions and events surrounding each accident. Designed to complement the driving knowledge tests, the items referenced each respondent's internal and emotional state immediately prior to the crash and queried for the presence of adverse environmental or physical conditions (see Appendix C).

Crash Criteria

Driver–crash ratio. The primary criterion was the driver at-fault crash rate because such rates have greater stability than those based on total crash numbers (Elander et al., 1993). Also, our primary interest was in understanding crash culpability as opposed to crash victimization. We used data obtained from the Accident Report Form to compute the driver–crash ratio across participants as the ratio of at-fault crashes to days the respondent had been licensed.

Driver at-fault status. The second criterion corresponded to driver (respondent) fault in a crash and was scored dichotomously. Driver at-fault status was computed by incident and was reported only in the event of a crash; therefore, no data were collected from drivers with perfect records. Conversely, multiple records occurred for drivers with multiple crashes.

Procedure

The data were collected between June and September of 1998 at five U.S. Army installations. Individuals were informed that participation was voluntary and were asked to complete the two driving knowledge tests and the Accident Report Form. The data were collected in groups, with 4 hr allowed to administer a battery of measures; however, only the experiential driving knowledge tests and the self-report crash measures are relevant to the current study. The battery also contained a self-description form used to estimate the number of days the respondent had been licensed.

Results

Analysis Overview

Two series of analyses were required to address the two hypotheses. The first set of analyses validated the experiential driving knowledge tests against the driver–crash ratio criterion. The second series evaluated the role of contextual variables in crashes, and therefore driver at-fault status are the incidents of interest. Relevant demographics are listed in Table 2.

Experiential Driving Knowledge Test Analyses

Initial data reduction. The consensual scaling method we used to score the tacit driving knowledge tests was unusual in comparison with traditional scoring techniques. The procedure is based on the distance between a specific individual's rating and the mean rating across all participants for an item, that is, the distance equals the absolute value of the difference between the two values. Descriptive item statistics for the Safe Speed Knowledge and Accident Causation Knowledge Tests, including the means used to score the scales, are shown in Tables 3 and 4.

By using this scaling procedure, better (more consensually accurate) responses are indicated by lower values, and a distance of 0 indicates an optimum response (cf. Legree, 1995; Legree, Martin, & Psotka, 2000). However, the distances were inverted so that

Table 2
Participant Demographics Relevant to the Two Series of Analyses

	Driving knowledge hypothesis	Crash antecedents hypothesis	
Demographic	Total sample	Crash involved	Crash culpable
AFQT			
M	56.77	57.61	57.81
SD	19.80	19.97	21.37
Male (%)	86	88	90
White (%)	62	67	71
Hispanic (%)	13	11	10
Black (%)	25	21	18
Age (years)			
M	26.91	27.33	26.69
SD	6.03	6.14	5.65

Note. AFQT = Armed Forces Qualification Test.

Table 3
Safe Speed Knowledge Item Response Distributions and Factor Loadings

				Factor loading		
Test item	*M*	*SD*	Speed (%)[a]	Emotional Knowledge	Uncomplicated Conditions	Precipitation Conditions
Upset with family finances	8.39	5.30	16	**.73**	−.01	.04
Sick with a head cold	8.50	5.08	13	**.73**	−.09	−.05
Slightly worn tires	7.62	4.92	3	**.55**	.05	−.02
Stressed over work	7.61	4.90	18	**.46**	.06	.17
Light traffic and hilly	6.17	4.28	20	**.44**	.17	.05
Clear and light traffic	1.50	3.19	78	−.02	**.92**	−.11
Clear and breezy	2.77	3.52	49	−.02	**.68**	.14
Dry and midnight	4.52	3.79	28	.20	**.62**	.02
Light rain and curves	10.40	4.07	1	.06	−.08	**.59**
Angry and light rain	10.59	4.43	3	.23	−.12	**.44**
Snow and no traffic	11.17	4.11	2	.02	.01	**.49**
Snow and heavy traffic	14.81	4.01	0	−.07	.13	**.40**
Moderately heavy traffic[b]	7.70	4.17	8			
Gravel and light traffic[b]	7.77	4.02	7			
				Factor correlation		
				1.00	.19	.50
					1.00	.25
						1.00

Note. $n = 387$.
[a] Percentage of respondents who reported that speed should not be reduced. [b] Variables excluded from analysis because of cross-loadings.

higher values would indicate superior performance, consistent with conventional knowledge and aptitude tests.

