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HUMAN RESPONSE TO VIBRATION

ABSTRACTS

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H. Okiyama, N. Michida, K. Nishikawa and T. Nouzawa 2001 *Society of Automotive Engineers*, *SAE Paper*, 2001-01-03877 *Sp*-1591, *Human Factors in Automotive Design*. Objective evaluation of seated lateral support for cornering. (5 pages, 8 figures, 0 tables, 4 references) (in English).
Authors' Abstract. For an automobile seat, lateral support is considered to be one of the most essential elements for comfort. This report examines lateral support with two selected seats. Driver's movement while cornering was observed by seat pressure distribution (SPD), and muscle activity was simultaneously recorded in electromyogram (EMG). SPD showed larger lateral movement of driver and EMG showed higher muscle activity on a poor lateral support seat than on a good lateral support seat. The higher muscle activity on the poor seat was explained as an effort to compete against the larger lateral movement of the body. Thus, poor lateral support was proved to lead to heavier physical burden.
Topics: Subjective assessment (general); Physiological effects (muscle and nerve); seating (general).

W. J. Pielemeier, J. A. Greenberg, V. Jeyabalan and J. L. van Niekerk 2001 *Society of Automotive Engineers*, *SAE Paper*, 2001-01-0392, *Sp*-1591, *Human Factors in Automotive Design*. The estimation of SEAT values from transmissibility data. (8 pages, 6 figures, 3 tables, 3 references) (in English).
Authors' Abstract. Seat effective amplitude transmissibility (SEAT) values can be obtained from direct measurements at seat track and top or estimated transmissibility data and seat track input. Vertical transmissibility was measured for 16 seats and six subjects on the Ford Vehicle Vibration Simulator, and these 96 functions were used to estimate the seat top response for rough road input. SEAT values were calculated, and good correlation to values computed from direct seat top measurements was obtained (R^2 of 0·86). Averaging transmissibilities and direct seat measurements over the six subjects to obtain correlations for the 16 seats improved R^2 to 0·94, validating this approach.
Topics: Seating (general).

D. D. Harrison, S. O. Harrison, A. C. Croft, D. E. Harrison and S. J. Troyanovich 2000 *Journal of Manipulative and Physiological Therapeutics* **23**, 37–47. Sitting Biomechanics, Part II: optimal car driver's seat and optimal driver's spinal model. (11 pages, 11 figures, 0 tables, 106 references) (in English).
Authors' Abstract. Background—Driving has been associated with signs and symptoms caused by vibrations. Sitting causes the pelvis to rotate backwards and the lumbar lordosis to reduce. Lumbar support and armrests reduce disc pressure and electromyographically recorded values. However, the ideal driver's seat and an optimal seated spinal model have not been described. Objective—To determine an optimal automobile seat and an ideal

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spinal model of a driver. Data Sources—Information was obtained from peer-reviewed scientific journals and texts, automotive engineering reports, and the National Library of Medicine. Conclusions—Driving predisposes vehicle operators to low-back pain and degeneration. The optimal seat would have an adjustable seat back incline of 100° from the horizontal, a changeable depth of seat back to front edge of seat bottom, adjustable height, an adjustable seat bottom incline, firm (dense) in the seat bottom cushion, horizontally and vertically adjustable lumbar support, adjustable bilateral arm rests, adjustable head restraint with lordosis pad, seat shock absorbers to dampen frequencies in the 1–20 Hz range, and linear front–back travel of the seat enabling drivers of all sizes to reach the pedals. The lumbar support should be pulsating in depth to reduce static load. The seat back should be damped to reduce rebounding of the torso in rear-end impacts. The optimal driver's spinal model would be the average Harrison model in a 10° posterior inclining seat back angle.
Topics: Seating (general).

Y. Matsumoto and M. J. Griffin 2002 *The Journal of the Acoustical Society of America* **111**, 1280–1288. Effect of phase on discomfort caused by vertical whole-body vibration and shock-experimental investigation. (9 pages, 6 figures, 6 tables, 19 references) (in English).
Authors' Abstract. An experimental study has investigated the effect of "phase" on the subjective responses of human subjects exposed to vertical whole-body vibration and shock. The stimuli were formed from two frequency components: 3 and 9 Hz for continuous vibrations and 3 and 12 Hz for shocks. The two frequency components, each with 1·0 m/s^2 peak acceleration, were combined to form various waveforms. The effects of the vibration magnitude on the discomfort caused by the input stimuli were also investigated with both the continuous vibration and shocks. Various objective measurements of acceleration and force at the seat surface, the effects of different frequency weightings and second and fourth power evaluations were compared with judgements of the discomfort of the stimuli. It was found that a 6–12% increase in magnitude produced a statistically significant increase in discomfort with both the continuous vibrations and shocks. Judgements of discomfort caused by changes in vibration magnitude were highly correlated with all the objective measurements used in the study. The effects on discomfort of the phase between components in the continuous vibrations were not statistically significant, as predicted using evaluation methods with a power of two. However, small changes in discomfort were correlated with the vibration dose value (VDV) of the W_b frequency-weighted acceleration. The effect of phase between frequency components within the shocks was statistically significant, although no objective measurement method used in the study was correlated with the subjective judgement.
Topics: Subjective assessment; complex vibration (shocks, phase).

