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ACCIDENTS, SAFETY, AND HUMAN ERROR

Bogenstätter, Yvonne; Tschan, Franziska; Semmer, Norbert K.; Spychiger, Martin; Breuer, Marc; Marsch, Stephan. *How Accurate Is Information Transmitted to Medical Professionals Joining a Medical Emergency? : a Simulator Study. S. 115-125(11).*

Objective: This study used a high-fidelity simulation to examine factors influencing the accuracy of 201 pieces of information transmitted to nurses and physicians joining a medical emergency situation. **Background:** Inaccurate or incomplete information transmission has been identified as a major problem in medicine. However, only a few studies have assessed possible causes of transmission errors. **Method:** Each of 20 groups was composed of two or three nurses (first responders), one resident joining the group later, and one senior doctor joining last. Groups treated a patient suffering a cardiac arrest. **Results:** Multilevel binomial analyses showed that 18% of the information given to newcomers was inaccurate. Quantitative information requiring repeated updating was particularly error prone. Information generated earlier (i.e., older information) was more likely to be transmitted inaccurately. Explicitly encoding information to be transmitted after the physicians arrived at the scene enhanced accuracy, supporting transfer-appropriate processing theory. **Conclusion:** Information transmitted to nurses and physicians who join an ongoing emergency is only partly reliable. Therefore, medical professionals should not take accuracy for granted and should be aware of the nature of transmission errors. **Application:** Medical professionals should be trained in adequate encoding of information and in standardized communication procedures with regard to error-prone information. In addition, technical devices should be implemented that reduce reliance on memory regarding information with error-prone characteristics.

- **Keywords:** INFORMATION TRANSFER; GROUP COMPOSITION; MEDICAL EMERGENCY DRIVEN GROUPS; HUMAN FACTORS IN MEDICINE; HIGH FIDELITY SIMULATION; INFORMATION TRANSMISSION ERRORS; CARDIAC ARREST; UPDATING QUANTITATIVE INFORMATION; TRANSFER-APPROPRIATE PROCESSING THEORY; INFORMATION ENCODING; STANDARDIZED COMMUNICATION PROCEDURES; ERROR-PRONE MEDICAL INFORMATION; MEDICAL TEAMS

ATTENTIONAL PROCESSES

Hameed, Shameem; Ferris, Thomas; Jayaraman, Swapnaa; Sarter, Nadine. *Using Informative Peripheral Visual and Tactile Cues to Support Task and Interruption Management*. S. 126-135(10).

Objective: This study examined the effectiveness of using informative peripheral visual and tactile cues to support task switching and interruption management. **Background:** Effective support for the allocation of limited attentional resources is needed for operators who must cope with numerous competing task demands and frequent interruptions in data-rich, event-driven domains. One prerequisite for meeting this need is to provide information that allows them to make informed decisions about, and before, (re)orienting their attentional focus. **Method:** Thirty participants performed a continuous visual task. Occasionally, they were presented with a peripheral visual or tactile cue that indicated the need to attend to a separate visual task. The location, frequency, and duration parameters of these cues represented the domain, importance, and expected completion time, respectively, of the interrupting task. **Results:** The findings show that the informative cues were detected and interpreted reliably. Information about the importance (rather than duration) of the task was used by participants to decide whether to switch attention to the interruption, indicating adherence to experimenter instructions. Erroneous task-switching behavior (nonadherence to experimenter instructions) was mostly caused by misinterpretation of cues. **Conclusion:** The effectiveness of informative peripheral visual and tactile cues for supporting interruption management was validated in this study. However, the specific implementation of these cues requires further work and needs to be tailored to specific domain requirements. **Application:** The findings from this research can inform the design of more effective notification systems for a variety of complex event-driven domains, such as aviation, medicine, or process control.