Factor analysis: Safe speed knowledge. The distance items for the Safe Speed Knowledge Test were analyzed by using principal axis factoring and an oblique rotation, and a three-factor solution had the best combination of fit and interpretability (see Table 3). The initial solution had two items, “moderately heavy traffic” and “gravel and light traffic,” which did not clearly load on any one factor and were dropped from subsequent analysis. The final analysis resulted in a three-factor solution accounting for 54.9% of

Table 4
Accident Causation Test Item Response Distributions and Factor Loadings

				Factor loading		
Test item	*M*	*SD*	Involve (%)[a]	Weather and Age	Alcohol	Intersections
Snowy conditions	58.39	21.43	4	**.59**	.09	−.09
Rainy conditions	47.65	18.39	2	**.36**	−.01	.18
Middle-aged drivers	47.26	22.83	3	**.36**	−.04	−.01
Young drivers	60.35	21.96	4	**.35**	−.04	.02
Old drivers	40.85	25.30	2	**.26**	.03	.11
Stressed drivers	41.70	20.30	2	**.25**	.01	.13
Sunny weather	17.30	16.14	1	**.21**	.15	.02
Drunk drivers	71.74	17.91	15	.25	**.62**	−.07
Windy roads	22.47	13.65	0	−.13	**.32**	.24
Stop light intersections	46.03	21.13	3	.23	−.30	**.50**
Stop sign intersections	46.43	20.91	2	.07	−.10	**.46**
Interstate highways	45.22	21.13	3	.08	.13	**.37**
Parking lots	21.22	16.56	0	.00	.00	**.34**
Excessive speed	67.78	18.43	8	.01	.11	**.30**
				Factor correlation		
				1.00	.09	.42
					1.00	.18
						1.00

Note. $n = 381$.
[a] Percentage of respondents who reported condition was present in all major crashes.

the variance. The first factor, Emotional Knowledge, was composed primarily of items corresponding to internal states, with a smaller contribution from items reflecting moderate external conditions. The second factor was defined by items that represent Uncomplicated Environmental Conditions, such as clear and dry driving situations. The final factor, Precipitation Conditions, was composed of items pertaining to rain and snow.

Factor analysis: Accident causation knowledge. The accident causation items were also factored, but the results were less clear than those obtained for the safe speed items. Although five eigenvalues were greater than 1.0, a three-factor solution was selected for presentation on the basis of the scree plot. Table 4 summarizes the three-factor solution, and these factors are named for the items to which they most closely corresponded: Weather and Age, Alcohol, and Intersections.

Predictor and Validity Correlations

Correlations among the experiential driving knowledge measures, general cognitive aptitude, and the driver–crash ratio criterion are presented in Table 5. Table 5 also contains population correlation estimates corrected for univariate range restriction related to cognitive aptitude. Hypotheses involving the predictor scales and the accident criterion are supported by negative correlations; that is, superior performance on the tacit knowledge scales was expected to be associated with lower crash ratios. These correlations show that factor scores from both the Safe Speed Knowledge Test and the Accident Causation Knowledge Test correlated significantly with the driver–crash ratio criterion and had a low correlation with cognitive aptitude.

The factor scores obtained from the Safe Speed Knowledge Test were consistently related to the driver–crash ratio criterion and support the experiential driving knowledge hypothesis. The more substantial of these correlations corresponded to the Emotional Knowledge factor and indicate that safer drivers are better able to adjust their speed to take into account the impact of a driver's internal or emotional state on traffic safety. Although the factor scores for the Accident Causation Knowledge Test were significantly correlated with the driver–crash ratio, these correlations were less substantial than those obtained for the Safe Speed Knowledge Test factors and did not consistently support the experiential driving knowledge hypothesis.

Odds Ratios

Because accidents are rare events and are difficult to predict (cf. Elander et al., 1993), odds ratios provide an alternative perspective on the magnitude of the relationship between performance on the Safe Speed Knowledge Test and crash involvement. These analyses show that compared with individuals scoring one standard deviation above the mean (superior scoring individuals and therefore expected safer drivers), (a) individuals scoring within one standard deviation of the mean (average scoring) were involved in 2.3 times as many at-fault crashes, and (b) individuals scoring one standard deviation below the mean (low scoring) were involved in five times as many at-fault crashes.

