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HUMAN RESPONSE TO VIBRATION ABSTRACTS

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S. Sumitomo, S. Tsujimoto, S. Maeda and Y. Kitamura 1998 *Industrial Health* **36**, 290–296. The influence of the great Hanshin earthquake on human response to environmental vibration due to the Shinkansen. (7 pages, 10 figures, 1 table, 8 references) (in English).
Authors' Abstract. A severe earthquake of magnitude 7·2 hit the west part of Japan on January 17, 1995. A part of the Shinkansen railway, which is one of the most popular high-speed mass transportation systems in Japan, was seriously damaged by the earthquake. About 80 days later, the Shinkansen service was resumed but complaints about vibration due to the passing of Shinkansen increased rapidly among residents near the tracks. This paper reports the results of two investigations that were carried out on both stricken and non-stricken areas to determine the cause of complaint. In the first investigation, the ground vibration propagation induced by passing trains was measured. In the second investigation, questionnaires were distributed to the people living near the Shinkansen tracks. As a result, it was found out that the vibration levels before and after the earthquake were almost the same at most measured points in the stricken area. It was also found that the vibration levels in the stricken area and a non-stricken area were almost the same within 50 m from the Shinkansen tracks. However the results of the questionnaire survey showed that people's nuisance due to the vibration in the stricken area was clearly greater than that in the non-stricken area. This inconsistency was explained using the "category judgement method", which is generally used to determine the relationship between a physical stimulus and psychological reaction. According to the results of this analysis, the vibration level, at which 50% of the inhabitants complained about Shinkansen vibration, was approximately 54 dB in the non-stricken area and 50 dB in the stricken area. This result suggests that the people who experienced the severe earthquake became 4 dB more sensitive to the Shinkansen vibration than the people living in a non-stricken area despite the fact that this investigation was carried out 10 months after the earthquake struck.
Topics: Vibration sense (thresholds); Building vibration.

S. Radovanovic, S. Jaric, S. Milanovic, J. Vukcevic, M. Ljubisavljevic and R. Anastasijevic 1998 *Journal of Electromyography and Kinesiology* **8**, 139–145. The

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effects of prior antagonist muscle vibration on performance of rapid movements. (7 pages, 2 figures, 2 tables, 28 references) (in English).

Authors' Abstract. The effects of prior vibration of the antagonist triceps muscle on the performance of rapid discrete elbow flexion movements were studied in healthy volunteers. The subjects performed 520 movements over five experimental sessions. The application of prior vibration resulted in a shift of the initial position, an undershoot of the final position in untrained subjects, and also in trained subjects if not applied during practice. On the contrary, no undershoot occurred in trained subjects when prior vibration was applied during practice. Improvement in movement performance, as judged by a decrease invariability of the final position, was less successful when vibration was applied during practice. It is supposed that the undershoots were due to prior vibration-induced alterations in proprioceptive messages and a consequent erroneous sense of the arm position. These effects seem to be overcome by practice, but also seem to interfere with learning-based movement improvement.

Topics: Performance effects (proprioception).

W. Qassem, M. Jarrah, and M. Othman 1998 *Journal of Medical Engineering and Technology* **22**, 82–90. Heart response to horizontal impulse. (9 pages, 10 figures, 2 tables, 43 references) (in English).

Authors' Abstract. Lumped body parameters linear and non-linear models have been developed and used for the analysis of the response of the heart in a seated human body due to impulsive horizontal inputs at various body segments. The acceleration transfer magnitude and phase due to impulsive inputs at various body segments are reported. Time histories of the heart acceleration transfer were obtained for both linear and non-linear models. The results indicate that the largest acceleration transfer occurs at 2–3 Hz frequency. Inputs at the upper body segments excite a second peak in the acceleration transfer at 10–12 Hz. The non-linear model shows large attenuation at the high frequency range (larger than 10 Hz) and less attenuation at the 1–5 Hz frequency range.

Topics: Biodynamics; Physiological effects (cardiovascular).

A. S. Aruin, W. R. Forrest and M. L. Latash 1998 *Electroencephalography and Clinical Neurophysiology* **109**, 350–359. Anticipatory postural adjustments in conditions of postural instability. (10 pages, 8 figures, 0 tables, 29 references) (in English).

