Risks of Occupational Vibration Exposures

VIBRISKS

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Title: Effects of prior exposure to hand-transmitted vibration on neurosensory function

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SUMMARY

The objective was to investigate whether the conditions in the field are likely to influence the results obtained from the objective diagnostic tests that are used to detect symptoms (i.e. whether prior exposure to vibration on the day of the test may influence neurological function). The findings will be used to establish an improved definition of test conditions, especially the length of time required between the last occupational exposure to tool vibration and the commencement of objective testing.

Three different laboratory experiments were set up with a similar study design. The post stimulatory effects on vibrotactile threshold were studied in the first experiment and in the second experiment the effects on thermotactile perception thresholds. In the third experiment the differences on the respective thresholds due to exposure with continuously and intermittent vibration exposure was studied. In the different experiment 10 subjects, five male and five female, participated.

From the experiments it could be concluded that it is important to recognize that prior exposure to vibration on the day of a test is likely to influence the results obtained for determining the vibrotactile and thermotactile thresholds. The test person should therefore be given a vibration free period before testing. Moreover, it can be concluded that work with continuously vibration exposure without rest periods implies that longer rest period are needed.

From this study it could be stated the minimum require vibration free period before measuring the thermal perception threshold is 2 min and 30 min for tactile perception measurements. However, these time periods are without any safety margins and therefore it is likely that prior exposure to vibration on the day of a test still could influence the results. The recommendation is therefore to avoid vibration exposure 2 hours prior the measurement of the thermal perception thresholds and 4 hours prior the measurement of the vibrotactile perception thresholds.

CONTENTS

Task 3.2.2: Laboratory studies of neurological effects of HTV on detection of symptoms

The objective was to investigate whether the conditions in the field are likely to influence the results obtained from the objective diagnostic tests that are used to detect symptoms (i.e. whether prior exposure to vibration on the day of the test may influence neurological function). The findings will be used to establish an improved definition of test conditions, especially the length of time required between the last occupational exposure to tool vibration and the commencement of objective testing.

Three different laboratory experiments were set up and the study design was similar to Task 3.1.2. The post stimulatory effects on vibrotactile threshold were studied in the first experiment and in the second experiment the effects on thermotactile perception thresholds. In the third experiment the differences on the respective thresholds due to exposure with continuously and intermittent vibration exposure was studied.

1 Recovery of the vibrotactile perception thresholds shifts after exposure to vibration

The aim of the first experimental study was to study the recovery of the vibrotactile thresholds after exposure to vibrations with different magnitudes, frequencies, and durations.

1.1 Methods

Ten healthy subjects, five male and five female, with no prior history of regular use of hand-held vibrating tools in occupational or leisure activities participate in the study. All ten subjects were non-smokers and reported no cardiovascular or neurological disorders in their dominant hand. The subjects mean age was 23.3 years (range 21-25), mean height 173.1 cm (range 160-183) and mean weight 66 kg (range 51-80). The Ethical Committee of Umeå University approved the study.

The experiments were performed in a room with an ambient temperature of 22ºC (± 2ºC) and with airflow less than 0.2 m/s. The subjects were asked to avoid alcohol 12 hours before testing and to avoid nicotine and caffeine consumption 1 hour before testing. During the experiment the subjects were dressed in light indoor clothing and they wore hearing protections during the entire test. After an acclimatisation period of 15 minutes, finger temperature was measured by a thermocouple attached to the distal phalanx of the examined index finger (digit 2). The finger skin temperature was not allowed to be less than 28°C. When the fingers were at lower temperature the subjects used hand warmers to increase the temperature.

A computer-based system was used to measure vibrotactile thresholds (thresholds at 31.5 Hz and 125 Hz) via the von Békésy method in a manner compliant with the methods in ISO 13091-1 (2001). The system consists of a laptop with a special developed program in LabView, a DAQ-card (National Instrument 6221M) and a vibration exciter (Brüel & Kjaer 4809) with an external amplifier (Sentec PA9). Thresholds were measured on the distal phalanx of the index finger of the dominant hand. Subjects were instructed to place their finger such that the centre of the whorl was situated over the centre of the probe of the applicator. The subjects were seated in a chair in front of the instrumentation setup and instructed to apply a downward (push) force of 0,5 N (± 0.25 N) during the tests. The applied force could be controlled by the research leader on a pointer instrument. During the test, the hand of the subject was supported at the wrist. Subjects were instructed to press and hold the response button down as soon as they perceived a vibration sensation and to release the response button as soon as they did not perceive the vibration.

A measure of the vibrotactile perception was conducted before the different exposures to vibration. After completing pre-test the subjects were instructed to place their index, middle finger and their ring finger on a horizontal wooden platform (70x70mm) mounted on a vibrator (Ling Altec Model 40). Their elbows rested at a comfortable angle on an adjustable supported platform. The exposed area of the fingers ranged from the fingertip to the second phalange. The subjects were instructed to apply a downward force of 5 N during the entire exposure time. The force was monitored by both the subjects and research leader. Immediately after the vibration exposure, the vibrotactile threshold measurements were conducted on the exposed index finger. The acute effect was measured continuously for the first 75 seconds, followed by 30 seconds of measures at every minute up to ten minutes. The data from the last measurement were then compared with the results from the pre-test. A deviation larger than 2 dB compared with the pre-test was not accepted, and further tests were then carried out every 5 minutes until the deviation was acceptable. The measurements continued up to 30 minutes.

The subjects were exposed to vibration under 16 conditions (Table 1) with a combination of different frequency, intensity, and exposure time. The subjects were only allowed to conduct one test per day, and the test order was distributed with a repeated measures design. The vibration, a sinusoidal vibration at a frequency of 31.5 Hz and 125 Hz, was generated by an IBM computer based system. The vibration was sent via an amplifier (Sentec PA 9) to the vibrator, producing motions in the vertical direction. The frequency-weighted vibration intensity ranged from 2.50 to 14.14 m/s^2, corresponding to an unweighted acceleration magnitude between 4.82 and 111.36 m/s^2. According to ISO 5349-1, the calculated energy-equivalent frequency weighted acceleration magnitude for the whole experimental time of 16 minutes was either 2.5 m/s^2 or 5.0 m/s^2 (Table 1).

Table 1. Conditions of exposure used in this study (the r.m.s. acceleration magnitude of vibration and the energy-equivalent frequency weighted acceleration magnitude for the whole experimental time of 16 minutes)

Experimental condition (number)	Vibration frequency (Hz)	Frequency – weighted acceleration magnitude (m/s^2)	Unweighted acceleration magnitude (m/s^2)	Exposure duration (min)	Equivalent acceleration magnitude (m/s^2)
1	31.5	7.07	13.62	2	2.5
2	31.5	5.00	9.63	4	2.5
3	31.5	3.54	6.81	8	2.5
4	31.5	2.50	4.82	16	2.5
5	31.5	14.14	27.25	2	5.0
6	31.5	10.00	19.27	4	5.0
7	31.5	7.07	13.62	8	5.0
8	31.5	5.00	9.63	16	5.0
9	125	7.07	55.68	2	2.5
10	125	5.00	39.37	4	2.5
11	125	3.54	27.84	8	2.5
12	125	2.50	19.69	16	2.5
13	125	14.14	111.36	2	5.0
13	125	10.00	78.74	4	5.0
15	125	7.07	55.68	8	5.0
16	125	5.00	39.37	16	5.0

Computer software SAS was used for the statistical analysis. In the analysis, the measured vibrotactile thresholds at 30 s after exposure for each subject and condition were compared with the corresponding measured thresholds before the exposure to vibration (the pre-test). The difference was used as an indication of response on the perception sensation. For the statistical analysis, repeated measures analysis of variance (ANOVA) with mixed model was used to test the hypothesis of “no difference” in the responses for the different exposure conditions.