Contextual Crash Antecedent Analyses

Table 6 reports correlations between the self-report contextual variables and the driver at-fault status criterion. These correlations identify contextual factors relating to crash involvement, such as transient emotional states and related situational events. Consistent with the second hypothesis, emotional contextual variables were significantly related to the crash criterion. For example, drivers were more likely to be at-fault when they reported being distracted by passengers ($r = .17$, $p < .01$) or when experiencing a life event ($r = .23$, $p < .01$).

Table 6 also contains correlations between driver at-fault status and the factors from the safe speed and accident causation tests. The significant correlations between the driver at-fault status criterion and the factor scores from the safe speed and accident causation tests are consistent with a variation and extension of the first hypothesis: Individuals who can more accurately appraise the level of risk associated with a range of driving hazards respond more appropriately, are involved in fewer accidents, *and are less likely to be at fault when involved in a crash.*

Incremental Validity Associated With the Experimental Scales

Safe speed knowledge and the crash rate criterion. We used backward multiple regression analysis to evaluate the predictive power of the experiential knowledge factors against the driver–crash ratio. The regression of driver–crash ratio on the three

Table 5
Correlations Among Tacit Knowledge, Driver–Crash Ratio, and Cognitive Aptitude

	Driver–crash ratio		Cognitive aptitude	
Measure	Observed	Corrected	Observed	Corrected
Cognitive aptitude	.03	.04	—	—
Safe Speed Knowledge Test				
Emotional Knowledge	−.19***	−.19	.10*	.15
Uncomplicated Conditions	−.10*	−.09	.31***	.43
Precipitation Conditions	−.16***	−.16	.11**	.16
Accident Causation Knowledge Test				
Weather and Age	−.11**	−.11	.03	.04
Alcohol	.11**	.11	−.04	−.06
Intersections	−.04	−.04	.09**	.13

Note. n ranges from 169 to 378. Hypotheses involving the driver–crash ratio are supported by negative values. Dashes in cells indicate data that were not reported.
* $p < .10$. ** $p < .05$. *** $p < .01$.

factors from the Safe Speed Knowledge Test and cognitive aptitude was significant for the Emotional Knowledge factor, $\beta = .19$, $p < .01$, $F(1, 381) = 14.98$, $p < .01$, $R^2 = .04$. Cognitive aptitude, Uncomplicated Environmental Conditions, and Precipitation Conditions were not significant predictors ($\beta = .05$, $\beta = .06$, and $\beta = .04$, respectively, all *ns*).

Emotional context. We used forward logistic regression analysis to assess the predictive value of the 14 emotional and environmental antecedent variables gathered from the self-report situation measure against driver at-fault status. The results were significant, $\chi^2(6, N = 178) = 38.00$, $p < .01$, identifying six variables as significant predictors of driver at-fault status (see Table 7). Two of these variables, heightened stress due to life events and stressed versus calm, reflected the emotional state of the driver. Two additional variables, road condition and passengers disturbing driver, reflected the driving context and the associated mental workload. The final two variables, insufficient sleep the night before the accident and medicine or drug use, reflected the internal state of the driver.

Table 6
Correlations Between Contextual Measures and Driver At-Fault Status

Measure	Driver at-fault status
Emotional state prior to accident	
Stressed vs. calm	.22***
Heightened stress due to life events (divorce, illness)	.23***
Fatigued at time of accident	.16**
Insufficient sleep the night before the accident	.20***
Passengers disturbing driver	.17***
No. of passengers	−.02
Alcohol and drug involvement	
Medicine or drug use	.22***
Alcohol use	.13**
Affected by alcohol	.20***
Alcohol contributed	.18***
Driving conditions and speed	
Speed of traffic	.02
Driver speed versus others	−.06
Driver speed versus limit	.13
Amount of traffic	.01
Weekend night hour	−.01
Road condition contributed	.14**
Vehicle condition contributed	.07
Seatbelt use	−.01
Safe Speed Knowledge Test factors	
Emotional Knowledge	−.20***
Uncomplicated Conditions	−.16**
Precipitation Conditions	−.16**
Accident Causation Knowledge Test factors	
Weather and Age	−.13*
Alcohol	.01
Intersections	−.09

Note. n ranges from 211 to 307. All significant correlations were in the expected directions.
* $p < .10$. ** $p < .05$. *** $p < .01$.

