Transportation Safety

The Distracted

How dangerous is "multitasking"?

By George A. Peters and Barbara J. Peters

A SERIOUS HEATH PROBLEM is developing due to automobile collisions caused by distracted drivers. This is the result of the rapid proliferation of portable cell phones and personal organizers used while driving (inattention to roadway conditions), the development of more-sophisticated entertainment systems and instrument panel controls (less vigilance), the advent of navigation and television displays in vehicles (eyes off the road), and promises of sophisticated wireless e-mail, fax and Internet services in the vehicle (addition of complex activities).

Preoccupation with electronic gadgets may degrade human driving performance. Yet, many drivers sincerely believe they can perform several tasks at the same time, such as hold and look at a cell phone in one hand, drive with a beverage container in the other and exercise their personal skills. Obviously, these drivers feel they do not need two hands on the steering wheel and two eyes on the road.

This unique situation requires intensive health promotion because distracted or "offensive driving" may be habit-forming and difficult to change. Furthermore, any significant design remedies will be slow to arrive and may be circumvented, and laws have proven difficult to enforce. This special need may require research to determine the most-effective techniques for health promotion.

A vehicle driver may dramatically increase the risk of an accident if unaware of special hazards involved in the use of certain accessories and after-market equipment. For example, in-vehicle use of a cell phone could result in inattentive driving on crowded roadways; increased use of navigation displays could cause drivers to focus on the displays rather than ever-changing roadway conditions; the presence of captivating entertainment and interactive information systems such as onboard TVs, fax machines, computers, wireless communication devices and other complex electronic devices may distract drivers from a focus on safe driving.

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The key words are "detractors" (devices) that create cumulative "distraction" from driving tasks which can result in injury risks that are largely unrecognized and unexpected by drivers. The problem may worsen if vehicle manufacturers do not conduct proper research to minimize risks and if information on residual risks is not effectively communicated to both dealers and vehicle operators. In general, health promotion has become a critical factor to the successful introduction of advanced technology for automotive vehicles.

Distractors & Risk Reduction

For electronically wired cars, some marketers and dealers insist that no substantial distraction exists because most drivers can "multitask" (deal with several sources of information simultaneously) while a vehicle is in motion.

However, some human factors specialists insist that "cognitive tunneling" can occur and the driver could momentarily lose track of close-in traffic (for safe navigation) while concentrating on a phone call or other electronic device (a distraction). Such distinctions might be important to research and in accident reconstruction, particularly if the vehicle features after-market electronic devices that could act as primary, secondary or cumulative distractors.

Three obvious risk-reduction techniques are available for this situation. First, printed and audible warnings not to use a device unless the vehicle is stopped could be incorporated. For example, the operating instructions of a front-center-mounted computer may feature a written warning to use the computer only when the vehicle is parked. However, if the computer can be viewed while the car is in motion, some drivers will predictably do so. Similarly, a recorded voice warning to use a fax or display an e-mail only when stopped may not be thought applicable to passengers. Drivers are often

Driver

Preoccupation with electronic gadgets ***may degrade human driving performance.***

distracted by or become involved in passenger activity, thus becoming degraded in terms of primary driving tasks.

The second technique is to have an integrated system in which all devices (except for warnings, heads-up navigation prompts or customary radio signals) are either shut off or out of the driver's sight when the vehicle is in motion. This approach might categorize possible distractors as primary or secondary in importance, with needed information highlighted for quick cognitive access and understanding, and with warning overrides for commandeering control. For example, an adaptive cruise control might first provide advisory information, then a priority warning, and finally, automatically slow or steer the vehicle if an object detected by radar or other sensors could cause harm.

The third technique involves marketing and dealer restraint. Dealers should recognize that prospective vehicle purchasers vary greatly in comprehension, attention, perception, encoding and resolution of competing information, and executive-type decision making.

