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OBJECTIVE EVALUATION OF THE INFLUENCE OF WHOLE BODY VIBRATION (WBV) AMPLITUDE DURING READING

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Abstract: *Whole-body vibration (WBV) has a strong influence on humans, either on their comfort, their health or their tasks performance. Regarding the latter, reading is one of the activities affected by the WBV influence. Having to read a text or a command panel and to interpret correctly what is shown is very common the situation. However, the reading quality should not be too much degraded by the presence of the WBV. Both the main frequency and the amplitude content vary according to each means of transport and also to the track used. In the research presented here, an eye tracker device used to record the eye movements was employed to monitor, in an objective way, the difficulty of reading a text when a subject was submitted to WBV sinusoidal excitation at a 5 Hz frequency in the z-axis. The position of the text was kept fixed, in an attempt to isolate its influence. The parameter varied was the WBV amplitude (no vibration, 0.8 m/s^2 and 1.4 m/s^2). The time to perform such task was also monitored to be one additional measure of the reading difficulty. First, a graphical analysis was performed. Then, the data was compared statistically using the non-parametric Wilcoxon test. The statistical analysis corroborates the findings shown graphically, that is, although the subjective evaluation showed a clear difference within the tests - with the higher amplitudes causing more difficulty than the lower amplitudes regarding reading - the objective evaluations were not that conclusive. However, there are some points to be observed regarding the way the objective data was obtained that deserves better investigation. Nevertheless, what the subjective evaluation already shows is the way in which the amplitude influences the reading activity, helping to improve the vehicles design regarding vibration amplitudes for reading.*

Keywords: Whole-body vibration (WBV), Reading, Task accomplishment.

1. INTRODUCTION

Whole-body vibration is very common on the everyday life. It may be caused by a different number of sources, such as machinery, vehicle, building vibration, among others. It is also common the situation when a subject submitted to whole-body vibration (WBV) needs to perform a certain task. Among the most frequent examples is the need to read a text, either for work or leisure. In that sense, both the object and the subject may be vibrating, only the object may be vibrating or only the subject may be vibrating. There is no simple universal answer to what amplitude of vibration is required to cause decrements in vision or how this amplitude depends on the vibration frequency (Griffin, 1996), as several factors interfere in such evaluation.

Whole-body vibration evaluations are generally performed using either the weighted RMS acceleration (m/s^2) or the Vibration Dose Value (VDV) (m/s$^{1.75}$) (Griffin, 1996), (ISO2631-1, 1997). The accelerometer has to be placed as close as possible to the first contact point between the vibration source and the subject. According to the ISO standard (ISO2631-1, 1997), the energy transmitted to the subject is linked to both exposure time and amplitude. Several instruments to perform such calculation according to this standard may be found on the internet (HSE, 2006). However, this standard only mentions such relationship as a guideline and mainly related to health or comfort effects, although there are some controversies even in relation to such effects (de Araújo, 2010). Therefore, when considering the accomplishment of tasks, such as the one discussed in this paper, their main importance is related to safety. The values set by the European Parliament (Directive 2002/44/EC, 2002) and the ISO standard (ISO13090-1, 1998) should be observed in order to guarantee the safety of the volunteers during the tests performed.

What varies from one type of vehicle to the other are the main frequency and the amplitude a subject is submitted when in WBV. The main excitation direction for the majority of the vehicles used in the Brazilian fleet is in the z-axis - as stated in the ISO standard (ISO2631-1, 1997) - and that is going to be the direction used for the current tests. The ISPESL (Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro) in Italy has on the internet a database containing a list of different types of vehicles, from buses to trucks and trains, where it is possible to find the main amplitude content of each vehicle. Such values may be either declared by the manufactures or measured (ISPESL,

2008) and from this data it is possible to identify that the maximum amplitude values vary a lot, depending on the type of vehicle, manufacture, etc. Some range from below the EAV (Exposure Action Value) of 0.5 m/s^2, others to above the ELV (Exposure Limit Value) of 1.15 m/s^2 set by the European Directive [(4)] for an 8h journey. However, there is no mention about the frequency content, as a more sophisticated instrumentation is required to get such characteristic.