Table 7
Logistic Regression Predicting Driver At-Fault Status With Contextual Variables

Variable	b	Wald	−2 log likelihood
Stressed versus calm	0.80	4.13	
Heightened stress due to life events	5.19	3.45	
Road condition	0.71	4.39	
Medicine or drug use	7.98	0.10	
Insufficient sleep the night before the accident	−1.16	5.34	
Passengers disturbing driver	8.63	0.11	207.32

Note. $n = 178$.

Discussion

Driving Style Model

Experiential driving knowledge hypothesis. We designed the experiential or tacit driving knowledge tests to examine the hypothesis that safer drivers can more accurately assess driving risks. Prior to this research, there were no driving knowledge tests developed for the general population empirically linked to crash involvement or training effectiveness.[1] Even more perplexing, high school driver education programs, designed to provide practical driving knowledge and experience to new drivers, have only a minor impact on lowering the incidence of crash involvement (Evans, 1991; Lund, Williams, & Zador, 1986; Robertson & Zador, 1978). This lack of relationship is surprising because knowledge forms a foundation for performance in most domains, and it is usually possible to improve performance by teaching relevant knowledge (Chi, Glaser, & Rees, 1982). Instead of assuming that driving constitutes a special knowledge-independent performance domain, we suspected conventional driving knowledge tests have been deficient in corresponding to the type of information that differentiates high- and low-risk drivers. Past research has identified risk assessment and perception as a domain likely to correlate with crash involvement (cf. Deery, 1999; Evans, 1991, 1993; Gregersen & Bjurulf, 1996; Jonah, 1986) and led to the development of these driving knowledge tests.

The driving knowledge tests required individuals to provide safe-speed and crash-risk judgments across a variety of conditions. The correlations and odds ratios obtained for these scales demonstrate the importance and relevance of this knowledge to driver safety. From a conventional wisdom perspective, these results are credible because (a) crash risk decreases with driving experience (cf. Evans, 1991), (b) knowledge is acquired through experience, and (c) novice drivers differ from experienced drivers in their perception and assessment of risk (Deery, 1999). These data demonstrate that risk assessment and management are critical skills and are consistent with expectations that drivers learn to assess and manage risk through experience (cf. Evans, 1991; Mayhew & Simpson, 1995). These results suggest that low-risk drivers are more aware of when and how to modify their driving styles in

[1] Driving knowledge tests developed for license certification represent a different class of scales because they assess a minimal level of competency (cf. Veiling, 1982).

response to changing conditions, whereas higher risk individuals are more likely to react either minimally or excessively to changing conditions. In these data, this increased awareness was associated with (a) lower at-fault driver–crash ratios and (b) decreased likelihood of culpability (driver at-fault status) given crash involvement.

The positive results obtained for the driving knowledge scales reflect the tacit knowledge conceptualization presented in Table 1. This conceptualization emerged from multiple sources (e.g., Anderson & Lebiere, 1998; Sternberg, 1997), and the results demonstrate its utility for identifying performance-oriented knowledge domains that have low *g* loadings. It is interesting that higher validities were associated with the more procedural scale (i.e., the Safe Speed Knowledge Test, see Table 5). This observation supports the notion that procedural tacit knowledge usually provides more effective assessment information than does declarative tacit knowledge (cf. Sternberg et al., 2000). This reasoning suggests that the Accident Causation Knowledge Test, which was more declarative, might have provided higher validities had participants provided more activity-oriented responses; for example, participants could have estimated appropriate vigilance levels for those items, as opposed to accident involvement rates.

Contextual emotional crash antecedents hypothesis. We designed the accident report measure to test the hypothesis that stress and related psychological states elevate crash risk. This hypothesis was assessed by analyzing self-report items addressing the presence of emotionally disturbing states or events and of conventional risk factors, such as alcohol level and weather conditions. The analyses for the contextual variables demonstrate strong relationships between emotionally disturbing events and related states with driver at-fault crash status.

Implications for Emotional Awareness and Control

The strongest relationships between the safe speed factor scores and the crash criteria were obtained for the Emotional Knowledge factor. The data show low-risk (safer) drivers provide moderate adjustments in safe speed estimates in response to emotional conditions, whereas high-risk individuals provide more extreme responses. Individuals low on emotional awareness may be disadvantaged in several respects regarding driver safety. First, they may be less aware of the importance of moderating driving styles during stress. Second, they may lack emotional coping mechanisms to avoid or minimize the impact of adverse or unusual events, therefore being more frequently distressed or distressed to a greater extent. Finally, they may be less likely to be influenced by individuals who are more aware of the potential effects of emotional states on driver safety and whose advice might improve safety.

