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AGING

Guanhua Hou, Ying Hu. Designing *Combinations of Pictogram and Text Size for Icons: Effects of Text Size, Pictogram Size, and Familiarity on Older Adults' Visual Search Performance*. pp. 1577–1595.

Objective: This study aimed to determine suitable combinations of text and pictogram sizes for older adults and investigated the visual prioritization of pictogram versus text.**Background:** Icons have become an indispensable part of application (app) design. Pictogram size and text size of icons influence the usability of apps, especially by aged users. However, few studies have investigated the influences of different pictogram and text size combinations on readability, legibility, and visual search performance for older adults. **Method:** This study used eye-tracking technology to investigate the effects of different pictogram and text size combinations as well as familiarity on readability, legibility, and visual search performance for older adults. A 3 (pictogram size) × 3 (text size) × 2 (familiarity) repeated-measures experimental design was used. **Results:** The results of this study suggest that pictogram size and text size significantly affect visual search performance and that familiarity moderates the effect of text size on distribution of fixation duration proportion for text and pictograms. **Conclusion:** Large pictogram and text sizes improved the readability and legibility of icons for older adults. Furthermore, the older adults fixated the area of text prior to pictograms when the pictogram size was larger than 72 × 72 px (1.38° × 1.38°) in the visual search task. **Application:** The results of this study suggest using different combinations of pictogram and text sizes for older adults under different scenarios. The findings of this study act as practical support for designers and developers of mobile apps for older adults.

AUTOMATION, EXPERT SYSTEMS

Jack Hutchinson, Luke Strickland, Simon Farrell, Shayne Loft. *The Perception of Automation Reliability and Acceptance of Automated Advice*. pp. 1596–1612.

Objective: Examine (1) the extent to which humans can accurately estimate automation reliability and calibrate to changes in reliability, and how this is impacted by the recent accuracy of automation; and (2) factors that impact the acceptance of automated advice, including true automation reliability, reliability perception, and the difference between an operator's perception of automation reliability and perception of their own reliability. **Background:** Existing evidence suggests humans can adapt to changes in automation reliability but generally underestimate reliability. Cognitive science indicates that humans heavily weight evidence from more recent experiences. **Method:** Participants monitored the behavior of maritime vessels (contacts) in order to classify them, and then received advice from automation regarding classification. Participants were assigned to either an initially high (90%) or low (60%) automation reliability condition. After some time, reliability switched to 75% in both conditions. **Results:** Participants initially underestimated automation reliability. After the change in true reliability, estimates in both conditions moved towards the common true reliability, but did not reach it. There were recency effects, with lower future reliability estimates immediately following incorrect automation advice. With lower initial reliability, automation acceptance rates tracked true reliability more closely than perceived reliability. A positive difference between participant assessments of the reliability of automation and their own reliability predicted greater automation acceptance. **Conclusion:** Humans underestimate the reliability of automation, and we have demonstrated several critical factors that impact the perception of automation reliability and automation use. **Application:** The findings have potential implications for training and adaptive human-automation teaming.

J. B. Manchon, Mercedes Bueno, Jordan Navarro. *Calibration of Trust in Automated Driving: A Matter of Initial Level of Trust and Automated Driving Style?* pp. 1613–1629.

Objective: Automated driving is becoming a reality, and such technology raises new concerns about human–machine interaction on road. This paper aims to investigate factors influencing trust calibration and evolution over time. **Background:** Numerous studies showed trust was a determinant in automation use and misuse, particularly in the automated driving context. **Method:** Sixty-one drivers participated in an experiment aiming to better understand the influence of initial level of trust (Trustful vs. Distrustful) on drivers' behaviors and trust calibration during two sessions of simulated automated driving. The automated driving style was manipulated as positive (smooth) or negative (abrupt) to investigate human–machine early interactions. Trust was assessed over time through questionnaires. Drivers' visual behaviors and take-over performances during an unplanned take-over request were also investigated. **Results:** Results showed an increase of trust over time, for both Trustful and Distrustful drivers regardless the automated driving style. Trust was also found to fluctuate over time depending on the specific events handled by the automated vehicle. Take-over performances were not influenced by the initial level of trust nor automated driving style. **Conclusion:** Trust in automated driving increases rapidly when drivers' experience such a system. Initial level of trust seems to be crucial in further trust calibration and modulate the effect of automation performance. Long-term trust evolutions suggest that experience modify drivers' mental model about automated driving systems. **Application:** In the automated driving context, trust calibration is a decisive question to guide such systems' proper utilization, and road safety.