Some typical vehicles´ characteristics are shown in references (de Oliveira, 2007) and (Balbinot, 2001) from which it is possible to see that the main frequency of most vehicles is around 4 to 8 Hz. Besides, in this range, the weighting curves of the ISO standard (ISO2631-1, 1997) are close to unity, therefore decreasing its influence on the results obtained, as this fact was questioned in (Morioka, 2008). Moreover, (Liang and Chiang, 2006) showed that the highest seat-to-head (STH) transmissibility occurs around 5 Hz, minimizing the level of excitation necessary for the subject to feel the vibration.

The research described in this paper has the aim to investigate the situation when both the subject and the object are vibrating. The text is always located in the same position, although the tests considered different vibration amplitudes. It tried to simulate passengers reading a text inside different types of vehicles, since the text was hold by the own subject. Some previous studies undertaken by $\text{GRAVI}_{\text{HB/UFMG}}$ researchers (Group of Acoustics and Vibration on Human Beings of UFMG) have investigated the influence that the amplitude of vibration (Duarte, et al., 2008a) and the text position (Duarte, et al., 2008b) have on the difficulty of reading a text. However, on such studies, only a subjective evaluation of the reading difficulty was obtained. The main innovation of this study is that an eye tracker device was used to monitor, in an objective way, the reading difficulty. That is possible by recording the saccadic movement of the eyes and examing several different parameters (Taylor Online Inc, 2008a), some of which will be used in this work. The study of eye movements allows for estimation of the reading performance (Wikipedia, 2009). It may change in the presence of external agents, such as WBV, and becomes an objective indicator of reading difficulty. An investigation about the differences between these objective and subjective evaluations was also performed by the researchers in another study (Duarte, et al., 2009).

This paper is organized as follows: first, the setup, as well as the instrumentation used during the tests, is presented. That is followed by the methodology of the tests, including the volunteers´ selection, the tests description and a description about the objective and subjective parameters used. An explanation about how the statistical analysis is performed for the available data is also included in this section. Then, the results obtained are presented and interpreted both graphically as well as statistically using the Wilcoxon tests. Finally, the conclusions are drawn.

2. SETUP AND INSTRUMENTATION USED

Figure 1 shows a schematic view of the setup used for the tests presented here, with a photo of such configuration presented in Figure 2. The vibrating platform consisted of a steel plate (700 x 1000 x 3 mm and folded edges), supported by four 1020 steel compression springs (76 mm external diameter, 350 mm height, 6 mm wire diameter and 9 coils). PVC tubes positioned outside a steel tube welded into a flat metal basis were used to guide the springs. That assembly was used to ensure the vertical motion of the spring, reducing fluctuations in the x- and y- axes. Therefore, the main excitation was in the z-axis, as this is the direction of greatest interest for this study. The platform was also guided by a metal structure, with polypropylene plates fixed at its internal corners, lubricated with grease to decrease the friction between these plates and the ones made of the same material and fixed at the corners of the platform

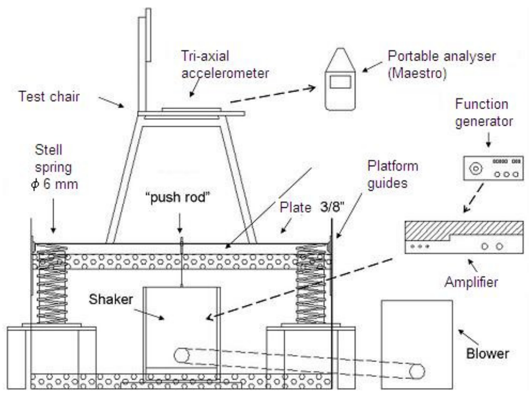

Figure 1: Schematic drawing of the WBV setup and instrumentation.

Figure 2: Photo of the setup used for the WBV Reading Tests

A Dynamics Solution shaker, VTS150 model, was installed under the plate. A steel push rod (2.0 mm diameter, 100 mm length, bolted at each end to a 60 mm and 30 mm length 4.0 mm diameter screws) was used to transmit the sinusoidal signal used during the tests from the shaker to the platform. The screws at the end of the push rod were used to control the height of the push rod according to the weight of each volunteer.