- **Keywords:** INTERRUPTION MANAGEMENT; TASK SWITCHING; INFORMATIVE CUES; COGNITIVE PROCESSES; MULTIMODAL INTERFACES

Český abstrakt: Podporu pro přidělení omezených zdrojů pozornosti potřebují operátoři, kteří musí zvládat mnoho požadavků a časté přerušování v doménách bohatých na údaje a řízených událostmi. Bylo zjištěno, že informativní podněty byly stanoveny a interpretovány spolehlivě. Byla oceněna efektivnost podnětů, jejich specifická implementace však vyžaduje přizpůsobení specifickým požadavkům.

- podněty vizuální - podněty - úkoly pracovní - operátoři - informace

Jahn, Georg; Krems, Josef F.; Gelau, Christhard. *Skill Acquisition While Operating In-Vehicle Information Systems : interface Design Determines the Level of Safety-Relevant Distractions*. S. 136-151(16).

Objective: This study tested whether the ease of learning to use human-machine interfaces of in-vehicle information systems (IVIS) can be assessed at standstill. **Background:** Assessing the attentional demand of IVIS should include an evaluation of ease of learning, because the use of IVIS at low skill levels may create safety-relevant distractions. **Method:** Skill acquisition in operating IVIS was quantified by fitting the power law of practice to training data sets collected in a driving study and at standstill. Participants practiced manual destination entry with two route guidance systems differing in cognitive demand. In Experiment 1, a sample of middle-aged participants was trained while steering routes of varying driving demands. In Experiment 2, another sample of middle-aged participants was trained at standstill. **Results:** In Experiment 1, display glance times were less affected by driving demands than by total task times and decreased at slightly higher speed-up rates (0.02 higher on average) than task times collected at standstill in Experiment 2. The system interface that minimized cognitive demand was operated more quickly and was easier to learn. Its system delays increased static task times, which still predicted 58% of variance in display glance times compared

with even 76% for the second system. **Conclusion:** The ease of learning to use an IVIS interface and the decrease in attentional demand with training can be assessed at standstill. **Application:** Fitting the power law of practice to static task times yields parameters that predict display glance times while driving, which makes it possible to compare interfaces with regard to ease of learning.

- **Keywords:** DRIVER DISTRACTION; TIME-SHARING VISUAL ATTENTION; COGNITIVE ERGONOMICS; IN-VEHICLE INFORMATION SYSTEMS; SKILL ACQUISITION; DUAL-TASK PERFORMANCE; DRIVER BEHAVIOR; SURFACE TRANSPORTATION SYSTEMS; INTERFACE EVALUATION; USABILITY; MENTAL WORKLOAD; ATTENTIONAL PROCESSES; SKILL DEVELOPMENT; HIGHWAY SAFETY; HUMAN-MACHINE INTERFACES; POWER LAW OF PRACTICE; POWER LAW OF LEARNING; TRAINING; MANUAL DESTINATION ENTRY; ROUTE GUIDANCE SYSTEMS; GLANCE DURATION; ATTENTIONAL DEMAND; EASE OF LEARNING; GAZE BEHAVIOR; TRANSFER; TEXT ENTRY; HUMAN COMPUTER INTERACTION; HUMAN MACHINE INTERFACE; VISUAL DEMAND; TRANSPORTATION; ADVANCED TRAVELER INFORMATION SYSTEMS; INTERFACE DESIGN; CONTROLS

Český abstrakt: Studie zkoumala, zda snadnost naučit se používat rozhraní člověk - stroj informačních systémů ve voze (IVIS) může být stanovena ve stavu klidu. Bylo zjištěno, že snadnost naučit se užívat interface IVIS a snížení pozornostních požadavků s výcvikem v tomto stavu stanovena být může. Lze takto umožnit srovnání rozhraní podle snadnosti naučení.