Therefore, risk reduction should become a greater priority for marketers, dealers and other stakeholders. This may be helped by increased dealer consolidation, restructuring, electronic communication and technical sophistication. The new responsibilities of marketers and dealers should be a health promotion concern. Dealers can only accomplish so much, but knowledge and motivation must be fostered by public promotion efforts.

Magnitude of the Risk

In recent years, many have opined that in-vehicle use of wireless telephones causes accidents. The Japan National Police Agency asked drivers not to talk on mobile telephones while driving; other countries have attempted to limit the use to hands-free phones. Many local municipalities have attempted to institute bans or prohibitions (e.g., use only when the vehicle is stopped or during emergencies).

In 1997, the National Highway Traffic Safety Administration (NHTSA) concluded that insufficient data existed to estimate the magnitude of the problem, so no federal action could be taken. Clearly, there are differences of opinion regarding the potential danger and need for corrective action. However, the policy in the U.S. requires convincing field data, even if reliable data might be difficult to obtain; the U.S. does not apply the precautionary principle utilized in the European Union under which a possible danger raises a "red flag" (Foster; Raffensberger) and risk assessments are conducted differently ("General Product Safety"). In essence, the hazards (propensity to cause harm) may be recognized, but the actual danger (magnitude of the risk) may be disputed.

In July 2000, radio and television reports—with information attributed to the American Automobile Assn.—indicated that millions of collisions each year could be blamed on distracted drivers. Others estimated that more than 25 percent of all accidents were caused by distracted drivers. In fact, one report indicated that a driver using a cell phone was believed to increase the risk of an accident by a factor of four and, if drinking, it would further increase the risk by another factor of four. These were primarily statements concerning a probable hazard—opinions as to possible risk—but they did not advocate or express a need for a remedy.

Media reports also noted that vehicle collision warning systems with a radar range of 500 ft. were being tested; reportedly, they could provide about 0.5 to 1.0 seconds of additional time to avoid an accident. It was estimated that such devices would result in a 50-percent reduction in some types of acci-

Table 1

Human Reaction Times*

(seconds)

Activity	Situation		Commonly Utilized	Source
PERCEPTION (detection and awareness)	simple complex	0.5 3.0-4.0	1.5	AASHTO 1973
REACTION (braking)	simple complex	0.5 1.0	1.0	AASHTO 1973
SWERVE (avoidance)		0.9-2.0	1.5	Johansson 1971 Hulbert 1984
MANEUVER (passing)		3.5-4.5	4.5	AASHTO 1973
PREVIEW (scene)	look ahead look back	2.0-2.5 0.8-1.0	2.5	Hulbert 1984 Robinson 1972 AASHTO 1973
HEADWAY (distance)	60 mph (96 km/hr)	1.0	1.0	Hulbert 1984, 1976 Robinson 1972
SEARCH (visual)	lane change enter crossroad	0.8-1.6 1.1-2.6	0.8 2.5	Robinson 1972 Hulbert 1984
SIGHT DISTANCE (hazard detection up to braking)	legal assumption 95th %-ile	 1.6	0.75 2.5	Hulbert 1984 Olson 1986

*highly variable

Speeds for pedestrians: Actual 2.5-6.0 ft./sec. (AASHTO)
Design 3.0-4.0 ft./sec. (MUTCD)

Side wind gust correction: 0.30-0.59 sec (Wierwille)
Conversions: 1 mph = 1.467 ft./sec. = 1.609 km/hr = 26.8 m/min.

dents. This suggests the importance of one second in driver reaction time (Table 1).

As Table 1 shows, dangerous events can materialize very quickly. For example, a vehicle can make a quick lane change (in two to three seconds) and slow down in front of a distracted driver (with a blind time of four seconds) and a collision might occur. Similarly, a distracted driver might be following too closely when the vehicle in front initiates a sudden braking action. Perhaps more serious is the person using the vehicle as a mobile office who becomes distracted when attempting to interpret a garbled voice communication. In such cases, the driver could suffer a complete loss of overall situational awareness and have virtually no readiness to respond to some situations noted in Table 1.