The sinusoidal signal was generated by a Topward Function Generator 8102 and amplified by a Crown Amplifier CE2000. A tri-axial accelerometer APTechnologies AP5213 was placed at the chair seat and connected to a four channels analyzer, model Maestro® from 01dB. The measurements were performed using the built in weighting functions of the (ISO2631-1, 1997) for whole body vibration. Therefore, it was the weighted acceleration measured by the accelerometer and provided by the analyzer that was used to adjust the amplitude of the signal sent by the generator up to the desired level for each test performed.

The volunteers were sat during the entire length of the test on a chair having wooden seat/backrest and metallic feet positioned on the top of this assembly (see Figure 3). Although in front of the chair, at the platform width centre, there was a metal rod fixed by screws (1 mm thick, 20 mm square section and 1 m height), having at its upper end a wooden support for reading (10 mm thick, 355 mm wide and 410 mm long) with a 45^{o} slope, that was not used for the results presented in this paper, as it will be described in section 3.2. This assembly, rod/reading support, will be called from now on pedestal. Details of this pedestal and chair can be seen in Figure 3.

Figure 3: Details of the pedestal and chair used during the reading WBV tests

During all tests presented here, an Eye-Movement Recording/Assessment System called Visagraph III from Taylor Inc. (Taylor Online Inc., 2008a) (see Figure 4) was used to monitor the reading difficulty in an objective way according to a Taylor National Norm (Taylor Online Inc, 2008b). For that, several saccadic movement parameters are used. That device is also called generically as Eye Tracker. The time considered in this study was monitored using a regular chronometer.

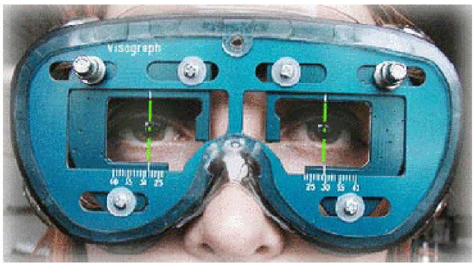

Figure 4: The Visagraph III device (Eye Tracker) used to monitor the eye movement

3. METHODOLOGY

3.1. Volunteers Selection

Due to, but not only, the easiness of recruitment, all volunteers who attended the tests reported here were students from the Federal University of Minas Gerais (UFMG). At first they filled in a form about their health history, therefore, their actual condition to take part in vibration tests. If they had any impediment, they would be excluded from the tests already at this first stage. On the contrary, they were given an explanation on how the tests would be conducted and signed in a free and informed consent for taking part in the experiments. The research was approved by the Research Ethics Committee of UFMG as a requirement, although it is also recommended by Griffin (Griffin, 1996) and the ISO standard (ISO13090-1, 1998).

Since the main objective of the tests was to verify the influence of the WBV during reading, if the volunteer had any serious eyesight problem, he/she would also be excluded from the tests. Common sight problems which could be correct using eye glasses or contact lenses were not an impediment to take part in the experiments, as long as the volunteer used such correction during the tests. Therefore, to verify that and to confirm that the correction was right, all volunteers were submitted to normal ophthalmological tests prior to the vibration tests. Such information was put on the volunteers test sheet for further records. However, during the tests, some volunteers using eyesight corrections had problems with the Eye Tracker device and their data could not be recorded. Therefore, at the end, they could not be included in the analysis also.

A total of 16 volunteers took part in the present research. Each volunteer performed all the tests proposed, being a total of 6 different situations (Duarte, et al., 2009). However, only three distinct results are shown here, as it will be described in section 3.2, since only the influence of the amplitude of vibration is of interest for the analysis. Generally, researches involving evaluations of the vibration effects in human uses between 8 to 30 volunteers. Therefore, the work presented here is within that range. However, due to the problems already mentioned during the recording of the data from the Eye Tracker device, at the end, not all data could be registered. Consequently, for some experiments, the number of volunteers was smaller than the one mentioned. Nevertheless, for the tests included in the present paper, the number of volunteers was enough to allow a statistical evaluation of the results.