BIOMECHANICS, ANTHROPOMETRY, WORK PHYSIOLOGY

Sarah Tinitalo, Terry Haines, Kelly-Ann Bowles. Lumbar *Flexion During Driving: Establishing a Methodology for Characterising Real-Time Posture Data Collected by Innovative Technology*. pp. 1630–1640.

Objective: To determine a methodology for the analysis of real-time driving posture data in the low back pain population. **Background:** The strength of the relationship between driving posture and low back pain is yet to be defined due to the lack of studies in the field using validated and repeatable posture measurement tools. Reliable and validated real-time measurement tools are now available, yet reliable methods of analysis of these data are yet to be established. **Method:** Ten occupational drivers completed a typical work shift while wearing an inertial motion sensor system (dorsaVi ViMove). Real-time lumbar flexion data were extracted, with test–retest reliability of mean lumbar flexion, peak lumbar flexion, and standard deviation of lumbar flexion analysed at different times across a work shift, and in different sections within a drive. **Results:** Mean lumbar flexion was highly repeatable over numerous drives in one day, with greater test–retest reliability if the first five minutes of driving data were excluded. Peak lumbar flexion had acceptable test-retest reliability over numerous drives in one day, while standard deviation of lumbar flexion was not a repeatable measure. **Conclusion:** Mean lumbar flexion was a reliable outcome for characterising driving posture in drivers with low back pain. Peak lumbar flexion may be used if appropriate to the individual study. Standard deviation of lumbar flexion is not a reliable posture outcome. **Application:** This paper provides a reliable methodology for analysis of real-time driving posture data in occupational drivers with low back pain.

Ilseok Lee, Jiwon Choi, Sang Hyeon Kang, Sangeun Jin. *Alternative to Reduced Stresses on the Upper Extremity in a Standing Workstation*. pp. 1641–1654

Objective: This study evaluated a standing armrest to provide more acceptable ergonomic guidelines that may reduce the cost of standing computer workstations. **Background:** Of the many advantages of standing workstations, there have been no efforts to minimize the biomechanical cost, such as larger wrist extension and greater forearm muscle activity than sitting. **Method:** Sixteen participants were asked to perform a typing task under a combination of the following factors: (1) desk shape (rectangular and concave); (2) desk height (0, +5, -5 cm from 90° elbow flexion); and (3) monitor height (0, −10 cm from the eyes). During the trials, the trunk kinematics, muscle activation levels, and CoP were recorded. **Results:** Both arms were further away from the upper body under the concave and +5 desk height than under the normal condition, but significant decreases in the extensor carpi radialis (8.6%), anterior deltoid (28.8%), and L4 paraspinals (5.5%) were observed. Similarly, the wrist extension angle decreased by 10.5° (42%) under this condition, but the posture required a 2.2° (19%) increase in wrist adduction angle. The CoP irregularity was greater under the concave workstation, indicating more complex motion. **Conclusion:** A higher and concave desk can provide an armrest effect while engaged in a standing workstation by reducing the wrist extension and related muscle activation level, but at the cost of a larger wrist adduction angle. **Application:** Providing a standing armrest (+5 cm height and concave desk) could reduce the stresses on the upper extremities, but a split keyboard should be considered to minimize wrist adduction.

Moritz Weitbrecht, Fabian Holzgreve, Laura Fraeulin, Jasmin Haenel, Werner Betz, Christina Erbe, Christian Maurer-Grubinger, Eileen M. Wanke, Doerthe Brueggmann, Albert Nienhaus, David A. Groneberg, Daniela Ohlendorf. *Ergonomic Risk Assessment of Oral and Maxillofacial Surgeons – RULA Applied to Objective Kinematic Data*. pp. 1655–1673.