- rozhraní - systém člověk - stroj - automobily - pozornost

BIOMECHANICS, ANTHROPOMETRY, WORK PHYSIOLOGY

Grieshaber, D. Christian; Armstrong, Thomas J.; Chaffin, Don B.; Keyserling, W. Monroe; Ashton-Miller, James. *The Effects of Insertion Method and Force on Hand Clearance Envelopes for Rubber Hose Insertion Tasks. S. 152-163(12).*

Objective: The aim of this study was to determine how hand space for manual insertion of flexible hoses is affected by insertion method and force. **Background:** Adequate space is needed during assembly tasks in which workers join parts together with their hands. Hose installations are an example of such a task. Hand clearance envelopes for insertion tasks that involve cylindrical objects, such as a hose, are currently unavailable in the literature. **Methods:** Participants inserted a flexible 25-mm rubber hose onto a stationary flange using simulated methods similar to those observed in field studies of automotive assembly tasks. Markers placed on the back of the hand and wrists were used to measure postures during the insertion task. **Results:** Hand clearance envelopes for high-force insertions were significantly larger across methods by an average of 15% for both male ($p < .05$) and female ($p < .01$) participants. Rocking insertions resulted in the largest hand clearance envelopes compared with other insertion methods. Rocking and twisting the hose resulted in mean increases in the cross-sectional area of the hand clearance envelopes of 35% and 24%, respectively, compared with the straight push. Differences were significant ($p < .05$) for male and female participants for both bead height conditions. **Conclusion:** Both required insertion force and method affect hand clearance envelopes during simulated insertions. **Application:** These methods can be used by engineers to determine if there is adequate clearance for the hand to grip selected objects.

- **Keywords:** [PHYSICAL WORK](#); [LOADING](#); [BIOMECHANICS](#); [ANTHROPOMETRY](#); [WORK PHYSIOLOGY](#); [INDIVIDUAL DIFFERENCES](#); [HAND CLEARANCE ENVELOPES](#); [RUBBER HOSE INSTALLATION](#); [INSERTION TASKS](#); [INSERTION METHOD](#); [INSERTION FORCE](#); [ASSEMBLY TASKS](#); [HAND GRIP](#)

COGNITIVE PROCESSES

Neal, Andrew; Kwantes, Peter J. *An Evidence Accumulation Model for Conflict Detection Performance in a Simulated Air Traffic Control Task*. S. 164-180(17).

Objective: The aim of this article is to develop a formal model of conflict detection performance. **Background:** Our model assumes that participants iteratively sample evidence regarding the state of the world and accumulate it over time. A decision is made when the evidence reaches a threshold that changes over time in response to the increasing urgency of the task. **Method:** Two experiments were conducted to examine the effects of conflict geometry and timing on response proportions and response time. **Results:** The model is able to predict the observed pattern of response times, including a nonmonotonic relationship between distance at point of closest approach and response time, as well as effects of angle of approach and relative velocity. **Conclusion:** The results demonstrate that evidence accumulation models provide a good account of performance on a conflict detection task. **Application:** Evidence accumulation models are a form of dynamic signal detection theory, allowing for the analysis of response times as well as response proportions, and can be used for simulating human performance on dynamic decision tasks.

- **Keywords:** [SIGNAL DETECTION \(PERCEPTION\)](#); [REACTION TIME](#); [AIR TRAFFIC CONTROL](#); [CONFLICT DETECTION](#); [RANDOM WALK](#); [RELATIVE JUDGMENT](#); [DECISION THEORY](#); [PSYCHOPHYSICAL MEASUREMENT](#); [MATHEMATICAL MODELING](#)

Smith-Jentsch, Kimberly A.; Kraiger, Kurt; Cannon-Bowers, Janis A.; Salas, Eduardo. *Do Familiar Teammates Request and Accept More Backup? : transactive Memory in Air Traffic Control*. S. 181-192(12).