The results from the Safe Speed Emotional Knowledge factor are consistent with the contextual relationships; a driver's emotional state immediately preceding an accident (e.g., being stressed, being disturbed by passengers) was predictive of the crash ratio criterion. These relationships demonstrate the importance of a driver's emotional or internal state to crash involvement. A reasonable interpretation of these data is that (a) emotionally stressful states are predisposing factors for crash involvement and (b) emotional awareness and knowledge mitigate the adverse effect of emotions on driving safety.

Experiential Driving Knowledge in Relation to Cognitive Aptitude

The Safe Speed Emotional Knowledge factor correlated with crash involvement but had only a modest relationship with cognitive aptitude. Although this finding is consistent with our theoretical conceptualization of tacit knowledge, and low correlations between cognitive aptitude and crash involvement are common in driver safety research (Arthur et al., 1991), it is difficult to intuitively understand this negligible relationship because driving is a complex cognitive task, and performance on most complex tasks correlates with general cognitive aptitude.

The low correlations between emotionally related driving knowledge and cognitive aptitude might reflect individual differences in exposure to learning environments. Exposure to learning environments may be highly variable across individuals; for example, students taught by unknowledgeable drivers may not acquire much detailed knowledge regardless of their general ability to learn. This type of variance would decrease the magnitude of the correlation between cognitive aptitude and tacit knowledge and could explain the correlations in Table 5. This explanation reflects the personal relevance and experience characteristics described in Table 1 and suggests that more substantial correlations between cognitive aptitude and tacit driving knowledge would be obtained if this knowledge were explicitly taught.

This explanation is consistent with analyses of tacit knowledge and situational judgment tests (McDaniel, Morgeson, Finnegan, Campion, & Braverman, 2001). McDaniel et al. (2001) noted that tacit knowledge tests often adopt a situational judgment test format but tend to be more detailed in the number of assessment alternatives and response options. This greater level of detail tends to "minimize observed relationships with cognitive ability" (McDaniel et al., 2001, p. 737). This finding may demonstrate that general responses to situations can be taught formally, although detailed, situation-specific knowledge often is learned tacitly, on one's own.

Methodological Concerns

A methodological limitation of this study is the use of a retrospective design to collect crash criteria and to evaluate the tacit driving knowledge and emotional crash antecedent hypotheses. However, an important advantage to adopting a retrospective design is that this approach allowed for the assessment of the role of stress and related psychological states in understanding crash culpability. Although a retrospective approach is problematic to the extent that predictor stability must be assumed, this study has the strength of addressing two related questions from different perspectives. Convergence between these approaches lends credence to each set of analyses, and interpretations of this research should consider the consistency of the results for the two hypotheses, as well as their relationship to general safety findings.

Public Safety Implications

The driving knowledge tests identified dimensions differentiating high- and low-risk drivers, and these dimensions may provide information that should be explicitly taught to inexperienced or high-risk drivers. These analyses suggest drivers should be encouraged to adjust their driving styles in a manner proportional to the severity of environmental factors and emotional conditions. To assess the magnitude of this need, we reviewed the item response distributions for the Safe Speed Knowledge Test and determined that approximately 16% of the sample did not identify emotional or internal states as a cause to modify speed. This distribution suggests many drivers have not learned to moderate their driving actions in response to their internal state.

Although it is important to teach individuals that internal and emotional events are associated with crash involvement, some drivers may have trouble identifying these states and may benefit from learning to identify events eliciting these states. Widely conveying that crash risk is increased by stressful events such as relational contentions or financial troubles might enhance public safety. Passengers should be taught that inappropriate behavior includes disturbing or otherwise stressing a driver and should be encouraged to help drivers maintain traffic safety.

These recommendations are consistent with the notion that higher risk drivers could benefit by using safe drivers as models for their own behavior. They are also consistent with the expectation that individuals are more likely to be involved in traffic crashes when under emotional or internal stress. From this perspective, this study provides a summary of beliefs and attitudes distinguishing better drivers who could be taught to improve driving safety.

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(*Appendixes follow*)

Appendix A

Safe Speed Knowledge Test

Assume someone is driving a safe car in light traffic under optimal/perfect conditions. Given the following considerations, please *estimate* how much that individual (driver) should or shouldn't slow down and change speed to ensure safety.