1.2 Results

In Table 2 the results from the conducted experiments presented as the mean changes in the vibrotactile thresholds compared to the pre-test for the different experimental conditions (Table 1). In the table is shown the changes as function of time of measurement up to 30 min.

The frequency of the vibration stimuli (31.5 or 125 Hz) had significant ($p<0.0001$) influence on the vibrotactile thresholds after exposure. The increase of the thresholds was greater at 125 Hz compared to 31.5 Hz ($p<0.001$) and 30 s after the exposure the mean difference was about 13 dB. The difference was, calculated for all experimental conditions, significant up to 20 min after the vibration exposure, Figure 1.

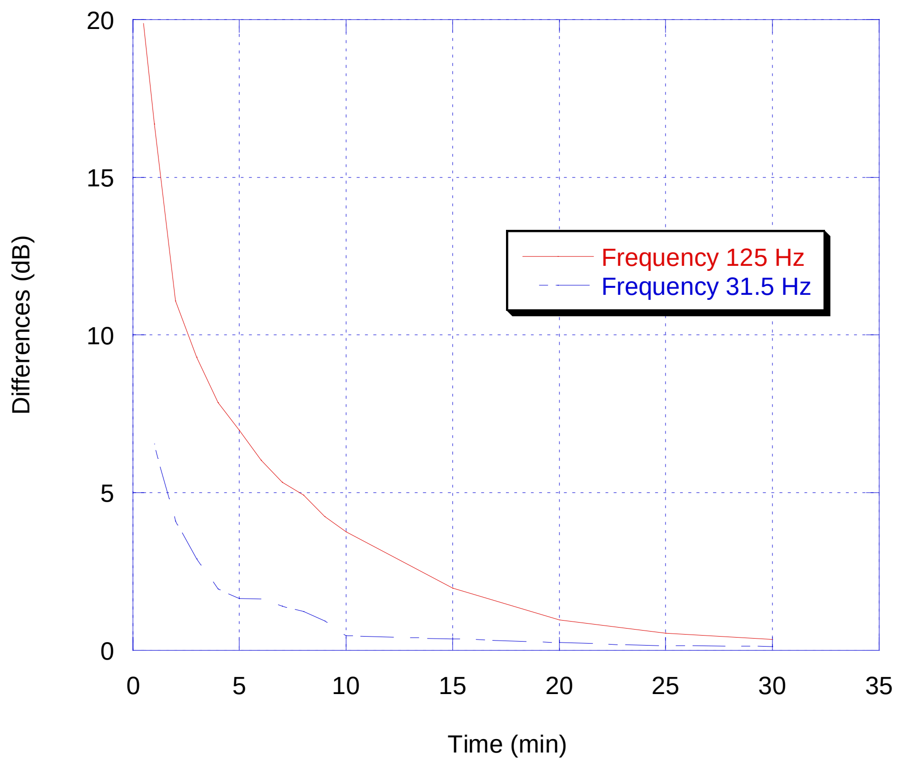

Figure 1. The changes (dB) in the mean vibrotactile threshold, calculated for all experimental conditions, for the two test frequencies as function of time of measurement after the vibration exposure.

The thresholds were significantly affected by the exposure levels ($p<0.0001$). An increase of the equivalent frequency weighted acceleration from 2.5 m/s^2 to 5.0 m/s^2 resulted in a mean increase of the thresholds with about 2.1 dB at 30 s after exposure, calculated for all experimental conditions. In Figure 2 is shown the differences (dB) in the mean vibrotactile threshold, calculated for all experimental conditions, between the two different equivalent frequencies weighted accelerations for the two test frequencies as function of time of measurement. For 31.5 Hz the differences are significant for the first 2 min and for 125 Hz for 25 min after the exposure.

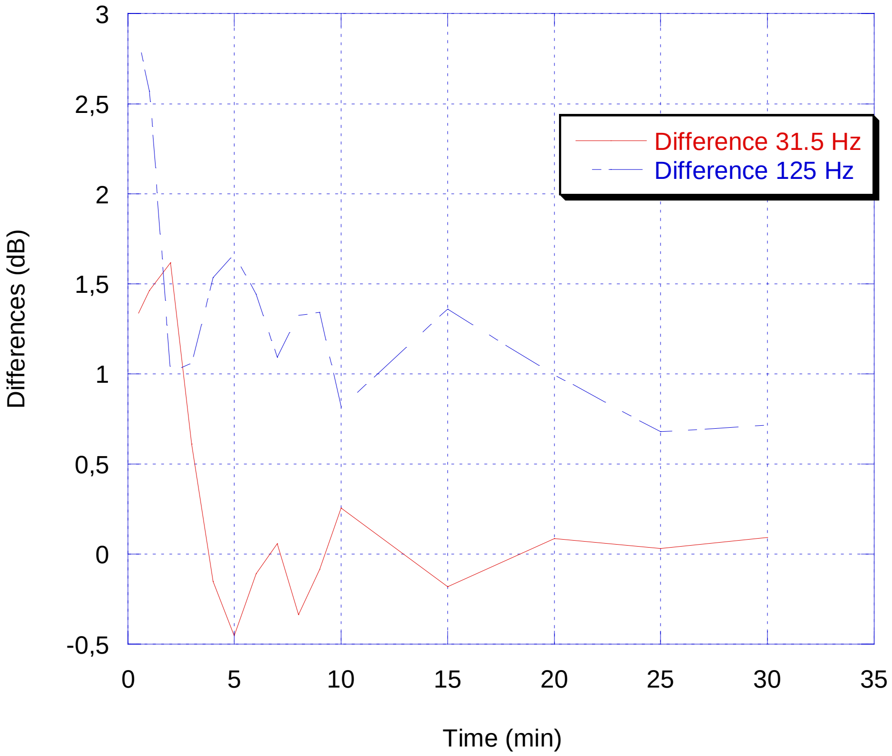

Figure 2. The differences (dB) in the mean vibrotactile threshold, calculated for all experimental conditions, between the two different equivalent frequencies weighted accelerations for the two test frequencies as function of time of measurement.

The influences of different frequency weighted accelerations are illustrated in Figure 3 for the test frequency of 31.5 Hz. The mean difference between the lowest and highest accelerations was about 3.6 dB at 30 s after exposure. There was a significant difference between the lowest and highest frequency weighted accelerations for the first six minutes after exposure. None of the other acceleration were significant different. For the test frequency of 125 Hz none of the frequency weighted accelerations were significant different. For the different frequency un-weighted accelerations the same results as for the weighted accelerations was found.

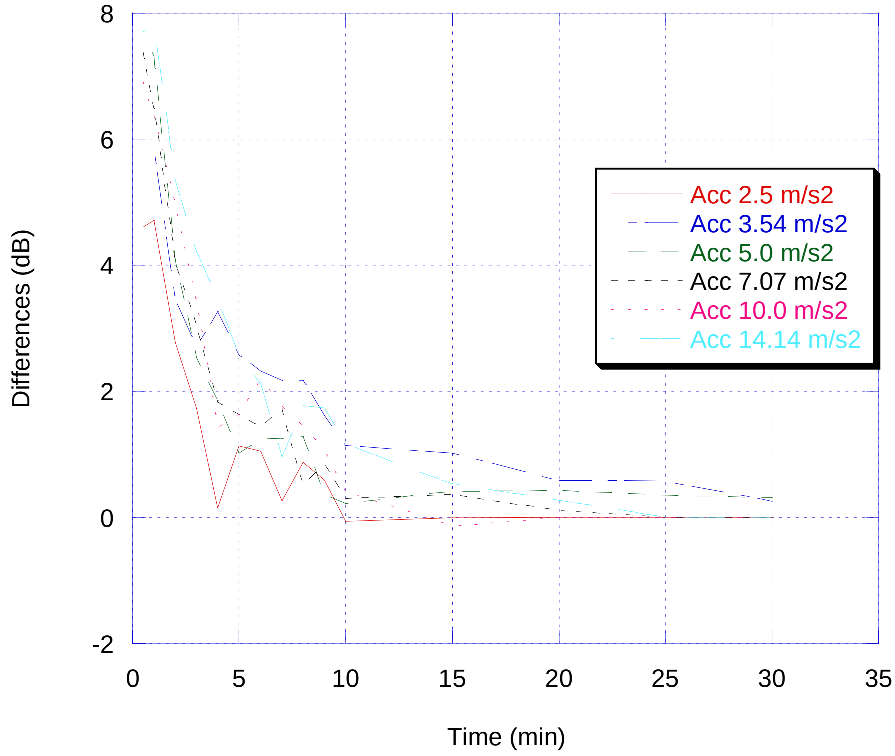

Figure 3. The differences (dB) of the vibrotactile thresholds after exposure to frequency weighted accelerations with different levels for the test frequency of 31.5 Hz as function of time of measurement.