Authors' Abstract. Objectives: The purpose of this study was to investigate anticipatory adjustments (APAs) in standing subjects who performed a standard motor action triggering a standard postural perturbation (releasing a 2·2 kg load from extended arms) in conditions of different stability requirements. Methods: The degree of stability was varied either by balancing on special boards with long and narrow support beams or by instructions to the subjects. In the first series of experiments 13 subjects stood on the board facing either perpendicular to the beam (instability in a sagittal plane) or along the beam (instability in frontal plane); different widths of the beam were used to vary the degree of instability. During the second series of experiments (6 subjects) inclined and one-

legged postures were used to induce instability in sagittal and frontal planes respectively. EMG activity of rectus abdominis, erector spinae, rectus femoris, biceps femoris, tibialis anterior, and soleus muscles were recorded. Statistic methods included repeated measures analysis of variance (ANOVA) with direction of instability and level of instability being major factors, descriptive statistics, and *post hoc* Student's-*t* tests. Results: The integral measure of changes in the background electromyographic activity of postural muscles during APAs depended on two factors related to the postural task: (1) standing on a platform with a narrow support area led to an attenuation of the APAs; and (2) these effects were stronger when instability was in a sagittal rather than in the frontal plane. The anticipatory component in the displacement of the center of pressure did not show a clear attenuation that would depend on the direction of instability. Conclusions: We suggest a hypothesis that, in conditions of high stability demands, the central nervous system may suppress APAs as a protection against their possible destabilizing effects. These effects are more pronounced when the direction of an expected perturbation is in the plane of instability.
Topics: Postural stability.

J. M. Randall and R. H. Bradshaw 1998 *Animal Science* **66**, 239–245. Vehicle motion and motion sickness in pigs. (7 pages, 1 figure, 3 tables, 18 references) (in English).
Authors' Abstract. Low frequency oscillatory motion (0·05–0·5 Hz) experienced in ships and road vehicles is known to cause motion sickness in humans and some predictive models are available. There have been very few studies of the incidence of motion sickness in pigs and none which has attempted to identify the frequencies of motion transporters which are likely to be implicated. In this study, the vibration and motion characteristics of a commercial pig transporter were measured while seven individually penned 40 kg pigs were transported for short (110 min) journeys and 80 kg pigs penned in groups of 12 or 13 were transported for longer (4·5 h) journeys. Direct behavioural observations with made of individual pigs for symptoms of travel sickness (sniffing, foaming at the mouth, chomping, and retching or vomiting). A comparison was then made between the incidence of travel sickness in pigs and that expected in humans given the measured vehicle vibration characteristics. The low frequencies of motion measured on the transporter (0·01–0·2 Hz) were well within the range implicated in human motion sickness with considerable power in the longitudinal and lateral axes but little in the vertical axis. On both short and long journeys pigs exhibited symptoms of travel sickness. The likely incidence of travel sickness on the short journeys predicted by the human model was 24–31% which corresponds to approximately two of the seven 40 kg pigs becoming travel sick. The numbers observed were generally lower than this although the same pigs were transported twice each day for 2 days and this may have therefore reflected the effects of habituation. The incidence of travel sickness on the long journey predicted by the human model was 34%. During three journeys which involved four groups of 80 kg pigs which were not repeatedly transported, 26% of pigs

vomited or retched (13 out of 50) while 50% showed advanced symptoms of foaming and chomping. These results are not inconsistent with the human model which should form the basis of further research.
Topics: Motion sickness; Non-human subjects.

S. Hewitt 1998 *Annals of Occupational Hygiene* **42**, 245–252. Assessing the performance of anti-vibration gloves—a possible alternative to ISO 10819, 1996. (8 pages, 2 figures, 2 tables, 8 references) (in English).
Authors' Abstract. Special gloves (commonly referred to as anti-vibration gloves) have been offered for many years as personal protection against hand–arm vibration generated, for example, by powered hand tools. An internationally agreed means of quantifying the vibration-reducing performance of such gloves was not available until the publication of International Standard ISO 10819, 1996. The evaluation of the Standard reported here has led to the conclusion that the test could be improved to give more information to the potential glove user about how the glove might perform. Investigations of the main factors which can influence the results of glove transmissibility tests have formed the basis for a proposal to develop the Standard. The proposed alternative test measures the performance of a glove in octave bands and the resultant data can be used to estimate the potential that the glove has to protect against any given vibration source. Examples of the application of the proposed alternative test for selection of anti-vibration gloves matched to particular vibration sources (powered hand tools) are given. The advantages and disadvantages of the two test methods are discussed. The evaluation of the Standard and proposals for its development are under discussion with members of the committee which developed ISO 10819, 1996.
Topics: Anti-vibration devices (gloves); Standardization.