3.2. Tests Description

In order to verify the influence of the WBV during reading, the volunteers were sat still in a wooden chair having a backrest but no cushion throughout the tests, as mentioned before. For the tests presented here, only the vibration amplitude was varied, being the text kept in the same position. The characteristics of the tests are presented in Table 1.

Table 1: Summary of the tests reported here

Test number	Frequency (Hz)	Weighted RMS acceleration (m/s^2)	Text Position
T1	Static	No vibration	Hand held clipboard
T3	5 Hz	0.8	Hand held clipboard
T5	5 Hz	1.4	Hand held clipboard

For the tested configurations presented in Table 1, the maximum time to reach the EAV of 0.5 m/s^2 and the ELV of 1.15 m/s^2 set by the European Directive (Directive 2002/44/EC, 2002) are about 3h and 16h for the 0.8 m/s^2 amplitude and about 1h and 5h for the 1.4 m/s^2 amplitude, respectively. However, there is no found relationship between that time and the influence on reading.

The saccadic moment of the eyes (Wikipedia, 2009) was monitored using goggles placed by the examiner over the volunteer´s eyes, adjusted in relation to the volunteer´s pupil, as already shown in Figure 4. The volunteer then had to read a short text selected among the options available inside a test booklet of the equipment and at the end of the reading had to answer 10 questions to determine his/her comprehension of the text. However, these answers were used in the present study only to stop the software acquisition, not really to evaluate the reading comprehension. The main reason for that is due to the fact that only two answers were possible, that is, yes or no. Therefore, even if the volunteer did not understand the text correctly, he/she had to give one of these two answers. So, the evaluation of the reading comprehension could be masked by the answers´ options.

Simulation of the eye-moments over text, multiple reports and data presentation were then auto-generated by the software provided with the eye tracker device. It is important to mention here that the texts used were translated from English to Portuguese, although the software assumed the English version. That could have caused some problems with the data collected, due to the different characteristics of the words at each language. However, the number of words per line was kept the same between the languages and the alignment of the text was justified. Therefore, it could have happened that at some lines the spacing between the words was changed. That fact may be important in order to analyze the data obtained.

As it can be seen in Table 2, the selected texts in the booklet (Text #) had similar levels (6 and 7), being the higher number, the higher in difficulty. Moreover, the tests had similar characteristics, apart from the number of characters in test 3, what make some other characteristics related to that to be different. That will also be considered in the analysis later on.

Table 2: Summary of the texts characteristics

Test number	Text #	Level	Mean Words/Line	Mean Character/Line	Total Words	Total Characters	Mean Characters/Words
T1	78	7	9.83	48	118	576	4.9
T3	65	6	9.67	38	116	456	3.9
T5	74	6	9.54	42	124	544	4.4

The text used was changed from test to test and were chosen to be in a level compatible to the volunteer´s age and comprehension. Such procedure was adopted in order to avoid previous knowledge of the contents, what could mask both the real time taken and the degree of difficulty to accomplish such task. The same text was used for all volunteers in the same test situation, although, for some volunteers, due to a problem with the acquisition software, a different text was tried. However, such data was discarded at the end of the analysis. It was used only to test the equipment. The time taken to read the text was measured using a regular chronometer.

3.3. Objective Parameters Used

As mentioned in the previous section, the software included with the Visagraph III eye tracker device records several different parameters to monitor the eye-movements over text. Such parameters can be used to evaluate the difficulty of reading the text and some of them will be used here as analysis parameters. The parameters chosen are: 1) regression, 2) fixation, 3) average span recognition and 4) time. Regression means the eye movement to return to the previous word, that is, the bigger the number of regressions, the worse (more difficult) is the reading. Therefore, the better the reading, the lower number of regressions is expected. Fixation means how many times the eyes make a stop movement to collect information when reading a sentence. More fixations translate a poorer reading. Thus, a higher number of fixations mean a more difficult reading. The average span recognition is a variable that tells the ability of the reader to span the words in the text. It measures the visual field the subject can fixate. Therefore, the wider the span, the better is the reading. The results presented in the following section will be analyzed with these concepts in mind. The time to read each text for each test was also recorded as an objective parameter.