The exposure time (2, 4, 8, 16 min) for the vibration stimuli had no significant influence on the thresholds ($p=0.7591$).

The analysis show that 10 minutes after the vibration exposure, 41% of the vibrotactile threshold tests showed a shift in the thresholds compared with the pre-test and therefore the measurement was continued. After 15 minutes 14% of the tests still had an effect and for 4 % of the experiments the measurements had to be continued for 30 minutes. The length of the recovery time was correlated with the frequency of the vibration stimuli. For all subjects and experimental conditions, the effect of the vibration exposure was significant on the vibrotactile threshold for the first ten minutes ($p<0.0001$).

1.3 Conclusion

The outcome from this study clearly shows that vibration produces a significant acute effect on the vibrotactile thresholds of the exposed finger. The strength of the effect depends on the vibration frequency and magnitude. The increase of the vibrotactile thresholds was greater at a vibration stimuli of 125 Hz compared to 31.5 Hz.

Threshold recovery measures show that the significant influence on the thresholds due to pre-vibration exposure was dependent of the vibration frequency and could be measured up to 20 minutes. However, the exposure time did not exceed 16 minutes and the corresponding 8-hour equivalent acceleration, A(8), according to ISO 5349-1 is 0.46 m/s^2 and 0.92 m/s^2, respectively. These accelerations are well below the action level (2.5 m/s^2) established in the European vibration directive (2002). Therefore, it could be concluded it is important to recognize that prior exposure to vibration on the day of a test is likely to influence the results obtained for determining the vibrotactile thresholds. The test person should be given a vibration free period before testing. From this study it could be stated the minimum require vibration free period before measuring the tactile perception threshold is 30 min. However, this time period is without any safety margins and therefore it is likely that prior exposure to vibration on the day of a test still could influence the results. The recommendation is therefore to avoid vibration exposure 4 hours prior the measurement of the vibrotactile perception thresholds.

2 Recovery of the thermotactile perception thresholds shifts after exposure to vibration

This second experiment focuses on the acute thermotactile perception thresholds shifts after exposure to vibration and the influence of different vibration magnitudes, frequencies, and durations.

2.1 Methods

Ten healthy subjects, five male and five female, participated in the study. The subjects had no prior history of regular use of hand-held vibrating tools in occupational or leisure activities. All ten subjects were non-smokers and reported no cardiovascular or neurological disorders in their dominant hand. One subject had neurological disorder in the none-dominant hand due to previous hand surgery. The subjects mean age was 25 years (range 22-28), mean height 174.6 cm (range 160-183) and mean weight 70 kg (range 55-89). The Ethical Committee of Umeå University approved the study.

All subjects were asked to avoid alcohol 12 hours before testing and to avoid nicotine and caffeine consumption 1 hour before testing. The experiments were performed in a room with an ambient temperature of 22ºC (± 2ºC) and with airflow less than 0.2 m/s. The subjects were dressed in light indoor clothing and they wore hearing protections during the entire test. After an acclimatisation period of 15 minutes, finger temperature was measured by a thermocouple attached to the distal phalanx of the examined index finger (digit 2). The finger skin temperature was not allowed to be less than 28°C. When the fingers were at lower temperature the subjects used hand warmers to increase the temperature.

Thermal perception was measured using instruments outfitted with a flat contact thermo stimulator, Peltier contact thermode. The instruments were provided by Somedic (Thermo test; Somedic, Sales AB, Sweden). When measuring the perception of coldness and warmness, the volar surface of the distal phalanges of the index finger was gently applied to the probe (25x50 mm). The measured area of the index finger ranged from the fingertip to the distal interphalangeal joint. During the test, the hand of the subject was supported at the wrist. The perception threshold of cold and warmth was assessed by the Marstock method. The rate of the temperature change was linear and about 1°C/s. The subjects were seated in a chair in front of the instrumentation setup and instructed to apply a downward (push) force of 1 N during the tests. The applied force could be controlled by the subject and the research leader on a pointer instrument. The subject was instructed to press a switch whenever he or she experienced the onset of a change in the sensation of temperature (cold or warm). After a response, the temperature of the thermo stimulator changed direction from warmth to cold and vice versa.

A measure of the thermal perception of cold and warmth was conducted before the different exposures to vibration. The finger skin temperature was used as the reference temperature (starting point). After completing pre-test the subjects were instructed to place their index, middle finger and their ring finger on a horizontal wooden platform (70x70mm) mounted on a vibrator (Ling Altec Model 40). Their elbows rested at a comfortable angle on an adjustable supported platform. The exposed area of the fingers ranged from the fingertip to the second phalange. The subjects were instructed to apply a downward force of 5 N during the entire exposure time. The force was monitored by both the subjects and research leader. Immediately after the vibration exposure, the temperature threshold measurements were conducted on the exposed index finger. The acute effect was measured continuously for the first 75 seconds, followed by 30 seconds of measures at every minute up to ten minutes. The data from the last measurement were then compared with the results from the pre-test. If the deviation was larger than 2ºC compared with the pre-test, then further tests were carried out every 5 minutes until the deviation was smaller than 2ºC. The measurements continued up to 30 minutes.

Each subject was exposed to vibration under 16 conditions with a combination of different frequency, intensity, and exposure time. The conditions were the same as in experiment 1 (Table 1).

Computer software SAS was used for the statistical analysis. The thresholds were taken as the mean of the cold and warm measurements and the average number of measures for each threshold and test period was 3.5 (SD 1.8). The neutral zone was defined as the temperature difference between the warmth and cold perception thresholds. For the first 75 seconds, the analysis was divided in two time intervals (15-45s, 45-75s). In the analysis, the measured thermal thresholds for each subject and condition were compared with the corresponding measured thresholds before the exposure to vibration (the pre-test). The difference was used as an indication of response on the thermal sensation. For the statistical analysis, repeated measures analysis of variance (ANOVA) with mixed model was used to test the hypothesis of “no difference” in the responses for the different exposure conditions.

2.2 Results

In table 3 and 4 are the results from the conducted experiments presented as the mean temperature changes in the thresholds compared to the pre-test for the different experimental conditions (table 1). In the tables are shown the changes for the first 10 min after the vibration exposure for the vibration frequency of 31.5 Hz and 125 Hz, respectively. Moreover, are given in the tables the calculated neutral zones. The mean changes of the thresholds, for all experimental conditions and measurement times, were found to be between –1.5°C and 0.7°C. The corresponding changes in the neutral zone were found to be less then 1.8 °C.

The frequency of the vibration stimuli (31.5 or 125 Hz) had no significant ($0.667<p<0.953$) influence on total mean perception thresholds for the sensation of cold or warmth as well as on the neutral zone.