Objective: The present study investigated factors that explain when and why different groups of teammates are more likely to request and accept backup from one another when needed in an environment characterized by extreme time pressure and severe consequences of error: commercial air traffic control (ATC). **Background:** Transactive memory theory states that teammates develop consensus regarding the distribution of their relative expertise as well as confidence in that expertise over time and that this facilitates coordination processes. The present study investigated whether this theory could help to explain between-team differences in requesting and accepting backup when needed. **Method:** The present study used cross-sectional data collected from 51 commercial ATC teams. Hypotheses were tested using multiple regression analysis. **Results:** Teammates with greater experience working together requested and accepted backup from one another more than those with lesser experience working together. Teammate knowledge consensus and perceived team efficacy appear to have mediated this relationship. **Conclusion:** Transactive memory theory extends to high-stress environments in which members' expertise is highly overlapping. Teammates' shared mental models about one another increase the likelihood that they will request and accept backup. **Application:** Teammate familiarity should be considered when choosing among potential replacement team members. Training strategies that accelerate the development of teammate knowledge consensus and team efficacy are warranted.

- **Keywords:** [TEAMMATE FAMILIARITY](#); [SHARED MENTAL MODELS](#); [BACKUP](#); [TRANSACTIVE MEMORY](#); [TEAM EFFICACY](#); [COMMERCIAL AIR TRAFFIC CONTROL](#); [INTACT TEAMS](#); [HIGH STRESS ENVIRONMENT](#); [TEAM COMPOSITION](#); [TEAM MEMBERSHIP STABILITY](#)

CONSUMER PRODUCTS, TOOLS

Kolich, Mike. *Repeatability, Reproducibility, and Validity of a New Method for Characterizing Lumbar Support in Automotive Seating*. S. 193-207(15).

Objective: This article describes a new and more repeatable, reproducible, and valid test method for characterizing lumbar support in automotive seating. **Background:** Lumbar support is important because it affects occupant accommodation and perceptions of seat comfort. Assessing only the lumbar mechanism—particularly in terms of travel—is inadequate because it does not consider the effects of trim and foam. **Method:** The Society of Automotive Engineers' next-generation H-Point machine and associated loading protocol were used as the basis for the new test. **Results:** The method was found to satisfy minimum gage repeatability and reproducibility requirements. Validity was demonstrated through a regression model that revealed 93.9% of the variance in subjective ratings of poor uncomfortable lumbar support can be explained by two objective indicators: (1) lumbar support prominence in the full-off position and (2) effective travel. **Conclusion:** The method can be used to differentiate between seats offering two-way adjustable lumbar support. The best two-way adjustable lumbar seat systems are those that couple little to no lumbar support in the starting or off position (i.e., they are nonintrusive) with a considerable amount of effective or perceptible travel. **Application:** The automotive industry has long needed a way to address the fact that consumers want more lumbar support than their seats currently supply. This contribution offers a method to objectify an important aspect of automotive seating comfort—namely, lumbar support. This should help human factors professionals produce, but not necessarily guarantee, better consumer ratings.

- **Keywords:** GAGE REPEATABILITY AND REPRODUCIBILITY; METHOD FOR CHARACTERIZING LUMBAR SUPPORT; AUTOMOTIVE SEATING COMFORT; SAE'S NEXT-GENERATION H-POINT MACHINE; REGRESSION MODELING; ADJUSTABLE LUMBAR SEAT SYSTEMS

Český abstrakt: Článek popisuje novou metodu pro charakterizaci bederní opory u automobilových sedadel, která uspokojuje minimální požadavky na opakovatelnost a schopnost reprodukce. Platnost metody lze vysvětlit na dvou objektivních indikátorech. Může být použita k diferenciaci mezi sedadly poskytujícími dvoucestnou nastavitelnou oporu. Bederní opora, kterou metoda objektivizuje, je významným aspektem komfortu sedadel.

- sedadla řidičů - komfort - opěrky - řidiči

DISPLAYS AND CONTROLS

Jehoel, Sandra; Sowden, Paul T.; Ungar, Simon; Sterr, Annette. *Tactile Elevation Perception in Blind and Sighted Participants and Its Implications for Tactile Map Creation*. S. 208-223(16).