Background: The prevalence of musculoskeletal disorders is high in oral and maxillofacial surgeons (OS) due to their static and contorted working positions. Hence, the aim of this study was to conduct posture analyses in this specific group of dental professionals using the Rapid Upper Limb Assessment (RULA). **Methods:** In total, 15 (12 m/3 f) OS participated in this study. An inertial motion capture system (Xsens) was used to collect kinematic data during a simulated workflow. Computer-based routines calculated the RULA score for the extracted joint angles at each defined time point. Then, an analysis of the time-dependent RULA scores by body regions was conducted. Key variables were the relative occurrence of specific RULA scores during the complete workflow, individual subtasks, and for treatment of each of the four different dental quadrants. The subtasks and dental quadrants were compared using the Friedman test. **Results:** The total median RULA score represented a high risk for OS during their work (7), including the temporal component (OS spent 77.54% of their working time with a RULA score of 7). The wrists and hands, elbows, lower arms, and the neck were exposed to postures with the highest risk for musculoskeletal strain. **Discussion:** For OS, both the right and the left assisting hand were heavily strained while working on the first dental quadrant caused the most unfavorable postures for OS.

COGNITION

Wiebke Frank, Kristin Mühl, Agnes Rosner, Martin Baumann. *Advancing Knowledge on Situation Comprehension in Dynamic Traffic Situations by Studying Eye Movements to Empty Spatial Locations*. pp. 1674–1688.

Objective: This study used the looking-at-nothing phenomenon to explore situation awareness (SA) and the effects of working memory (WM) load in driving situations. **Background:** While driving, people develop a mental representation of the environment. Since errors in retrieving information from this representation can have fatal consequences, it is essential for road safety to investigate this process. During retrieval, people tend to fixate spatial positions of visually encoded information, even if it is no longer available at that location. Previous research has shown that this "looking-at-nothing" behavior can be used to trace retrieval processes. **Method:** In a video-based laboratory experiment with 2 (WM) x 3 (SA level) within-subjects design, participants (N = 33) viewed a reduced screen and evaluated auditory statements relating to different SA levels on previously seen dynamic traffic scenarios while eye movements were recorded. **Results:** When retrieving information, subjects more frequently fixated emptied spatial locations associated with the information relevant for the probed SA level. The retrieval of anticipations (SA level 3) in contrast to the other SA level information resulted in more frequent gaze transitions that corresponded to the spatial dynamics of future driving behavior. **Conclusion:** The results support the idea that people build a visual-spatial mental image of a driving situation. Different gaze patterns when retrieving level-specific information indicate divergent retrieval processes. **Application:** Potential applications include developing new methodologies to assess the mental representation and SA of drivers objectively.

Tobias Grundgeiger, Annabell Michalek, Felix Hahn, Thomas Wurmb, Patrick Meybohm, Oliver Happel. *Guiding Attention via a Cognitive Aid During a Simulated In-Hospital Cardiac Arrest Scenario: A Salience Effort Expectancy Value Model Analysis*. pp. 1689–1701.

Objective: To investigate the effect of a cognitive aid on the visual attention distribution of the operator using the Salience Effort Expectancy Value (SEEV) model. **Background:** Cognitive aids aim to support an operator during the execution of a task. The effect of cognitive aids on performance is frequently evaluated but whether a cognitive aid improved, for example, attention distribution has not been considered. **Method:** We built the Expectancy Value (EV) model version which can be considered to indicate optimal attention distribution for a given event. We analyzed the eye tracking data of emergency physicians while using a cognitive aid application versus no application during a simulated in-hospital cardiac arrest scenario. **Results:** The EV model could fit the attention distribution in such a simulated emergency situation. Partially supporting our hypothesis, the cognitive aid application group showed a significantly better EV model fit than the no application group in the first phases of the event, but a worse fit in the last phase. **Conclusion:** We demonstrated that a cognitive aid affected attention distribution and that the SEEV model provides the means of capturing these effects. We suggest that the aid supported and improved visual attention distribution in the stressful first phases of a cardiopulmonary resuscitation but may have focused attention on objects that are relevant for lower priority goals in the last phase. **Application:** The SEEV model can provide insights into expected and unexpected effects of cognitive aids on visual attention distribution and may help to design better artifacts.