Conditions:	−20 mph Slow down	−10 mph	0 mph Same speed
1. Snow and heavy traffic			
2. Clear weather and light traffic			
3. Snow and no traffic			
4. Dry roads at midnight			
5. Stressed driver due to problems at work			
6. Moderately heavy traffic			
7. Gravel and light traffic			
8. Clear roads and somewhat breezy			
9. Light rain and curvy roads			
10. Angry and light rain			
11. Light traffic and hilly terrain			
12. Slightly worn tires			
13. Upset with family over finances/money			
14. Sick with a head cold			
	−20 mph Slow down	−10 mph	0 mph Same speed

Note. mph = miles per hour.

Appendix B

Accident Causation Knowledge Test

Please mark the bubble to *estimate* the percentage of major accidents that involve the following conditions:

0% 50% 100%

1. Windy roads
2. Drunk drivers
3. Excessive speed
4. Interstate highways
5. Intersections at stop signs
6. Parking lots
7. Rainy conditions
8. Drivers between 25 and 55 years old
9. Emotionally stressed drivers
10. Sunny weather
11. Drivers between 20 and 25 years old
12. Snowy conditions
13. Drivers between 55 and 75 years old
14. Intersections at traffic lights

0% 50% 100%

Appendix C

Accident Report Form

Fill out one of these accident reports for each accident you have been involved in as a driver within the last 5 years.

Accident number ____

1. When did the accident occur?
   ______ Season ______ Year

2. Was it a weekend (Friday evening through Sunday) or weekday?
   __ Weekend __ Weekday

3. Approximately what time of day or night did it occur? ________

4. Were you at fault in causing this accident?
   __ Yes, fully responsible/at fault
   __ Yes, partially responsible/at fault
   __ No, not responsible/at fault

5. Did a condition of your vehicle (e.g., blown tire, faulty brakes) contribute to this accident?
   __ Yes __ No

6. Did weather conditions contribute to this accident?
   __ Yes __ No

7. In what type of traffic were you (how many other cars on roadway)?
   __ Heavy traffic __ Light traffic
   __ Moderate traffic __ No other traffic

8. How fast was most of the other traffic around you?
   __ Very high speed (> 70 mph) __ Low speed (< 30 mph)
   __ High speed (55–69 mph) __ No traffic
   __ Moderate speed (30–54 mph)

9. How fast were you driving compared to the other traffic?
   __ About the same __ Slower
   __ Faster __ No traffic

10. How fast were you driving compared to the speed limit?
    __ Below the speed limit
    __ At the speed limit (within 5 mph)
    __ Slightly above speed limit (5–10 mph)
    __ Clearly above speed limit (> 11 mph)

11. Did the condition of the road, terrain, or traffic contribute to the accident?
    __ Yes __ No

12. What was your emotional/mental state just before the accident?
    __ Calm __ Fatigued
    __ Somewhat stressed, anxious or excited __ Cannot remember
    __ Very stressed, anxious or excited

13. Were you experiencing major life events at the time of the accident? (Check all that apply)
    __ Divorce or breakup of a long-term relationship
    __ Own illness or injury
    __ Illness/injury/death of someone close to you
    __ Getting married/engaged
    __ New parent/expecting child
    __ Major financial problems
    __ Loss of job
    __ Problems at work or school
    __ Moving/changing homes
    __ Graduation from school/college
    __ Problems with parents/guardians
    __ Other

14. Had you been getting sufficient sleep in the days preceding the accident?
    __ Yes __ No

15. What was your marital status at the time of the accident?
    __ Single __ Divorced
    __ Married __ Separated

16. Had you any alcoholic drinks in the hours preceding the accident?
    __ Yes __ No

17. Had you had any medication or drugs (including legal or illegal) in the hours immediately preceding the accident?
    __ Yes __ No

18. Were you affected by alcohol or medication when the accident occurred?
    __ Yes __ No

19. Do you think the effects of alcohol or medication taken by you was a contributing factor in this accident?
    __ Yes __ No

20. Were you wearing a seat belt when the accident occurred?
    __ Yes __ No

21. How many passengers were in the vehicle with you? ________

22. Were the passengers distracting you or drawing your attention from the road?
    __ Yes __ No

Note. This Appendix presents representative items from the Accident Report Form, which contained greater detail and could be scanned to tabulate results. Peter J. Legree may be contacted for the entire instrument. mph = miles per hour.

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