ATTENTIONAL PROCESSES

Rubén Daniel Ledesma, Silvana Andrea Montes, Fernando Martín Poó, and María Fernanda López-Ramón. **Measuring Individual Differences in Driver Inattention: Further Validation of the Attention-Related Driving Errors Scale.** S. 193-207.

**Objective:** The aim of this research was (a) to study driver inattention as a trait-like variable and (b) to provide new evidence of validity for the Attention-Related Driving Errors Scale (ARDES). **Background:** Driving inattention is approached from an individual differences perspective. We are interested in how drivers vary in their propensity to experience failures of attention and in the methods to measure these differences. **Method:** In a first sample ($n = 301$), we tested, via confirmatory factor analysis, a new theoretical model for the ARDES. In a second sample ($n = 201$), we evaluated the relationship between inattention and internal and external sources of distraction and social desirability bias in ARDES responses. A subsample ($n = 65$) was reevaluated to study temporal stability of the ARDES scores. **Results:** Errors measured by the ARDES can be classified according to the driving task level at which they occur (navigation, maneuvering, or control). Differences in ARDES scores based on collision history were observed. ARDES was related to internal sources of distraction and was independent of the level of exposure to distracting activities. Test-retest showed a high degree of stability in ARDES scores. Low correlations were found with a social desirability measure. **Conclusion:** ARDES appears to measure a personal trait that remains relatively stable over time and is relatively independent of distracting activities. New evidence of validity emerged for this self-report. **Application:** ARDES can be used to measure individual differences in driving inattention and to help tailor preventive interventions for inattentive drivers. It can serve as an instrument of driver self-assessment in educational and training contexts.

- **Keywords:** road safety, driving, driver inattention, measurement, social desirability, temporal stability, personality traits

BIOMECHANICS, ANTHROPOMETRY, WORK PHYSIOLOGY

Tahere Seyed Hoseinpoor, Sedighe Kahrizi, Bahram Mobini, and Mohsen Naji. **A Comparison of Abdominal Muscle Thickness Changes After a**

**Objective:** Using ultrasound imaging, the abdominal muscles’ response to the back extensor muscle fatigue was assessed in subjects with chronic low-back pain (CLBP).

**Background:** Lumbar muscle fatigue is a common occurrence among workers. Alteration in motor coordination is one consequence of muscular fatigue. According to previous studies, CLBP subjects use their back and abdominal muscles in different ways, but questions remain about abdominal muscle responses to back muscle fatigue in CLBP patients. **Method:** Thirteen CLBP patients and 15 healthy subjects participated in this study. The thickness of abdominal muscles—including transverse abdominis (TrA), internal oblique abdominis (IO), and external oblique abdominis (EO) muscles—was measured in standing position with and without axial loads before and after a lifting fatigue task. **Results:** The results reveal a significant difference for the main effects of group on percentage of change in TrA thickness ($F = 8.9$, $p = .004$). Percentage of change in thickness of TrA was 10% greater in the CLBP group. Although IO thickness displayed greater percentage of change in the CLBP group, the difference between groups was not significant. **Conclusion:** Abdominal muscle behavior changes with back-muscle fatigue in both healthy and CLBP subjects, but responses were more exaggerated in CLBP patients. **Application:** Ultrasound imaging technique can provide critical information about the effect of fatigue on spinal muscle activation and consequently about the stability of the spine. As a more applicable and easy technique, ergonomists can use ultrasound imaging in musculoskeletal system assessment in worker populations in future studies.

- **Keywords:** ultrasonography, thickness, fatigue, back pain, abdominal muscles


**Objective:** The aim of this study was to examine changes in the body posture parameters defining asymmetry of the trunk and lateral flexion of the spine in children while carrying a backpack weighing 10% of a child’s weight. **Background:** Carrying a backpack may negatively affect the posture of schoolchildren and contribute to spinal pain. **Method:** The study involved 162 primary school students ages 11 to 13 years. The parameters describing body posture were assessed with a backpack carried on the right or left shoulder as well as without a load. To assess the predefined parameters, we used the CQ Elektronik System, employing the photogrammetric method. **Results:** Trunk inclination shifted significantly in the opposite direction to the shoulder the backpack was carried on, and an increase in shoulder asymmetry was also found. We also observed a more pronounced right-side lateral flexion of the spine when the backpack was carried on the right shoulder and an analogous relationship for the left side. **Conclusion:** The results of this study show that carrying a backpack in an asymmetrical manner negatively affects spine, even if the backpack weight constitutes 10% of the child’s weight, which has been previously recommended as a safe load for a child’s shoulders. **Application:** We suggest that the issue of safe backpack weight be reassessed and that students be taught basic ergonomic principles on how to carry loads. Changes to the management pattern of carrying textbooks to and from school also should be considered.