The thresholds for the cold and warmth sensation were significantly affected by the exposure levels ($0.001<p<0.003$) regardless of the how the exposure levels were expressed (frequency weighted, unweighted or equivalent). An increase of the equivalent frequency weighted acceleration from 2.5 m/s^2 to 5.0 m/s^2 resulted in a mean decrease of the cold and warmth thresholds with about 0.2°C and 0.1°C respectively. For the frequency weighted acceleration or the unweighted acceleration, no clear exposure response relationship could be found. If the acceleration is divided into two categories, low and high acceleration levels, a significant difference could be found ($p=0.005$; $p=0.006$ respectively). Higher acceleration level produced a decrease of both thresholds with about 0.1°C. The neutral zone was significantly ($p=0.001$) affected by the unweighted acceleration, but not for the other two measures ($0.150<p<0.158$).

The exposure time (2, 4, 8, 16 min) for the vibration stimuli had a significant influence on the thresholds for cold and warmth sensations ($p=0.002$; $p=0.003$ respectively), but the neutral zone was not affected ($p=0.127$). There was a significant difference ($p=0.015$) between short exposure time (2 and 4 minutes) and long exposure time (8 and 16 minutes). Longer exposure time resulted in a decreased of both thresholds with about 0.1°C.

The analysis shows that 10 minutes after the vibration exposure, 14% of the tests had a larger deviation than 2ºC compared with the pre-test and therefore the measurement was continued. After 15 minutes 6% of the tests still had an effect and in 2 experiments the measurements had to be continued for 30 minutes. No correlation was found between the length of recovery time and different experimental conditions as well as individual factors among the subjects. The effect of the vibration exposure was only significant ($p<0.001$) on the cold threshold and the neutral zone for the first minute after exposure. Figure 1 shows the relationship between time of measurement and changes (ºC) in the mean cold threshold compared to the pre-test. The decrease in the threshold is within the range of 0.5-0.7 ºC. The effect was independent of the exposure time, vibration level and gender. The warmth threshold was not significantly affected.

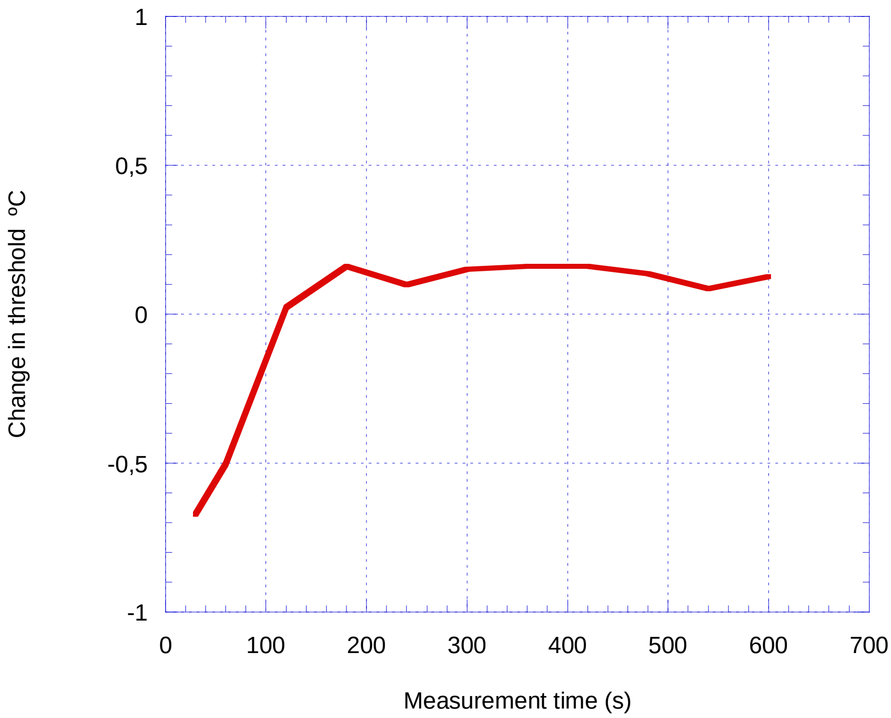

Figure 4. The relation between time of measurement and changes (ºC) in the mean cold threshold compared to the pre-test.

2.3 Conclusion

Threshold recovery measures show that the significant influence on the thresholds due to pre-vibration exposure was relatively short, about 1 minute. Moreover, in two experiments it took up to 30 minutes before recovery. However, the exposure time did not exceed 16 minutes and the corresponding 8-hour equivalent acceleration, A(8), according to ISO 5349-1 is 0.46 m/s^2 and 0.92 m/s^2, respectively. These accelerations are well below the action level (2.5 m/s^2) established in the European vibration directive (2002).

Therefore, it could be concluded that it is important to recognize that prior exposure to vibration on the day of a test is likely to influence the results obtained for determining the thermotactile thresholds. The test person should be given a vibration free period before testing. From this study it could be stated the minimum require vibration free period before measuring the thermal perception threshold is 2 min. However, this period is without any safety margins and therefore it is likely that prior exposure to vibration on the day of a test still could influence the results. The recommendation is therefore to avoid vibration exposure 2 hours prior the measurement of the thermal perception thresholds.

3 Recovery of the vibrotactile and thermotactile perception thresholds after exposure to continuous and intermittent vibration

In the third experiment, the acute effects of continuous and intermittent vibration on the vibrotactile and thermotactile perception thresholds were investigated by combinations of vibration with different periods of exposure and rest periods.

3.1 Methods

The subjects and experimental procedure were the same as in experiment 1 and 2 for measuring the respective thresholds. The subjects were exposed to vibration under 4 conditions (Table 5) of vibration with different periods of exposure and rest periods. The subjects were only allowed to conduct one test per day, and the test order was distributed with a repeated measures design. The vibration, a sinusoidal vibration at a frequency of 125 Hz, was generated by an IBM computer based system. The vibration was sent via an amplifier (Sentec PA 9) to the vibrator, producing motions in the vertical direction. The frequency-weighted vibration intensity was 5 m/s^2, corresponding to an unweighted acceleration magnitude of 39.37 m/s^2. According to ISO 5349-1, the calculated energy-equivalent frequency weighted acceleration magnitude for the exposure time of 16 minutes was 5.0 m/s^2 (Table 3) and calculated for the experimental time include vibration free periods it varied between 3.6 to 5.0 m/s^2.

The combination is: 1 period of 16-min continuous vibration (rest period 0 min), 2 periods of 8 min, separated by a 8-min period with no vibration (rest period 8 min), 4 periods of 4 min, separated by 4 min periods with no vibration (rest period 12 min) and 8 periods of 2 min, separated by 2-min periods with no vibration (rest period 14 min).

Table 5. Conditions of exposure used in this study (the r.m.s. acceleration magnitude of vibration and the energy-equivalent frequency weighted acceleration magnitude for the whole experimental time of 16 minutes)

Vibration frequency (Hz)	Frequency - weighted acceleration magnitude (m/s^2)	Unweighted acceleration magnitude (m/s^2)	Exposure duration (min)	Equivalent acceleration magnitude (m/s^2)
125	5.00	39.37	2+2+2+2	5
125	5.00	39.37	4+4+4	5
125	5.00	39.37	8+8	5
125	5.00	39.37	16	5

Computer software SAS was used for the statistical analysis. The thermotactile thresholds were taken as the mean of the cold and warm measurements. The neutral zone was defined as the temperature difference between the warmth and cold perception thresholds. For the first 75 seconds, the analysis for both vibrotactile and thermotactile perception thresholds, was divided in two time intervals (15-45s, 45-75s). In the analysis, the measured thresholds for each subject and condition were compared with the corresponding measured thresholds before the exposure to vibration (the pre-test). The difference was used as an indication of response on the thermal sensation. For the statistical analysis, repeated measures analysis of variance (ANOVA) with mixed model was used to test the hypothesis of "no difference" in the responses for the different exposure conditions.