HEALTH CARE/HEALTH SYSTEMS

Ian Robertson, Philip Kortum. *The Usability of Face Coverings Used to Prevent the Spread of COVID-19*. pp. 1702–1717.

Objective: To describe the perceived usability and usability problems associated with face coverings used to prevent the spread of COVID-19. **Background:** Since public health experts have now identified the appropriate use of facemasks as one of the critical elements in an effective COVID mitigation strategy, understanding how people use and care for them has become important. **Method:** Data were collected via a survey that was shared on social media to which 2148 people responded. Participants were asked to identify the category class of the face covering they most often wear, rate its usability, answer demographic information, and questions about their mask use and hygiene, and identify issues they may suffer in relation to face cover use. **Results:** Overall, users appear to perceive their face coverings favorably from a usability and satisfaction standpoint, even though almost two-thirds of users indicated that they experienced discomfort and problems with glasses fogging with the most popular mask types. When considering demographic information, users' political party affiliation appears related to how they perceive the usability of their face covering. **Conclusion:** Designers should work to improve the fit and comfort properties of protective masks; evidence suggests the System Usability Scale may be a useful tool in those efforts. **Application:** Understanding mask design and behavioral issues related to their use can help in the development of masks and will maximize their acceptance and effectiveness in the field.

HUMAN-COMPUTER INTERACTION, COMPUTER SYSTEMS

Shaowei Chu, Huawei Tu. *Understanding the Effects of Tactile Grating Patterns on Perceived Roughness Over Ultrasonic Friction Modulation Surfaces*. pp. 1718–1739.

Objective: Our study aims to investigate the effects of grating patterns of perceived roughness on surfaces with ultrasonic friction modulation, and also to examine user performance of identifying different numbers of grating patterns. **Background:** In designing grating-based tactile textures, the widths of low- and high-friction zones are a crucial factor for generating grating patterns that convey roughness sensation. However, few studies have explored the design space of efficient grating patterns that users can easily distinguish and identify via roughness perception. **Method:** Two experiments were carried out. In the first experiment, we conducted a magnitude estimation of perceived roughness for both low- and high-friction zones, each with widths of 0.13, 0.25, 0.38, 0.5, 1.0, 1.5, 2.0, 3.5, and 5.5 mm. In the second experiment, we required participants to identify 5 pattern groups with 2–6 patterns respectively. **Results:** Perceived roughness fitted a linear trend for low- or high-friction zones with widths of 0.38 mm or lower. Perceived roughness followed an inverted U-shaped curve for low- or high-friction zones with widths greater than 0.5 mm but less than 2.0 mm. The peak points occurred at the widths of 0.38 mm for both low- and high-friction zones. The statistical analysis indicates that both low- and high-friction zones had similar effects on human perception of surface roughness. In addition, participants could memorize and identify up to four tactile patterns with identification accuracy rates higher than 90% and average reaction time less than 2.2 s. **Conclusions:** The relation between perceived roughness and varying widths of grating patterns follows linear or inverted U-shape trends. Participants could efficiently identify 4 or fewer patterns with high accuracy (>90%) and short reaction time (<2.2 s).**Application:** Our findings can contribute to tactile interface design such as tactile alphabets and target-approaching indicators.

Hao Chen, Chao Liu, Szu-Erh Hsu, Ding-Hau Huang, Chia-Yi Liu, Wen-Ko Chiou. *The Effects of Animation on the Guessability of Universal Healthcare Symbols for Middle-Aged and Older Adults*. pp. 1740–1758.

