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Hand's Vibration Perception Thresholds – a systematic review

Emanuel Silva [a, 1], Isabel C. Lisboa [b], Nélson Costa [a]

[a] ALGORITMI, Campus de Azurém, 4800-058 Guimarães, Portugal

[b] NOVA School of Science and Technology, UNINOVA-CTS and LASI, NOVA University Lisbon, 1099-085 Lisbon, Portugal

Abstract

The term vibration perception threshold (VPT) refers to the minimum amplitude required for a vibration to be consciously perceived. Knowledge of VPTs can be used to aid in the diagnosis of various pathologies, or to support design decisions during human-machine interface development. However, several factors affect VPTs measurements (e.g., contactor size and pressure), thus, comparing VPT results from multiple studies should not be done without considering both the similarities and differences between said studies. This paper presents a systematic review on VPT results obtained across multiple studies, taking into consideration the different factors affecting the values reported in the literature. We intended to answer the following question: "What are the Vibration Perception Thresholds assessed on the glabrous skin of the hands and fingers of healthy humans?" To the best of our knowledge, this is the first attempt at conducting a systematic review focused specifically on numerical VPT results. Starting from 936 records, VPT results from 37 studies were organized according to various factors (gender, age, probe size, contact pressure, psychophysical method, room temperature, skin temperature, and hand location). This data was organized into a table, the Organization Table that is available for readers. This revision can help future

[1] Corresponding author.

E-mail address: id10249@alunos.uminho.pt

Phone number: +351 913905090

researchers and developers working on or working with the topic of human perception of vibrations by examining the factors that affect VPTs and discussing strategies to address them. We offer recommendations for future research and insights on how design engineers can utilize VPT in the development of new haptic devices.

Keywords: Vibration perception threshold; VPT; systematic review; hands; fingers

1. Introduction

The human perception of touch has been the focus of various research studies. The skin is the human body's largest organ and our sense of touch allows us to perceive distinct sensations from pressure, and contact, to vibrations. The perception of touch has also been studied in different locations of the human body, such as the arms (Forta et al., 2012; Lisboa et al., 2024; Pardo et al., 2022), wrists (Gaudeni et al., 2019), shoulders (Pardo et al., 2022), back (Lisboa et al., 2024; Nothnagel et al., 2017), feet (Gu & Griffin, 2013; Rasmussen et al., 2023), and hands (Gaudeni et al., 2019; Hwang et al., 2013; Lisboa et al., 2024). However, from all these body locations, the glabrous (non-hairy) skin of the hands, which includes the glabrous skin of the palms and fingers, has been particularly investigated, both because the hands are the primary means with which we touch the world around us (Choi & Kuchenbecker, 2013; Jansson-Boyd, 2011; Jones & Lederman, 2006), as well as due to the large number of mechanoreceptors found within glabrous skin; the hands are thus finely tuned for perceiving tactile sensations, in contrast with areas with hairy skin (Bolanowski et al., 1994).

1.1. Mechanisms of human touch perception

The glabrous skin of the hand of individuals between 18 and 28 years old has around 17000 mechanoreceptor afferent fibre units (Johansson & Vallbo, 1979b). Depending on their characteristics, such as the size of their receptive fields and how they respond to vibration

stimuli of different frequencies, each of these units can be classified into one of four groups, namely Rapidly Adapting (RA) fibres, which are also known as Fast Adapting Type I (FA I) fibres; Type I Slowly Adapting (SA I) fibres; Type II Slowly Adapting (SA II) fibres; and Pacinian Corpuscle (PC) fibres, also known as Fast Adapting Type II (FA II) fibres (Bolanowski et al., 1988; Johansson & Vallbo, 1979b; Jones & Lederman, 2006). RA and SA I fibres are the most numerous and can mostly be found at the pads of each finger. PC and SA II fibres, in turn, are the least numerous of the four types, and are more equally distributed across the different areas of the glabrous skin of the hand (Vallbo & Johansson, 1984).

Depending on their type, each fibre unit is thought to end at a specific type of ending, with RA fibres ending at Meissner corpuscles, PC fibres ending at Pacinian corpuscles, SA I fibres ending at Merkel discs, and SA II ending at Ruffini endings (Johansson & Vallbo, 1979b). As each fibre unit is connected to both an ending and a nerve, they each create a channel between the ending and the brain through which information is transmitted (Bolanowski et al., 1988; Griffin, 2012; Jones & Lederman, 2006). In their work, Bolanowski et al. (1988) proposed the Four-Channel Model, suggesting that a total of four different channels contribute towards our sense of touch. These channels are the Pacinian (P) channel, physiologically correlated to PC fibres; the non-Pacinian I (NP I) channel, physiologically correlated to RA fibres; the non-Pacinian II (NP II) channel, physiologically correlated to SA II fibres; and the non-Pacinian III (NP III) channel, physiologically correlated to SA I fibres (Bolanowski et al., 1988). While the Four-Channel Model is the currently most accepted theory to explain how humans perceive touch, according to Griffin (2012), our understanding of these four channels and how they work in regards to our perception of touch is still limited.

1.2. Human perception of vibrations

During touch interactions, each channel is thought to be activated in response to different types of tactile sensations, transmitting information regarding said stimulation to the

brain. When in contact with vibrotactile stimuli, different channels are suspected to be activated by vibration frequencies inside different ranges. The P and NP II channels are thought to be activated by a similar range of frequencies, namely from around 35 Hz to more than 500 Hz, while the NP I channel is thought to be activated by frequencies between 3 Hz and 100 Hz, and the NP III channel is thought to be activated by frequencies up to 100 Hz (Bolanowski et al., 1988; Griffin, 2012).

For a vibration to activate a channel, however, not only must its frequency be in that channel's activation range, but its amplitude must also be above that channel's minimum sensitivity threshold for that given frequency. Additionally, each channel has certain frequencies to which they are more sensitive, meaning that vibrations of those frequencies require less amplitude to activate those channels. The Four-Channel Model also suggests that, when encountering vibrations of certain frequencies, different channels may be activated simultaneously in response to said vibration, if its frequency corresponds to an overlap of the frequency ranges of more than one channel. When this occurs, the likelihood of that vibration being consciously perceived is increased, even if its amplitude is only slightly above each channel's threshold level, as more channels being activated results in more information being transmitted to the brain (Bolanowski et al., 1988). Furthermore, vibrations actuated at a specific area of the hand, such as the pulp of a finger, are not restricted to only activating the channels found in that area alone. Depending on its frequency, a vibration may travel through the skin's surface as far as 6 cm away from the contact point, and, depending on how high its amplitude still is when it reaches that distance, it can further activate other channels along the way, thus increasing the likelihood of that stimulus being perceived, as more of the same fibre types are activated in response to the same vibration (Manfredi et al., 2012).

Thus, at a base level, for a vibration of a given frequency to be consciously perceived, its amplitude must be above a certain psychophysical threshold (Bolanowski et al., 1988).

This Vibration Perception Threshold (VPT) (Griffin, 1990; Zamyslowska-Szmytke et al., 2003), is affected by various factors, such as skin temperature (Bolanowski & Verrillo, 1982), contact conditions (Morioka & Griffin, 2005), vibration direction (Morioka & Griffin, 2008), contact location (Ekman et al., 2021; Johansson & Vallbo, 1979a), and the subject's age (Verrillo, 1980). Readers interested in learning more about these and other factors that affect VPTs are advised to consult the works of Gandhi et al. (2011) and Griffin (2012).

1.3. Motives to study Vibration Perception Thresholds

The study of VPTs is useful in various ways. For example, studying VPTs contributes to improving our knowledge regarding the inner workings of our sense of touch under various conditions, such as under different temperatures or contact conditions (for examples, see Bolanowski et al., 1988; Jones & Lederman, 2006). In addition, by comparing patient data against normative data collected from healthy subjects, VPTs can also be used to help diagnose or prevent various pathologies, such as diabetes (Thomsen et al., 2011) or neurological dysfunctions brought about by exposure to hand-transmitted vibrations (Lindsell & Griffin, 2003). Furthermore, VPTs can also be used to improve human-machine interface (HMI) technologies, especially those which make use of vibration signals to transmit information to users–be it for traffic safety (Lisboa et al., 2024), medical work (Koehn & Kuchenbecker, 2015), communication (Plaisier et al., 2020), or entertainment purposes (Foottit et al., 2016).

1.3.1. VPTs in product design

Many HMI devices favour the use of visual, audio, or both audio and visual stimuli as the preferred method to transmit information to users (MacLean, 2008). Depending on their intended application, however, users might have to interact with such devices in a variety of different environments and situations, which may not always be favourable to the transmission of information through visual or audio means. In these situations, transmitting

information through haptic stimuli, such as vibrations, can be an effective alternative, as the sense of touch is usually less loaded during various activities, such as driving (Gaffary & Lécuyer, 2018; Lisboa et al., 2024). Furthermore, transmitting HMI information through haptics can enable users with visual or hearing impairments to also interact with said devices over a multitude of scenarios, without requiring aid from other users (Basdogan et al., 2020). For devices to make proper use of vibration stimuli, however, haptic experience designers must ensure that said vibrations are perceived by users, over multiple scenarios and situations, but academic knowledge regarding how to design haptic content is limited (Schneider et al., 2017).

By knowing the minimum amplitude that a vibration must reach to be perceived by users under various situations, haptic experience designers can start planning for those situations from an early stage of development. Moreover, by having access to VPT data gathered from various factor combinations–including individual human characteristics, or characteristics related to the interactions between user and interface–, these designers can make it so that a vibration's parameters change to better fit each end-user and interaction scenario (Culbertson et al., 2018), For example, as age is known to negatively impact VPTs (Verrillo, 1980), when designing HMI devices with haptic feedback capabilities, meant to be used by both older and younger users, designers may want to set the minimum amplitude of vibrations to be higher for the former than for the latter. Alternatively, users may interact with an HMI device by pressing it harder or more gently in some situations over others. As contact conditions, such as different levels of applied force, are known to impact VPTs as well (Morioka & Griffin, 2005), devices that are capable of assessing these different levels of pressure may be set to adapt the minimum amplitude of their vibrations accordingly, so as for them to always be perceivable, but not uncomfortable.

With these different aspects in mind, designers can thus plan out which type of haptic actuator they wish to employ in their device, taking into consideration, among other aspects, the need for these actuators to be able to produce vibrations of various amplitudes, how many actuators to include, how they will be placed on the device, and how they will interact with the other various components, such as the device's shell, and how those components may help or hinder the transmission of vibrations. Doing so can increase the chances of vibration signals being detected by users, thus improving their confidence in the interface, and, consequentially, improving their experience with it (Culbertson et al., 2018).

1.4. VPT assessment methodologies

As VPTs are affected by a variety of factors, there is no single right way to assess them. Consequently, a variety of instruments and psychophysical methods have been used in the literature. To try and standardise this variety, at least for VPT assessments conducted for diagnostical purposes, the International Organization for Standardization created a set of norms, ISO 13091-1, addressing the preferred instrument characteristics and psychophysical methods to be used during such cases (International Organization for Standardization, 2001). For example, according to ISO 13091-1, the contactor probe, which is in contact to the subject's skin and through which vibrations are transmitted, should be a flat-ended cylinder with a diameter of about 4.0 mm ± 2.1 mm, while maintaining a contact force of 0.15 N ± 0.09 N, which is equivalent to 1.5 mm ± 0.08 mm skin indentation.

As for the method, ISO 13091-1 indicates that both the von Békésy algorithm, or a variant of the up and down algorithm, such as the Staircase method, can be employed. However, preference is given for the latter, as the use of intermittent stimulation helps prevent temporary threshold shifts brought about by constant stimulation (International Organization for Standardization, 2001). While both approaches can be used, Morioka and Griffin (2002) found significant differences between VPT results assessed with both

approaches from the same participants. In this study, results from intermittent stimulation were lower than those assessed with constant stimulation. However, this difference was only significant at 125 Hz, the highest frequency employed in this study. Nonetheless, the authors concluded that the choice of which psychophysical method to employ when assessing VPTs should be conducted taking into account the effect that the method itself might have on VPT values (Morioka & Griffin, 2002).

1.5. VPT metrics

ISO 13091-1 (International Organization for Standardization, 2001) informs that VPT results should be calculated as the arithmetic mean of all peaks and troughs that occurred during measurements at a given frequency, with the exclusion of the first peak and trough. These results should then be reported as the root-mean-square (r.m.s.) acceleration levels, in decibels relative to 10^{-6} metres per second squared (or dB re. 10^{-6} m/s^2).

According to Griffin (1990), while m/s^2 (sometimes also presented as ms^{-2}) is the preferred S.I. unit to quantify a vibration's acceleration, other units have also been used to report VPT results, such as velocity in metres per second (m/s, or ms^{-1}), and displacement in micrometres (μm). To compare results, these units can be converted between one another, if the frequency (in Hz) at which they were assessed is also known. However, Griffin (1990) also informs that, depending on how authors report their results, conversions between peak, peak-to-peak (p-p), and r.m.s. values may also be necessary to compare VPT results from different sources, as each represents different magnitudes of a waveform.

1.6. Current study

As a complement to the recommendations provided in ISO 13091-1 (International Organization for Standardization, 2001), ISO 13091-2 (International Organization for Standardization, 2003), in turn, provides normative VPT data, collected from healthy male and female subjects, at frequencies of 3.15 Hz, 4 Hz, 5 Hz, 20 Hz, 25 Hz, 31.5 Hz, 100 Hz,

125 Hz, and 160 Hz. While data collected from males is available for those 9 frequencies, data assessed from females, in turn, is only available for 3 (20 Hz, 31.5 Hz, and 125 Hz).

While these recommendations and normative data are helpful for diagnostical purposes, they also have some limitations regarding their potential application in other areas. For example, authors, throughout their work, may want access to data regarding VPTs for frequencies not contemplated on the ISO's recommendations, or for other different probe sizes, skin pressures, or gathered from different psychophysical methodologies, either to help guide their research's formulation, to compare the results they collected, or even to help develop their own apparatuses that employ vibrotactile stimuli to transmit information to users. In these situations, authors must search for data reported in other scientific studies, but organizing and comparing data from multiple studies can be a complex task, as different authors make use of different combinations of factors and frequencies, with some aspects falling outside the scope of what the searcher wants (Gandhi et al., 2011). These comparisons can become even more complex when considering that different authors may also report VPT data under different units of measurement as well, which if incorrectly accounted for and dealt with, can make data interpretation unreliable (Griffin, 1990).

For these reasons, we conducted a systematic review, following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis 2020 (PRISMA) methodology (Page et al., 2021), to collect, organize, catalogue, and present data, from recent literature, regarding Vibration Perception Thresholds assessed at the glabrous skin of the hands and fingers of healthy subjects. One of our goals was to develop an instrument that would aid future researchers and developers working on or with the subject of human vibration perception, by presenting numerical results from vibration perception threshold assessments, organized taking into consideration various combinations of factors that are known or suspected to affect these thresholds. Thus, we considered various combinations of factors affecting the

human perception of vibration reported in the literature, and, when possible, converted reported results into the same unit of measurement, to answer the following research question: "What are the Vibration Perception Thresholds assessed on the glabrous skin of the hands and fingers of healthy humans?" To the best of our knowledge, this is the first attempt at conducting a systematic review specifically focused on VPT results. Data extracted from papers whose content was included in this review was organized and catalogued into a table format. This table, referred to as the Organization Table (Table S1), is one of the outputs of this work and is made available to aid future researchers and developers. Table S1 can be freely accessed either through the following URL, https://osf.io/cvg56?view_only=87b902b6571643f2b2d8cef1238ff316, or by direct request to the corresponding author. Nonetheless, all the data relevant to the abovementioned research question can be found in this paper.

2. Methods

2.1. Search Methods

A systematic review was conducted regarding the Vibration Perception Threshold (VPT) results obtained by various studies that have assessed VPTs on the palmar side of the hands and fingers of healthy participants. Specifically, VPT results were compiled and analysed according to relevant variables related to both the participants and the experimental protocols themselves, such as age and probe size, to provide readers with a broad overview of VPTs over a wide range of frequencies and conditions. Readers should be advised that this paper is not meant to be an in-depth meta-analysis regarding all variables that might potentially affect VPT measurements, as such an analysis is beyond the scope of this review.

This review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analysis 2020 (PRISMA) methodology (Page et al., 2021). The acquisition, content analysis, data compilation and data analysis of each paper was conducted by a singular author (ES,

first author). The reviewed studies were collected from searches carried out in 3 of the main electronic databases, Web of Science, Scopus, and PubMed.

Two searches were carried out. The first (hereafter identified as "2012-2022 search") was carried out by January 13th, 2023, and restricted results to only those published in the English language between January 1st, 2012, and December 31st, 2022. The second search (hereafter identified as "2023 search"), in turn, was carried out by November 24th, 2023, and restricted results to only those published in the English language between January 1st, 2023, and December 31st, 2023. The final search strings used in each database, in each search, and the resulting number of entries, are presented in Chapters 2.1.1 to 2.1.3. Searches employing other search terms, such as "vibrotactile perception", "oscillation perception", and "vibration disappearance thresholds", were not conducted in this review. However, if records which employed these and other synonym terms were encountered during these searches, they were also considered for screening.