Many drivers orient their heads to keep their eyes on the path of travel, yet are actually driving while distracted. They may believe that they can react normally should a danger arise. Under such circumstances, the issue is whether tunnel vision (restricted peripheral vision), limited search (of the field of view), degradation of visual quality (impaired detection) or a total loss of situational awareness (a temporary ignorance of what is happening around the vehicle) may occur. A driver's belief may be misleading and be an expression of controlled risk-taking behavior, but can foster attitudes antagonistic to a true understanding of the limitations of human capability in that situation.

During the past 30 years, many studies have examined mobile phone use in vehicles (e.g., Alm; Briem; Brookhuis; Brown; Fairclough; Kames; Maclure; McKnight; Pachiandi; Parkes; Petica; Redelmeier; Spelke; Stein; Sussman; Violant; Wang; and Zwahlen). Despite such illustrative publications, there is still much to learn, perhaps because of the differences between what drivers "could do" in laboratory and simulation tests and what they "actually do" in typical driving situations.

One benefit from distractors may cancel another. For example, where tedium and fatigue could occur in continuous and monotonous truck driving, a secondary voice communication task was found beneficial in terms of performance (immediate alertness and concentration), although it had a fatiguing effect on the driver (Drory).

However, it has been known for some time that multiple tasks can degrade performance (Noble). When the driver is a single-channel information processor, his/her attention may be rapidly shifted between tracking and object avoidance (Hulbert). For the tracking task on a committed pathway, the driver "looks ahead" (preview time) for about 2.5 seconds (AASHTO). For a safe lane change, the "look back," by head turn or rearview mirrors, takes about one second. In essence, the time allowances for forward vision and for preparation to change lanes is relatively small compared to common distraction times. That is, during distraction time (blind time) objects can suddenly appear and become collision prone.

Will a Cell Phone Policy Reduce Distractions?

The safety manager may be concerned with distracted drivers in company fleet operations, delivery and maintenance vehicles and the coming/going of passenger vehicles. Instant communication with company drivers may be a valuable tool, but what rules should apply for cell phone and navigator use?

In-vehicle use of handheld cell phones has been restricted in Austria, Brazil, Chile, Denmark, England, Germany, Greece, Israel, Italy, Japan, Poland, Portugal, Philippines, Romania, Singapore, Slovenia, South Africa, Switzerland, Turkey and the State of New York. However, questions remain regarding enforcement, the habit and convenience of use and what constitutes an emergency exception to rules forbidding driving while using a cell phone. Is distraction reduced with headsets, voice dialing or other hands-free accessories?

The safety objective may be eyes on the road, hands on the steering wheel, full attention to the driving task and an appropriate level of information processing by the driver. These issues are being researched by government agencies, universities and device manufacturers. Until this research matures, the safety manager must devise appropriate controls for these comparitively new risks.

The reaction time advantage of a heads up (windshield) display may be appreciable when compared to an instrument panel display. Eye travel time may be half of that of a look-down movement (head and eyes) combined with a simple visual search, perception and comprehension task. However, considerable variability exists among drivers and even slight complexities in the visual task greatly escalate time requirements and safety implications.

For example, the difference between two, four and eight seconds (blinks of an eye) of off-the-road vision can be translated into 176 ft., 352 ft. and 704 ft. at a 60 mph (96 km/h) vehicle speed. Assume a crowded highway and what another vehicle might do, and those hundreds of feet in a few seconds with eyes off the road become important. Even on a rural or country road, with vehicles traveling only 30 mph (48 km/h), what about an intersection with a vehicle approaching on a side road? For eight seconds, the driver's eyes are off the road for 352 ft. of travel while the other vehicle also travels 352 ft. toward the intersection—and it may enter the driver's view and pathway during the blind time. In other words, logic suggests that just a few seconds may appreciably increase accident risks. Thus, the key design requirement is to minimize off-the-road distraction time by appropriate display location, cues and alerts, search time, perceptual simplicity and accuracy, and relevant comprehension.