Objective: Our goal was to determine the optimal elevation of tactile map symbols. **Background:** Tactile perception research predicts that symbol elevation (vertical height) and texture on tactile maps could influence their readability. However, although research has shown that elevation influences *detection* and *discrimination* thresholds for single tactile stimuli and that the physiological response of fingertip receptors varies with texture, little is known about the influence of these parameters on the *identification* of stimuli in the context of multiple symbols as found on tactile maps. **Method:** Sighted and visually impaired participants performed tactile symbol identification tasks. In Experiment 1, we measured the effect of elevation on identification accuracy. In Experiment 2, we measured the effect of elevation and symbol texture on identification speed. **Results:** Symbol elevation influenced both speed and accuracy of identification; thresholds were higher than those found in work on detection and discrimination but lower than on

existing tactile maps. Furthermore, as predicted from existing knowledge of tactile perception, rough features were identified more quickly than smooth ones. Finally, visually impaired participants performed better than sighted ones. **Conclusion:** The symbol elevations necessary for identification (0.040 to 0.080 mm) are considerably lower than would be expected on the basis of existing tactile maps (generally 0.5 mm or higher) and design guidelines (0.4 mm). **Application:** Tactile map production costs could be reduced and map durability increased by reducing symbol elevation. Furthermore, legibility of maps could be improved by using rough features, which are read more easily, and smaller symbols, which reduce crowding of graphics.

- **Keywords:** [SYMBOL ELEVATION](#); [TACTILE MAP](#); [HAPTIC PERCEPTION](#); [VISUAL IMPAIRMENT](#); [HAPTIC AND OTHER DISPLAYS](#); [DISPLAYS AND CONTROLS](#); [HAPTICS AND OTHER SENSES](#); [SENSORY AND PERCEPTUAL PROCESSES](#); [VISION](#)

Kilgore, Ryan M. *Simple Displays of Talker Location Improve Voice Identification Performance in Multitalker, Spatialized Audio Environments*. S. 224-239(16).

Objective: The aim of this study was to assess the voice identification benefits of visual depictions of the relative locations of spatialized talkers in a serial listening task. **Background:** Although spatialized audio is known to improve speech intelligibility and voice identification accuracy within multitalker environments, prior studies have not found any additional benefit for augmenting spatialized audio with visual depictions of relative voice locations. These studies, however, were restricted to small audio environments (four voices), potentially limiting the ability of simple talker location displays to provide additional identification benefit. **Method:** In the first experiment, 18 participants performed a voice identification task for four- and eight-voice environments under three display conditions: (a) nonspatialized voices with an audio-only display, (b) spatialized voices with an audio-only display, and (c) spatialized voices augmented by a visual display of relative talker locations. In the second experiment, 32 participants performed the same voice identification task within a spatialized eight-voice environment but with audio and visual displays of differing angular scale. **Results:** Visually depicting relative talker locations improved voice identification performance in terms of both accuracy and response time, particularly for more populous auditory spaces. Both auditory and visual display scale affected these benefits, with large-angle displays performing the best for both modalities. **Conclusion:** Results indicate that simple visual representations of spatialized audio environments help listeners identify voices and that these representations are more effective when the angular spacing (auditory and visual) between talker locations is increased. **Application:** These results have important implications for the design and implementation of collaborative audio environments for shared, desktop, and portable communication devices.

- **Keywords:** SPATIALIZED AUDIO ENVIRONMENTS; SPATIALIZED VOICES; TALKER LOCATION DISPLAYS; RELATIVE VOICE LOCATIONS; VOICE-IDENTIFICATION TASKS; AUDITORY AND VISUAL DISPLAY SCALE; AUDITORY DISPLAYS; VISUAL DISPLAYS; MULTITALKER ENVIRONMENTS; VOICE-IDENTIFICATION PERFORMANCE; LARGE ANGLE DISPLAYS; SMALL ANGLE DISPLAYS; COLLABORATIVE AUDIO ENVIRONMENTS; DISPLAYS AND CONTROLS; COMMUNICATION SYSTEMS

Český abstrakt: Cílem studie bylo stanovit výhody vizuálního znázornění relativních umístění mluvčích při identifikaci hlasu v prostoru v sériovém odposlouchávacím úkolu. Bylo zjištěno, že vizuální znázornění umístění mluvčího zlepšilo hlasový identifikační výkon jak v přesnosti, tak i v reakční době, zvláště v lidnatějším prostoru. Výsledky jsou efektivnější při zvýšení úhlové vzdálenosti mezi mluvčími.