2.1.1. Scopus

- 2012-2022 search
  - TITLE-ABS-KEY ((vibration AND perception AND threshold) AND (hand OR finger)) AND PUBYEAR > 2011 AND PUBYEAR < 2023 AND (LIMIT-TO (LANGUAGE , "English"))" – 185 results.
  - "TITLE-ABS-KEY ("Vibration perception thresholds" AND finger) AND PUBYEAR > 2011 AND PUBYEAR < 2023 AND (LIMIT-TO (LANGUAGE , "English"))" – 20 results.
  - "TITLE-ABS-KEY ("Vibration perception thresholds" AND hand) AND PUBYEAR > 2011 AND PUBYEAR < 2023 AND (LIMIT-TO (LANGUAGE , "English"))" – 35 results.
- 2023 search

- "TITLE-ABS-KEY ((vibration AND perception AND threshold) AND (hand OR finger)) AND PUBYEAR > 2022 AND PUBYEAR < 2024 AND (LIMIT-TO (LANGUAGE , "English"))" – 14 results.
- "TITLE-ABS-KEY ("Vibration perception thresholds" AND finger) AND PUBYEAR > 2022 AND PUBYEAR < 2024 AND (LIMIT-TO (LANGUAGE , "English"))" – 5 results.
- "TITLE-ABS-KEY ("Vibration perception thresholds" AND hand) AND PUBYEAR > 2022 AND PUBYEAR < 2024 AND (LIMIT-TO (LANGUAGE , "English"))" – 5 results.

2.1.2. Web of Science (WoS)

- 2012-2022 search
  - "(ALL=((vibration AND perception AND threshold))) AND ALL=((Hand OR Finger)) and English (Languages)" – 165 results.
  - "(ALL=(("Vibration perception thresholds"))) AND ALL=((Hand)) and English (Languages)" – 19 results.
  - "(ALL=(("Vibration perception thresholds"))) AND ALL=((Finger)) and English (Languages)" – 13 results.
- 2023 search
  - "(ALL=((vibration AND perception AND threshold))) AND ALL=((Hand OR Finger)) and English (Languages)" – 5 results.
  - "(ALL=(("Vibration perception thresholds"))) AND ALL=((Hand)) and English (Languages)" – 1 results.
  - "(ALL=(("Vibration perception thresholds"))) AND ALL=((Finger)) and English (Languages)" – 0 results.

2.1.3. PubMed

- 2012-2022 search
  - "Search: ((vibration AND perception AND threshold)) AND ((hand OR finger)) Filters: English, from 2012/1/1 - 2022/12/31" – 181 results.
  - "Search: ((vibration AND perception AND threshold)) AND ((finger)) Filters: English, from 2012/1/1 - 2022/12/31" – 99 results.
  - "Search: ((vibration AND perception AND threshold)) AND ((hand)) Filters: English, from 2012/1/1 - 2022/12/31" – 168 results.
- 2023 search
  - "Search: ((vibration AND perception AND threshold)) AND ((hand OR finger)) Filters: English, from 2023/1/1 - 2023/12/31" – 9 results.
  - "Search: ((vibration AND perception AND threshold)) AND ((finger)) Filters: English, from 2023/1/1 - 2023/12/31" – 5 results.
  - "Search: ((vibration AND perception AND threshold)) AND ((hand)) Filters: English, from 2023/1/1 - 2023/12/31" – 7 results.

Across these 18 searches, 936 records were identified and exported to a Microsoft® Excel® for Microsoft 365 MSO (version 2210) file. A total of 294 records were identified following the removal of duplicate entries.

2.2. Eligibility Criteria – Title and Abstracts Screening

To assess their inclusion onto the content analysis stage of this review, the title and abstract of all 294 records were manually screened for against the following criteria:

1. *Abstract.VPT* (*A.VPT*) — The paper will report the results of at least one quantitative experimental study in which VPT assessments were made, either as the main goal of the study, or as one of the study's metrics.
2. *Abstract.Hand/Finger (A.Hand/Finger)* — At least one of the locations where VPTs were assessed was at the glabrous skin of a hand's palm or finger.

3. *Abstract.Healthy/Control* (*A.Healthy/Control*) — At least one study or experiment was conducted with a group of healthy or control individuals of any age.

For each record, the presence ("Yes") or absence ("No") of all 3 criteria were assessed. In cases where it was not clear if a criterion was present or absent, it was deemed as either not mentioned or not overtly clear ("N/M"). Following this assessment, records were organized into either inclusion or exclusion groups (deemed Abstract Inclusion and Abstract Exclusion, respectively). The Abstract Inclusion group was further subdivided into 4 groups, organized according to how many criteria were deemed as being present or not mentioned or not overtly clear. Records for which all 3 criteria were deemed as present were allocated to the "Abstract Inclusion 3" group. Records for which 2 criteria were deemed as present and 1 was deemed as "N/M" were allocated to the "Abstract Inclusion 2" group. Records for which all 3 criteria were deemed as "N/M" were allocated to the "Abstract Inclusion 0" group.

In a similar manner, the Abstract Exclusion group was subdivided into 2 groups. Records for which at least one criterion was deemed as absent were allocated to the "Abstract Exclusion 1" group. Records whose title or abstract informed that the focus of the paper would be either on a literature review, or on the presentation or description of an instrument or tool, without providing quantitative data gathered from a study with healthy human participants, were allocated to the "Abstract Exclusion 2" group. A summary of Abstract Inclusion and Exclusion groups can be found in Table 1, alongside the number of records allocated to each group. From this assessment, 141 reports were sought for retrieval.

Table 1 — Title/Abstract inclusion and exclusion groups, with number of records attributed to each.

Group		**Nº**
Abstract Inclusion 3	3 "Yes", 0 "N/M"	51
Abstract Inclusion 2	2 "Yes", 1 "N/M"	55
Abstract Inclusion 1	1 "Yes", 2 "N/M"	25
Abstract Inclusion 0	0 "Yes", 3 "N/M"	10
Total included for retrieval		141

Group		Nº
Abstract Exclusion 1	≥ 1 "No"	143
Abstract Exclusion 2	Literature review or presentation / description of instruments / tools	10
Total excluded from retrieval		153

Note: N/M – Not Mentioned or Not overtly clear.

2.3. Eligibility Criteria – Content

Three of the 141 reports sought for retrieval could not be retrieved due to no access. The content of the 138 successfully retrieved reports was manually analysed for eligibility according to the following 5 criteria:

1. *Content.VPT* (*C.VPT)* — The paper reports on the result(s) of at least one quantitative experimental study that assessed the VPT at a given frequency, or similar procedure (e.g., the lowest amount of amplitude reached before a vibration of a given frequency is no longer detected, i.e., Vibration Extinction/Disappearance Threshold; the lowest amount of frequency reached before a vibration of a given amplitude is no longer detected). Vibrations did not have to specifically be of any type of waveform (e.g., sinusoidal, cubic, triangle waves).

2. *Content.Metrics* (*C.Metrics*) — If C.VPT is present, data from those assessments is provided as specific values, with clear indication of the scale or metrics used (e.g., dB re. 10^{-6} m/s^2; µm,). Said scale/metric must be suitable for comparing data from other studies. In papers where the scale or metrics are not clearly stated (e.g., paper only informs that "data is presented as dB"), the paper offers sufficient information to enable readers to find it elsewhere (e.g., instrument's brochure or leaflet, ISO standards). Additionally, data is available in either text format, graph format with labelled markers, as supplementary material, or can be provided by the authors after direct contact.

3. *Content.Healthy/Control* (*C.Healthy/Control*) — The paper reports on at least one study or experiment conducted with a population or group of healthy or control individuals (not exposed to vibrations daily, nor with a prior history of neuropathy). If

different experimental conditions were employed, paper reports on at least one baseline/control condition. When applicable, data obtained from healthy/control individuals, and/or baseline/control conditions, is reported separately. In cases where data from separate groups or conditions is presented only after being combined, a justification is provided regarding said combination (e.g., initial analysis revealed no significant differences between the results of groups/conditions).

4. *Content.Frequency* (*C.Frequency*) — The paper presents either the specific frequencies used to generate vibrations, or associates each reported threshold value with its corresponding frequency. The results for each frequency are presented separately, with a clear indication of which threshold corresponds to each frequency.

5. *Content.Hand/Finger (C.Hand/Finger)* — The paper reports on at least one assessment conducted at the glabrous skin of a hand's palm or finger, and provides the results obtained from distinct locations separately. In cases where data from separate locations is presented only after being combined, a justification is provided regarding said combination (e.g., initial analysis revealed no significant differences between the results of locations).

As was performed previously (Section 2.2), the presence ("Yes") or absence ("No") of each criterion was assessed for each record. Records in which all criteria were deemed as present were allocated to the Content Inclusion group. Records in which at least one criterion was deemed as absent were allocated to a Content Exclusion group, depending on which criteria were deemed as absent. One further Content Exclusion group was also created to house reports which only described a device and/or experimental protocol ("Content Exclusion 14"). These Content Inclusion and Content Exclusion groups are found in Table 2, alongside which respective present and absent criteria combination they refer to, as well as how many reports were allocated to each one.

Table 2 — Content inclusion categories according to criteria, and attributed number of papers.

Group	C.VPT	C.Metrics	C.Healthy/Control	C.Frequency	C.Hand/Finger	N[a] included
Content Inclusion	Yes	Yes	Yes	Yes	Yes	37
Total included in review						37
Content Exclusion 1	Yes	No	No	No	No	9
Content Exclusion 2	Yes	No	Yes	Yes	No	16
Content Exclusion 3	Yes	No	Yes	No	No	13
Content Exclusion 4	No	No	Yes	No	No	19
Content Exclusion 5	Yes	No	Yes	Yes	Yes	21
Content Exclusion 6	No	No	No	No	No	2
Content Exclusion 7	Yes	Yes	Yes	Yes	No	3
Content Exclusion 8	Yes	Yes	No	Yes	No	1
Content Exclusion 9	Yes	No	No	Yes	Yes	2
Content Exclusion 10	Yes	Yes	Yes	No	Yes	3
Content Exclusion 11	Yes	No	Yes	No	Yes	3
Content Exclusion 12	Yes	Yes	No	Yes	Yes	5
Content Exclusion 13	No	No	Yes	Yes	Yes	2
Content Exclusion 14	Paper describes device and/or experimental protocol only, no assessments were conducted					2
Total excluded from review						101

Two important aspects were additionally considered for the *C.Metrics* criterion:

- Papers which presented VPT results in relative units, such as decibels (dB) or volts (V, or Volt), without a clear reference value (e.g., 10^{-6} m/s^2) or indication of where such value could be found (e.g., procedure or instrument is compliant with ISO 13091-1 recommendations), were initially classified as having the *C.Metrics* criterion be absent. However, if for a given paper this was the only reason for the absence of this criterion (Content Exclusion 5 group), then in cases where the reported study(ies) was carried out with either commercially available instruments to measure VPTs, or with instruments described in previous literature referenced in the paper itself, then the authors of this review searched through either publicly available sources (e.g., instrument booklets, leaflets, webpages), in the case of commercial devices, or through said previously mentioned literature, to try and find reference values for said devices. If said reference values were found, and the

information matched the one provided in the paper in question, than the *C.Metrics* criterion was deemed as being present.

- Papers which presented VPT results in the form of graphical information only, with no concrete textual reference either in the body of text, supplementary material, or as marker labels in graphs, were initially classified as having the *C.Metrics* criterion being absent. However, if for a given paper this was the only reason for the absence of this criterion (Content Exclusion 5 group), the authors of this review contacted the corresponding authors of said papers through the contact information indicated in the paper itself, requesting access to the data files containing the reported VPT results. If the requested data was provided within four weeks of the initial request, and if said data files contained the required information, said files were considered as being part of the paper's supplementary material, and the *C.Metrics* criterion was deemed as being present.

After content analysis, 37 studies out of the 139 records whose content was analysed were included in this systematic review. Figure 1 presents the PRISMA 2020 flowchart (Page et al., 2021) summarizing this process, from the initial 936 reports to the 37 studies whose content was considered for this review's analysis. Further details regarding the screening process–such as which content inclusion or exclusion group was each report attributed to–are also available as supplementary material.

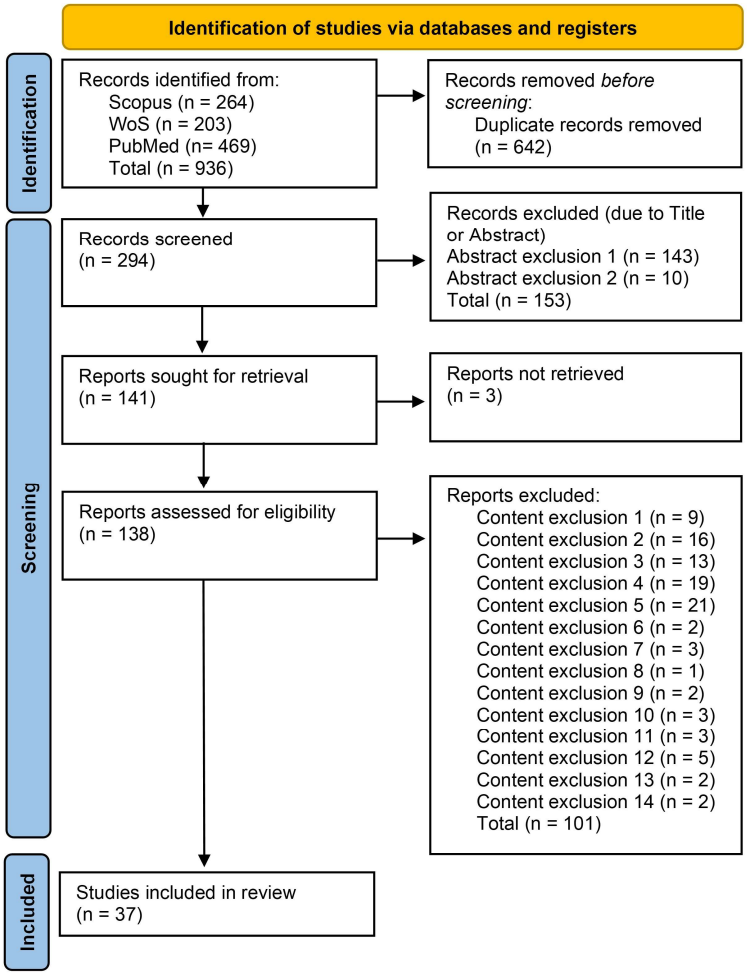


Figure 1 – PRISMA 2020 flowchart of the systematic review (Page et al., 2021)

3. Data extraction and organization

After selecting the 37 studies to include in this review, the VPT data included in each one was extracted and organized. The focus was on data assessed from the glabrous skin of the hands of healthy participants. For studies with available supplementary materials, data contained in said materials was also extracted and organized accordingly. For studies in which VPT were assessed on different occasions over one session (e.g., to study the effect of independent variables, as in Haseleu et al., 2014 and Tanaka et al. 2015), only the results corresponding to baseline conditions were considered. In a similar vein, for studies in which VPTs were assessed at different moments in time, either during the same session, or over

multiple sessions (e.g., Ekman et al., 2019), but without manipulation of other independent variables, the average VPT, calculated from all reported moments, was considered.

To organize the data extracted from each study, a table, henceforth referred to as Organization Table (Table S1) was created containing the following information (extracted when possible; the following list is not exhaustive of all extracted information included in this table, which is available at the URL presented in Section 1.6):

A. Paper's title.

B. Paper's authors.

C. Paper's year of publication.

D. Measurement locations (i.e., at which hand and at which area/location of the hand were assessments conducted).

E. Participant's gender.

F. Participant's age (either the study's reported average; the study's reported age group [e.g., 30-39 years old]; or the average age calculated by the authors of this review based on the individual data points reported in the study).

G. Number of data points from which the reported VPT was calculated (either the number of valid participants or the number of valid locations from which the corresponding VPTs were obtained/calculated).

H. Area pressure/force, or skin indentation between the skin location and the assessment probe.

I. Diameter size of the probe (calculated when needed).

J. Psychophysical method(s) used to assess VPTs.

K. Room temperature.

L. Skin temperature.

M. Units used to report VPT results.

N. Frequency (in Hertz) at which VPT results were assessed at.

O. Were VPT results reported as mean or median.

P. VPTs (either the mean or median reported in the paper, or an average calculated by the authors of this review based on the individual data points reported in the study).

Q. VPTs' standard deviation (SD).

R. VPTs' inter-quartile range.

S. VPTs' range.

T. When VPTs are reported as median (see point O), does paper also report enough information from the five-number summary to fit into any of the scenarios (as explained in Shi et al., 2023), and, if so, which scenario (see Section 3.2).

The data mentioned in points K and L were recorded in degrees Celsius (ºC) and converted to this unit when needed. Data mentioned in points P-S were recorded following the same units as in the original paper (point M). Across all 37 studies included for analysis, displacement units or acceleration units were the most common units used to express the amplitude related to reported VPT results. These units were: micrometres (μm), used in 10 papers; dB re. 1 μm peak, used in 4 papers; μm peak-to-peak (p-p), used in 1 paper; nanometres (nm), used in 1 paper; μm and nm, used in 1 paper; dB re. 10^{-6} m/s^2 root-mean-square (r.m.s.), used in 14 papers; m/s^2 r.m.s, used in 2 papers; and ms^{-2} r.m.s. (equivalent to m/s^2 r.m.s.), used in 3 papers. Additionally, 1 paper reported VPT results as force units, namely millinewton (mN) peak.

3.1. Mean VPTs' conversion to dB relative to 10^{-6} m/s^2 r.m.s.

After data extraction was completed, for papers which reported mean VPTs (point O), said reported VPTs (point P) were converted to the same unit of report, dB relative to 10^{-6} m/s^2 r.m.s. ISO 13091-1 (International Organization for Standardization, 2001) requires that VPT results be expressed in either this unit, or as metres per second squared r.m.s. (expressed

as m/s^2 r.m.s.). dB relative to 10^{-6} m/s^2 r.m.s. (henceforth referred to as dB re. 10^{-6} m/s^2) was selected for consistency with this standard, and to aid in the handling and presentation of results. The main equations used for these conversions, provided here for transparency, were:

Converting m/s^2 r.m.s. to dB re. 10^{-6} m/s^2 (1).

$$dB = 20 * log_{10} \frac{ms^{-2}_rms}{refdB} \quad (1)$$

Converting dB re. to 1 μm peak displacement (disp.) to μm peak disp. (2).

$$\mu m_peak = 10^{\left(\frac{dB\mu m}{20}\right)} \quad (2)$$

Converting metres peak disp. to 10^{-6} m/s^2 peak acceleration (acc.) (3).

$$ms^{-2}_peak = (2 * \pi * freq)^2 * m_peak \quad (3)$$

Converting 10^{-6} m/s^2 peak acc. to 10^{-6} m/s^2 r.m.s. acc. (4).

$$ms^{-2}_rms = \frac{ms^{-2}_peak}{\sqrt{2}} \quad (4)$$

Converting 10^{-6} m/s^2 r.m.s. acc. to dB re. 10^{-6} m/s^2 r.m.s. acc. (1).