Objective: The purpose of this study was to investigate whether animation can help to improve the comprehension of universal healthcare symbols for middle-aged and older adults.**Background:** The Hablamos Juntos (HJ) healthcare symbol system is a set of widely used universal healthcare symbols that were developed in the United States. Some studies indicated that HJ healthcare symbols are not well-understood by users in non-English-speaking areas. Other studies found that animations can improve users' comprehension of complex symbols. Thus, we wanted to test whether animation could help to improve users' comprehension of HJ symbols. **Methods:** The participants included 40 middle-aged and 40 older adults in Taiwan. We redesigned the 12 HJ symbols into three visual formats—static, basic animation, and detailed animation—and compared them to find which best improved the participants' guessability scores. **Results:** (1) Middle-aged adults' comprehension of static and basic animated symbols was significantly better than that of older adults, but there was no significant difference in the guessability scores between the two age groups in terms of detailed animated symbols; (2) In general, both basic animation and detailed animation significantly improved the guessability score, but the effect with detailed animation was significantly greater than that with basic animation; (3) Older women were more receptive to detailed animation and showed better guessing performance. **Conclusion:** Detailed animation contains more details and provides a more complete explanation of the concept of the static symbols, helping to improve the comprehension of HJ symbols for middle-aged and older adult users. **Application:** Our findings provide a reference for the possibility of new

style symbol design in the digital and aging era, which can be applied to improve symbol comprehension.

Xiaomeng Li, Ronald Schroeter, Andry Rakotonirainy, Jonny Kuo, Michael G. Lenné. *Get Ready for Take-Overs: Using Head-Up Display for Drivers to Engage in Non–Driving-Related Tasks in Automated Vehicles*. pp. 1759–1775.

Objective: The study aims to investigate the potential of using HUD (head-up display) as an approach for drivers to engage in non–driving-related tasks (NDRTs) during automated driving, and examine the impacts on driver state and take-over performance in comparison to the traditional mobile phone. **Background:** Advances in automated vehicle technology have the potential to relieve drivers from driving tasks so that they can engage in NDRTs freely. However, drivers will still need to take-over control under certain circumstances. **Method:** A driving simulation experiment was conducted using an Advanced Driving Simulator and real-world driving videos. Forty-six participants completed three drives in three display conditions, respectively (HUD, mobile phone and baseline without NDRT). The HUD was integrated with the vehicle in displaying NDRTs while the mobile phone was not. Drivers' visual (e.g. gaze, blink) and physiological (e.g. ECG, EDA) data were collected to measure driver state. Two take-over reaction times (hand and foot) were used to measure take-over performance. **Results:** The HUD significantly shortened the take-over reaction times compared to the mobile phone condition. Compared to the baseline condition, drivers in the HUD condition also experienced lower cognitive workload and physiological arousal. Drivers' take-over reaction times were significantly correlated with their visual and electrodermal activities during automated driving prior to the take-over request. **Conclusion:** HUDs can improve driver performance and lower workload when used as an NDRT interface. **Application:** The study sheds light on a promising approach for drivers to engage in NDRTs in future AVs.

Philipp Wintersberger, Clemens Schartmüller, Shadan Sadeghian, Anna-Katharina Frison, Andreas Riener. *Evaluation of Imminent Take-Over Requests With Real Automation on a Test Track*. pp. 1776–1792.

Objective: Investigating take-over, driving, non-driving related task (NDRT) performance, and trust of conditionally automated vehicles (AVs) in critical transitions on a test track. **Background:** Most experimental results addressing driver take-over were obtained in simulators. The presented experiment aimed at validating relevant findings while uncovering potential effects of motion cues and real risk. **Method:** Twenty-two participants responded to four critical transitions on a test track. Non-driving related task modality (reading on a handheld device vs. auditory) and take-over timing (cognitive load) were varied on two levels. We evaluated take-over and NDRT performance as well as gaze behavior. Further, trust and workload were assessed with scales and interviews. **Results:** Reaction times were significantly faster than in simulator studies. Further, reaction times were only barely affected by varying visual, physical, or cognitive load. Post-take-over control was significantly degraded with the handheld device. Experiencing the system reduced participants' distrust, and distrusting participants monitored the system longer and more frequently. NDRTs on a handheld device resulted in more safety-critical situations. **Conclusion:** The results confirm that take-over performance is mainly influenced by visual-cognitive load, while physical load did not significantly affect responses. Future take-over request (TOR) studies may investigate situation awareness and post-take-over control rather than reaction times only. Trust and distrust can be considered as different dimensions in AV research. **Application:** Conditionally AVs should offer dedicated interfaces for NDRTs to provide an alternative to using nomadic devices. These interfaces should be designed in a way to maintain drivers' situation awareness. **Précis:** This paper presents a test track experiment addressing conditionally automated

driving systems. Twenty-two participants responded to critical TORs, where we varied NDRT modality and take-over timing. In addition, we assessed trust and workload with standardized scales and interviews.