- displeje - hlas - identifikace - řeč - podněty vizuální

Pavlovic, Nada J.; Keillor, Jocelyn; Hollands, Justin G.; Chignell, Mark H. *Reference Frame Congruency in Search-and-Rescue Tasks*. S. 240-250(11).

Background: Previous studies have demonstrated that spatial auditory cues, when combined with visual displays, can enhance performance and decrease workload. However, this facilitation was achieved only when auditory cues shared a common reference frame (RF) with the visual display. In complex and dynamic environments, such as airborne search and rescue (SAR), it is often difficult to ensure such congruency.

Method: In a simulated SAR operation, participants performed three spatial tasks: target search, target localization, and target recall. The interface consisted of the camera view of the terrain from the aircraft-mounted sensor, a map of the area flown over, a joystick that controlled the sensor, and a mouse. Auditory cues were used to indicate target location. While flying in the scenario, participants searched for targets, identified their locations in one of two coordinate systems, and memorized their location relative to the terrain layout. **Results:** Congruent cues produced the fastest and most accurate performance. Performance advantages were observed even with incongruent cues relative to neutral cues, and egocentric cues were more effective than exocentric cues.

Conclusion: Although the congruent cues are most effective, in cases in which the same cue is used across spatial tasks, egocentric cues are a better choice than exocentric cues.

Application: Egocentric auditory cues should be used in display design for tasks that involve RF transformations, such as SAR, air traffic control, and unmanned aerial vehicle operations.

- **Keywords:** VISUAL DISPLAYS; AUDITION; AUDITORY DISPLAYS; AUDITORY CUES; DISPLAYS AND CONTROLS; SIMULATION AND VIRTUAL REALITY; SENSORY AND PERCEPTUAL PROCESSES; AEROSPACE SYSTEMS; AIRBORNE SEARCH-AND-RESCUE (SAR); COMMON REFERENCE FRAME (RF); REFERENCE FRAME CONGRUENCY; CONGRUENCY EFFECT; TARGET SEARCH; TARGET LOCALIZATION; TARGET RECALL; EGOCENTRIC CUES VS. EXOCENTRIC CUES

Český abstrakt: Cílem práce bylo vyzkoumat, jak shoda mezi zrakovými displeji a sluchovými podněty zasahuje výkon v různých prostorových úkolech. Bylo zjištěno, že shoda v podnětech zajišťuje nejrychlejší a nejpřesnější výkon. Výhody byly pozorovány i s neshodujícími se podněty ve vztahu k neutrálním podnětům a egocentrické podněty jsou efektivnější než exocentrické.

- podněty - podněty akustické - podněty vizuální - záchranáři - záchranářství - displeje - vyhledávání

PSYCHOLOGICAL STATES

Gunzelmann, Glenn; Byrne, Michael D.; Gluck, Kevin A.; Moore, L. Richard. *Using Computational Cognitive Modeling to Predict Dual-Task Performance With Sleep Deprivation*. S. 251-260(10).

Objective: The effects of fatigue on multiple-task performance were explored through computational cognitive modeling. **Background:** Fatigue typically has a negative impact on human performance. Biomathematical models exist that characterize the dynamics of human alertness, but the link between alertness and in situ performance on specific tasks is tenuous. Cognitive architectures offer a principled means of establishing that link.