Health promotion efforts should include demonstrating the blind-time hazard (eyes off the road) and just how easily time extension (added seconds) can occur. The driver can be advised to practice visually locating displays, how to make quick interpretations when necessary, and when to ignore entertainment features. To ensure safety, advanced cell phones with

Table 2

Distraction Stages

Stage	Phase	Activity	Brain Function
1	PRELIMINARY (arousal)	EXPECTATIONS (goal established)	CODE SELECTION (local, sparse and bias for neural circuits)
2	CONDUCT (directed attention)	SEARCH (locate and fixate)	VISUO-MOTOR-SPATIAL (guidance)
3	PERCEPTION (understanding)	IDENTIFICATION and READOUT	FILTERING, CODE MATCHING and FACT ACQUISITION
4	COMPREHENSION (meaning)	INTERPRETATION in CONTEXT	ASSOCIATIVE INTERACTION and NETWORK RECRUITMENT
5	VERIFICATION (achievement)	SUBSEQUENT CHOICES	EXECUTIVE JUDGMENT

Time required: primed ~ 2 sec., novel ~ 4 sec., complex > 8 sec.

access to the Internet, e-mail, games and other services should not be used by the driver when the vehicle is on the roadway.

The use of cell phones varies greatly as to roadway location, the percentage of the local population owning cell phones and local laws regulating their use while driving. In one urban location, some eight percent were driving while distracted. The individual increase in relative risk of 4 would result in an overall relative risk of only 0.32. This suggests that in-vehicle cell phone use may be acceptable, but this does not include the cumulative and interacting effects of other distractors that are just beginning to appear in new vehicles (and available for installation in older vehicles). Cumulative risk may be added, but interactive risks may be multiplicative. Certainly research is needed, but health promotion may be a quicker solution because of the diverse mix of vehicles, current distractors and future advanced technology distractors.

Information Processing

The human information processing system can deal with vast quantities of data, such as the ever-changing flow of visual information presented to the driver of a fast-moving vehicle on a crowded scenic highway. Obviously, humans have some built-in means to prevent information overload as well as a process to select that which may need prompt attention. Certain brain mechanisms filter out nonrelevant clutter, suppress multiple competing stimuli and direct attention for fast reaction (Kastner; Henson; Johnson-Laird).

Vehicle design, including all accessories and options, should not challenge or be antagonistic to the biological mechanisms of human response and survival. In essence, they should not significantly degrade reaction times, interfere with identification accuracy or disrupt essential cognitive functions. Rather, they should enhance directed attention when necessary for injury avoidance; ensure the accuracy of perceptions and interpretations; facilitate priming, coding and executive functions; and help to minimize undesirable distractions, conflicts and confusion. Such a design-oriented approach requires considerable interdisciplinary research, engineering development and risk assessments that take substantial time and effort. Thus, some other, more-immediate action is needed because accident injury risks are already high, are rapidly increasing and could become unmanageable in the near future with the proliferation of technology-driven detractors.

Distraction time (eyes off the road) varies based on the task performed; it should be minimized and controlled for safe driving. However, the current critical questions directly relate to information processing capabilities. First, under what circumstances might there be separate, shifting or shared attention to the driving task during distraction? Is there time batched shifting, proportional sharing or a delayed single focus? In other words, are there moments of blackout and blind driving or periods of degraded driving that might/might not be tolerable under the circumstances? Stated another way, when distracted on a primary task, is there any meaningful awareness of or attention to the secondary driving task? Could there be a mental model of the secondary scene where unexpected changes would alert a driver? If so, how timely and effective would such secondary or peripheral perception be for simple and complex tasks? Second, what are the effects of the driver's head position, the distracter location, the distracter target complexity, practice and priming, and hazard conspicuity? Appropriate research might reveal how distractors could be made more acceptable and testing might provide a risk rating for each distractor.