MOTOR BEHAVIOR

Jasmine A. Dang, Tyler H. Shaw, Patrick E. McKnight, William S. Helton. *A Closer Look at Warning Cues on the Sustained Attention to Response Task Performance*. pp. 1793–1803.

Objectives: We investigated the effects of auditory cues of varying reliability levels on response inhibition performance using a target detection task to determine if external cues offer performance benefits. Further, we examined how the slope of the speed accuracy trade-off changes as a function of auditory cue reliability and used the trade-off to understand where any performance gains may be realized. **Background:** Researchers have proposed that the sustained attention to response task (SART) can be used to study the mechanisms causing failures of response inhibition. External cues may mitigate the results of motor inhibition failure. The extent to which external cues can effectively aid performance depends on the level of cue reliability. **Method:** Ninety-one participants performed three SARTs with auditory cue assistance at three different levels of reliability (i.e. 0%, 60% and 100% reliable at cueing imminent No-Go stimuli). **Results:** We observed fewer errors of commission and faster reaction time in conditions with higher cue reliability. The slope of speed-accuracy trade-off relationship was impacted by cue reliability and was not a simple linear function. **Conclusion:** Reliable auditory cues aid performance by reducing reaction time and errors of commission. Auditory cues also impact the relationship between speed and accuracy trade-off. **Application:** Insights of cue effectiveness at different reliability levels help people make informed decisions in developing automation interfaces or sensors based on expected performance. Reliable cues mitigate the risk of impulsive errors; however, the reliability has to be high to have a noticeable impact on the speed-accuracy trade-off.

NEUROERGONOMICS

Oshin Tyagi, Sarah Hopko, John Kang, Yangming Shi, Jing Du, Ranjana K. Mehta. *Modeling Brain Dynamics During Virtual Reality-Based Emergency Response Learning Under Stress*. pp. 1804–1820.

Background: Stress affects learning during training, and virtual reality (VR) based training systems that manipulate stress can improve retention and retrieval performance for firefighters. Brain imaging using functional Near Infrared Spectroscopy (fNIRS) can facilitate development of VR-based adaptive training systems that can continuously assess the trainee's states of learning and cognition. **Objective:** The aim of this study was to model the neural dynamics associated with learning and retrieval under stress in a VR-based emergency response training exercise. **Methods:** Forty firefighters underwent an emergency shutdown training in VR and were randomly assigned to either a control or a stress group. The stress group experienced stressors including smoke, fire, and explosions during the familiarization and training phase. Both groups underwent a stress memory retrieval and no-stress memory retrieval condition. Participant's performance scores, fNIRS-based neural activity, and functional connectivity between the prefrontal cortex (PFC) and motor regions were obtained for the training and retrieval phases. **Results:** The performance scores indicate that the rate of learning was slower in the stress group compared to the control group, but both groups performed similarly during

each retrieval condition. Compared to the control group, the stress group exhibited suppressed PFC activation. However, they showed stronger connectivity within the PFC regions during the training and between PFC and motor regions during the retrieval phases. **Discussion:** While stress impaired performance during training, adoption of stress-adaptive neural strategies (i.e., stronger brain connectivity) were associated with comparable performance between the stress and the control groups during the retrieval phase.

PHYSICAL/AMBIENT ENVIRONMENT

Iris C. Levine, Roger E. Montgomery, Alison C. Novak. *Grab Bar Use Influences Fall Hazard During Bathtub Exit*. pp. 1821–1829.