3.4. Subjective Parameters

The first test (without WBV) was used as the reference one for later comparison and there was no subjective evaluation regarding it. For all the other tests, just after finishing reading the text, the volunteer had to qualify the easiness of reading using pre-established scales (both numeric, as well as, conceptual). However, only the numeric scale will be presented here. It varied from 0 to 10 (from extremely easy to impossible to read) according to the volunteers´ judgment, whereas the conceptual had only 5 levels. Therefore it covered a wider range of values.

3.5. Statistical Analysis

The statistical method used to compare the volunteers´ responses in each group was the “Non-parametric Wilcoxon test” (Siegel, 1997). It can be used to compare two correlated samples, each sample with, at least, 6 elements. As mentioned earlier, at first, 16 volunteers composed each sample used in the present study. However, if the volunteers´ results are equal, that volunteer has to be discarded from the sample, decreasing therefore, the final sample size. Moreover, due to the problems already (and to be) mentioned at the data acquisition by the eye tracker device for some volunteers, for the statistical analysis, at some comparisons, the sample size was smaller.

The hypothesis and the confidence level used in the tests are:

- Null Hypothesis (H0) = No difference between the samples
- Alternative Hypothesis (H1) = Second sample is different from the first sample,
- Confidence level set: $\alpha = 2.5\%$ (unilateral)

The smaller the confidence level set, the bigger the results’ precision. However, for phenomena involving humans, there is a great variability in the collected data related to the subjective parameters as mentioned earlier (Griffin, 1996). Therefore, a 2.5% unilateral confidence level (considered high for exact sciences) may be reasonable to human studies and it was the value adopted for the present case.

The statistical analysis was performed using the commercial statistical software SPSS®. The results are shown in the following section.

4. RESULTS

The results to be presented here are for the tests with the characteristics shown in Table 1, that is, the texts are on the same position (hold by the subject) and the only variation between them is the WBV amplitude used. However, during the tests, four (4) volunteers had problems with the eye tracker device and a different text was used just to continue with the experiments. Therefore, their data are not included in the analysis, since it did not correspond to the same test. The mentioned tests are T1 for volunteers 8 and 12; T3 for volunteer 2 and T5 for volunteer 1.

The following figures show some objective parameters measured by the Visagraph III eye tracker device (Taylor Online Inc, 2008b), as that is the purpose of this work. Apart from the use of a different text as mentioned above (which excluded some of the volunteer´s data), there were other problems with some subjects using eyesight corrections (not all of them using such corrections) and the software could not record their data (T1 for volunteer 5 and T5 for volunteers 14 and 15). Therefore, their data are not included in the analysis also for the mentioned reason.