3.2 Results

In Table 6 and 7 the results from the conducted experiments presented as the mean changes in the vibrotactile and thermotactile perception thresholds compared to the pre-test for the different experimental conditions (Table 5).

The influences on the vibrotactile thresholds due to the different type of exposures are illustrated in Figure 5 as function of time of measurement. The influence on the vibrotactile thresholds was significant different due to the different combination of exposure for the first three min (p=0.019) after the exposure. The observed significant differences were between the one with shortest (2 min) exposure periods and the longest (16 min (p=0.048; 8+8 min p=0.004 respectively). For the other combination no significant influence was found. The 2 min exposures lead to a mean lower temporary threshold shift of 3.5 – 4.5 dB, 30 s after the exposure.

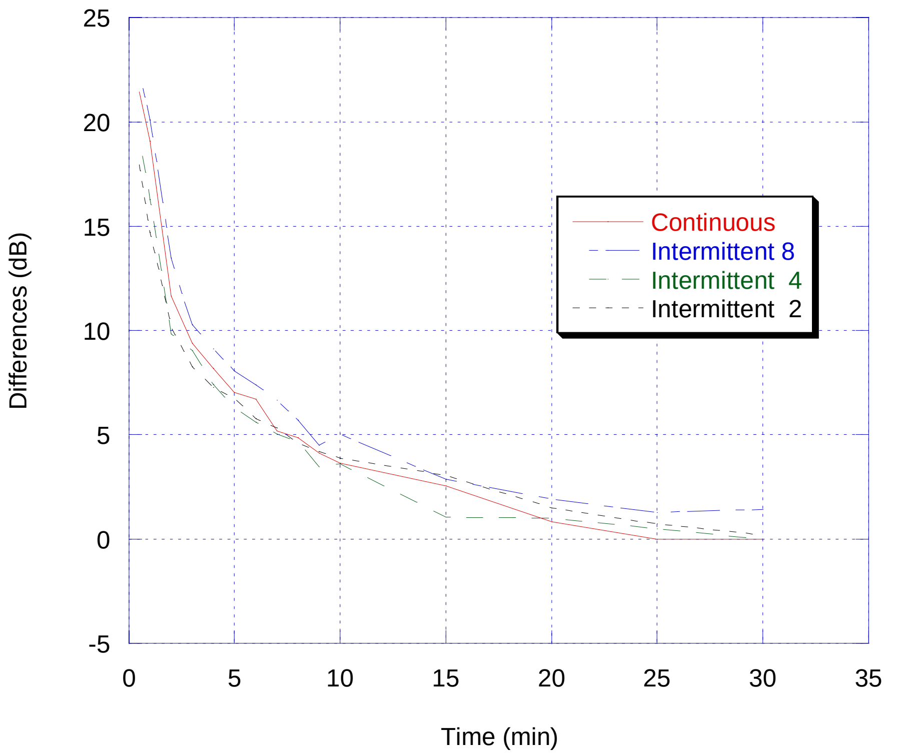

Figure 5. The differences (dB) of the vibrotactile thresholds after exposure to frequency weighted accelerations with different levels for the test frequency of 31.5 Hz as function of time of measurement.

The combinations of the different exposure types had no significant ($0.242<p<0.413$) influence on the thermotactile thresholds for the sensation of cold or warmth as well as on the neutral zone.

3.3 Conclusion

No significant acute effects on the thermal perception thresholds for the sensation of cold or warmth as well as on the neutral zone were found between combinations of vibration with different periods of exposure and rest periods. For the influences on the vibrotactile thresholds due to the different type of exposures was related to the combinations of exposure periods. Shorter period of exposure led to lower temporary threshold shift.

Table 2. The mean changes (dB) in the vibrotactile perception thresholds compared to the pre-test for the different experimental conditions (Table 1). The results are presented for the 30 min (1800 s) after the vibration exposure. Within parenthesis the standard deviation is given.

	Time (s)														
Con.	30	60	120	180	240	300	360	420	480	540	600	900	1200	1500	1800
1	7,28 (1,88)	6,42 (2,95)	3,50 (2,73)	3,58 (2,76)	2,72 (2,29)	2,17 (4,04)	2,13 (2,79)	2,31 (2,42)	1,20 (3,07)	1,63 (2,42)	0,53 (2,80)	0,73 (2,30)	0,22 (0,68)	0,00 (0)	0,00 (0)
2	7,15 (2,84)	6,26 (3,17)	3,46 (2,59)	2,38 (3,32)	2,00 (3,50)	1,64 (3,01)	1,23 (2,75)	0,70 (3,03)	1,35 (3,58)	0,05 (3,43)	-0,27 (4,77)	0,10 (0,33)	0,00 (0)	0,00 (0)	0,00 (0)
3	5,89 (2,74)	5,84 (3,30)	3,45 (2,77)	2,71 (3,17)	3,26 (3,79)	2,57 (3,44)	2,32 (3,59)	2,17 (4,51)	2,17 (4,10)	1,61 (4,64)	1,14 (3,63)	1,02 (1,93)	0,58 (1,83)	0,58 (1,83)	0,26 (0,82)
4	4,61 (4,08)	4,72 (4,90)	2,78 (3,63)	1,73 (2,75)	0,15 (4,48)	1,13 (3,22)	1,05 (2,97)	0,26 (3,74)	0,87 (2,99)	0,59 (3,18)	-0,06 (4,41)	-0,01 (0,28)	0,00 (0)	0,00 (0)	0,00 (0)
5	17,10 (3,94)	14,91 (4,77)	10,21 (3,46)	9,57 (4,01)	8,24 (4,13)	7,54 (4,13)	6,32 (4,29)	6,07 (4,20)	5,50 (4,09)	4,88 (3,55)	5,36 (3,69)	2,43 (2,70)	0,81 (2,49)	0,45 (1,28)	0,00 (0)
6	17,74 (3,93)	14,60 (3,86)	10,36 (3,11)	8,67 (3,30)	7,42 (3,18)	6,37 (2,38)	5,57 (2,65)	5,10 (2,51)	4,44 (2,69)	4,09 (2,97)	3,79 (3,44)	1,01 (2,16)	0,38 (1,19)	0,35 (1,12)	0,00 (0)
7	19,67 (4,61)	15,61 (5,26)	11,08 (3,65)	8,58 (3,72)	6,27 (2,98)	5,63 (2,48)	4,29 (2,33)	3,67 (2,88)	2,97 (2,99)	2,28 (2,62)	1,47 (2,81)	0,36 (1,44)	0,35 (1,10)	0,00 (0)	0,00 (0)
8	19,33 (3,78)	16,50 (4,12)	10,71 (3,61)	8,26 (3,34)	6,42 (3,22)	5,09 (3,16)	5,10 (2,87)	4,27 (2,63)	4,14 (2,47)	3,05 (2,99)	2,81 (2,32)	1,38 (2,09)	0,39 (1,22)	0,00 (0)	0,00 (0)
9	7,71 (3,89)	7,80 (2,85)	5,36 (3,81)	4,21 (3,76)	3,46 (4,53)	2,56 (4,72)	2,11 (4,18)	0,96 (2,65)	1,77 (3,92)	1,74 (4,66)	1,16 (3,49)	0,54 (1,76)	0,27 (0,86)	0,00 (0)	0,00 (0)
10	6,91 (3,91)	6,37 (3,19)	4,98 (3,44)	3,44 (3,96)	1,42 (3,72)	1,63 (4,18)	2,20 (2,86)	1,77 (3,26)	1,45 (3,09)	1,07 (3,35)	0,41 (3,18)	-0,14 (0,45)	0,00 (0)	0,00 (0)	0,00 (0)
11	7,48 (4,68)	6,55 (4,15)	4,60 (4,24)	2,51 (3,12)	0,95 (2,26)	1,10 (2,30)	0,74 (2,87)	1,13 (2,48)	-0,17 (2,19)	0,08 (1,70)	0,07 (2,06)	0,00 (0)	0,00 (0)	0,00 (0)	0,00 (0)
12	8,17 (4,70)	8,37 (4,84)	4,72 (4,19)	2,68 (3,40)	1,70 (3,23)	0,40 (3,81)	1,25 (3,21)	1,81 (3,29)	1,21 (3,53)	0,66 (4,18)	0,71 (3,80)	0,72 (2,50)	0,86 (2,73)	0,70 (2,22)	0,63 (1,99)
13	19,54 (3,92)	15,16 (4,78)	10,31 (3,94)	9,36 (4,34)	7,97 (4,06)	6,99 (3,18)	6,22 (3,38)	5,18 (3,35)	5,29 (3,23)	4,49 (3,53)	3,58 (3,81)	2,54 (2,87)	2,12 (4,27)	1,43 (3,42)	1,34 (4,20)
14	20,87 (3,89)	17,77 (3,76)	11,23 (3,27)	9,67 (3,02)	8,81 (3,51)	8,06 (3,49)	7,36 (3,06)	6,63 (3,11)	6,28 (3,01)	5,41 (2,51)	4,88 (2,80)	2,16 (3,59)	1,49 (2,61)	0,99 (2,25)	0,54 (1,71)
15	23,49 (2,67)	19,90 (3,51)	13,18 (3,11)	10,90 (3,83)	9,52 (3,70)	9,23 (4,20)	6,76 (3,83)	6,50 (3,80)	5,91 (4,08)	5,65 (4,00)	4,58 (4,06)	3,36 (3,41)	1,43 (3,46)	1,10 (2,48)	0,97 (2,28)
16	21,44 (6,03)	19,08 (5,77)	11,67 (5,66)	9,38 (5,84)	8,20 (5,29)	7,03 (4,88)	6,71 (4,64)	5,18 (4,95)	4,87 (4,48)	4,12 (4,87)	3,64 (4,49)	2,56 (4,54)	0,85 (2,74)	0,00 (0)	0,00 (0)

