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Miyuki Morioka
University of Southampton

Michael J. Griffin
University of Southampton

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MASKED THRESHOLDS FOR FORE-AND-AFT VIBRATION OF THE BACK

Miyuki Morioka and Michael J. Griffin
Human Factors Research Unit, Institute of Sound and Vibration Research, University of Southampton, United Kingdom

Introduction

The optimization of vehicle ride comfort requires understanding of vibration perception. The detection of one type of vehicle oscillation may be influenced by the presence of other vibrations (e.g. background vibration): a phenomenon known as 'masking' (i.e. the detection of one stimulus is 'masked' by another stimulus). With vibrotactile stimuli applied to an area of skin, masking only occurs when the masker and the test stimulus stimulate the same tactile channel (e.g., Gescheider *et al*., 1982). Masking influences the perception of hand-transmitted vibration (Morioka and Griffin, 2005), and may influence the perception of low magnitude disturbances to vehicle ride.

This laboratory study was designed to determine masked thresholds of seated persons exposed to fore-and-aft vibration of a backrest and how the detection of one frequency of vibration is influenced by the presence of another frequency of vibration.

Methods

Nine male subjects were exposed to fore-and-aft vibration at the back via a rigid flat vertical backrest (640 x 680 mm) mounted on a Derritron VP 85 vibrator. Unmasked thresholds (Study A) and masked thresholds (Study B) were determined using a two-interval two-alternative forced-choice (2IFC) tracking method (Zwislocki *et al.*, 1958) with the up-down transformed response procedure and a three-down one-up rule. The sinusoidal test motions had frequencies of 4, 8, 16 and 31.5 Hz. The masking stimuli were $^{1}/_{3}$-octave bandwidth random vibrations centered on 4 Hz and presented at five intensities (0 to 24 dBSL). Unmasked thresholds of each test vibration, and the absolute threshold of the masker, were determined in Study A: subjects judged whether the first or the second observation period contained a vibration stimulus (see Figure 1). Masked thresholds were determined in Study B: subjects judged which observation period contained the test stimulus presented at the beginning of each trial. In both Studies, subjects responded by saying, 'first' or 'second'. The masked threshold was defined as:

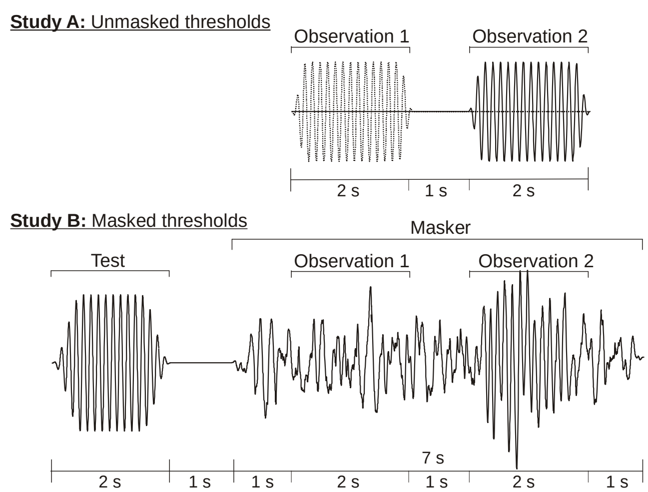

Figure 1 Stimulus timing of a trial for Study A and Study B. Study B example illustrates a $^{1}/_{3}$-octave bandwidth masker centred on 4 Hz with a test stimulus of 8 Hz occurring during the second observation period.

$$\text{Masked threshold (dB)} = 20 \cdot \log_{10}\left(\frac{A_{N\text{dB}}(f)}{A_{0\text{dB}}(f)}\right) \qquad (1)$$

where, at frequency f, $A_{N\text{dB}}(f)$ is the threshold (r.m.s. acceleration) with the masker at N dBSL, and $A_{0\text{dB}}(f)$ is the threshold (r.m.s. acceleration) with the masker at 0 dBSL.

Results

The lowest median unmasked thresholds (about 0.01 ms^{-2} r.m.s.) were obtained at 4 and 8 Hz, with no significant differences between these frequencies (p=0.26, Wilcoxon). From 8 to 31.5 Hz, thresholds increased with increasing frequency (p<0.01) (Figure 2: left). At each test frequency, linear regression of individual masking functions (thresholds with the masker) provided the slopes in Figure 2 (right), showing a significant decrease in masking with increasing frequency of the test stimulus (p<0.015).

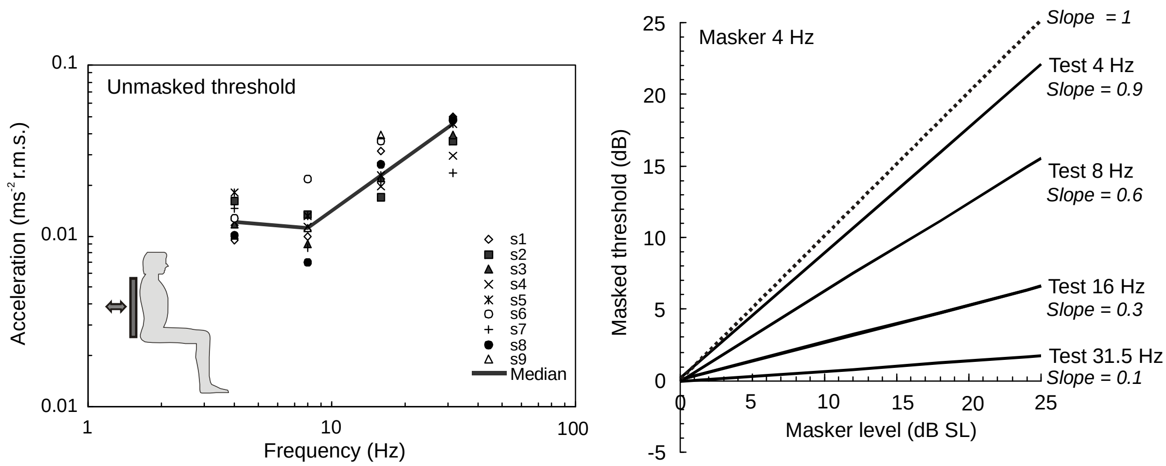

Figure 2 Left: Unmasked thresholds of 9 subjects with median data. Right: Masking functions for test frequencies of 4, 8, 16 and 31.5 Hz with 4-Hz masker vibration.

Discussion

The threshold contour is consistent with the W_c frequency weighting advocated for evaluating the discomfort of fore-and-aft back vibration in ISO 2631-1 (1997). The reduction in the threshold shift as the difference in frequency between the test stimulus and the masker increases can be explained by the involvement of different sensory systems and different body locations in the detection of the test and masker stimuli.

References

1. Gescheider GA, Verrillo RT, and Van Doren CL (1982) Prediction of vibrotactile masking functions. The Journal of the Acoustical Society of America 72: 1421-1426.
2. Morioka M and Griffin MJ (2005) Independent responses of Pacinian and Non-Pacinian systems with hand-transmitted vibration detected from masked thresholds. Somatos & Motor Research 22, 69-84.
3. Zwislocki J, Meire F, Feldman AS, and Rubin H (1958) On the effect of practice and motivation on the threshold of audibility. The Journal of the Acoustical Society of America 30: 254-262.
4. International Organization for Standardization (1997) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration – Part 1: General requirements. ISO 2631-1, Geneva.