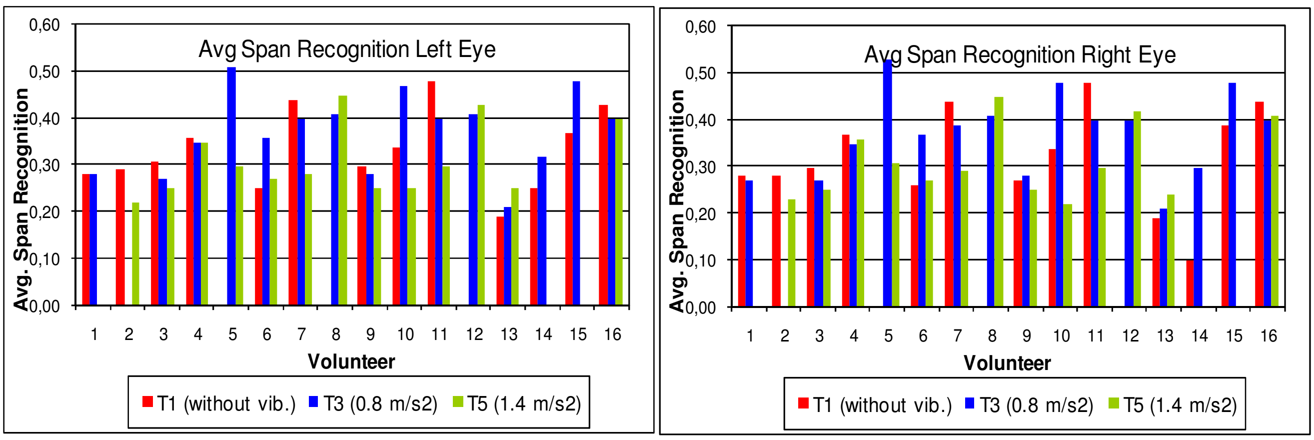

Figure 5: Average span recognition of both left and right eye over the text

The first objective parameter to be analyzed is the average span recognition. For a good reading, its value has to be high. So, analyzing the data in Figure 5, it is not possible to conclude anything about the influence of the WBV in the reading difficulty. It can be seen that for a considerable number of volunteers an increase on the WBV amplitude had a negative influence on reading (the span recognition decreased, therefore, indicating a poor reading). However, for some other volunteers it had a positive influence (the span recognition increased, therefore, indicating a good reading). Nevertheless, for this objective evaluation parameter, the number of parameters decrease with WBV amplitude increase is slightly higher, what may suggest that the higher the WBV amplitude, the more difficult is the reading. Figure 5 shows the average span recognition of both left and right eyes over the text with the purpose to demonstrate that the values between the eyes are very similar. Therefore, for the other objective parameters, only the left eye data is shown.

The regression and fixation behaviors are very similar, as seen in Figure 6. The behavior of such objective parameters is exactly opposite to the behavior of the average span recognition, as expected. Therefore, the same conclusion may be drawn.

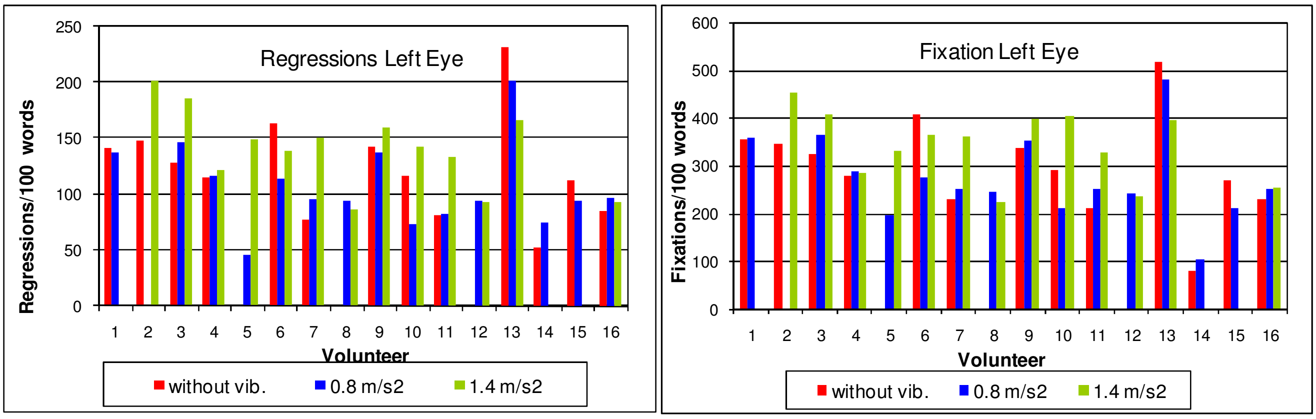

Figure 6: Number of regressions (left) and fixations (right) of the left eye over the text

Therefore, since the objective conclusion was not clear, the objective evaluations are compared with the subjective evaluation to see if the doubt persists. Although the time spent to read the text cannot be considered a subjective parameter, since it is not a parameter directly obtained from the eyes´ movement as the others, it will be considered here as such.