Table 3. The mean changes (ºC) in the warm and cold thresholds compared to the pre-test for the different experimental conditions (Table 1) that contains a vibration frequency of 31.5 Hz as well as the corresponding calculated neutral zones. The results are presented for the first 600 s after the vibration exposure. Within parenthesis the standard deviation is given.

Experimental condition	Measure	Time (s)										
		30	60	120	180	240	300	360	420	480	540	600
1	Warm	-0,24 (1,75)	-0,14 (1,73)	0,47 (0,67)	0,33 (0,67)	0,24 (0,77)	0,16 (0,63)	0,43 (0,91)	0,36 (0,86)	0,23 (1,10)	0,20 (0,99)	0,01 (1,12)
	Cold	0,00 (0,61)	0,07 (0,72)	0,34 (0,50)	0,32 (0,45)	0,32 (0,45)	0,22 (0,35)	0,36 (0,77)	0,43 (0,33)	0,42 (0,39)	0,47 (0,70)	0,34 (0,68)
	Neutral zone	-0,25 (1,57)	-0,21 (1,28)	0,13 (0,81)	0,01 (0,75)	-0,08 (0,93)	-0,06 (0,70)	0,07 (1,17)	-0,07 (0,84)	-0,19 (1,13)	-0,27 (1,04)	-0,33 (1,10)
2	Warm	0,10 (0,81)	0,59 (1,29)	0,19 (0,69)	0,29 (0,63)	0,32 (0,82)	0,39 (0,80)	0,45 (0,69)	0,29 (0,52)	0,22 (0,85)	0,38 (0,99)	0,21 (0,73)
	Cold	-0,34 (0,79)	-0,22 (0,99)	0,09 (0,83)	0,21 (0,74)	0,17 (0,82)	0,26 (0,61)	0,36 (0,70)	0,22 (0,56)	0,16 (0,79)	0,10 (0,63)	0,03 (0,70)
	Neutral zone	0,44 (0,68)	0,81 (1,47)	0,10 (0,77)	0,08 (0,69)	0,15 (0,79)	0,13 (0,65)	0,09 (0,74)	0,07 (0,69)	0,06 (0,71)	0,28 (0,88)	0,18 (0,80)
3	Warm	0,11 (0,45)	0,12 (0,83)	0,41 (0,56)	0,51 (0,84)	0,11 (0,70)	0,38 (1,11)	0,49 (1,17)	0,45 (1,21)	0,42 (1,20)	0,32 (1,08)	0,54 (1,23)
	Cold	-0,15 (1,06)	-0,37 (1,12)	0,05 (0,74)	0,33 (0,65)	-0,17 (1,06)	0,10 (0,58)	-0,13 (0,39)	0,27 (0,70)	0,17 (0,61)	-0,01 (0,60)	0,29 (0,44)
	Neutral zone	0,26 (0,93)	0,48 (0,98)	0,36 (0,71)	0,18 (0,92)	0,28 (0,99)	0,28 (1,10)	0,62 (1,18)	0,18 (0,95)	0,25 (1,03)	0,33 (0,91)	0,25 (1,19)
4	Warm	-0,13 (1,23)	0,11 (1,45)	0,42 (0,99)	0,61 (1,29)	0,58 (1,04)	0,25 (1,11)	0,56 (0,98)	0,46 (0,79)	0,31 (0,93)	0,41 (0,96)	0,73 (0,89)
	Cold	-0,56 (1,07)	-0,21 (0,96)	0,14 (0,65)	0,24 (0,69)	0,28 (0,77)	0,36 (0,75)	0,47 (0,69)	0,23 (0,73)	0,26 (0,99)	0,12 (0,88)	0,32 (0,88)
	Neutral zone	0,43 (1,39)	0,33 (1,34)	0,28 (0,82)	0,37 (1,27)	0,30 (1,16)	-0,11 (1,13)	0,09 (0,86)	0,23 (0,82)	0,05 (0,81)	0,29 (0,78)	0,41 (0,77)
5	Warm	-0,02 (1,02)	0,45 (0,95)	0,32 (0,63)	0,45 (0,73)	0,46 (0,63)	0,42 (0,92)	0,43 (0,96)	0,32 (1,05)	0,49 (1,02)	0,37 (0,96)	0,35 (1,12)
	Cold	-0,75 (0,71)	-0,41 (0,86)	-0,15 (0,47)	-0,06 (0,61)	-0,02 (0,59)	-0,01 (0,67)	0,08 (0,82)	-0,02 (0,75)	0,04 (0,53)	0,05 (0,80)	-0,12 (0,56)
	Neutral zone	0,72 (1,08)	0,86 (1,04)	0,47 (0,77)	0,51 (0,96)	0,48 (0,70)	0,43 (0,93)	0,35 (0,94)	0,34 (0,96)	0,45 (0,89)	0,32 (0,94)	0,47 (0,88)
6	Warm	-0,45 (1,47)	-0,22 (1,35)	-0,19 (1,21)	-0,17 (1,14)	0,15 (1,38)	0,13 (1,79)	-0,05 (1,37)	0,10 (1,66)	-0,08 (1,75)	-0,10 (1,68)	-0,17 (1,51)
	Cold	-1,00 (1,27)	-0,79 (1,21)	-0,12 (0,79)	-0,12 (0,71)	-0,28 (0,77)	-0,14 (0,70)	-0,11 (0,76)	0,06 (0,64)	-0,03 (0,73)	-0,43 (1,02)	-0,24 (0,91)
	Neutral zone	0,55 (1,17)	0,57 (1,31)	-0,07 (0,83)	-0,05 (1,22)	0,43 (1,51)	0,27 (2,01)	0,06 (1,43)	0,04 (1,42)	-0,05 (1,57)	0,33 (1,71)	0,07 (1,66)
7	Warm	0,26 (1,08)	0,23 (1,13)	0,17 (0,89)	0,16 (0,68)	0,43 (1,01)	0,25 (0,98)	0,17 (1,08)	0,30 (0,98)	0,21 (1,17)	0,04 (0,80)	0,17 (0,95)
	Cold	-0,53 (0,52)	-0,29 (0,55)	0,17 (0,66)	0,30 (0,65)	0,34 (0,48)	0,28 (0,73)	0,33 (0,77)	0,22 (0,72)	0,15 (0,76)	0,28 (0,57)	0,25 (0,67)
	Neutral zone	0,79 (1,38)	0,52 (0,88)	0,00 (1,21)	-0,14 (0,87)	0,09 (0,97)	-0,03 (1,03)	-0,16 (1,20)	0,08 (1,01)	0,06 (1,51)	-0,24 (0,92)	-0,08 (1,39)
8	Warm	-0,35 (2,21)	-0,15 (2,18)	-0,21 (1,67)	0,07 (1,53)	-0,03 (1,63)	-0,05 (1,58)	-0,07 (1,59)	-0,06 (1,76)	-0,09 (1,62)	-0,18 (1,81)	-0,17 (1,80)
	Cold	-1,17 (1,94)	-0,95 (2,04)	-0,40 (1,17)	-0,01 (0,96)	-0,18 (0,65)	-0,10 (0,74)	-0,05 (0,68)	-0,03 (0,83)	-0,02 (0,75)	-0,21 (1,01)	-0,05 (0,96)
	Neutral zone	0,82 (1,56)	0,81 (1,33)	0,19 (1,29)	0,08 (1,23)	0,15 (1,48)	0,05 (1,23)	-0,02 (1,41)	-0,03 (1,20)	-0,07 (1,08)	0,03 (0,91)	-0,12 (1,08)