Converting metres peak-to-peak (p-p) to 10^{-6} m/s^2 p-p acc. (Formula 3, replacing m_peak with m_p-p, and ms^{-2}_peak with ms^{-2}_p-p, and).

Converting 10^{-6} m/s^2 p-p acc. to 10^{-6} m/s^2 r.m.s. acc. (5).

$$ms^{-2}_rms = \frac{ms^{-2}_p-p}{2 * \sqrt{2}} \quad (5)$$

And, lastly, converting 10^{-6} m/s^2 r.m.s. acc. to dB re. 10^{-6} m/s^2 r.m.s. acc. (1).

In the equations presented above, *dB* describes the VPT result outputted as dB re. 10^{-6} m/s^2 r.m.s.; *ms^{-2}_rms* describes the m/s^2 r.m.s acceleration; *refdB* describes 10^{-6}; *μm_peak* describes μm peak disp.; *dBμm* describes the VPT result outputted as dB re. 1 μm peak; *ms^{-2}_peak* describes peak acceleration; *freq* describes frequency, in Hz; *m_peak* describes metres peak disp.; *m_p-p* describes metres peak-to-peak-displacement; and *ms^{-2}_p-p* describes the p-p acceleration. Equations 3, 4, and 5 were based on Griffin (1990).

The results from these conversions were added to the appropriate row of a new column in Organization Table, henceforth referred to as *VPT-Mean-dB* column, which only held mean VPT results in dB re. 10^{-6} m/s^2, either those obtained after data conversion, or the original data, if already provided in dB re. 10^{-6} m/s^2.

Three points should be noted regarding these conversions. First, while the VPT results obtained by Hatzfeld et al. (2016)'s Experiment I were extracted and organized like all others, they were not converted to dB re. 10^{-6} m/s^2, despite their results being presented in mN peak units, and were thus not included in the analysis of this review. The reasoning behind this decision was as follows. In their paper, Hatzfeld et al. (2016) calculated and reported the actual force that was presented to each subject, based on the force measured by a force sensor, set to the International System of Units (SI), taking into account the mechanical impedance of the force source, a model of the mechanical impedance of the subject's finger, as well as the actual velocity of the setup. While Equation (6)—where *N* describes the force, in Newtons, *Kg* describes the mass, in kilograms, *m* describes metres, and *s* describes seconds—, can be used to convert from force, in mN, to acceleration, in m/s^2 , this equation requires an object's mass be known, information which was neither provided for each data point, nor was it referred to always be a constant value. Thus, using Equation (6) to convert between mN and m/s^2 could not be carried out with full confidence on the results of said calculations and were therefore not carried out.

$$1\,N = 1\,Kg * 1\frac{m}{s^2} \quad (6)$$

Second, due to the differences in their methodology when compared to all other studies included in this analysis, the VPT results obtained by Chauvelin et al. (2014), while extracted and organized like all others, were also not included in the analysis of this review. While the usual approach to assessing VPTs involves maintaining a stable vibration frequency while varying vibration amplitude, Chauvelin et al. (2014), in turn, maintained a stable amplitude

while varying vibration frequency. Thus, while their results can be paired up in terms of frequency and corresponding VPT results, this difference in methodology makes it difficult to compare said results with those obtained from the remaining studies with high confidence.

Thirdly, the results from studies which reported data in μm or nm, but did not provide indication if this referred to either peak, peak-to-peak, or root-mean-square displacement, were also not converted to dB, to avoid mistaken assumptions that could occur for wrongly assuming, for example, that provided results referred to peak values instead of peak-to-peak or r.m.s. values, as such mistaken assumptions could lead to misleading results and comparisons. Before removing said studies from the following analysis of this paper, for each of those studies, the authors of this review conducted a search through the paper's supplementary materials, and/or through the indicated instrument's brochures and datasheets (if available), to search for this information. If said information was found, it was identified, in Organization Table's column M with a * alongside the respective information. Thus, data from 8 studies (Arredondo & Perez, 2017; Calder et al., 2012; Folmli et al., 2018; Haseleu et al., 2014; Koszewicz et al., 2021; Labbé et al., 2016; Marcuzzi et al., 2019; Tanaka et al., 2016) was identified with "N/A" (not applicable) in each of their rows in the VPT-Mean-dB column, and were not considered during the analyses presented in Section 4. Data from 3 studies (Held et al., 2021; Moshourab et al., 2017; Prsa et al., 2021), in turn, was converted to dB re. 10^{-6} m/s^2 and included in the VPT-Mean-dB column and was considered for the analyses presented in Section 4.

3.2. Median VPTs conversion to dB relative to 10^{-6} m/s^2 r.m.s.

Following data extraction, for papers which reported median VPTs (point O), said papers were scanned for information to complete the five-number summary. This summary is composed of $\{a, q_1, m, q_3, b\}$, where *a* describes the minimum value, *q1* and *q3* describe the first and third quartile, respectively, *m* describes the sample median, and *b* describes the

maximum value. If sufficient information was found to complete at least one of the scenarios described in Shi et al. (2023), the scenario for which more information could be found would be identified for each of the paper's corresponding rows (point T). If not, then said paper's rows would be marked with "No" (point T). These scenarios, wherein *n* describes the data size, were:

- Scenario 1 (S_1) = {*a*, *m*, *b*; *n*}.
- Scenario 2 (S_2) = {*q1*, *m*, *q3*; *n*}.
- Scenario 3 (S_3) = {*a*, *q1*, *m*, *q3*, *b*; *n*}

Median VPTs were reported in 5 studies (Flondell et al., 2017; Gerhardsson et al., 2013; Gu & Griffin, 2013; Ye & Griffin, 2013, 2016). Three studies did not provide enough information to fit into any of the scenarios, while 2 studies reported enough information to fit S_1 (Gerhardsson et al., 2013; Ye & Griffin, 2013), namely minimum value, median, maximum value, and size of the data. For these 2 studies, a skewness test was conducted using Shi et al. (2023)'s *T2* test statistic, for each of their respective rows on the Organization Table's point P that contained median VPT data. Calculations were done through the indicated online calculator (Shi et al., n.d.). Only one row, pertaining to Ye and Griffin (2013), passed this skewness test. Following this, a log transformation was applied to the data of the remaining rows, and a second skewness test was carried out using the log scale data. All remaining rows then passed the skewness test under the log scale. Thus, their original data was treated as being log-normally distributed, and their sample means and SD were estimated, using Luo et al. (2018)'s and Wan et al. (2014)'s equations, respectively, through the online calculator provided by Shi et al. (n.d.). These estimated means were then converted, when necessary, from their original units to dB re. 10^{-6} m/s^2, using the appropriate equation(s), as mentioned in Section 3.1, and added to their respective location in the VPT-Mean-dB column. The three studies which did not provide enough information to fit into any

578 of the scenarios, in turn, were identified in VPT-Mean-dB column with "N/A", and were not
579 considered during the analyses presented in Section 4.

580 **3.3. Data grouping**

581 To enhance the manageability of data from the 24 studies whose results were included
582 in the analysis, after completing the VPT data conversion process, data from each row's
583 points F, H, I, J, K, and L—i.e., participant's age, area pressure/force or skin indentation
584 between the skin location and the assessment probe, probe's diameter size, psychophysical
585 algorithm employed, room temperature, skin temperature, and hand location—was organized
586 into different categorical groups, created based on the information contained in each point.
587 Thus, 4 new columns were created in the Organization Table, containing information, for
588 each row, corresponding to their respective allocation into the different categories that were
589 created for the "Ages [Grouped]", "Pressure [Grouped]", "Probe size [Grouped]",
590 "Psychophysical method [Grouped]", "Room temperature [Grouped]", "Skin temperature
591 [Grouped]", and "Hand location" factor groups. Each row was associated with each category,
592 per factor group, according to the information presented for each respective factor that was
593 present in points F, H, I, J, K, and L. Descriptions of each category in each factor group, and
594 an overview of how these categories were elaborated, are presented and discussed over the
595 following sections.

596 ***3.3.1. Gender***

597 Categories for the "Gender" factor group were created based on the gender information
598 reported by each paper.

599 *Table 3 — Categories of the "Gender" factor group, the associated number of rows and papers, alongside their description.*

Category	Description	Nº data rows	Nº papers
Male	VPT data reportedly assessed from male participants.	191	12
Female	VPTs reportedly assessed from female participants.	138	3

Category	Description	Nº data rows	Nº papers
Male & Female	VPT data was assessed from male and female participants and presented after being combined.	66	10
N/M	Participant's gender information was not reported nor mentioned (N/M).	30	2

3.3.2. Ages [Grouped]

Categories for the "Ages [Grouped]" factor group were created based on either the mean ages or the age ranges reported for each data point by each paper, with preference given to the former in cases where both were reported. Categories were initially created to encompass ranges of 10 years. However, in situations where age ranges from different papers overlapped—such as in Dahlin et al. (2015), who reported data from participants aged between 16 and 20 years old (years old), and Ekman et al. (2021), who reported data from participants aged between 18 and 29 years old—both ranges were added to the same category, and, if needed, said category's range was adjusted accordingly. The lowest reported age across all examined papers was 8 years old (Dahlin et al., 2015), and the highest was 90 years old (Ekman et al., 2021).

Table 4 — Categories of the "Ages [Grouped]" factor group, the associated number of rows and papers, alongside their description.

Category	Description	Nº data rows	Nº papers
[8,11[yo.	Participants' age or age-group reported as between 8 and 11 years old (yo.) (excluded).	28	1
[11,16[yo.	Participants' age or age-group reported as between 11 and 16 years old (excluded).	28	1
[16,30[yo.	Participants' age or age-group reported as between 16 and 30 years old (excluded).	110	15
[30,40[yo.	Participants' age or age-group reported as between 30 and 40 years old (excluded).	101	8
[40,50[yo.	Participants' age or age-group reported as between 40 and 50 years old (excluded).	54	4
[50,60[yo.	Participants' age or age-group reported as between 50 and 60 years old (excluded).	5	1
[60,70[yo.	Participants' age or age-group reported as between 60 and 70 years old (excluded).	67	2
[70,90] yo.	Participants' age or age-group reported as between 70 and 90 years old.	32	3

3.3.3. Pressure [Grouped]

Categories for the "Pressure [Grouped]" factor group were created based on either the pressure or the force exerted between the skin location and the probe or based on the skin

indentation caused by the probe on the subject's skin, as reported by each paper. No entries were found for ranges or values not encompassed by the categories presented in Table 5. As many data rows (302) contained data gathered from conditions where an area pressure/force of 0.15 N was reportedly exerted between the subject's skin and the moving probe, this value was added to a separate category.

Table 5 — Categories of the "Pressure [Grouped]" factor group, the associated number of rows and papers, alongside their description.

Category	Description	Nº data rows	Nº papers
[0.03,0.1] N	Area pressure/force reported as between 0.03 and 0.1 N.	9	3
0.15 N	Area pressure/force reported as 0.15 N.	302	5
[0.2,0.5] N	Area pressure/force reported as between 0.2 and 0.5 N.	32	5
[1,2] N	Area pressure/force reported as between 1 and 2 N.	11	3
[4.9,5] N	Area pressure/force reported as between 4.9 and 5 N.	5	3
[7.8,8] N	Area pressure/force reported as between 7.8 and 8 N.	3	2
[10.8,15] N	Area pressure/force reported as between 10.8 and 15 N.	3	2
(0.5 sk.ind.)	0.5 mm skin indentation reported.	11	2
(1.5 sk.ind.)	1.5 mm skin indentation reported.	12	1
N/cm2	Area pressure/force reported as 3.5 N/cm2.	7	1
N/M	Area pressure/force and skin indentation were not reported nor mentioned (N/M).	30	4

Note: no entries were found for ranges or values not encompassed by any of these categories.

3.3.4. Probe size [Grouped]

Categories for the "Probe size [Grouped]" factor group were created based on the diameter of the moving probe. These diameters were either reported in each paper, or were calculated, based on information provided in each paper, by the authors of this review, as was the case for the probe radius reported in Koszewicz et al. (2021). No entries were found for ranges or values not encompassed by the categories presented in Table 6.

Table 6 — Categories of the "Probe size [Grouped]" factor group, the associated number of rows and papers, alongside their description.

Category	Description	Nº data rows	Nº papers
[1,2] mm	Probe's diameter reported as between 1 and 2 mm.	3	1
[2.6,5] mm	Probe's diameter reported as between 2.6 and 5 mm.	341	13
[6,10] mm	Probe's diameter reported as between 6 and 10 mm.	37	5
[12.46,14] mm	Probe's diameter reported as between 12.46 and 14 mm.	11	2
[19.2,20] mm	Probe's diameter reported as between 19.2 and 20 mm.	11	1
N/M	Probe's diameter was not reported nor mentioned (N/M).	22	5

Note: no entries were found for ranges or values not encompassed by any of these categories.

3.3.5. Psychophysical method [Grouped]

Categories for the "Psychophysical method [Grouped]" factor group were created based on the main method referred to by the authors of each paper—for example, Moshourab et al. (2017) reportedly assessed VPTs using a two-alternative forced choice task, following an up/down staircase paradigm. Thus, data from this paper was added to the 2AFC category—. Thus, methods were added to each relevant category regardless of which rule, paradigm, step-size, or change-rate they followed.

Table 7 — Categories of the "Psychophysical method [Grouped]" factor group, the associated number of rows and papers, alongside their description.

Category	Description	Nº data rows	Nº papers
2AFC	VPTs reportedly assessed using either a two-answer or a two-alternative forced choice (2AFC) task, following any rule or paradigm.	41	7
Staircase	VPTs reportedly assessed using the Staircase method, following any rule or step-size.	11	1
von Békésy	VPTs reportedly assessed using the von Békésy method, following any rule or change-rate.	346	13
Binary choice	VPTs reportedly assessed using the Binary choice method, following any rule.	2	1
Method of limits	VPTs reportedly assessed using the Method of limits, following any rule, step-size or change-rate.	1	1
Psi-marginal	VPTs reportedly assessed using the Psi-marginal adaptative algorithm (Psi-marginal), following any form, rule, or step-size.	24	1

3.3.6. Room temperature [Grouped]

Categories for the "Room temperature [Grouped]" factor group were created based on either the mean room temperature or the room temperature ranges reported for each data point by each paper, with preference given to the former in cases where both were reported. As described for the categories in the "Ages [Grouped]" factor group, in situations where room temperature ranges from different papers overlapped, both ranges were added to the same category, and, if needed, said category's range was adjusted accordingly. For example, a room temperature range of 20ºC to 22ºC was reported by Ekman et al. (2019), while a room temperature range of 20ºC to 30ºC was reported by Clemm et al. (2019), so both ranges were added to the same category, [20,31[ºC. Additionally, room temperature ranges without a clear lower or upper bound were added to separate categories.

Table 8 — Categories of the "Room temperature [Grouped]" factor group, the associated number of rows and papers, alongside their description.

Category	Description	Nº data rows	Nº papers
[20,31[ºC	Room temperature reported as between 20ºC and 31ºC (excluded).	164	10
>28ºC	Room temperature reported as greater than 28ºC.	15	2
N/M	Room temperature was not reported.	246	12

3.3.7. Skin temperature [Grouped]

Categories for the "Skin temperature [Grouped]" factor group were created based on either the mean skin temperature or the skin temperature ranges reported for each data point by each paper, with preference given to the former in cases where both were reported. As described for the categories in the "Ages [Grouped]" and "Room temperature [Grouped]" factor groups, in situations where skin temperature ranges from different papers overlapped, both ranges were added to the same category, and, if needed, said category's range was adjusted accordingly. For example, a skin temperature range of 20ºC to 36ºC was reported in

Hopkins et al. (2016), while a skin temperature range of 27ºC to 35ºC was reported in Dahlin et al. (2015), so both ranges were added to the same category, [20,37[ºC.

Lastly, room temperature ranges without a clear lower or upper bound were added to separate categories.

Table 9 — Categories of the "Skin temperature [Grouped]" factor group, the associated number of rows and papers, alongside their description.

Category	Description	Nº data rows	Nº papers
[20,37[ºC	Skin temperature reported as between 20ºC and 37ºC (excluded).	281	8
>30ºC	Skin temperature reported as greater than 30ºC.	2	1
N/M	Skin temperature was not reported.	142	15

3.3.8. Hand location

Categories for the "Hand location" factor group were created based on at which hand (either right, R, left, L, dominant, D, or non-dominant, ND) and at which hand location (thumb to little finger, D1 to D2, distal palmar crease, DPC, and thenar eminence, TE) were VPT assessments conducted at. No entries were found for hand locations not encompassed by the categories presented in

Table 10 — Categories of the "Hand location" factor group, the associated number of rows and papers, alongside their description.