The left side of Figure 7 shows the time taken by each subject to read the text with the tests characteristics presented in Table 1. It can be seen that as the vibration amplitude increased; the time to perform the reading was also increased (comparing T3 with T5). However, comparing the reading time without vibration (T1) with the 0.8 m/s^2 amplitude (T3), the time to perform the reading was smaller for the latter. Such behavior was not the expected one, since the presence of WBV was expected to interfere in a bad way in the reading quality. However, that behavior may be explained by some factors. The first is related to the level of T1 (higher than for T3 and T5, although similar). The second is related to the other characteristics of T3. Although the mean words/line is not much different from the other tests presented, all the other characteristics related to the number of characters are smaller for T3 than for T1 and T5 (see Table 2). So, that may have influenced the quality of the reading. Another explanation may be that at the first test the volunteer may have tried a perfect reading trial in a longer reading; once it is exposed to a WBV situation the uncomfortable reading situation urge it to finish his/her task faster though not perfectly, and at T5 situation the higher amplitude level make the target so high that the subject takes more time to finish the reading even not understanding the text perfectly.

The right side of Figure 7 shows the numerical difficulty evaluation by each subject, according to the range presented in section 3.4 above. When the results are compared between the tests, it can be seen again that the higher the amplitude, the more difficult the reading is, as evaluated subjectively by the volunteer. The assessment was made in comparison to the reference test assumed to be 0 (zero), that is, extremely easy. Such value was based on some other subjective experiments undertaken by the $GRAVI_{HB}$ researchers which concluded that the text hold by the volunteer was the least difficult to read (Duarte, et al., 2008b). However, looking at all the other parameters presented in this paper, the subjective evaluation should also have been considered for the test without vibration. The reason may be the influence of the use of the eye tracker device. Therefore, that is a suggestion for future work continuation. Moreover, it should be noticed that the difference between the subjective numeric evaluations is much stronger than the difference between the times taken to read, although both plots show an increase in the reading difficulty with the increase in the WBV amplitude. Comparing the subjective and objective evaluations, it can be seen a clear pattern on the subjective evaluation that was not clear with the objective evaluation. However, there are several doubts about the way the objective parameters were collect and suggestions to check that are given at the conclusions.

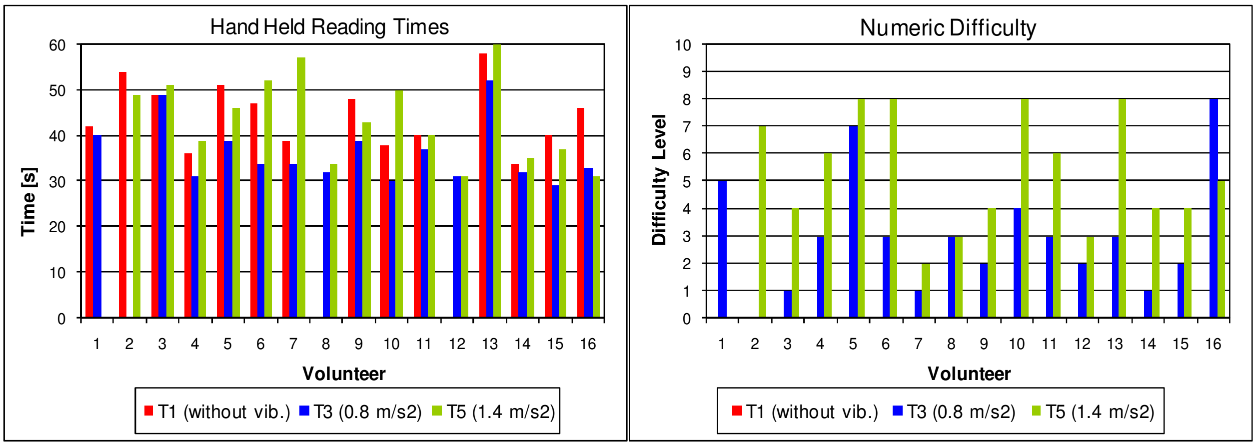

Figure 7: Time taken to accomplish the reading task (Left) and numeric difficulty evaluations (Right)

Finally, the results are compared statistically. Table 3 shows the results obtained using the Wilcoxon Tests (Siegel, 1997), as mentioned in section 3.5, remembering that H1 means that the second group is different from the first, whereas H0 means that both groups are equal. Therefore, if the results presented in Table 3 are H1, it means that for the evaluated parameter, the second group is different from the first. In order words, the amplitude of WBV plays a role on the difficulty level, that is, the higher the amplitude, the higher the reading difficulty.