J. Malchaire, A. Piette and L. S. Rodriguez Diaz 1998 *Annals of Occupational Hygiene* **42**, 121–127. Temporary threshold shift of the vibration perception threshold following a short duration exposure to vibration. (7 pages, 6 figures, 1 table, 16 references) (in English).
Authors' Abstract. The objective of this study is to analyze the evolution of the vibration perception threshold (VPT) following a short duration exposure to vibration. The literature reports experiments with 3–10 min exposure to vibration after which a steady state is not necessarily reached. The temporary threshold shifts (TTS) of the VPT is extrapolated from data recorded during the recovery period. The assumption of a linear decrease with the logarithm of time gives erroneous results for the TTS extrapolated at the end of the exposure. Eighty-one experiments were conducted on nine young subjects without any neurological problem, exposed to acceleration amplitudes of 5, 20 and 80 ms^{-2} r.m.s. at frequencies of 31·5 Hz (conditions 1–3), 125 Hz (conditions 4–6) and 500 Hz (conditions 7–9). The exposure to vibration lasted 32 min and was interrupted shortly at time 2, 4, 8, 16 to record the VPT at 31·5 and 125 Hz. The VPT was also recorded before the exposure and several times during the recovery. The evolution of the VPT appears to follow a first order model

characterized by a maximum amplitude TTS, a time constant τ and a residual value (r, as a fraction of the TTS). The correlation coefficients between observed and predicted values in the 81 experiments are 0·881 at 31·5 Hz and 0·885 at 125 Hz. The TTS is influenced by the exposure amplitude and frequency and is different at the two test frequencies. It varies also significantly between the subjects and with their initial VPT value. The time constant is about 3 min at both test frequencies, while the residual fraction is of the order of 0·14 at 31·5 Hz and 0·07 at 125 Hz. Both parameters appear to be independent of the exposure parameters.
Topics: Vibration sense (temporary threshold shifts).

J. Malchaire, L. S. Rodriguez Diaz, A. Piette, F. Gonçalves Amaral and D. De Schaetzen 1998 *International Archives of Occupational and Environmental Health* **71**, 270–276. Neurological and functional effects of short-term exposure to hand–arm vibration. (7 pages, 3 figures, 2 tables, 25 references) (in English).
Authors' Abstract. Objective: The aim of the present study was to quantify the sensory and functional effects resulting from a short-duration (30 min) exposure to hand–arm vibration. Subjects and methods: Nine subjects went through nine laboratory experiments. For 32 min they grasped a handle vibrating at three different amplitudes (5, 20, and 80 ms^{-2}) and at three frequencies (31·5, 125, and 500 Hz). Additionally, a reference experiment was conducted in which the handle did not vibrate. Three sensory tests (vibration perception threshold (VPT), pressure perception threshold (PPT), and distal sensory latency time (DSL)), two functional tests (Purdue peg-board (PPB) and maximal voluntary force (MVF)), and a questionnaire concerning the perceived paresthesia and numbness were completed before, during, and after exposure. Results: A 32-min period of exposure to vibration leads to a temporary threshold shift (TTS) of the VT and to the development of paresthesia and numbness. The VPT appears to vary with the exposure duration according to a first-order model with a time constant about equal to 3 min. The TTS increases with the vibration acceleration amplitude and is greater for an exposure frequency of 125 Hz than for that of 31·5 or 500 Hz. It is also greater at the test frequency 125 Hz than at 31·5 Hz. The other tests do not demonstrate any significant variation. In particular, the PPB test does not demonstrate any loss of dexterity. Conclusions: After some 30 min of exposure to vibration the VPTs are increased and parathesia and numbness develop. However, these do not appear to influence significantly the capacity or performance at work.
Topics: Vibration sense (temporary threshold shifts).

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*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.*