R. Cederlund, U. Nordenskiöld and G. Lundborg 2001 *Disability and Rehabilitation* **23**, 570–577. Hand–arm vibration exposure influences performance of daily activities. (8 pages, 2 figures, 4 tables, 48 references) (in English).
Authors' Abstract. Purpose—Although much research has been performed on the effects of vibration on nerves, muscles and vascular structures, little is known of the effects that vibration exposure to handheld tools can give on the ability to perform activities of daily living. The objective of the present study was to analyze the consequences of vibration exposure on performance of daily activities. Method—In a total group of 105 exposed male workers, a standardized self-administered ADL questionnaire, the EDAQ including 102 activity items plus 22 diagnosis-specific activity items, was filled out. Results—Forty-four workers (42%) expressed one or more difficulties in performing daily activities in the total

study group. The data demonstrated that pain and reduced grip force showed a strong correlation with difficulties in performing daily activities. Conclusions—Working in a cold environment, using vibrating machines, handwriting, picking up small objects, opening lids, lifting and carrying were activities perceived as most difficult to accomplish.
Topics: Hand-transmitted vibration; vibration syndrome (dexterity).

T. Nilsson and R. Lundström 2001 *Occupational and Environmental Medicine* **58**, 472–478. Quantitative thermal perception thresholds relative to exposure to vibration. (7 pages, 3 figures, 4 tables, 36 references) (in English).
Author's Abstract. Objectives—To assess the risk of disturbed thermal perception relative to exposure to vibration, to investigate a possible exposure–response relation between thermal perception and sensory symptoms. Methods—The study was based on a cross-section of 123 male workers exposed to vibration and 62 male workers who were not exposed. Thermal perception of cold, warmth, and heat pain was bilaterally determined from the thenar eminence by the method of limits. Perception of cold and warmth was also tested in the second digit. Personal energy equivalent exposure to vibration was measured for all subjects. Vibration was measured in accordance with International Standards Organisation (ISO) 5349 and assessed separately for the left and the right hand. Results—Combining exposure times and intensities gave the left hand a 0·80 exposure to vibration compared with the right. The risk of having contracted reduced thermal perception was increased at all test sites. The risk was higher for the thenar measurements than the finger measurements. A yearly extra contribution of 4000 m h/s^2 in cumulative exposure increases the risk of contracting a wider neutral zone by 18% (95% confidence interval (95% Cl) 1·06–1·32) for the right and 18% (1·05–1·32) for the left side. Subjects with symptoms of nocturnal parathesia had a rate ratio (95% Cl) of 2·80 (1·17 to 6·67) for the right hand and 2·72 (1·12 to 6·63) for the left hand for increased neutral zones at the thenar eminence. Conclusions—The results indicate thermal sensory impairment related to cumulative exposure to vibration. The effect appeared at vibration levels below the current guiding standard. Quantitative sensory testing of thermal perception offers the chance to assess this specific hazard to the peripheral sensorineural system associated with hand intensive work entailing vibration.
Topics: Vibration syndrome; perceptual mechanisms (touch).

K. Tomida, N. Miyai, H. Yamamoto, S. M. Mirbod, T.-K. Wang, S. Sakaguchi, I. Morioka and K. Miyashita 2000 *Journal of Occupational Health* **42**, 292–296. A cohort study on Raynaud's phenomenon in workers exposed to low level hand–arm vibration. (5 pages, 4 figures, 4 tables, 7 references) (in English).
Authors' Abstract. To clarify the incidence of Raynaud's phenomenon among workers exposed to low level hand–arm vibration for a long time, a sample cohort of workers mainly operating a bush cleaner (the vibration level was 2–4 m/s^2 r.m.s.) was followed up for a period of 20 years. The sample cohort consisted of 331 male workers mainly working at maintaining public roads of afforesting and gardening on a farm. The examination was based on questionnaires used in special medical examinations for vibration syndrome from 1977 to 1996. Raynaud's phenomenon was observed in 11 subjects. The accumulative occurrence rate increased linearly in the case of more than 11 operating years. The mean number of operating years at the occurrence of Raynaud's phenomenon was $11{\cdot}7 \pm 7{\cdot}1$ years. The mean total operating time at the occurrence of Raynaud's phenomenon was 3756 h on the geometric average. Stockholm Workshop scale classified one subject as Stage 1 (mild), four subjects Stage 2 (moderate) and six subjects Stage 3 (severe). By the person-year method, the incidence of Raynaud's phenomenon was 4·48 per 1000 person

year. These findings show that the number of operating years for a bush cleaner should be considered to prevent Raynaud's phenomenon, even though the hand–arm vibration level is low.
Topics: Vibration syndrome.

NOTE: Copies of all papers in this section will be found in the Human Response to Vibration Literature Collection at the Institute of Sound and Vibration Research, University of Southampton. The papers may be used by persons visiting the Institute.

*Contributions to the Literature Collection are invited. They should be sent to Professor M. J. Griffin, Human Factors Research Unit, Institute of Sound and Vibration Research, University of Southampton, Southampton, SO*17 1*BJ, England.*