Table 3: Wilcoxon test results

Parameter ↓ / Tests Comparison →	T1 x T3	T1 x T5	T3 x T5
Numeric	**H1**	**H1**	**H1**
Time	**H1**	H0	**H1**
Fixation Left Eye	H0	H0	H0
Regression Left Eye	H0	H0	H0
Avg Span Recog. Left Eye	H0	**H1**	H0

A close analysis at that table show us the same tendency related before, that is, the objective parameters are inconclusive (not different from each other) and the subjective parameter (remembering that time was considered here as subjective) take us to conclude that there are real differences between the situations related (as expected). It is important to notice the Time parameter line. According to it test T1 is different from T3 and T3 is different from T5 but T1 and T5 are equals. This result, tough not expected, was also observed at Figure 7 as reported before. Apart from the explanation already given there, probably it may have been influenced also by the subject expectations. A solution to this problem, that is also a test for this hypothesis of expectation, is the combined evaluation of Time and Text Perceptual Comprehension, once both are known through the Eye Tracker software. However, it is important to include among the possible answers at the software an option "I do not know/remember", in order to access the comprehension properly, since that is not an option among the answers to stop the software acquisition as shown in section 3.2.

Table 4 presents the initial/considered sample size used in the statistical analysis, as it can be observed at the previous figures. Therefore, the investigated parameter has to be measured at both tests for the analysis. The initial sample (IS) is the number of volunteers where the parameter could be measured (due to the problems already mentioned). The considered sample (CS) is the one excluding the similar responses, as mentioned in section 3.5. It can be seen that the biggest "initial sample" size was 14 volunteers (out of the 16 in total), whereas the smallest was 10. However, due to the equal results, the biggest "considered sample" decreased to 13 volunteers, whereas the smallest remained the same. Therefore, the sample size used was enough to perform the Wilcoxon non-parametric test with a good confidence level.

Table 4: Number of Volunteers: Initial / Considered Sample at the statistical analysis

Parameter ↓ / Tests Comparison →	T1xT3 (IS/CS)	T1xT5 (IS/CS)	T3xT5 (IS/CS)
Numeric	**(13/13)**	**(13/13)**	**(14/13)**
Time	**(13/12)**	(13/12)	**(14/13)**
Fixation Left Eye	(12/12)	(10/10)	(12/12)
Regression Left Eye	(12/12)	(10/10)	(12/12)
Avg Span Recog. Left Eye	(12/11)	**(10/10)**	(12/10)

5. CONCLUSIONS

This paper had the aim to investigate the influence of the whole-body vibration (WBV) amplitude in the reading difficulty using an objective evaluation. This objective evaluation is then compared with the subjective evaluation later on for a better analysis of the results. However, the time spent to read the text is considered in the present study as a subjective parameter since it is not directly dependent on the eyes´ movement as obtained using the eye tracker device. Finally, some statistical analysis of both objective and subjective parameters is performed. The results are analyzed objectively by using some eye tracker device parameters (time, regression, fixation and average span recognition), subjectively by using the volunteer judgment and time and statistically by using the Wilcoxon non-parametric test on all these parameters. Although the subjective evaluation showed a clear influence of the WBV amplitude, that is, the higher the amplitude, the more difficult was the reading; the objective evaluation was not that conclusive. Some unexpected results on that may have been caused by the expectation of the volunteer while using the eye tracker device. Apart from that, there are a lot of questions about the influence of the translation used in the software which collected the objective parameters (changes in the spacing between the words, among other factors). Therefore, before continuing the study, it is necessary to correct the software first. Currently, the LABBIO Group of Federal University of Minas Gerais is developing a similar eye tracker device with its own software, where the translation problem could be corrected, as also as the answers included in the comprehension part, which can be used an additional evaluation parameter. It is important to include among the possible answers at the software an option "I do not know/remember", in order to access the comprehension properly. Moreover, it is important to investigate the subjective evaluation at all tests, without considering Test 1 as a reference test.

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