EFFECTS OF VIBRATION EXPOSURE ON PROFESSIONAL DRIVERS' VISUAL AND COGNITIVE PERFORMANCE: A PROPOSAL FOR A 'REAL' ENVIRONMENT

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INTRODUCTION

Whole-body vibration seems to be a well studied subject considering its effects on the driver/operator health. Studies on the effects of vibration on tracking performance first began in the 1960's. Almost at the same time, physiological parameters were measured as secondary indicators of performance. Harris (1966), for example, investigated the effects of vibration on three different perceptual tasks: target identification, probability monitoring and warning-lights monitoring [I]. Since the 1970's several studies of the effects of vibration on visual acuity have also been reported [IV]. From these studies, it is possible to verify that, in most cases, exposure to sinusoidal or random vibration did not produce any significant increase in simple reaction time, despite the tested frequencies. However, almost all of them were performed under strictly controlled laboratory conditions and with a well-defined vibration exposure intensity and/or frequency.

AIM

Accordingly, the aim of this study was to evaluate the vibration effects on cognitive and visual performance. With this purpose and to, hopefully, achieve innovating results, this study will include tests performed in a 'real' performing context.

METHODOLOGY AND RESULTS

The considered sample is composed of 40 volunteers, from both genders, with ages between 18 and 62 years old. All of the selected subjects have more than one year of driving experience. In order to test the effects on a 'real' environment, the back of a 2.5 ton van was modified with the inclusion of two car seats and a platform to accommodate the 'Action Judgment Tester', item No. 1105 developed by the Takei & Company, LTD [V]. This instrument was designed to examine the relation between the distribution of attention and the resultant reaction to ever-changing conditions. The performance test tool/instrument is equipped with a synchronous motor to ensure a constant-speed of rotation for a disk that is marked with 16 red arrows and a peripheral red line. A subject is required to use a steering wheel to move two needles (on both the left and right side of his vision field) trying, from start to finish, not only to keep them clear of all the red arrows and the peripheral red line, but also to pass them on the side of each arrow neck and not on the arrow heads.

In the first stage of this study, a vibration exposure assessment on several types of moving vehicles was performed. In the second stage, the procedure for assessing subjects' visual and cognitive performance was developed. From previous validation tests, it was possible to identify some restraints to tests application and, accordingly, the test procedures are being improved to overcome these difficulties. According to the identified needs for the tests standardization and homogeneity, subjects have no other stimuli than the information presented on the screen. The movement of the van is performed in a closed circuit for each test and with a vehicle speed up to 30 Km/h. This circuit has two different pavements, one of asphalt and one of cobblestone. This feature allowed performing the 'Action Judgment Test' under three different conditions: (i) with the van halted, (ii) with the van performing a circuit on asphalt, and (iii) on cobblestone. The vibration r.m.s. values, measured accordingly to the NP ISO 2631-1:2007 [III], obtained during the three different conditions are summarized in Table 1.

Table 1 - Vibrations values for the 3 test conditions, measured according to NP ISO 2631-1:2007.

Test conditions	Vibration axis		
	x	**y**	**z**
	r.m.s. (m/s^2)		
Van halted	0,115	0,156	0,274
Circuit on asphalt	0,444	0,839	2,037
Circuit on cobblestone	2,241	3,122	10,050

The order of the test conditions was randomized in order to minimize de skill/proficiency effect, which may occur when the subjects become more familiarized with the tests. It is expected that the obtained results will help at identifying the main visual and cognitive impairment resulting from vibration exposure in vehicles. These data will, ultimately, be used to improve vehicle characteristics and reduce the corresponding effects.
The results obtained in the pilot study seem to point out that there is an increasing number of total errors, as the vibration exposure increases (Table 2).

Table 2 - Pilot study preliminary results.

Test conditions	Mean total no. of errors	Mean degree of the effect of training	Judgment value
Van halted	92,00	21,21	0:+1
Circuit on asphalt	95,25	15,60	0:0
Circuit on cobblestone	121,75	28,65	-1:+1

Reaction judgment is done based on the degree of the effects of training and the total number of errors. Accordingly, for the first two conditions the result obtained was of an 'eligible' subject and for the third condition, the result obtained was of a 'not eligible' subject.

CONCLUSIONS

This pilot study allowed the validation of the test conditions and point out some limitations that need to be addressed, in order to obtain much more reproducible and accurate results.
Nevertheless, the preliminary results already show a degree of impairment as an effect of the vibration exposure level. The degree of impairment seems to be strong enough to obtain a 'not eligible' subject when vibration exposure levels are higher. In the same way, Nakashima and Cheung (2006) have also reported that performance was not significantly affected for tasks involving simple reaction time. However, vibration has been shown to have a negative effect on more complex cognitive tasks, such as those involving short- and long-term memory [II].

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