Table 4. The mean changes (ºC) in the warm and cold thresholds compared to the pre-test for the different experimental conditions (Table 1) that contains a vibration frequency of 125 Hz as well as the corresponding calculated neutral zones. The results are presented for the first 600 s after the vibration exposure. Within parenthesis the standard deviation is given.

Experimental condition	Measure	Time (s) 30	60	120	180	240	300	360	420	480	540	600
9	Warm	0,51 (0,94)	0,45 (1,27)	0,60 (0,93)	0,60 (0,80)	0,38 (0,94)	0,51 (0,73)	0,57 (0,87)	0,32 (1,13)	0,44 (1,08)	0,39 (1,21)	0,15 (1,28)
	Cold	-0,41 (0,99)	-0,46 (1,16)	0,19 (1,05)	0,40 (0,96)	0,55 (1,02)	0,67 (0,97)	0,55 (0,93)	0,48 (0,84)	0,40 (0,98)	0,60 (1,02)	0,54 (0,97)
	Neutral zone	0,92 (1,27)	0,91 (1,02)	0,41 (1,33)	0,20 (1,14)	-0,17 (1,22)	-0,16 (0,91)	0,02 (1,08)	-0,16 (1,22)	0,04 (1,16)	-0,21 (1,39)	-0,39 (1,39)
10	Warm	0,21 (0,45)	0,18 (1,17)	0,49 (0,68)	0,57 (0,83)	0,60 (0,74)	0,63 (1,10)	0,60 (0,91)	0,33 (0,88)	0,50 (1,02)	0,17 (0,90)	0,45 (1,11)
	Cold	-0,73 (0,78)	-0,57 (0,78)	0,19 (0,47)	0,51 (0,81)	0,53 (0,77)	0,42 (0,69)	0,46 (0,63)	0,32 (0,92)	0,38 (0,64)	0,31 (0,51)	0,27 (0,52)
	Neutral zone	0,94 (1,02)	0,75 (1,11)	0,30 (0,77)	0,06 (1,08)	0,07 (0,91)	0,21 (1,25)	0,14 (0,91)	0,01 (1,20)	0,12 (0,95)	-0,14 (1,01)	0,18 (1,18)
11	Warm	0,43 (0,94)	0,23 (0,78)	0,22 (0,71)	0,26 (0,93)	0,04 (0,87)	-0,24 (0,67)	0,02 (0,99)	0,19 (0,95)	0,34 (1,38)	0,33 (1,26)	0,23 (1,20)
	Cold	-0,47 (1,14)	-0,39 (0,90)	-0,19 (0,73)	0,08 (0,88)	0,00 (0,86)	-0,09 (0,97)	-0,06 (0,86)	-0,12 (0,89)	-0,10 (0,96)	-0,11 (1,05)	-0,02 (0,94)
	Neutral zone	0,89 (1,32)	0,62 (0,79)	0,41 (0,78)	0,18 (0,90)	0,04 (0,77)	-0,15 (0,69)	0,08 (0,91)	0,31 (0,80)	0,44 (1,00)	0,44 (0,87)	0,25 (1,28)
12	Warm	-0,07 (0,87)	0,09 (0,94)	-0,08 (0,63)	-0,18 (0,80)	-0,20 (0,52)	-0,18 (0,65)	-0,05 (0,51)	-0,27 (0,93)	-0,04 (0,93)	-0,01 (1,18)	-0,23 (0,96)
	Cold	-0,84 (1,58)	-0,55 (1,31)	0,00 (1,04)	0,09 (1,17)	0,00 (0,79)	0,15 (0,99)	0,07 (0,82)	0,09 (1,29)	0,05 (0,85)	-0,05 (0,62)	0,00 (1,07)
	Neutral zone	0,77 (1,37)	0,64 (1,21)	-0,08 (1,01)	-0,27 (0,84)	-0,20 (0,53)	-0,33 (0,73)	-0,12 (0,57)	-0,36 (0,57)	-0,09 (0,54)	0,04 (0,75)	-0,23 (0,61)
13	Warm	0,18 (1,65)	0,45 (1,69)	0,27 (0,84)	0,26 (0,56)	0,05 (1,03)	0,04 (1,08)	0,01 (1,04)	-0,31 (1,10)	-0,09 (0,95)	0,01 (0,95)	-0,07 (1,24)
	Cold	-0,94 (1,34)	-0,52 (1,61)	0,02 (0,81)	0,28 (0,71)	0,27 (0,99)	0,31 (1,06)	0,13 (0,76)	0,03 (0,86)	0,13 (0,99)	0,11 (0,88)	0,12 (1,13)
	Neutral zone	1,12 (0,97)	0,96 (0,74)	0,25 (0,27)	-0,02 (0,43)	-0,22 (0,74)	-0,27 (0,80)	-0,12 (0,48)	-0,34 (0,71)	-0,22 (0,44)	-0,10 (0,56)	-0,19 (0,68)
14	Warm	-0,13 (1,28)	0,10 (1,24)	0,02 (0,70)	0,07 (1,03)	-0,13 (0,91)	0,06 (0,93)	-0,10 (1,04)	0,05 (0,95)	-0,05 (1,23)	0,06 (1,42)	0,23 (1,43)
	Cold	-1,50 (1,23)	-1,08 (1,28)	0,04 (0,60)	-0,01 (0,46)	-0,02 (0,71)	-0,01 (0,70)	0,15 (0,59)	0,28 (0,50)	0,03 (0,85)	0,13 (0,58)	0,26 (0,59)
	Neutral zone	1,37 (1,28)	1,18 (1,32)	-0,02 (0,78)	0,08 (0,96)	-0,11 (0,62)	0,07 (0,50)	-0,25 (0,66)	-0,23 (0,79)	-0,08 (0,76)	-0,07 (1,04)	-0,03 (1,05)
15	Warm	0,49 (0,55)	0,54 (0,88)	0,51 (0,97)	0,42 (0,86)	0,40 (0,88)	0,52 (1,05)	0,50 (0,93)	0,28 (0,62)	0,24 (0,62)	0,46 (0,79)	0,31 (0,80)
	Cold	-0,53 (0,82)	-0,40 (0,72)	0,07 (0,31)	0,05 (0,80)	-0,02 (0,42)	-0,07 (0,43)	0,23 (0,73)	0,07 (0,37)	0,00 (0,72)	0,11 (0,70)	0,10 (0,91)
	Neutral zone	1,02 (0,75)	0,94 (0,87)	0,44 (0,98)	0,37 (1,06)	0,42 (0,85)	0,59 (1,06)	0,27 (1,24)	0,21 (0,84)	0,24 (0,96)	0,35 (1,06)	0,21 (1,20)
16	Warm	-0,07 (0,60)	-0,19 (0,99)	0,04 (0,93)	-0,11 (0,82)	-0,20 (0,87)	0,08 (0,66)	0,10 (0,86)	0,12 (0,61)	0,27 (0,89)	0,13 (0,68)	0,19 (0,74)
	Cold	-0,86 (0,85)	-0,90 (1,08)	-0,08 (0,62)	-0,03 (0,63)	-0,24 (0,49)	0,07 (0,70)	-0,27 (0,76)	0,03 (0,64)	0,13 (0,78)	-0,11 (0,62)	-0,07 (0,60)
	Neutral zone	0,79 (0,39)	0,71 (1,18)	0,12 (0,92)	-0,08 (0,90)	0,04 (0,75)	0,01 (0,69)	0,37 (0,96)	0,09 (0,65)	0,14 (0,94)	0,24 (0,76)	0,26 (0,75)