Category	Description	Nº data rows	Nº papers
R.D2	VPT data presented from assessments on the index finger of the right hand.	180	12
R.D3	VPT data presented from assessments on the middle finger of the right hand.	4	1
R.D4	VPT data presented from assessments on the ring finger of the right hand.	4	1
R.D5	VPT data presented from assessments on the little finger of the right hand.	139	5
R.DPC	VPT data presented from assessments on the distal palmar crease of the right hand.	4	1
R.TE	VPT data presented from assessments on the thenar eminence of the right hand.	2	1
L.D2	VPT data presented from assessments on the index finger of the left hand.	2	1
L.D3	VPT data presented from assessments on the middle finger of the left hand.	11	2
L.D4	VPT data presented from assessments on the ring finger of the left hand.	4	1
L.D5	VPT data presented from assessments on the little finger of the left hand.	2	1
L.DPC	VPT data presented from assessments on the distal palmar crease of the left hand.	4	1

Category	Description	Nº data rows	Nº papers
D.D2	VPT data presented from assessments on the index finger of the dominant hand.	26	6
D.D3	VPT data presented from assessments on the middle finger of the dominant hand.	11	1
D.D5	VPT data presented from assessments on the little finger of the dominant hand.	12	3
ND.D2	VPT data presented from assessments on the index finger of the non-dominant hand.	10	2
ND.D3	VPT data presented from assessments on the middle finger of the non-dominant hand.	1	1
ND.D5	VPT data presented from assessments on the little finger of the non-dominant hand.	9	2

Note: DPC: Distal Palmar Crease; TE: Thenar Eminence.

4. Data analysis

Analysis were carried out to assess the number of unique combinations for a) Frequency; b) Frequency and Gender; c) Frequency and Ages [Grouped]; d) Frequency and Pressure [Grouped]; e) Frequency and Probe size [Grouped]; f) Frequency and Psychophysical method [Grouped]; g) Frequency and Room temperature [Grouped]; h) Frequency and Skin temperature [Grouped]; i) Frequency and Hand location, and j) Frequency and all factor groups. The results from these analyses will be presented in Sections 4.1 to 4.10. From this current section onward, for brevity, all mentions of dB re. 10^{-6} m/s^2 will be referred to simply as "dB".

The total number of data rows from the Organization Table encompassed by each combination, as well as the median VPTs, the total number of data points (calculated by summing the number of data points, found in Organization Table's point G, encompassed by each combination), the minimum and maximum values, quartiles 1 and 3 (Q1 and Q3, respectively), and the inter-quartile range (IQR), were calculated for each unique combination in each group. Mean VPTs, weighted mean VPTs, and standard deviation, in turn, were calculated for combinations encompassing 3 or more rows of the Organization Table. All calculations were carried out based on the mean VPT data found on the VPT-Mean-dB column (see Sections 3.1 and 3.2), for each row included in each relevant combination. Weighted-mean VPTs were calculated using (7).

$$\bar{x}_{VPT} = \frac{\sum_{i=1}^{n} x_i * w_i}{\sum_{i=1}^{n} w_i} \quad (7)$$

Where $\bar{x}_{VPT}$ describes the weighted-mean VPT for a given unique combination of variables; x_i describes the mean VPT of a given study, included in that unique combination of variables, found on the Organization Table's VPT-Mean-dB column; and w_i describes the number of data points from which the mean VPT of said given study was calculated, found on the Organization Table's Point G.

Sections 4.2 to 4.9 also each contain plots, organized by frequency, presenting either a violin plot and associated mean VPT distribution, for all categories of that section's factor group that encompass 5 or more data rows, or a scatter plot, for all categories encompassing 4 or fewer data rows. Both plot types were created based on the information contained in the Organization Table's VPT-Mean-dB column. The respective calculated median VPT and the total number of data rows for each frequency and category are also presented in all plots for which data was available.

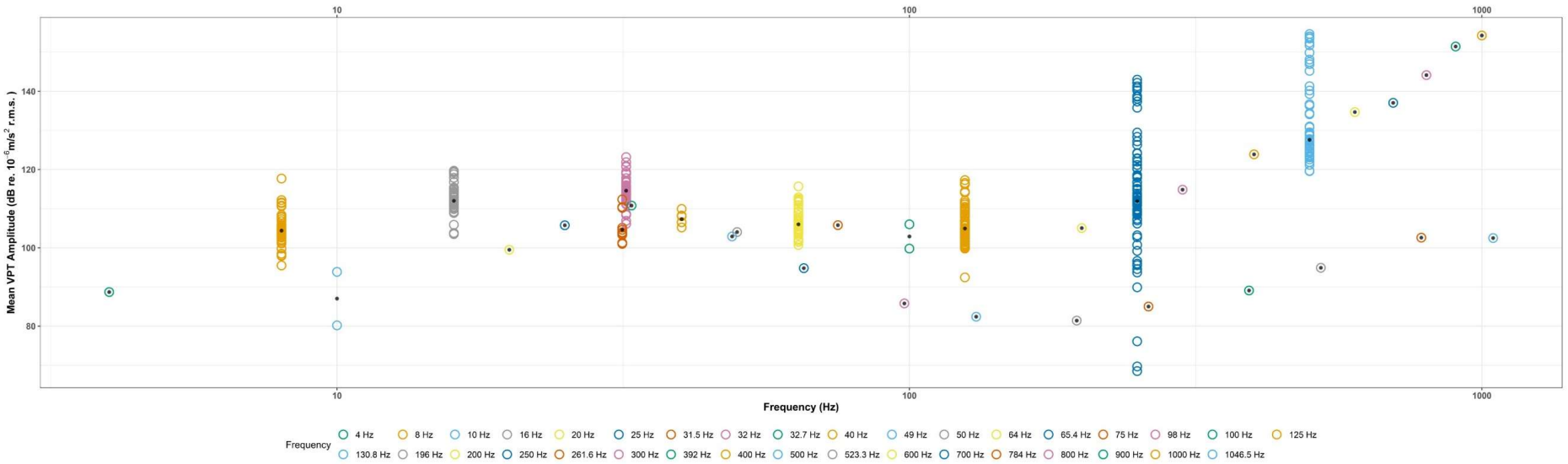
4.1. VPTs by Frequency

Mean VPT data was collected for 35 different frequencies, ranging from 4 Hz to 1046.5 Hz, and the total number of data rows, median VPTs, total number of data points, minimum and maximum values, Q1, Q3, and IQR were calculated for each one. Mean VPTs, weighted-mean VPTs, and SD were calculated for 9 of the 35 unique frequencies. This information is available as supplementary material. Figure 2 presents a distribution of the mean VPT results from each row related to each frequency, as well as the corresponding median VPT.

From a visual analysis of Figure 2, it can be noticed that many more VPT assessments have been conducted for frequencies equal to or below 250 Hz than for those above 250 Hz. This lack of attention is even more apparent when considering assessments conducted at frequencies above 500 Hz, which are not only less frequent, but also more spaced out

721 frequency-wise. Furthermore, as could be expected in light of previous knowledge regarding
722 factors that affect the human perception of vibrations on the hands–such as contact size and
723 pressure–, looking at median VPTs, while disregarding said factors, results in diverse
724 thresholds for some frequencies that, due to their proximity, would be expected to have
725 similar VPTs (e.g., 4 Hz – 88.7 dB, 8 Hz – 104.4 dB, 10 Hz – 81 dB).

726 The potential influence of various factors on VPTs can be seen at various frequencies,
727 especially those in which a wider variety of experimental protocols have been used to assess
728 VPTs from a wider variety of participants with different characteristics, such as 125 Hz, 250
729 Hz, and 500 Hz. Thus, the following eight sections will delve into an analysis of median
730 VPTs, calculated from the mean VPT results obtained by various studies. This analysis will
731 be carried out by first considering how a participant's gender, and each of the various factors
732 mentioned in Section 3.3, potentially affect VPT results, individually. Section 4.10 will then
733 offer a more comprehensive analysis of median VPTs, organized by frequency, and
734 incorporating all the factors previously discussed in Section 4. Readers should be aware,
735 however, that this does not constitute a thorough analysis of all factors that might potentially
736 or do indeed, influence VPTs. Such a complete and thorough analysis, accounting for all the
737 factors mentioned so far and more, is beyond the scope of this review.



738

739 *Figure 2 – VPTs, by Frequency (Hz). The ● symbol indicates the median VPT. Each scatter point represents a row from the Organization Table that contains data encompassed by each unique*

740 *frequency.*

741 **4.2. VPTs by Frequency and Gender**

742 A total of 57 unique combinations of Frequency and "Gender" factor group categories
743 were found, and the total number of data rows, median VPTs, total number of data points,
744 minimum and maximum values, Q1, Q3, and IQR were calculated for each one. Mean VPTs,
745 weighted-mean VPTs, and SD were calculated for 26 of these combinations (see
746 supplementary material). As mentioned in Section 4, Figure 3 presents either violin plots or
747 scatter plots, organized by frequency, for each of the categories in this factor group.

748 Of the 24 studies included in this analysis, 10 presented the results obtained from both
749 males and females in a combined manner. On the other end, 2 studies did not report nor
750 mention (N/M) information regarding their participant's gender. Nine studies only reported
751 VPT data obtained from male participants, and 3 studies reported data from both male and
752 female participants separately. None of the included studies reported data from female
753 participants only.

754 When distilling VPT information by gender alone, information for all 4 categories is
755 only concurrently available for 7 of the total 35 different frequencies. Data associated with
756 female participants only is available for 7 frequencies, while data associated with male
757 participants only is available for 11 frequencies. Separate information regarding mean VPTs
758 obtained from both male and female participants is simultaneously available for 7
759 frequencies, while mean VPT data for both males and females combined is available for 31 of
760 the 35 frequencies. At the 7 frequencies where separate data from both males and females are
761 available, VPTs obtained from each gender do not visually present wide disparities from each
762 other.

763 Data from males and females, both separate and combined, is concurrently available at
764 8 frequencies (8 Hz, 16 Hz, 32 Hz, 64 Hz, 100 Hz, 125 Hz, 250 Hz, and 500 Hz). At 7 of
765 these (8 Hz, 16 Hz, 32 Hz, 64 Hz, 125 Hz, 250 Hz, and 500 Hz), the calculated median VPT

for the "Male & Female" category is higher than the calculated median VPT for both males and females, separately. At 1 frequency (100 Hz), the calculated median VPT for the "Male & Female" category is lower than the calculated median VPT for males presented separately (Male = 106 dB; Male & Female = 99.8 dB).

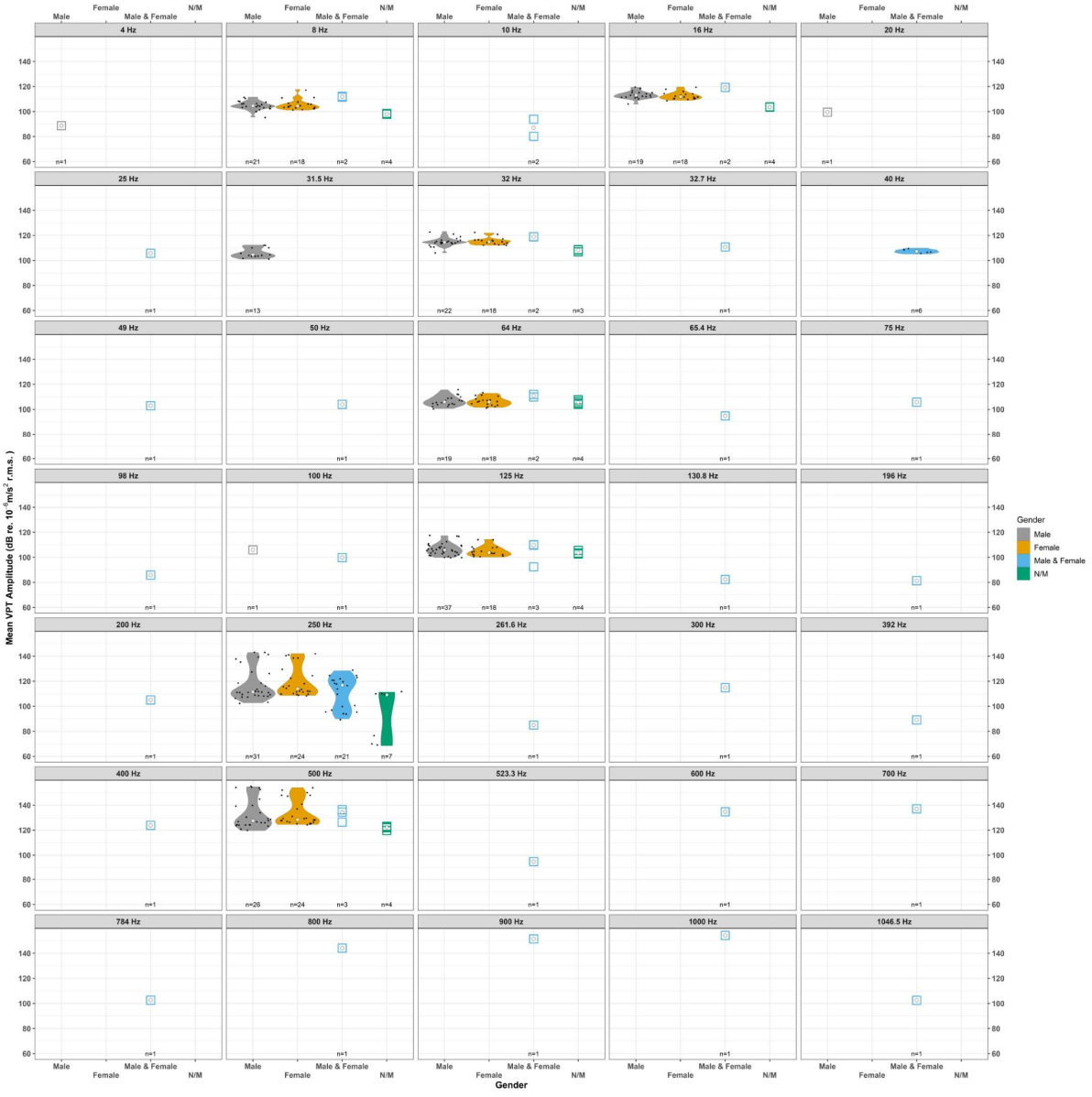


Figure 3 – Distribution of VPTs by Frequency (Hz) and Gender. The transparent ○ symbol represents the median VPT. 'n' denotes the number of data rows from the Organization Table for each combination. The ● symbol illustrates the distribution of individual data rows. "N/M" stands for not reported nor mentioned.

4.3. VPTs by Frequency and Ages [Grouped]

A total of 82 unique combinations of Frequency and "Ages [Grouped]" factor group categories were found, and the total number of data rows, median VPTs, total number of data points, minimum and maximum values, Q1, Q3, and IQR were calculated for each one. Mean VPTs, weighted-mean VPTs, and SD were calculated for 53 of these combinations (see supplementary material). As mentioned in Section 4, Figure 4 presents either violin plots or scatter plots, organized by frequency, for each of the categories in this factor group.

VPT data collected from participants aged between 30 and 40 years old ("[30,40[yo." category) was found in all but 1 of the 35 frequencies (40 Hz). Data from participants aged between 8 and 11 years old ("[8,11[yo." category), as well as data from participants aged between 60 and 70 years old ("[60,70[yo." category) was found in the same 7 frequencies (8 Hz, 16 Hz, 32 Hz, 64 Hz, 125 Hz, 250 Hz, and 500 Hz), while data from participants aged between 70 and 90 years old ("[70,90] yo." category) was found in those same 7 frequencies, plus 31.5 Hz.

Data from all categories is simultaneously present in 2 frequencies, namely 250 Hz and 500 Hz. Data from all but one category, namely "[50,60[" yo.", is simultaneously present in 5 further frequencies, 8 Hz, 16 Hz, 32 Hz, 64 Hz, and 125 Hz. Looking at the calculated median VPT for all categories found in each of these 8 frequencies, a pattern of VPTs decreasing with age (i.e., sensibility increasing), between the ages of 8 and 40 years old, and then increasing as age continues to progress, between 40 and 90 years old, appears to be noticeable, with sensitivities being lower between 16 and 40 years old. Additionally, at these 8 frequencies, VPTs assessed from individuals in the oldest age category, "[70,90] yo.", tended to be higher than VPTs assessed from individuals in the youngest age category, "[8,11[yo.", resulting in the calculated median VPT of the former (8 Hz = 111.2 dB, 16 Hz = 119.1 dB, 32 Hz = 121.4 dB, 64 Hz = 112.55 dB, 125 Hz = 114.25 dB, 250 Hz = 125.25 dB, 500 Hz = 139.75 dB) being higher than of the latter (8 Hz = 105.25 dB, 16 Hz = 112.6 dB, 32

Hz = 116.25 dB, 64 Hz = 110.1 dB, 125 Hz = 107.3 dB, 250 Hz = 116.25 dB, 500 Hz = 128.05 dB).