- **Keywords:** rucksack, trunk asymmetry, body posture, children

**Objective:** A multiaxis dynamometer was used to quantify grip force vector angles and longitudinal centers of pressure (COPs) while varying handle size and effort used.

**Background:** Authors of many studies have examined maximum grip strength using scalar instruments; a few have measured two-axis forces limited to one or more finger contact. This novel dynamometer uses two instrumented beams that are grasped by the distal fingers and proximal palm to compute two orthogonal components of force and the longitudinal COP through which the force acts. **Method:** Sixteen healthy, right-handed participants grasped the multiaxis dynamometer with plastic handles ranging in diameter from 3.81 to 7.62 cm. They were required to scale their effort to 25%, 50%, 75%, and 100% of maximum. **Results:** Grip force vector angles were affected by both handle diameter and effort level, with angles increasing an average of 8.1° from the least to greatest effort. Longitudinal COP, averaged among the two beams, shifted 1.75 cm radially as handle diameter increased from 3.81 cm to 7.62 cm. Average COP along the beam in contact with the distal finger segments shifted 0.75 cm ulnarily as effort level increased from 25% to 100% of maximum. **Conclusion:** Grip force characteristics changed with handle diameter and effort level. Overall grip force magnitude comprised both force components measured. **Application:** Understanding grip characteristics should be important for handle and grip design and for evaluating hand function.

- **Keywords:** biomechanics, ergonomic design, occupational safety and health, hand dynamometer, grip strength

**HEALTH CARE/HEALTH SYSTEMS**


**Objective:** The aim of this study was to evaluate the prevalence of upper-body-quadrant pain among ultrasonographers and to evaluate the association between individual ergonomics, musculoskeletal disorders, and occurrence of neck pain. **Method:** A hundred and ten (N = 110) Belgian and Dutch male and female hospital ultrasonographers were consecutively enrolled in the study. Data on work-related ergonomic and musculoskeletal disorders were collected with an electronic inquiry, including questions regarding ergonomics (position of the screen, high-low table, and ergonomic chair), symptoms (neck pain, upper-limb pain), and work-related factors (consecutive working hours a day, average working hours a week). **Results:** Subjects with the screen on their left had significantly more neck pain (odds ratio [OR] = 3.6, p = .0286). Depending on the workspace, high-low tables increased the chance of developing neck pain (OR = 12.9, p = .0246). A screen at eye level caused less neck pain (OR = .22, p = .0610). Employees with a fixed working space were less susceptible to arm pain (OR = 0.13, p = .0058). The prevalence of arm pain was significantly higher for the vascular department compared to radiology, urology, and gynecology departments (OR = 9.2, p = .0278). **Conclusions:** Regarding prevention of upper-limb pain in ultrasonography, more attention should be paid to the work environment and more specialty to the ultrasound workstation layout. Primary ergonomic prevention could provide a painless work situation for the ultrasonographer. **Application:** Further research on the ergonomic conditions of ultrasonography is necessary to develop ergonomic solutions in the work environment that will help to alleviate neck and arm pain.

- **Keywords:** ergonomics, musculoskeletal disorders, neck pain


**Objective:** The aim of this study was to determine the impact of sideways visuomotor rotations between 0° and 180° on novice performance in a laparoscopic simulator.
Background: The laparoscopic surgical environment often involves visuomotor rotations because the laparoscope may be placed to the surgeon's side. Basic research by Cunningham indicated that visuomotor rotations between 90° and 135° result in peak performance decrements. Research by Ames and colleagues failed to replicate Cunningham's results in the laparoscopic environment, possibly due to (a) confounds from carryover effects or (b) use of an alternative laparoscopic training task rather than the straight-line pointing task used by Cunningham. Two experiments were conducted to determine if Cunningham's results generalize to the laparoscopic environment when controlling for carryover effects for a three-dimensional “straight-line” pointing task (Experiment 1) and a laparoscopic training task (Experiment 2). Method: In Experiments 1 and 2, participants were assigned to one of five visuomotor rotations: 0°, 45°, 90°, 135°, or 180°. Utilizing a laparoscopic simulator, participants performed either a three-dimensional pointing task (Experiment 1) or a peg transfer task (Experiment 2). Results: In both experiments, visuomotor rotations of 90° or 135° resulted in the poorest performance. Conclusion: When controlling for carryover effects, Cunningham’s results generalize to novices’ performance of a pointing and a peg transfer task in the laparoscopic environment. Applications: The results indicate that 90° and 135° sideways laparoscope placements may result in worse performance for novices in the laparoscopic environment, indicating potentially longer learning curves for these conditions in the laparoscopic as well as other teleoperation environments.