Table 6. The mean changes (dB) in the vibrotactile perception thresholds compared to the pre-test for the different experimental conditions (Table 5). The results are presented for the 30 min (1800 s) after the vibration exposure. Within parenthesis the standard deviation is given.

	Time (s)														
Con.	30	60	120	180	240	300	360	420	480	540	600	900	1200	1500	1800
1	21,44 (6,03)	19,08 (5,77)	11,67 (5,66)	9,38 (5,84)	8,2 (5,29)	7,03 (4,88)	6,71 (4,64)	5,18 (4,95)	4,87 (4,48)	4,12 (4,87)	3,64 (4,49)	2,56 (4,54)	0,85 (2,74)	0 (0)	0 (0)
2	22,43 (5,41)	20,09 (5,75)	13,48 (5,88)	10,28 (6,13)	9,13 (5,58)	8,07 (6,35)	7,4 (5,61)	6,66 (5,32)	5,7 (5,14)	4,49 (5,34)	5,03 (4,99)	2,88 (4,75)	1,91 (3,54)	1,28 (2,94)	1,43 (3,19)
3	19,18 (2,73)	16,29 (3,08)	9,82 (4,21)	9,05 (2,92)	7,42 (2,94)	6,29 (3,2)	5,6 (3,28)	5,04 (3,12)	4,67 (3,15)	3,47 (2,93)	3,6 (2,95)	1,06 (2,38)	1,02 (2,16)	0,48 (1,06)	0 (0)
4	17,94 (3,95)	14,7 (5,15)	10,17 (4,78)	8,26 (4,87)	7,26 (4,73)	6,75 (4,7)	5,77 (4,26)	5,34 (4,16)	4,59 (4,4)	4,2 (3,67)	3,87 (3,72)	3,04 (3,91)	1,48 (2,49)	0,74 (1,67)	0,19 (0,6)

Table 7. The mean changes (ºC) in the warm and cold thresholds compared to the pre-test for the different experimental conditions (Table 5) as well as the corresponding calculated neutral zones. The results are presented for the first 600 s after the vibration exposure. Within parenthesis the standard deviation is given.

Experimental condition	Measure	Time (s)										
		30	60	120	180	240	300	360	420	480	540	600
1	Warm	-0,07 (0,60)	-0,19 (0,99)	0,04 (0,93)	-0,11 (0,82)	-0,20 (0,87)	0,08 (0,66)	0,10 (0,86)	0,12 (0,61)	0,27 (0,89)	0,13 (0,68)	0,19 (0,74)
	Cold	-0,86 (0,85)	-0,90 (1,08)	-0,08 (0,62)	-0,03 (0,63)	-0,24 (0,49)	0,07 (0,70)	-0,27 (0,76)	0,03 (0,64)	0,13 (0,78)	-0,11 (0,62)	-0,07 (0,60)
	Neutral zone	0,79 (0,39)	0,71 (1,18)	0,12 (0,92)	-0,08 (0,90)	0,04 (0,75)	0,01 (0,69)	0,37 (0,96)	0,09 (0,65)	0,14 (0,94)	0,24 (0,76)	0,26 (0,75)
2	Warm	-0,15 (1,17)	-0,09 (1,08)	-0,06 (0,85)	-0,06 (0,70)	-0,07 (0,70)	-0,12 (0,94)	0,21 (0,54)	-0,08 (0,80)	0,17 (0,76)	0,02 (1,12)	0,25 (0,82)
	Cold	-0,74 (0,94)	-0,81 (1,11)	-0,13 (0,76)	0,02 (0,70)	-0,11 (0,50)	0,08 (0,64)	0,26 (0,50)	0,07 (0,51)	0,13 (0,51)	0 (0,37)	0,25 (0,39)
	Neutral zone	0,58 (0,97)	0,72 (0,77)	0,07 (0,94)	-0,08 (0,86)	0,04 (0,69)	-0,20 (0,84)	-0,05 (0,67)	-0,15 (0,81)	0,04 (0,89)	0,02 (1,08)	0 (0,89)
3	Warm	-0,30 (1,02)	-0,38 (0,99)	-0,17 (0,68)	-0,07 (0,44)	-0,08 (0,33)	-0,10 (0,54)	0,15 (0,66)	-0,08 (0,78)	0,09 (0,47)	0,08 (0,62)	-0,05 (0,66)
	Cold	-0,47 (1,11)	-0,69 (1,19)	-0,15 (0,92)	-0,07 (0,69)	-0,09 (0,84)	-0,10 (0,79)	0,18 (0,69)	0,03 (0,67)	0,11 (0,76)	0,21 (0,89)	0,20 (0,66)
	Neutral zone	0,17 (1,02)	0,31 (1,11)	-0,02 (0,87)	0 (0,66)	0,01 (0,72)	0 (0,62)	-0,03 (0,69)	-0,11 (0,49)	-0,02 (0,54)	-0,13 (0,60)	-0,25 (0,58)
4	Warm	-0,54 (1,15)	0,12 (1,34)	0,14 (0,75)	0,08 (0,86)	-0,03 (0,49)	-0,04 (0,71)	-0,20 (0,61)	-0,19 (0,50)	-0,10 (0,76)	0 (0,67)	-0,04 (0,88)
	Cold	-0,72 (1,14)	-0,37 (0,99)	-0,06 (0,66)	-0,10 (0,51)	-0,07 (0,72)	0,05 (0,54)	-0,11 (0,77)	-0,13 (0,73)	-0,17 (0,87)	-0,28 (0,73)	-0,07 (0,60)
	Neutral zone	0,19 (1,11)	0,48 (1,06)	0,20 (0,96)	0,18 (1,15)	0,04 (0,99)	-0,09 (1,01)	-0,09 (1,27)	-0,06 (0,89)	0,07 (1,16)	0,28 (1,10)	0,03 (1,24)