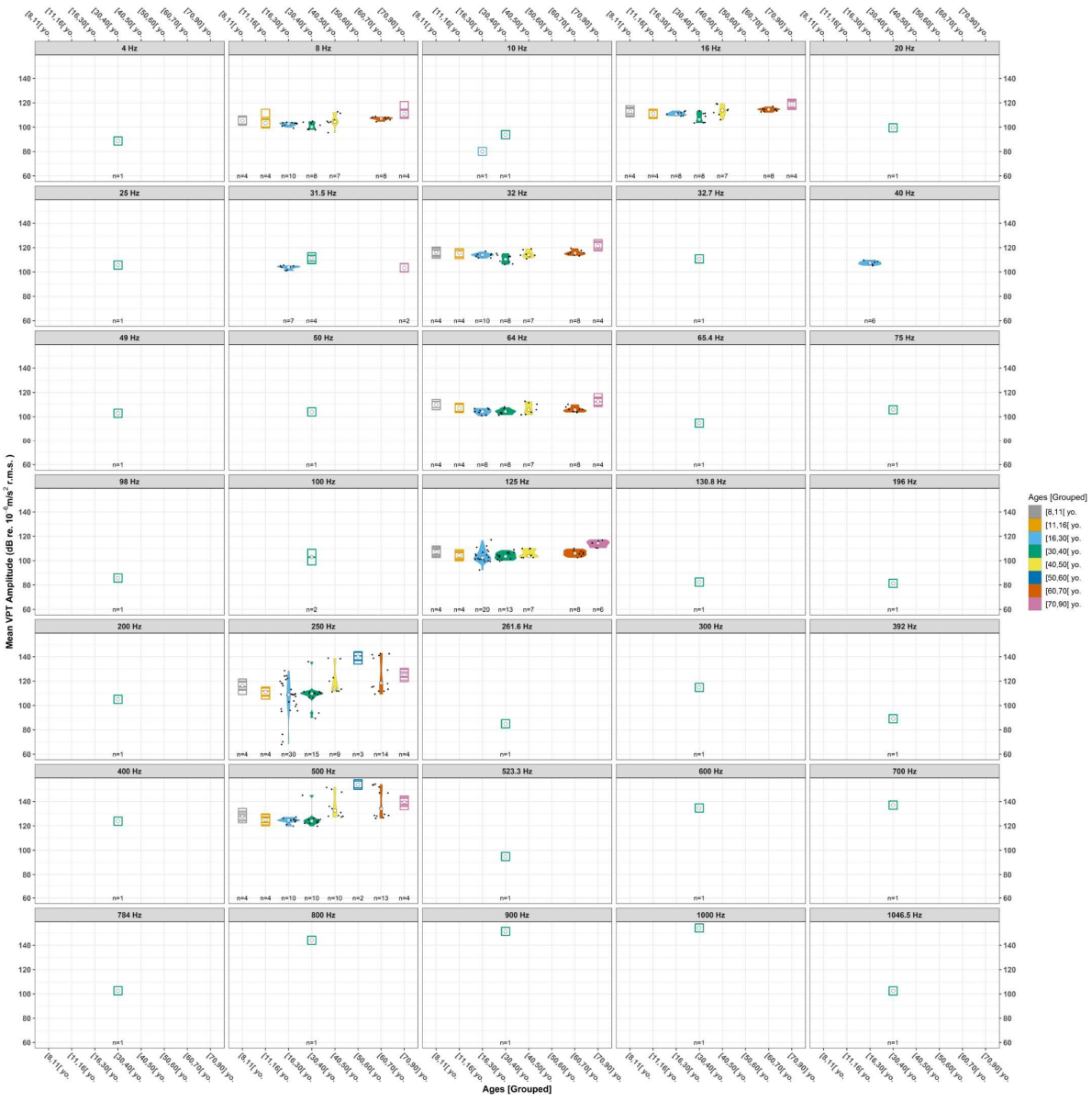


Figure 4 – Distribution of VPTs by Frequency (Hz) and Ages [Grouped]. The transparent ○ symbol represents the median VPT. 'n' denotes the number of data rows from the Organization Table for each combination. The ● symbol illustrates the distribution of individual data rows. "yo." stands for years old.

4.4. VPTs by Frequency and Pressure [Grouped]

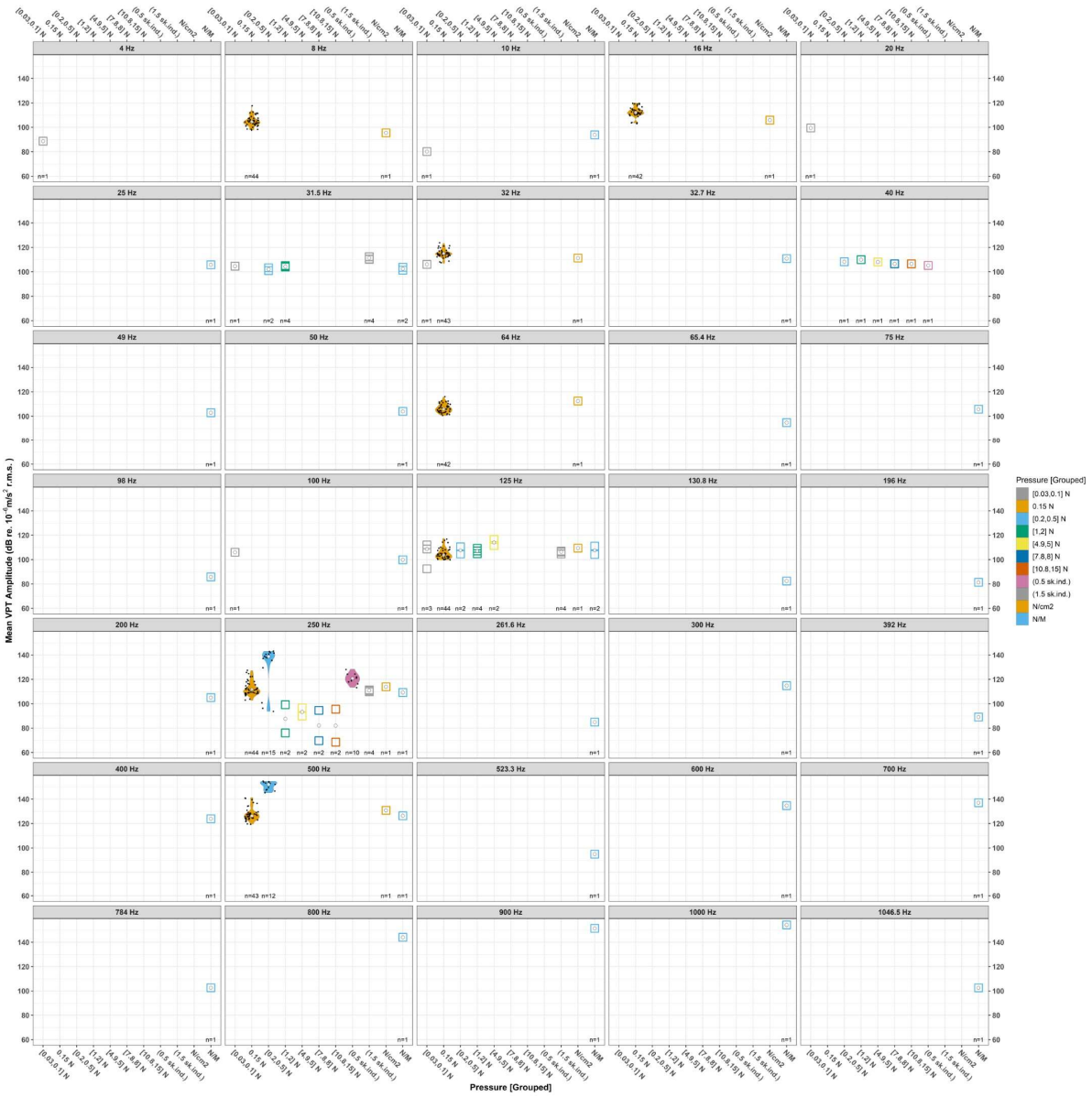
A total of 70 unique combinations of Frequency and "Pressure [Grouped]" factor group categories were found, and the total number of data rows, median VPTs, minimum and maximum values, Q1, Q3, and IQR were calculated for each one. Mean VPTs, total number

of data points, weighted-mean VPTs, and SD were calculated for 16 of these combinations (see supplementary material). As mentioned in Section 4, Figure 5 presents either violin plots or scatter plots, organized by frequency, for each of the categories in this factor group.

Across the 35 unique frequencies, entries on the "N/M" category could be found for 28 of them, making it the most widespread category of this factor group. Excluding this category, the other most widespread ones were the "[0.03,0.1] N", "0.15 N", and "N/cm^2" categories, found across 7 different frequencies. Data from these 3 categories could be simultaneously found for frequencies of 32 Hz and 125 Hz. On the other hand, the "(0.5 sk.ind.)" and "[7.8,8] N" categories were the least spread out, with data available for both only at 40 Hz and 250 Hz.

Data from all 11 categories could not be simultaneously found for any frequency. Data from 10 categories, sans "[0.03,0.1] N", could be found at 250 Hz. At this frequency, VPTs assessed using pressure between 0.2 N and 0.5 N ("[0.2,0.5] N" category) were higher than VPTs assessed with other reported pressures or skin indentations. The calculated median VPT for this combination of frequency and category was 138.61 dB, with the second highest calculated median VPT, at this frequency, being found for the "(0.5 sk.ind.)" category, at 120.76 dB. The third highest calculated median VPT, in turn, was found for the "0.15 N" category, at 111.6 dB, followed by the "(1.5 sk.ind.)" category, at 110.91 dB. Additionally, for this frequency, the calculated median VPT for the "[1,2] N", "[4.9,5] N", "[7.8,8] N", and "[10.8,15] N" categories were found to be lower than for the "0.15 N" and "[0.2,0.5] N" categories. However, it should be noted that data entries for these last 2 categories, at this frequency, were substantially more prevalent throughout the analysed 24 papers than data entries for the former 4.

833 At 500 Hz, in turn, VPT data from the "[0.2,0.5] N" category was also higher than VPT
834 data from the "0.15 N" category, which was also reflected in the calculated median VPT for
835 each, namely 152.08 dB and 126.3 dB, respectively.



836

837 *Figure 5 – Distribution of VPTs by Frequency (Hz) and Pressure [Grouped]. The transparent ○ symbol represents the*
838 *median VPT. 'n' denotes the number of data rows from the Organization Table for each combination. The ● symbol*
839 *illustrates the distribution of individual data rows. "N/M" stands for not reported nor mentioned.*

840 **4.5. VPTs by Frequency and Probe size [Grouped]**

841 A total of 53 unique combinations of Frequency and "Probe size [Grouped]" factor
842 group categories were found, and the total number of data rows, median VPTs, total number

of data points, minimum and maximum values, Q1, Q3, and IQR were calculated for each one. Mean VPTs, weighted-mean VPTs, and SD were calculated for 17 of these combinations (see supplementary material). As mentioned in Section 4, Figure 6 presents either violin plots or scatter plots, organized by frequency, for each of the categories in this factor group.

Mean VPT data from studies which reportedly collected data using a probe size diameter between 2.6 mm and 5 mm ("[2.6,5] mm" category) was found for 22 of the total 35 frequencies. In contrast, data from the "[12.46,14] mm" category was only found for two frequencies, 40 Hz and 250 Hz, while data from the "[1,2] mm" category was only found at 250 Hz. Data from the category related to the largest diameter sizes, "[19.2,20] mm", was found at 11 different frequencies, with only 1 data entry in each. Data related to unreported probe diameter sizes ("N/M" category") was found for 9 frequencies, and data from the "[6,10] mm" category was found for 8 frequencies.

VPT data from all 6 categories was not simultaneously found at any frequency. Similarly, VPT data from all 5 categories, excluding the "N/M" category, was also not found at any frequency. The frequency at which data from most categories was available was 250 Hz, with data from the "[1,2] mm", "[2.6,5] mm", "[6,10] mm", "[12.46,14] mm", and "N/M" categories being present. Between these 5 categories, at this frequency, the highest calculated median VPT belonged to the "[6,10] mm" category, at 138.35 dB, followed by the "[1,2] mm" category, at 121.17 dB. The lowest calculated median VPT, in turn, was found for the "N/M" category, at 89.9 dB, followed by the "[12.46,14] mm" category, at 97.94 dB.

At 8 Hz, 16 Hz, and 32 Hz, the calculated median VPT for the "[2.6,5] mm" category was higher (8 Hz = 104.4 dB, 16 Hz = 112.05 dB, 32 Hz = 114.9 dB) than the calculated median VPT for the "]6,10] mm" category (8 Hz = 95.5 dB, 16 Hz = 105.9 dB, 32 Hz = 111.3 dB), hinting at a lower sensibility to vibrations with a reduced probe size, at these frequencies. It should be noted, however, that a large difference can be found between the

number of data points for each category in these 3 frequencies, with the "[2.6,5] mm" category having substantially more entries than the "[6,10] mm" category. At 64 Hz, 125 Hz, 250 Hz, and 500 Hz, in turn, this VPT pattern is reversed, with the calculated median VPT for the "[2.6,5] mm" category being lower (64 Hz = 105.95 dB, 125 Hz = 104.84 dB, 250 Hz = 111.7 dB, 500 Hz = 126.4 dB) than the calculated median VPT for the "]6,10] mm" category (64 Hz = 112.5 dB, 125 Hz = 109.4 dB, 250 Hz = 138.35 dB, 500 Hz = 151.75 dB).

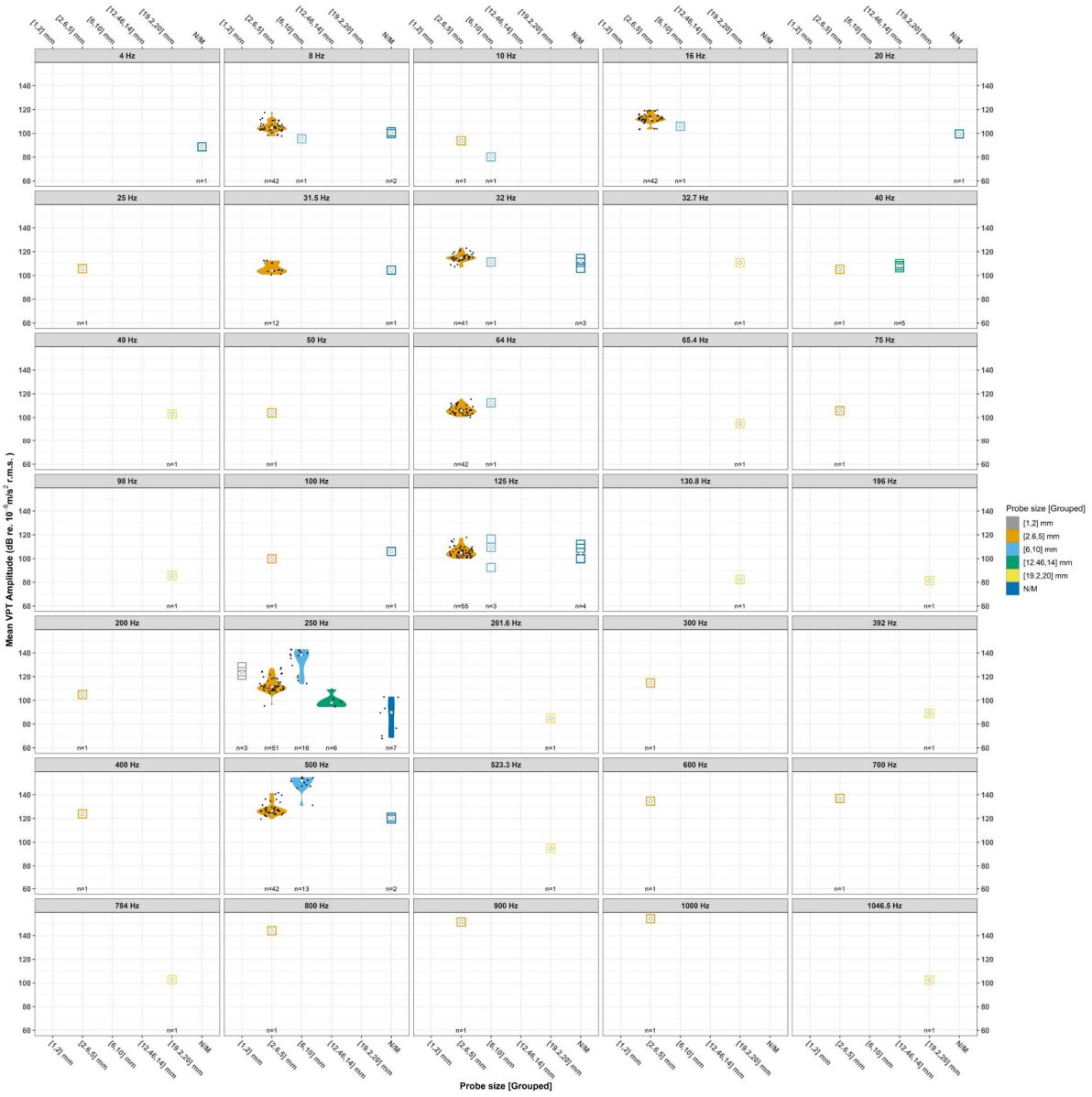


Figure 6 – Distribution of VPTs by Frequency (Hz) and Probe size [Grouped]. The transparent ○ symbol represents the median VPT. 'n' denotes the number of data rows from the Organization Table for each combination. The ● symbol illustrates the distribution of individual data rows. "N/M" stands for not reported nor mentioned.