Keywords: perceptual-motor adaptation, laparoscopy, laparoscopic training, minimally invasive surgery, visuomotor rotations

MACROERGONOMICS AND THE ENVIRONMENT


Objective: In this study, we sought to explain the rapid musculoskeletal symptomatology increase in correction officers (COs). Background: COs are exposed to levels of biomechanical and psychosocial stressors that have strong associations with musculoskeletal disorders (MSDs) in other occupations, possibly contributing to their rapid health deterioration. Method: Baseline survey data from a longitudinal study of COs and manufacturing line workers were used to model musculoskeletal symptom prevalence and intensity in the upper (UE) and lower (LE) extremity. Outcomes were regressed on demographics and biomechanical and psychosocial exposures. Results: COs reported significantly higher prevalence and intensity of LE symptoms compared to the industrial workers. In regression models, job tenure was a primary driver of CO musculoskeletal outcomes. In CO models, a single biomechanical exposure, head and arms in awkward positions, explained variance in both UE and LE prevalence (β of 0.338 and 0.357, respectively), and low decision latitude was associated with increased LE prevalence and intensity (β of 0.229 and 0.233, respectively). Manufacturing models were less explanatory. Examining demographic associations with exposure intensity, we found none to be significant in manufacturing, but in CO models, important psychosocial exposure levels increased with job tenure. Conclusion: Symptom prevalence and intensity increased more rapidly with job tenure in corrections, compared to manufacturing, and were related to both biomechanical and psychosocial exposures. Tenure-related increases in psychosocial exposure levels may help explain the CO symptom increase. Application: Although exposure assessment improvements are proposed, findings suggest focusing on improving the psychosocial work environment to reduce MSD prevalence and intensity in corrections.

Keywords: stress, psychosocial exposure, biomechanical exposure, work organization, aging
SENSORY AND PERCEPTUAL PROCESSES


Objective: In this study, we examined how effectively people can monitor new stimuli on a peripheral display while carrying out judgments on an adjacent central display. Background: Improved situation awareness is critical for improved operator performance in aviation and many other domains. Given the limited extent of foveal processing, acquiring additional information from peripheral vision offers high potential gains. Method: Participants carried out a sequence of central perceptual judgments while simultaneously monitoring the periphery for new stimuli. Peripheral detection was measured as a function of central-judgment difficulty, the relative timing of the two tasks, and peripheral event rate. Results: Participants accurately detected and located peripheral targets, even at the highest eccentricity explored here (~30°). Peripheral detection was not reduced by increased central-task difficulty but was reduced when peripheral targets arrived later in the processing of central stimuli and when peripheral events were relatively rare. Conclusion: Under favorable conditions—high-contrast stimuli and high event rate—people can successfully monitor peripheral displays for new events while carrying out an unrelated continuous task on an adjacent display. Application: In many fields, such as aviation, existing displays were designed with low-contrast stimuli that provide little opportunity for peripheral vision. With appropriate redesign, operators might successfully monitor multiple displays over a large visual field. Designers need to be aware of nonvisual factors, such as low event rate and relative event timing, that can lead to failures to detect peripheral stimuli.

• Keywords: peripheral detection, aviation, attention, dual task, situation awareness, monitoring, vigilance

SITUATION AWARENESS


Objective: The aim of this study was to examine whether the Situation Present Assessment Method (SPAM) and the Situation Awareness Global Assessment Technique (SAGAT) predict incremental variance in performance on a simulated submarine track management task and to measure the potential disruptive effect of these situation awareness (SA) measures. Background: Submarine track managers use various displays to localize and track contacts detected by own-ship sensors. The measurement of SA is crucial for designing effective submarine display interfaces and training programs. Method: Participants monitored a tactical display and sonar bearing-history display to track the cumulative behaviors of contacts in relationship to own-ship position and landmarks. SPAM (or SAGAT) and the Air Traffic Workload Input Technique (ATWIT) were administered during each scenario, and the NASA Task Load Index (NASA-TLX) and Situation Awareness Rating Technique were administered postscenario. Results: SPAM and SAGAT predicted variance in performance after controlling for subjective measures of SA and workload, and SA for past information was a stronger predictor than SA for current/future information. The NASA-TLX predicted performance on some tasks. Only SAGAT predicted variance in performance on all three tasks but marginally increased subjective workload. Conclusion: SPAM, SAGAT, and the NASA-TLX can predict unique variance in submarine track management performance. SAGAT marginally increased subjective workload, but this increase did not lead to any performance decrement. Application: Defense researchers have identified SPAM as an alternative to SAGAT because it would not require field exercises involving submarines to be paused. SPAM
was not disruptive, but it is potentially problematic that SPAM did not predict variance in all three performance tasks.