Objective: This study evaluated the hazard (risk of unrecovered balance loss and hazardous fall) and strategies associated with grab bar use, compared to no grab bar use, during unexpected balance loss initiated whilst exiting a bathtub. **Background:** While independent bathing is critical for maintaining self-sufficiency, injurious falls during bathing transfer tasks are common. Grab bars are recommended to support bathing tasks, but no evidence exists regarding fall prevention efficacy. **Method:** Sixty-three adults completed a hazardous bathtub transfer task, experiencing an unpredictable external balance perturbation while stepping from a slippery bathtub to a dry surface. Thirty-two were provided a grab bar, while 31 had no grab bar available. Slips and grab bar use were recorded via four video cameras. Slip occurrence and strategy were identified by two independent video coders. **Results:** Participants who had a grab bar were 75.8% more likely to recover their balance during the task than those who did not have a grab bar. Successful grab bar grasp was associated with balance recovery in all cases. Attempts to stabilize using other environmental elements, or using internal strategies only, were less successful balance recovery strategies. Grab bar presence appeared to cue use of the environment for stability. Proactive grasp and other strategies modified grasping success. **Conclusion:** Grab bars appear to provide effective support for recovery from unexpected balance loss. Grab bar presence may instigate development of fall prevention strategies prior to loss of balance. **Application:** Bathroom designs with grab bars may reduce frequency of fall-related injuries during bathing transfer tasks.

SIMULATION AND VIRTUAL REALITY

L. James Smart, Anthony Drew, Tyler Hadidon, Max Teaford, Eric Bachmann. *Using Nonlinear Kinematic Parameters as a Means of Predicting Motion Sickness in Real-Time in Virtual Environments*. pp. 1830–1840.

Objective: This article presents two studies (one simulation and one pilot) that assess a custom computer algorithm designed to predict motion sickness in real-time. **Background:** Virtual reality has a wide range of applications; however, many users experience visually induced motion sickness. Previous research has demonstrated that changes in kinematic (behavioral) parameters are predictive of motion sickness. However, there has not been research demonstrating that these measures can be utilized in real-time applications. **Method:** Two studies were performed to assess an algorithm designed to predict motion sickness in real-time. Study 1 was a simulation study that used data from Smart et al. (2014). Study 2 employed the algorithm on 28 new participants' motion while exposed to virtual motion. **Results:** Study 1 revealed that the

algorithm was able to classify motion sick participants with 100% accuracy. Study 2 revealed that the algorithm could predict if a participant would become motion sick with 57% accuracy. **Conclusion:** The results of the present study suggest that the motion sickness prediction algorithm can predict if an individual will experience motion sickness but needs further refinement to improve performance. **Application:** The algorithm could be used for a wide array of VR devices to predict likelihood of motion sickness with enough time to intervene.

SURFACE TRANSPORTATION

Annie Rydström, Mattias Söderholm Mullaart, Fjollë Novakazi, Mikael Johansson, Alexander Eriksson. *Drivers' Performance in Non-critical Take-Overs From an Automated Driving System: An On-Road Study*. pp. 1841–1857.

Objective: The objective of this semi-controlled study was to investigate drivers' performance when resuming control from an Automated Driving System (ADS), simulated through the Wizard of Oz method, in real traffic. **Background:** Research on take-overs has primarily focused on urgent scenarios. This article aims to shift the focus to non-critical take-overs from a system operating in congested traffic situations. **Method:** Twenty drivers drove a selected route in rush-hour traffic in the San Francisco Bay Area, CA, USA. During the drive, the ADS became available when predetermined availability conditions were fulfilled. When the system was active, the drivers were free to engage in non-driving related activities. **Results:** The results show that drivers' transition time goes down with exposure, making it reasonable to assume that some experience is required to regain control with comfort and ease. The novel analysis of after-effects of automated driving on manual driving performance implies that the after-effects were close to negligible. Observational data indicate that, with exposure, a majority of the participants started to engage in non-driving related activities to some extent, but it is unclear how the activities influenced the take-over performance. **Conclusion:** The results indicate that drivers need repeated exposure to take-overs to be able to fully resume manual control with ease. **Application:** Take-over signals (e.g., visuals, sounds, and haptics) should be carefully designed to avoid startle effects and the human-machine interface should provide clear guidance on the required take-over actions.