Method: We implemented mechanisms for fatigue, which produce microlapses in cognitive processing, into an existing model, adaptive control of thought-rational, and validated the performance predictions with Bratzke, Rolke, Ulrich, and Peters' data on fatigue and multiple-task performance. **Results:** The microlapse model replicated the human performance results very well with zero free parameters, although the fit was improved when we allowed two individual differences parameters to vary. **Conclusion:**

Increased frequency of microlapses as a result of fatigue provides a parsimonious explanation for the impact of fatigue on dual-task performance and is consistent with previous research. **Application:** Our results illustrate how using biomathematical models of fatigue in conjunction with a cognitive architecture can result in accurate predictions of the effects of fatigue on dual-task performance. Extending and generalizing this capability has potential utility in any safety-critical domain in which fatigue may affect performance.

- **Keywords:** PSYCHOLOGICAL REFRACTORY PERIOD; COGNITIVE ARCHITECTURE; COGNITIVE SLOWING; COGNITIVE LAPSING; ACT-R VIGILANCE; MONITORING; ATTENTIONAL PROCESSES; REACTION TIME; PSYCHOMOTOR PROCESSES; FATIGUE; PSYCHOLOGICAL STATES; DETECTION; SENSORY AND PERCEPTUAL PROCESSES

Český abstrakt: Byly zkoumány účinky únavy při výkonu složeného úkolu. Model drobných chyb velmi dobře opakoval výsledky lidského výkonu bez volných parametrů, avšak výsledek se zlepšil, bylo-li povoleno obměňovat dva individuální rozdílné parametry. Zvýšená četnost drobných chyb jako výsledek únavy poskytuje šetrné vysvětlení dopadu únavy na výkon při dvojitém úkolu.

- úkoly - úkoly kognitivní - modelování - modely - výkon - deprivace - spánek - únava - chyby lidské

SURFACE TRANSPORTATION SYSTEMS

Cooper, Joel M.; Vladislavljevic, Ivana; Medeiros-Ward, Nathan; Martin, Peter T.; Strayer, David L. *An Investigation of Driver Distraction Near the Tipping Point of Traffic Flow Stability*. S. 261-268(8).

Objective: The purpose of this study was to explore the interrelationship between driver distraction and characteristics of driver behavior associated with reduced highway traffic efficiency. **Background:** Research on the three-phase traffic theory and on behavioral driving suggests that a number of characteristics associated with efficient traffic flow may be affected by driver distraction. Previous studies have been limited, however, by the fact that researchers typically do not allow participants to change lanes, nor do they account for the impact of varying traffic states on driving performance. **Methods:** Participants drove in three simulated environments with differing traffic congestion while both using and not using a cell phone. Instructed only to obey the speed limit, participants were allowed to vary driving behaviors, such as those involving forward following distance, speed, and lane-changing frequency. **Results:** Both driver distraction and traffic congestion were found to significantly affect lane change frequency, mean speed, and the likelihood of remaining behind a slower-moving lead vehicle. **Conclusions:** This research suggests that the behavioral profile of "cell phone drivers," which is often described as compensatory, may have far-reaching and unexpected consequences for traffic efficiency. **Application:** By considering the dynamic interplay between characteristics of traffic flow and driver behavior, this research may inform both public policy regarding in-vehicle cell phone use and future investigations of driving behavior.

- **Keywords:** DRIVER BEHAVIOR; DRIVER DISTRACTION; TRAFFIC CONGESTION; HIGHWAY SAFETY; HIGHWAY AND VEHICLE DESIGN; SURFACE TRANSPORTATION SYSTEMS; SIMULATION AND VIRTUAL REALITY; ACCIDENTS, SAFETY, AND HUMAN ERROR; THREE-PHASE-TRAFFIC THEORY; DRIVING PERFORMANCE; IMPACT OF VARYING TRAFFIC STATES; CELL PHONE DRIVERS; FORWARD FOLLOWING DISTANCE; SPEED; LANE-CHANGING; TRAFFIC EFFICIENCY; TRAFFIC FLOW AND DRIVER BEHAVIOR; IN-VEHICLE CELL PHONE USE