4.6. VPTs by Frequency and Psychophysical method [Grouped]

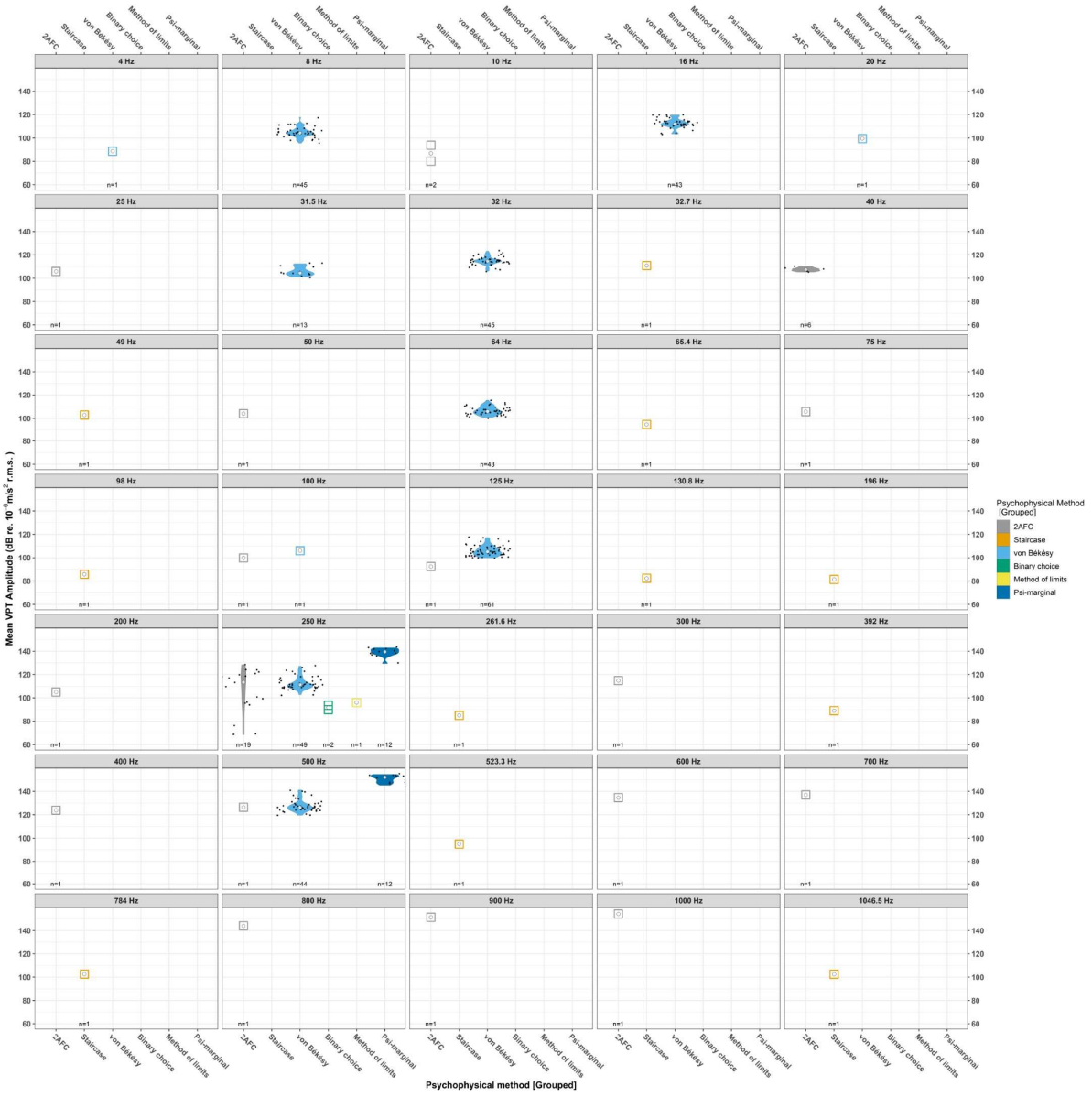
A total of 43 unique combinations of Frequency and "Psychophysical method [Grouped]" factor group categories were found, and the total number of data rows, median VPTs, minimum and maximum values, Q1, Q3, and IQR were calculated for each one. Mean VPTs, total number of data points, weighted-mean VPTs, and SD were calculated for 12 of these combinations (see supplementary material). As mentioned in Section 4, Figure 7

884 presents either violin plots or scatter plots, organized by frequency, for each of the categories
885 in this factor group.

886 VPT data assessed through either a two-answer or a two-alternative forced choice task,
887 with any rule or paradigm ("2AFC" category), was found for 17 of the 35 total frequencies.
888 Data obtained through either the von Békésy method, following any rule or change-rate ("von
889 Békésy" category), and the Staircase method, following any rule or step-size ("Staircase"
890 category), in turn, was found at 11 frequencies each, albeit not the same frequencies. On the
891 other hand, data from the "Binary choice" and "Method of limits" categories was only found
892 at 250 Hz. Lastly, data from the "Psi-marginal" category was only found at 250 Hz and 500
893 Hz.

894 Data from all 6 categories was not simultaneously found at any frequency. At 250 Hz,
895 data from 5 categories, excluding the "Staircase" category, was found. At this frequency,
896 VPT results reportedly obtained through the psi-marginal adaptative algorithm, following any
897 rule, form, or step-size ("Psi-marginal" category) were generally higher than those obtained
898 by all other categories present, with a calculated median VPT of 139.5 dB. VPT data
899 associated with the "2AFC" category, in turn, presented a wide variation, with a minimum of
900 68.5 dB, and a maximum of 128.36 dB, being found, with a calculated median VPT of 113.43
901 dB. A similar calculated median VPT, 111.4 dB, was obtained for the "von Békésy"
902 category, with much less data dispersion, with a minimum of 102.7 dB, and a maximum of
903 127.2 dB. As for the calculated median VPTs for the "Binary choice" and "Method of limits"
904 categories, these were 91.8 dB and 95.96 dB respectively. At 500 Hz, in turn, data was only
905 found for the "2AFC", "von Békésy", and "Psi-marginal" categories, with the latter having a
906 calculated median VPT higher than the other two, at 152.08 dB. This value was followed by
907 the "2AFC" category, with a calculated median VPT of 120.42 dB, and the "von Békésy"

908 category, with a calculated median VPT of 126.4 dB, though the former was calculated from
909 only 1 data row of the Organization Table, while the latter was calculated from 44 data rows.



910

911 *Figure 7 – Distribution of VPTs by Frequency (Hz) and Psychophysical method [Grouped]. The transparent ○ symbol*
912 *represents the median VPT. 'n' denotes the number of data rows from the Organization Table for each combination. The ●*
913 *symbol illustrates the distribution of individual data rows.*

914 **4.7. VPTs by Frequency and Room temperature [Grouped]**

915 A total of 53 unique combinations of Frequency and "Room temperature [Grouped]"
916 factor group categories were found, and the total number of data rows, median VPTs, total
917 number of data points, minimum and maximum values, Q1, Q3, and IQR were calculated for

each one. Mean VPTs, weighted-mean VPTs, and SD were calculated for 18 of these combinations (see supplementary material). As mentioned in Section 4, Figure 8 presents either violin plots or scatter plots, organized by frequency, for each of the categories in this factor group.

VPT data associated with entries to which room temperature values were not mentioned ("N/M" category) were found at 33 of the 35 total frequencies. Data associated with room temperatures between 20ºC and 31ºC ("[20,31[ºC" category), in turn, were found at 12 frequencies, while data associated with room temperatures above 28ºC (">28ºC" category) were found at 8 frequencies. Data from all 3 categories was simultaneously found at 8 frequencies, namely 8 Hz, 16 Hz, 31.5 Hz, 32 Hz, 64 Hz, 125 Hz, 250 Hz, and 500 Hz. Similar calculated median VPT values were obtained for the "[20,31[ºC" and "N/M" categories at 32 Hz, namely 114.75 dB and 114.7 dB, respectively. At the other 7 frequencies, the calculated median VPT for the "[20,31[ºC" category (8 Hz = 103.15 dB, 16 Hz = 111.4 dB, 31.5 Hz = 106.96 dB, 64 Hz = 107.15 dB, 125 Hz = 105.11 dB, 250 Hz = 110.84 dB, 500 Hz = 124.65 dB), in comparison to the calculated median VPT for the "N/M" category (8 Hz = 105.25 dB, 16 Hz = 113.75 dB, 31.5 Hz = 104.61 dB, 64 Hz = 104.15 dB, 125 Hz = 103.8 dB, 250 Hz = 114.12 dB, 500 Hz = 129.35 dB), was higher at 31.5 Hz, 64 Hz, and 125 Hz, and lower at 8 Hz, 16 Hz, 250 Hz, and 500 Hz.

Additionally, at 250 Hz, the dispersion of results for the "N/M" category varied between a minimum of 68.5 dB and a maximum of 142.98 dB, which was the widest variation of results across all 53 unique combinations.

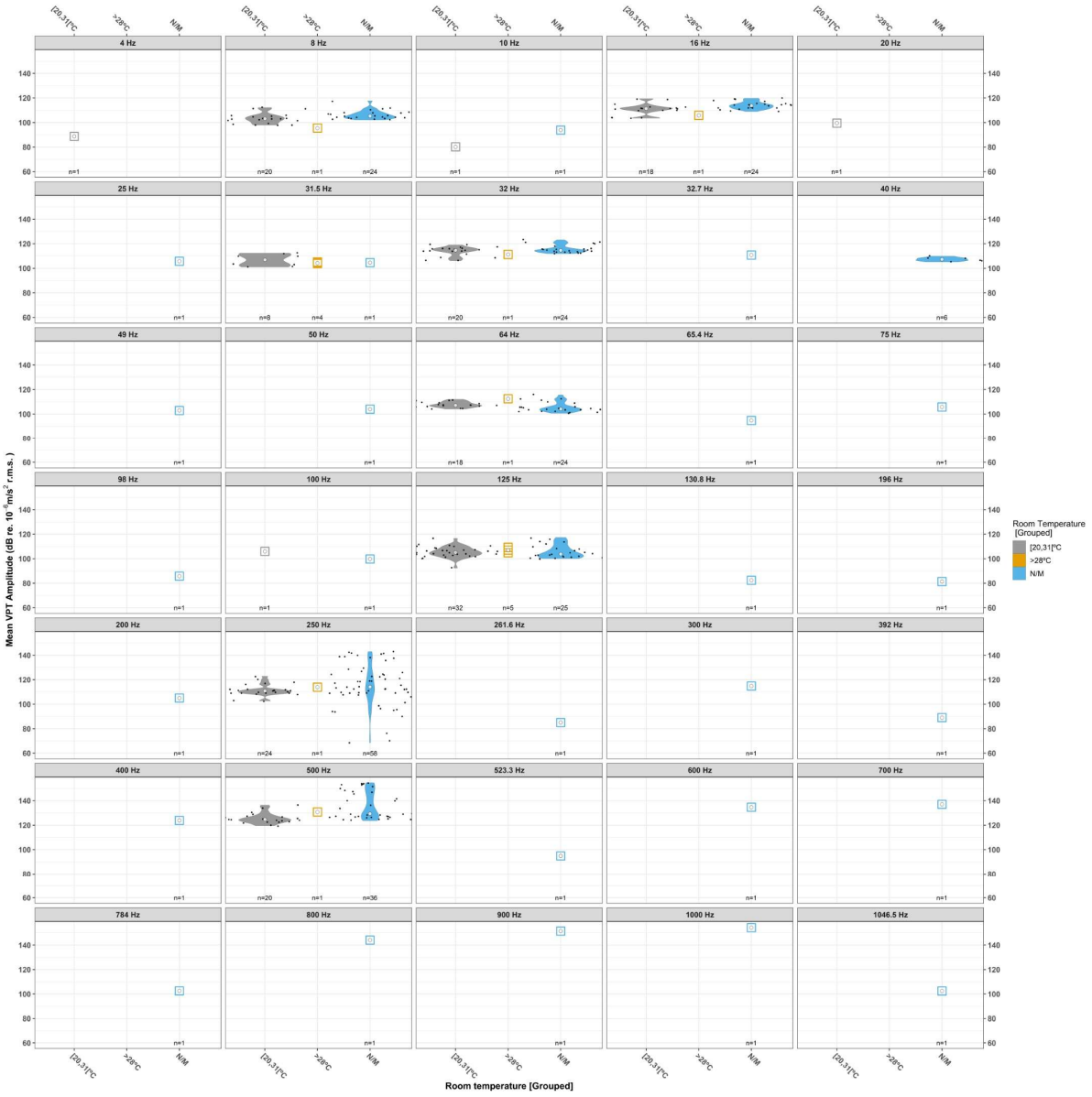


Figure 8 – Distribution of VPTs by Frequency (Hz) and Room temperature [Grouped]. The transparent ○ symbol represents the median VPT. 'n' denotes the number of data rows from the Organization Table for each combination. The ● symbol illustrates the distribution of individual data rows. "N/M" stands for not reported nor mentioned.

4.8. VPTs by Frequency and Skin temperature [Grouped]

A total of 46 unique combinations of Frequency and "Skin temperature [Grouped]" factor group categories were found, and the total number of data rows, median VPTs, minimum and maximum values, Q1, Q3, and IQR were calculated for each one. Mean VPTs, total number of data points, weighted-mean VPTs, and SD were calculated for 16 of these combinations (see supplementary material). As mentioned in Section 4, Figure 9 presents

either violin plots or scatter plots, organized by frequency, for each of the categories in this factor group.

VPT data associated with entries to which skin temperature values were not mentioned ("N/M" category) were found at 22 of the 35 total frequencies. VPT data collected with skin temperatures reportedly between 20ºC and 37ºC ("[20,37[ºC" category) was found for 23 frequencies, while data collected with skin temperatures above 30ºC (">30ºC" category) was only found at 125 Hz. Data from all 3 categories is found at this frequency, with the calculated median VPT for the ">30ºC" category being higher, at 114.06 dB, than the calculated median VPT for the "[20,37[ºC" (104.05 dB) and "N/M" (105.88 dB) categories.

Data from the "[20,37[ºC" and "N/M" categories is also simultaneously found at 9 other frequencies, namely 8 Hz, 16 Hz, 31.5 Hz, 32 Hz, 40 Hz, 64 Hz, 100 Hz, 250 Hz, and 500 Hz. At these frequencies, the calculated median VPT for the "[20,37[ºC" category (8 Hz = 104.7 dB, 16 Hz = 112.2 dB, 31.5 Hz = 104.61 dB, 32 Hz = 114.9 dB, 40 Hz = 105.2 dB, 64 Hz = 105.9 dB, 100 Hz = 106 dB, 250 Hz = 112.3 dB, 500 Hz = 127.1 dB), in comparison to the calculated median VPT for the "N/M" category (8 Hz = 98.5 dB, 16 Hz = 103.8 dB, 31.5 Hz = 104.28 dB, 32 Hz = 111.2 dB, 40 Hz = 108.7 dB, 64 Hz = 107.7 dB, 100 Hz = 99.8 dB, 250 Hz = 110.91 dB, 500 Hz = 146.06 dB), was higher at 8 Hz, 16 Hz, 32 Hz, 100 Hz, and 250 Hz, lower at 40 Hz, 64 Hz, and 500 Hz, and both were about equal at 31.5 Hz.

Additionally, at 250 Hz, the dispersion of results for the "N/M" category varied between a minimum of 68.5 dB and a maximum of 142.98 dB, which was the widest variation of results across all 53 unique combinations.

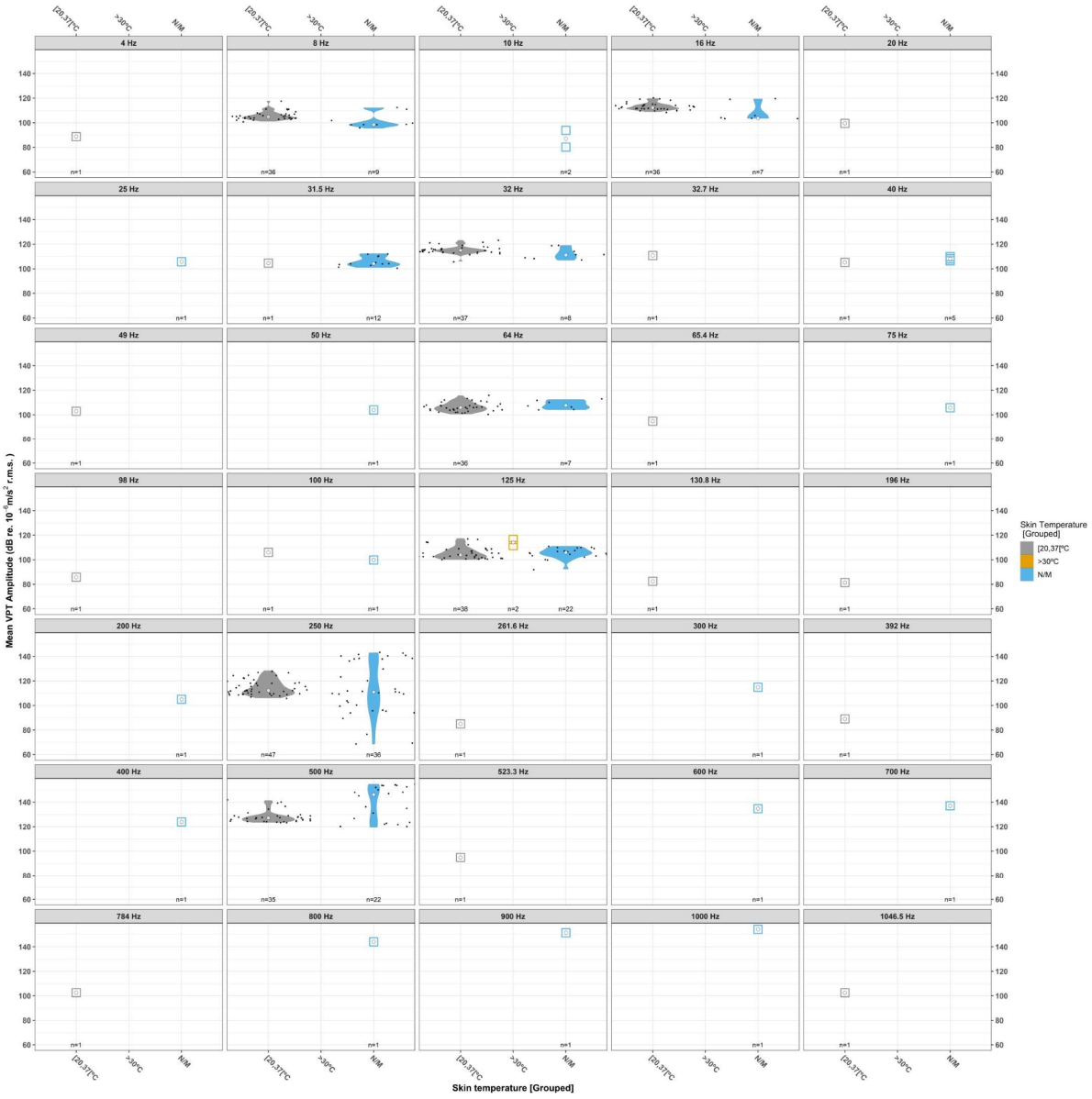


Figure 9 – Distribution of VPTs by Frequency (Hz) and Skin temperature [Grouped]. The transparent ○ symbol represents the median VPT. 'n' denotes the number of data rows from the Organization Table for each combination. The ● symbol illustrates the distribution of individual data rows. "N/M" stands for not reported nor mentioned.