- **Keywords:** situation awareness, Situation Awareness Present Method (SPAM), Situation Awareness Global Assessment Technique (SAGAT), submarine track management

**SURFACE TRANSPORTATION**


**Objective:** In this study, we aimed to demonstrate analysis methods that are sensitive to speed-related differences between experienced and young novice drivers. These differences may be linked to determining which group is better at anticipating hazards.

**Background:** Awareness of hazardous situations, especially potential ones, is a major discriminator between experienced and young novice drivers who tend to misidentify potential hazards in the traffic environment. **Method:** Experienced and young novice drivers were asked to drive a sequence of 14 scenarios in a driving simulator. Scenarios were created in two city areas, residential and business district, and included various types of hazards. Group homogeneity of speed for each group of drivers was computed for each scenario, and two business district scenarios were subjected to piecewise linear regression analysis. **Results:** Group homogeneity analysis showed consistent and significant experience-based differences across all scenarios, revealing that the experienced drivers as a group were more homogenous in choosing their driving speed. Differences between groups were larger in the business district where speed was less restricted. Piecewise linear regression analysis revealed that experienced drivers approached uncontrolled intersections by slowing down and responded earlier to materialized events. **Conclusion:** Young novice drivers were more likely than experienced drivers to choose diverse values of speed at any given road section, presumably due to their poor awareness of potential and hidden hazards. Unlike other analysis methods, it is argued that group homogeneity of speed is a more sensitive measurement to reveal these gaps. **Application:** Speed management could be the basis of future hazard anticipation simulator assessments.

- **Keywords:** hazard anticipation, driving simulator, young novice drivers, experienced drivers, speed management


**Objective:** Four experiments were conducted in order to assess the effectiveness of dynamic vibrotactile collision-warning signals in potentially enhancing safe driving.

**Background:** Auditory neuroscience research has demonstrated that auditory signals that move toward a person are more salient than those that move away. If this looming effect were found to extend to the tactile modality, then it could be utilized in the context of in-car warning signal design. **Method:** The effectiveness of various vibrotactile warning signals was assessed using a simulated car-following task. The vibrotactile warning signals consisted of dynamic toward-/away-from-torso cues (Experiment 1), dynamic versus static vibrotactile cues (Experiment 2), looming-intensity- and constant-intensity-toward-torso cues (Experiment 3), and static cues presented on the hands or on the waist, having either a low or high vibration intensity (Experiment 4). **Results:** Braking reaction times (BRTs) were significantly faster for toward-torso as compared to away-from-torso cues (Experiments 1 and 2) and static cues (Experiment 2). This difference could not have been attributed to differential responses to signals
delivered to different body parts (i.e., the waist vs. hands; Experiment 4). Embedding a looming-intensity signal into the toward-torso signal did not result in any additional BRT benefits (Experiment 3). Conclusion: Dynamic vibrotactile cues that feel as though they are approaching the torso can be used to communicate information concerning external events, resulting in a significantly faster reaction time to potential collisions. Application: Dynamic vibrotactile warning signals that move toward the body offer great potential for the design of future in-car collision-warning system.

- **Keywords:** driving, haptic, interface design, front-to-rear-end collision, car following break, reaction time


**Objective** In this study, we investigated how drivers adapt secondary-task initiation and time-sharing behavior when faced with fluctuating driving demands. **Background** Reading text while driving is particularly detrimental; however, in real-world driving, drivers actively decide when to perform the task. **Method** In a test track experiment, participants were free to decide when to read messages while driving along a straight road consisting of an area with increased driving demands (demand zone) followed by an area with low demands. A message was made available shortly before the vehicle entered the demand zone. We manipulated the type of driving demands (baseline, narrow lane, pace clock, combined), message format (no message, paragraph, parsed), and the distance from the demand zone when the message was available (near, far). **Results** In all conditions, drivers started reading messages (drivers’ first glance to the display) before entering or before leaving the demand zone but tended to wait longer when faced with increased driving demands. While reading messages, drivers looked more or less off road, depending on types of driving demands. **Conclusions** For task initiation, drivers avoid transitions from low to high demands; however, they are not discouraged when driving demands are already elevated. Drivers adjust time-sharing behavior according to driving demands while performing secondary tasks. Nonetheless, such adjustment may be less effective when total demands are high. **Application** This study helps us to understand a driver’s role as an active controller in the context of distracted driving and provides insights for developing distraction interventions.

- **Keywords:** time-sharing behavior, secondary-task initiation, eye-glance patterns, ocular measures, off-road glance, fluctuating driving demands