The Need for Health Promotion

Unlike many convenience and entertainment features built into a vehicle, the cell phone is portable and can be acquired independently of the vehicle. When few cell phones were in use and their cost of operation was high, overall risks were low. Now, many people have such phones, they are wireless, operating costs are low and they satisfy evolving communication needs. The latest devices provide Internet services that demand greater attention and reading time. Displays are becoming larger and more capable of high-resolution picture transmission. Many also allow personal calendars and schedules to be viewed. In essence, they are becoming miniature personal computers. In other words, the distraction problem clearly has future ramifications and probable risk increases.

Attempts to legally regulate the use of in-vehicle cell phones are much more difficult than the more-conspicuous efforts to prevent speeding. In addition, these phones have emergency, medical, location and security benefits. But, what will constitute an emergency or security problem in the mind of the driver who believes cell phone operation while moving is a necessity?

In addition to legislative initiatives, some manufacturers have attempted to design-out the risk or at least to develop some consensus design standards. At the same time, however, after-market designers have done the opposite—they have installed devices, such as TVs, that can be viewed by both the driver and passengers. Thus, design improvement and legal restrictions may have limited long-term effect.

The only immediate approach to significant risk reduction is an effective health promotion effort by many sources in many repeated forms (Peters and Peters). Special care is needed or short messages may have an opposite or unintended effect, particularly among young people or subpopulations prone to overt risk-taking (Peters). Tobacco (cigarette) marketing illustrates the challenge of formulating an appropriate and effective health promotion effort. Merely conveying the fact that distractors result in accidents will not appreciably reduce the risks when users perceive benefits or incentives to use the devices.

A Recent Verdict

The cost of the improper use of cellular telephones was revealed in a January 2002 court verdict in Miami. An SUV driver *may have been talking on a cell phone* when he collided with another vehicle. The jury awarded $21 million (subsequently settled for $16 million) to the driver and passenger of the other vehicle.

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It can be argued that consumers wanted cup holders in automobiles and this led to one-arm driving while drinking the beverage, which in turn led to eating while driving. Similarly, visor mirrors have led to increased grooming while driving. Conversely, onboard radios have slowly evolved into manual push-button, station self-searching and quick-mute devices that do not seem to be appreciable distractors when properly used. The basic problem is that drivers have become accustomed to the growth of various kinds of distractors and want to utilize the latest device, which could have an adverse cumulative effect on distraction. Thus, health promotion faces formidable obstacles in the general acceptance of the distractor situation.

The distraction problem clearly has future ramifications and probable risk increases.

Since the need for "education" is so important, some intensive and varied research projects should be undertaken to discover what might be the best (most-effective) methods to promote health in this unique situation. Remember, the danger is not restricted to the driver who undertakes undesirable behavior, since his/her conduct places many other vehicle drivers and pedestrians at risk—an unnecessary and avoidable risk that could be reduced significantly by appropriate health promotion efforts. Since large financial resources are being expended to develop devices that distract, why not apply a rather small fraction of that amount for independent targeted health promotion?

Conclusion

Distracted drivers represent a significant public health problem that is resulting in a growing number of personal injuries—crash-related injuries that often encompass other vehicle drivers, passengers, pedestrians and bystanders. Correction and preventive treatment should be interdisciplinary and multimodal, with targeted health promotion being a key component.

Research is needed relative to the identification of road hazards. What is the perceptual capture efficiency under conditions of expectation (conformance to a mental model), the unexpected-but-predictable event, and in terms of sudden surprise? What are the effects of complexity and ambiguity? How could these factors affect roadway design, traffic regulation enforcement and driver training?

Health promotion research would be helpful if it related the driver's awareness of the blind-time hazard (eyes off the road), recognition of time extension (excessive lost time in distracted concentration) and understanding the degraded perception (from rapid shifting of attention). The objective would be to determine how the driver could be properly informed or adequately educated as to the meaning of specific facts and the need for social conformity while on public roadways. The basic objective of health promotion would be to determine the most-effective, economical and long-lasting techniques for changing driver attitudes and behavior related to safe driving and crash injury reduction. ■

Adapted from an article published in The Journal of the Royal Society for the Promotion of Health, *March 2001: 23-28.*

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