4.9. VPTs by Frequency and Hand location

A total of 93 unique combinations of Frequency and "Hand location" factor group categories were found, and the total number of data rows, median VPTs, total number of data points, minimum and maximum values, Q1, Q3, and IQR were calculated for each one. Mean VPTs, weighted-mean VPTs, and SD were calculated for 19 of these combinations (see

supplementary material). As mentioned in Section 4, Figure 10 presents either violin plots or scatter plots, organized by frequency, for each of the categories in this factor group.

Of all 17 unique hand locations found among the 24 papers, the location most found across all 35 unique frequencies was the index finger of the right hand ("R.D2" category), for which data was found at 23 frequencies, followed by the middle finger of the dominant hand ("D.D3" category), for which data was found at 11 frequencies. On the opposite side, the thenar eminence of the right hand ("R.TE" category) and the middle finger of the non-dominant hand ("ND.D3" category) were only found at one frequency each, 125 Hz and 250 Hz, respectively. Thus, data from all locations was not simultaneously found at any frequency. At 250 Hz, data from 13 locations was present, with data from the "R.TE", "L.D2", "L.D5", and "D.D3" categories not being found. When comparing the calculated median VPTs for each category, at this frequency, it can be noted that the results from the "R.D2" (112.8 dB), "R.D5" (111.7 dB), "D.D5" (111.09 dB), and "ND.D5" (110.52 dB) categories were similar to each other. However, these results should take the disparity between the higher number of data entries for the "R.D2" (23 data rows) and "R.D5" (20 data rows) categories, in contrast with the number of data rows for the "D.D5" and "ND.D5" (2 data rows each) categories, into account. At this frequency, the lowest calculated median VPT was obtained by the "D.D2" category, 95.56 dB, while the highest was obtained by the "L.DPC" category, at 142.12 dB.

At 500 Hz, in turn, data was found for 11 locations, excluding the "R.TE", "L.D2", "L.D3", "L.D5", "D.D3", and "ND.D3" categories. At this frequency, the calculated median VPTs for the "R.D2" and "R.D5" categories were also similar, at 127.7 dB and 126.5 dB, respectively. Following these were the results for the "D.D2" and "D.D5" categories, at 123.1 dB and 122.6 dB, respectively. At this frequency, the lowest calculated median VPT was obtained by the "ND.D2" category, at 119.7 dB, while the highest was obtained by the

"R.DPC" category, at 153.18 dB, followed by the "R.D4" category, at 151.74 dB, the "R.D3" category, at 150.78 dB, the "L.DPC" category, at 150.48 dB, and the "L.D4" category, at 149.94. However, it should be noted that, at this frequency, only the "R.D2" (24 data rows) and the "R.D5" (19 data rows) categories contained data from more than 2 data rows of the Organization Table.

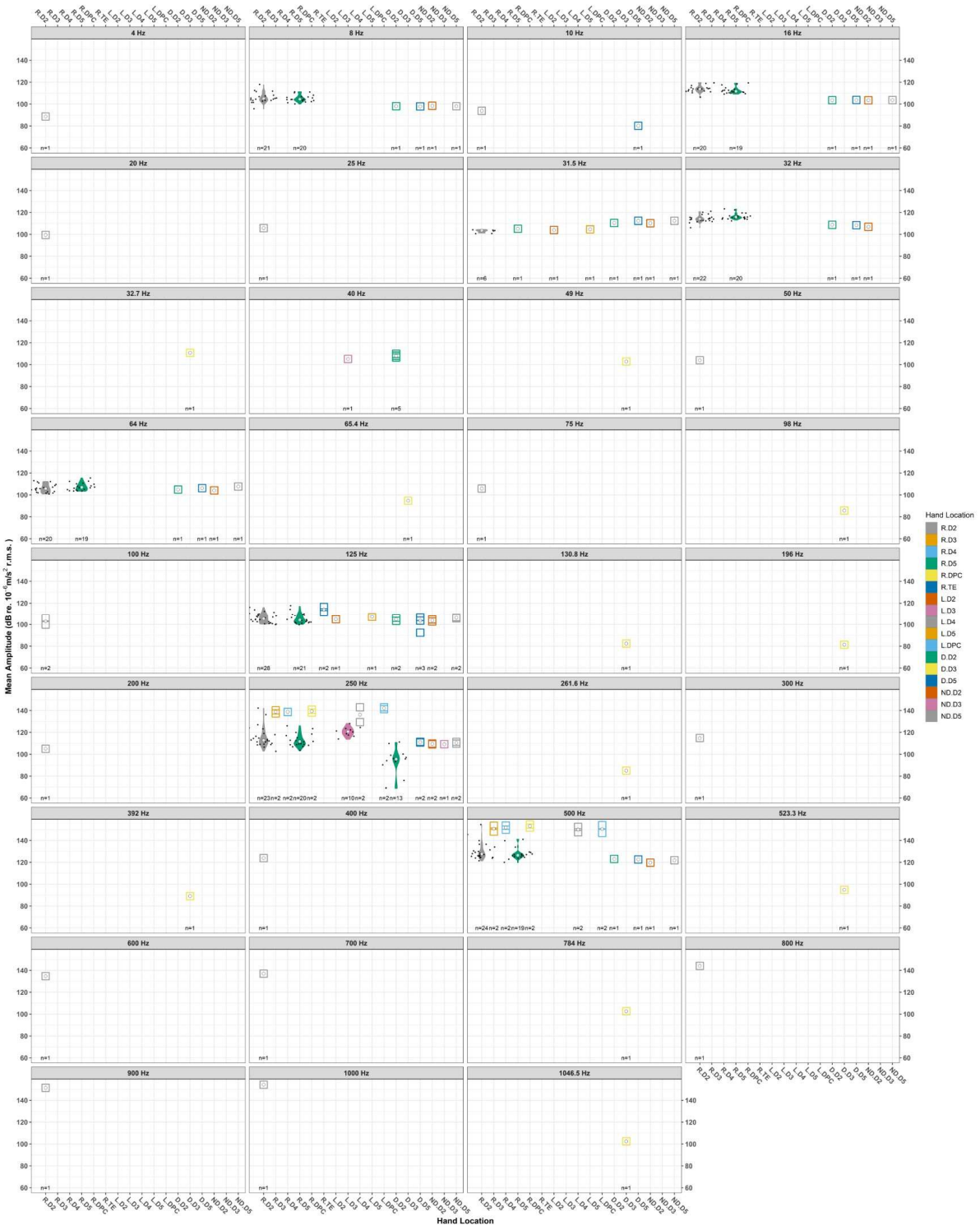


Figure 10 – Distribution of VPTs by Frequency (Hz) and Hand location. The transparent ○ symbol represents the median VPT. 'n' denotes the number of data rows from the Organization Table for each combination. The ● symbol illustrates the distribution of individual data rows.

4.10. VPTs by Frequency and All Groups

As demonstrated in the previous sections, VPT measurements are affected by several factors, related not only to the internal characteristics of the subjects themselves, but also to characteristics of the assessment methodology, and of the surrounding environment. Some of these factors influence VPT results more than others, but neither their effects nor the effects of their interactions should be ignored, especially when considered in real-life contexts of application. Therefore, to correctly compare the mean VPT results acquired from various studies, such comparisons should be made while considering the differences and similarities between said studies' methods and participants. In the same vein, any potential use or implementation of VPT data–be it, for example, as normative data for diagnostical purposes, or as data to drive an algorithm which controls and drives haptic stimulation delivered to users–, should also take the interaction between these and other factors into account, to avoid situations where the wrongful interpretation of this data leads to the wrong VPT results being selected and used as a basis for the vibration signal's parameters, which may not fit the intended use case.

Taking this into account, Table 11 provides the total number of data rows, the calculated median VPT, and the total number of data points for a total of 361 unique combinations of Frequency and all previously analysed factor groups— "Gender", "Ages [Grouped]", "Pressure [Grouped]", "Probe size [Grouped]", "Psychophysical method [Grouped]", "Room temperature [Grouped]", "Skin temperature [Grouped]", and "Hand location"—that were found throughout all 24 studies included in the analysis of this review. Additionally, the minimum and maximum values, Q1 and Q3, and the IQR for these 361 combinations, as well as the mean VPTs, weighted-mean VPT, and SD, which were calculated for 3 of these combinations (i.e., those combinations which encompassed 3 or more data row of the Organization Table), are available as supplementary material. A similar

table is also available as supplementary material, containing this same information, but for combinations organized without taking the "Hand location" factor group into consideration.

By analysing Table 11, the effects of the various factors mentioned previously on VPTs are notable, particularly when analysing frequencies at which a wider variety of experimental protocols have been employed to assess VPTs from a broader range of subjects (e.g., 125 Hz, 250 Hz, 500 Hz). It is also clear that 358 of the 361 total unique combinations only encompass 1 or 2 rows of the Organization Table. Nonetheless, only 51 unique combinations encompassed data gathered from 10 or less total data points, while 65 unique combinations encompassed data gathered from 101 or more total data points, with 14 unique combinations encompassing data gathered from 224 total data points each, the highest number of total data points for any combination. Additionally, 178 unique combinations encompassed data gathered from 11 to 50 data points, and 91 unique combinations encompassed data gathered from 51 to 100 data points. Readers are reminded that data points, in this context, refer to either the number of valid participants or the number of valid locations from which the corresponding VPTs were obtained/calculated.

When interpreting and comparing the median VPTs presented in Table 11, it is important to take note of the differences between the total number of data points which contributed data for each combination, especially when comparing combinations with the same categories on multiple factor groups, as a higher number of data points leads to a more reliable calculated median VPTs. Thus, median VPT data calculated for combinations with a higher number of data points should be taken as potentially more reliable than for those with a lower number.

Table 11 — Median VPTs, number of data rows from the Organization Table ('n'), and number of total data points, for each unique combination of Frequency (Hz), Gender, Age group, Pressure group, Probe size group, and Psychophysical Method group. Results presented in dB re. 10^{-6}m/s^2 r.m.s. "yo." stands for years old. "N/M" stands for not reported nor mentioned.

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
1	4	Male	[30,40[yo.	[0.03,0.1] N	N/M	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	10	88.7
2	8	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	36	105.1
3	8	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	36	105.9
4	8	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	54	102.8
5	8	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	54	103.5
6	8	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	40	103
7	8	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	40	103.9
8	8	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	58	103.5
9	8	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	58	104
10	8	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D2	1	8	101.3
11	8	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D5	1	8	99.8
12	8	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	53	104.6
13	8	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	53	104.8
14	8	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	75	105.7
15	8	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	75	104.4
16	8	Male	[40,50[yo.	N/cm2	[6,10] mm	von Békésy	>28ºC	N/M	R.D2	1	148	95.5
17	8	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	76	107.9
18	8	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	76	107.6

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
19	8	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	111.6
20	8	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	110.8
21	8	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	41	105
22	8	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	41	105.4
23	8	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	55	111.4
24	8	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	55	103.3
25	8	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	43	101.1
26	8	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	43	101.7
27	8	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	97	103
28	8	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	97	102.6
29	8	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	121	103.2
30	8	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	121	102.1
31	8	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	140	104.3
32	8	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	139	103.6
33	8	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	224	106.5
34	8	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	224	105.7
35	8	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	117.7
36	8	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	110.6
37	8	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	20	112.19
38	8	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D5	1	20	111.47
39	8	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	19	98.1

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
40	8	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	18	97.9
41	8	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	19	98.5
42	8	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D5	1	19	98.1
43	10	Male & Female	[16,30[yo.	[0.03,0.1] N	[6,10] mm	2AFC	[20,31[ºC	N/M	D.D5	1	111	80.19
44	10	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	93.86
45	16	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	36	114.4
46	16	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	36	112.3
47	16	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	54	111.4
48	16	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	54	111.5
49	16	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	40	112
50	16	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	40	110.2
51	16	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	58	113.5
52	16	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	58	111.1
53	16	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	53	113.6
54	16	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	53	111.4
55	16	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	75	113.9
56	16	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	75	111.7
57	16	Male	[40,50[yo.	N/cm2	[6,10] mm	von Békésy	>28ºC	N/M	R.D2	1	148	105.9
58	16	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	76	116
59	16	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	76	114
60	16	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	119.4

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
61	16	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	118.8
62	16	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	41	112.9
63	16	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	41	111.9
64	16	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	55	111.4
65	16	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	55	110.5
66	16	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	43	110
67	16	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	43	109.2
68	16	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	97	112.1
69	16	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	97	109.9
70	16	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	121	111.6
71	16	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	121	108.9
72	16	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	140	114.2
73	16	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	139	110.9
74	16	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	224	114.85
75	16	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	224	112.95
76	16	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	119.7
77	16	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	117.9
78	16	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	20	119.32
79	16	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D5	1	20	119.27
80	16	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	19	103.6
81	16	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	18	103.8

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
82	16	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	19	103.5
83	16	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D5	1	19	103.7
84	20	Male	[30,40[yo.	[0.03,0.1] N	N/M	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	10	99.5
85	25	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	105.76
86	31.5	Male	[16,30[yo.	[0.03,0.1] N	N/M	von Békésy	N/M	[20,37[ºC	R.D2	1	120	104.61
87	31.5	Male	[16,30[yo.	[0.2,0.5] N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	10	101
88	31.5	Male	[16,30[yo.	[1,2] N	[2.6,5] mm	von Békésy	>28ºC	N/M	R.D2	1	41	103.91
89	31.5	Male	[16,30[yo.	[1,2] N	[2.6,5] mm	von Békésy	>28ºC	N/M	R.D5	1	41	105.14
90	31.5	Male	[16,30[yo.	[1,2] N	[2.6,5] mm	von Békésy	>28ºC	N/M	L.D2	1	41	103.96
91	31.5	Male	[16,30[yo.	[1,2] N	[2.6,5] mm	von Békésy	>28ºC	N/M	L.D5	1	41	104.6
92	31.5	Male	[16,30[yo.	N/M	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	10	101.3
93	31.5	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	120	110.42
94	31.5	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	120	112.38
95	31.5	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	120	110.21
96	31.5	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D5	1	120	112.37
97	31.5	Male	[70,90] yo.	[0.2,0.5] N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	10	103.3
98	31.5	Male	[70,90] yo.	N/M	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	10	103.7
99	32	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	36	114.6
100	32	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	36	116.7
101	32	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	54	114.3
102	32	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	54	115.8

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
103	32	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	40	113.5
104	32	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	40	116.7
105	32	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	58	111.9
106	32	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	58	115.2
107	32	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D2	1	8	111.1
108	32	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D5	1	8	114.3
109	32	Male	[30,40[yo.	[0.03,0.1] N	N/M	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	10	106.1
110	32	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	53	114.3
111	32	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	53	115.3
112	32	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	75	113.5
113	32	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	75	114.9
114	32	Male	[40,50[yo.	N/cm2	[6,10] mm	von Békésy	>28ºC	N/M	R.D2	1	148	111.3
115	32	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	76	116.15
116	32	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	76	116.85
117	32	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	120.7
118	32	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	123.2
119	32	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	41	115.8
120	32	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	41	117.1
121	32	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	55	115.6
122	32	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	55	115.8
123	32	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	43	113.7

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
124	32	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	43	114.9
125	32	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	97	112.7
126	32	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	97	114.2
127	32	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	121	112.4
128	32	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	121	112.8
129	32	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	140	112.1
130	32	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	139	113.9
131	32	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	224	114.15
132	32	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	224	115.9
133	32	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	120.9
134	32	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	121.9
135	32	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	20	118.99
136	32	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D5	1	20	118.89
137	32	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	19	108.7
138	32	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	18	108.4
139	32	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	19	106.9
140	32.7	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	110.8
141	40	Male & Female	[16,30[yo.	[0.2,0.5] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	108.26
142	40	Male & Female	[16,30[yo.	[1,2] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	109.94

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
143	40	Male & Female	[16,30[yo.	[4.9,5] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	108.07
144	40	Male & Female	[16,30[yo.	[7.8,8] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	106.56
145	40	Male & Female	[16,30[yo.	[10.8,15] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	106.52
146	40	Male & Female	[16,30[yo.	(0.5 sk.ind.)	[2.6,5] mm	2AFC	N/M	[20,37[ºC	L.D3	1	8	105.2
147	49	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	102.9
148	50	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	104.03
149	64	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	36	109.1
150	64	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	36	109.3
151	64	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	54	107.3
152	64	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	54	106.9
153	64	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	40	104.6
154	64	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	40	107
155	64	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	58	100.7
156	64	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	58	103.6
157	64	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	53	102
158	64	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	53	104.8
159	64	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	75	102.3
160	64	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	75	105.7

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
161	64	Male	[40,50[yo.	N/cm2	[6,10] mm	von Békésy	>28ºC	N/M	R.D2	1	148	112.5
162	64	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	76	104.85
163	64	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	76	107.1
164	64	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	112.2
165	64	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	115.7
166	64	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	41	110.9
167	64	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	41	110.9
168	64	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	55	106.8
169	64	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	55	107.8
170	64	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	43	105.9
171	64	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	43	106.6
172	64	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	97	102
173	64	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	97	103.9
174	64	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	121	101.5
175	64	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	121	103.2
176	64	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	140	101.6
177	64	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	139	103.7
178	64	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	224	104.85
179	64	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	224	107.15
180	64	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	111.7
181	64	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	112.9

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
182	64	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	20	109.93
183	64	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D5	1	20	112
184	64	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	19	104.9
185	64	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	18	106.2
186	64	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	19	104.1
187	64	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D5	1	19	107.7
188	65.4	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	94.8
189	75	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	105.79
190	98	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	85.8
191	100	Male	[30,40[yo.	[0.03,0.1] N	N/M	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	10	106
192	100	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	99.8
193	125	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	36	106.8
194	125	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	36	105.9
195	125	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	54	105.6
196	125	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	54	104.1
197	125	Male	[16,30[yo.	[0.03,0.1] N	N/M	von Békésy	N/M	[20,37[ºC	R.D2	1	120	112.04
198	125	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	40	101
199	125	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	40	102.4
200	125	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	58	100.5
201	125	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	58	101.4
202	125	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D2	1	8	100.1

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
203	125	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D5	1	8	99.8
204	125	Male	[16,30[yo.	[0.2,0.5] N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	10	104.6
205	125	Male	[16,30[yo.	[1,2] N	[2.6,5] mm	von Békésy	>28ºC	N/M	R.D2	1	41	107.09
206	125	Male	[16,30[yo.	[1,2] N	[2.6,5] mm	von Békésy	>28ºC	N/M	R.D5	1	41	109.22
207	125	Male	[16,30[yo.	[1,2] N	[2.6,5] mm	von Békésy	>28ºC	N/M	L.D2	1	41	104.84
208	125	Male	[16,30[yo.	[1,2] N	[2.6,5] mm	von Békésy	>28ºC	N/M	L.D5	1	41	107.07
209	125	Male	[16,30[yo.	[4.9,5] N	[2.6,5] mm	von Békésy	[20,31[ºC	>30ºC	R.TE	1	15	111.53
210	125	Male	[16,30[yo.	[4.9,5] N	[6,10] mm	von Békésy	[20,31[ºC	>30ºC	R.TE	1	15	116.58
211	125	Male	[16,30[yo.	N/M	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	10	104.2
212	125	Male	[30,40[yo.	[0.03,0.1] N	N/M	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	10	108.7
213	125	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	53	100.1
214	125	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	53	101.4
215	125	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	120	106.17
216	125	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	120	106.94
217	125	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	120	104.63
218	125	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D5	1	120	106.69
219	125	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	75	102.9
220	125	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	75	103.8
221	125	Male	[40,50[yo.	N/cm2	[6,10] mm	von Békésy	>28ºC	N/M	R.D2	1	148	109.4
222	125	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	76	106.25
223	125	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	76	106.1

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
224	125	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	116.2
225	125	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	117.3
226	125	Male	[70,90] yo.	[0.2,0.5] N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	10	110.5
227	125	Male	[70,90] yo.	N/M	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	10	111.1
228	125	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	41	107.8
229	125	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	41	108.7
230	125	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	55	103.2
231	125	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	55	104.5
232	125	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	43	101.7
233	125	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	43	102.3
234	125	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	97	100.3
235	125	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	97	101.7
236	125	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	121	100.7
237	125	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	121	101.5
238	125	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	140	102.8
239	125	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	139	102.9
240	125	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	224	106.05
241	125	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	224	106.55
242	125	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	114.4
243	125	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	114.1
244	125	Male & Female	[16,30[yo.	[0.03,0.1] N	[6,10] mm	2AFC	[20,31[ºC	N/M	D.D5	1	111	92.44

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
245	125	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	20	109.81
246	125	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D5	1	20	110.15
247	125	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	19	103.3
248	125	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	18	103.5
249	125	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	19	102.7
250	125	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D5	1	19	105.6
251	130.8	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	82.4
252	196	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	81.4
253	200	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	105.04
254	250	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	36	115.8
255	250	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	36	112.3
256	250	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	54	110.9
257	250	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	54	108.6
258	250	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	40	108.4
259	250	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	40	109.3
260	250	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	58	108.8
261	250	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	58	107.4
262	250	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D2	1	8	102.7
263	250	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D5	1	8	103.2
264	250	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	53	106.2
265	250	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	53	107

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
266	250	Male	[30,40[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D2	1	1	135.79
267	250	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	120	111.04
268	250	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	120	110.78
269	250	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	120	109.84
270	250	Male	[30,40[yo.	(1.5 sk.ind.)	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D5	1	120	111.34
271	250	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	75	112
272	250	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	75	112.2
273	250	Male	[40,50[yo.	N/cm2	[6,10] mm	von Békésy	>28ºC	N/M	R.D2	1	148	113.9
274	250	Male	[50,60[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D3	1	5	137.38
275	250	Male	[50,60[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.DPC	1	19	140.8
276	250	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	76	115.05
277	250	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	76	113.7
278	250	Male	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D4	1	14	138.78
279	250	Male	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	L.D4	1	4	142.98
280	250	Male	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	L.DPC	1	4	142.98
281	250	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	127.2
282	250	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	126.3
283	250	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	41	118.4
284	250	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	41	116.7
285	250	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	55	111.8
286	250	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	55	111.7

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
287	250	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	43	109.6
288	250	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	43	108.6
289	250	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	97	109.3
290	250	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	97	108.6
291	250	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	121	109.5
292	250	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	121	109.2
293	250	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	140	112.8
294	250	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	139	111.7
295	250	Female	[40,50[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D4	1	23	138.61
296	250	Female	[40,50[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.DPC	1	27	138.09
297	250	Female	[50,60[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D3	1	4	140.22
298	250	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	224	113.95
299	250	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	224	113.5
300	250	Female	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D2	1	2	142.17
301	250	Female	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	L.D4	1	4	129.44
302	250	Female	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	L.DPC	1	3	141.27
303	250	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	124.2
304	250	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	122.9
305	250	Male & Female	[16,30[yo.	[0.2,0.5] N	[2.6,5] mm	Method of limits	N/M	N/M	D.D2	1	14	95.96
306	250	Male & Female	[16,30[yo.	[0.2,0.5] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	100.75

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
307	250	Male & Female	[16,30[yo.	[1,2] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	99.23
308	250	Male & Female	[16,30[yo.	[4.9,5] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	96.64
309	250	Male & Female	[16,30[yo.	[7.8,8] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	94.57
310	250	Male & Female	[16,30[yo.	[10.8,15] N	[12.46,14] mm	2AFC	N/M	N/M	D.D2	1	10	95.56
311	250	Male & Female	[16,30[yo.	(0.5 sk.ind.)	[1,2] mm	2AFC	N/M	[20,37[ºC	L.D3	3	21	124.24
312	250	Male & Female	[16,30[yo.	(0.5 sk.ind.)	[2.6,5] mm	2AFC	N/M	[20,37[ºC	L.D3	4	29	119.97
313	250	Male & Female	[16,30[yo.	(0.5 sk.ind.)	[6,10] mm	2AFC	N/M	[20,37[ºC	L.D3	3	21	118.45
314	250	Male & Female	[16,30[yo.	N/M	[12.46,14] mm	2AFC	N/M	[20,37[ºC	ND.D3	1	10	109.24
315	250	Male & Female	[30,40[yo.	[0.2,0.5] N	N/M	Binary choice	N/M	N/M	D.D2	1	22	93.7
316	250	Male & Female	[30,40[yo.	[4.9,5] N	N/M	Binary choice	N/M	N/M	D.D2	1	22	89.9
317	250	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	20	122.78
318	250	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D5	1	20	120.19
319	250	N/M	[16,30[yo.	[1,2] N	N/M	2AFC	N/M	N/M	D.D2	1	27	76.1
320	250	N/M	[16,30[yo.	[7.8,8] N	N/M	2AFC	N/M	N/M	D.D2	1	27	69.7
321	250	N/M	[16,30[yo.	[10.8,15] N	N/M	2AFC	N/M	N/M	D.D2	1	27	68.5
322	250	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	19	109.7

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
323	250	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	18	111.4
324	250	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	19	109.1
325	250	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D5	1	19	109.7
326	261.6	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	85
327	300	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	114.85
328	392	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	89.1
329	400	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	123.88
330	500	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	36	128.7
331	500	Male	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	36	125.9
332	500	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	54	124.2
333	500	Male	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	54	123.4
334	500	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	40	124.8
335	500	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	40	123.7
336	500	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	58	124.2
337	500	Male	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	58	126.3
338	500	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D2	1	8	121.2
339	500	Male	[16,30[yo.	0.15 N	N/M	von Békésy	[20,31[ºC	N/M	R.D5	1	8	119.6
340	500	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	53	123.6
341	500	Male	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	53	124.8
342	500	Male	[30,40[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D2	1	1	145.21
343	500	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	75	127.6

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
344	500	Male	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	75	128.9
345	500	Male	[40,50[yo.	N/cm2	[6,10] mm	von Békésy	>28ºC	N/M	R.D2	1	148	130.8
346	500	Male	[50,60[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D3	1	5	153.46
347	500	Male	[50,60[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.DPC	1	19	154.62
348	500	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	76	130.7
349	500	Male	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	44	126.2
350	500	Male	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D4	1	12	153.6
351	500	Male	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	L.D4	1	4	152.41
352	500	Male	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	L.DPC	1	5	154.03
353	500	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	139.3
354	500	Male	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	140.2
355	500	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	41	131
356	500	Female	[8,11[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	41	127.4
357	500	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	55	126
358	500	Female	[11,16[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	55	126.5
359	500	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D2	1	43	124.6
360	500	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	[20,37[ºC	R.D5	1	43	124.7
361	500	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	97	126
362	500	Female	[16,30[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	97	127.2
363	500	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	121	125.3
364	500	Female	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	121	124.5

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
365	500	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	140	127.8
366	500	Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	139	127.1
367	500	Female	[40,50[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D3	1	4	148.1
368	500	Female	[40,50[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D4	1	25	149.89
369	500	Female	[40,50[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.DPC	1	26	151.75
370	500	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	2	224	129.35
371	500	Female	[60,70[yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	2	224	128.35
372	500	Female	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	R.D2	1	2	154
373	500	Female	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	L.D4	1	3	147.47
374	500	Female	[60,70[yo.	[0.2,0.5] N	[6,10] mm	Psi-marginal	N/M	N/M	L.DPC	1	3	146.92
375	500	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D2	1	30	136.7
376	500	Female	[70,90] yo.	0.15 N	[2.6,5] mm	von Békésy	N/M	[20,37[ºC	R.D5	1	30	141.3
377	500	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	126.42
378	500	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D2	1	20	136.34
379	500	Male & Female	[40,50[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	R.D5	1	20	134.37
380	500	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D2	1	19	123.1
381	500	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	D.D5	1	18	122.6
382	500	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D2	1	19	119.7
383	500	N/M	[30,40[yo.	0.15 N	[2.6,5] mm	von Békésy	[20,31[ºC	N/M	ND.D5	1	19	121.9
384	523.3	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	94.9
385	600	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	134.69

Comb. nº	Frequency (Hz)	Gender	Ages [Grouped]	Pressure [Grouped]	Probe Size [Grouped]	Psychophysical Method [Grouped]	Room Temperature [Grouped]	Skin Temperature [Grouped]	Hand and Location (Short)	n	Total data points	Calculated median VPT (dB)
386	700	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	137.04
387	784	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	102.6
388	800	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	144.13
389	900	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	151.44
390	1000	Male & Female	[30,40[yo.	N/M	[2.6,5] mm	2AFC	N/M	N/M	R.D2	1	19	154.26
391	1046.5	Male & Female	[30,40[yo.	N/M	[19.2,20] mm	Staircase	N/M	[20,37[ºC	D.D3	1	32	102.5

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5. Discussion

This paper conducted a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis 2020 (PRISMA) methodology (Page et al., 2021), to address the following question: "What are the Vibration Perception Thresholds assessed on the glabrous skin of the hands and fingers of healthy humans?" To this end, 936 records were collected from three of the main electronic databases, over two separate searches at two different times. Thirty-seven papers were selected for content extraction and organization, with a focus on papers containing studies presenting vibration perception threshold (VPT) results assessed at the glabrous skin of the hands of healthy individuals

Data extracted from each paper was organized into a single table, referred to as the Organization Table (Table S1)—available at the URL presented in Section 1.6. Each row of this table was made to contain information corresponding to one VPT value, as well as information on various factors involved in its assessment, including information regarding the paper from which it was gathered. Eight main factors, which are known to affect VPT measurements, were given particular attention during data extraction, namely a) the participant's gender and b) age, c) the pressure/force between the instrument's probe and the subject's skin or skin indentation, d) the probe's diameter size, e) the psychophysical method through which VPTs were assessed, f) the temperature of the room in which assessments were conducted, g) the temperature of the skin during assessments, and h) hand location at which assessments were conducted. For each row, information was also collected regarding the number of data points from which each VPT result was calculated. Following this, from the 37 papers from which content was extracted and organized, the VPT results reported by 24 of those papers were converted, when needed, into mean VPTs presented as decibels relative to 10^{-6} m/s^2 root-mean-square acceleration, as recommended by ISO 13091-1 (International Organization for Standardization, 2001). The Organization Table is a

fundamental tool for future researchers, clinicians /or technology designers working with VPTs and perception of vibrations.

To organize data, factor groups were created for each of the 8 factors encompassed by this review, namely a) "Gender" b) "Ages [Grouped]", c) "Pressure [Grouped]", d) "Probe size [Grouped]", e) "Psychophysical method [Grouped]", f) "Room temperature [Grouped]", g) "Skin temperature [Grouped]", and h) "Hand location". Different categories were created for each factor group, with data from each row of the Organization Table being attributed to the corresponding categories.

For data analysis, VPT results were first organized by frequency. Following this, results were organized into different unique combinations created by combining this frequency information with each of the different categories created for each of the 8 factor groups. Results were organized by frequency and 1 factor group only, in sequence, followed by the creation of 391 unique combinations of frequency and all factor groups. For each combination, including by frequency alone, median VPTs, the total number of data points, the total number of encompassed data rows, the maximum and minimum values, quartiles 1 and 3, and the inter-quartile range, were calculated. In the same vein, mean VPTs, weighted mean VPTs, and standard deviation, were also calculated for each unique combination that encompassed 3 or more data rows of the Organization Table. All results are available in table format as supplementary material, while the results from the combinations of all frequencies and factor groups are presented in Table 11.

5.1. Impact of factors on VPTs

Overall, when comparing the VPT data obtained from male and female participants across multiple frequencies, it seems that one's gender does not impact VPTs. However, at 250 Hz, while the thresholds for males and females, reported separately, are similar, the combined data for both genders ("Male & Female" category of the "Gender" factor group)

shows lower reported thresholds compared to what was reported for males and females separately.

One's age, in turn, seems to have a positive impact on one's sensibility to vibrations, with thresholds appearing to progressively decrease (i.e., increased sensibility to vibrations) at various frequencies as one grows from 8 to around 30 years old. Between 16 and 40 years old, thresholds appear to stay the same, but one's sensibility to vibrations seems to then get progressively worse from one's 40s onwards.

The impact of different contact forces/pressures, or different skin indentations between skin and probe, can only be compared for a select number of frequencies, as data regarding different categories of the "Pressure [Grouped]" factor group was either not found for various frequencies, or was not very numerous. However, at both 250 Hz and 500 Hz, a pressure between 0.2 N and 0.5 N appears to result in higher threshold results than a pressure of 0.15 N. At 125 Hz, however, this does not appear to be the case. Additionally, at 250 Hz, applied forces between 1 N and 15 N were associated with lower reported thresholds than those reported for 0.15 N force at this same frequency.

The size of the contactor probe, in turn, appears to have a notable impact on VPT results assessed at 250 and 500 Hz. At these frequencies, participants appear to be reportedly more sensitive to vibrations delivered through probes of sizes between 2.6 mm to 5 mm in diameter, in contrast to those delivered by probes sized between 6 mm and 10 mm in diameter. At 250 Hz, however, participants appeared to show even greater sensitivities to vibrations delivered through probes with diameters between 12.46 mm and 14 mm, than to those delivered through probe sizes between 2.6 mm and 5 mm.

In a similar vein, the psychophysical method employed to assess VPTs also appears to have a notable impact on thresholds. At 250 Hz and 500 Hz, the highest thresholds were reportedly assessed using a psi-marginal adaptative algorithm. However, these were the only

2 frequencies at which this method was used for assessments, and was only reportedly used in one paper, Held et al. (2021). At other frequencies, most of the data that was available was assessed using the von Békésy method, which, at 250 Hz and 500 Hz, was associated with lower threshold results than those reportedly assessed with the psi-marginal adaptative algorithm. At 250 Hz, while the calculated median VPTs for the "von Békésy" and "2AFC" categories were similar, results reportedly assessed using either a two-alternative or a two-interval forced choice task were also associated with a wider variation of mean VPTs.

As for the influence of room and skin temperatures on VPTs, the impact of both factors is harder to assess based on the data presented in this review, especially when considering that 12 of the 24 papers did not report the temperature of the room where assessments were conducted at, and that 15 papers did not report the temperature of the skin during VPT assessments. Given that the different categories for both factor groups were organized in a way that best encompassed the two most predominant ways of reporting both room and skin temperature data, i.e., either as an average (Witte et al., 2022; Yıldız et al., 2015) or as a range (Clemm et al., 2019; Dahlin et al., 2015), only two categories were created, for each factor group, associated with reported temperature values, thus making comparisons difficult.

Lastly, it seems that the location of the hand at which assessments are conducted influences VPT results, with higher VPT results being reportedly assessed from some hand locations in comparison to others. For example, at 250 Hz, data from assessments conducted at the right index and little fingers were mostly similar to one another, but data from assessments conducted at the right middle and ring fingers, as well as in the right distal palmar crease were higher, potentially indicating that subjects might have less sensitivity to vibrations actuated at these locations. This same pattern seems to also be found at 500 Hz. At 64 Hz, 125 Hz, and 250 Hz, VPT results assessed at the right index and little fingers were also similar to the results obtained at the dominant hand's little finger, and at the index,

middle, and little fingers of the non-dominant hand. On the other hand, at 250 Hz, the lowest VPT results overall were obtained on assessments at the index finger of the dominant hand.

5.2. Review limitations and suggestions for future reviews

The separate categories created in this review for each factor group were meant to help organize the information extracted from each paper regarding the different factors that were focused on. During their creation, our goal was to organize each data row of the Organization Table according to how it was provided in their respective paper while keeping the number of categories per factor group manageable. For example, in some papers, such as Clemm et al. (2019) and Ekman et al. (2019), authors reported the mean age calculated from all participants, and presented VPT results for that mean age, while in others, such as Dahlin et al. (2015) and Ekman et al. (2021), authors organised participants by age ranges instead, and presented separate VPT results for each age range. These differences, as mentioned in Chapter 3.3.2, made the process of defining the categories for the "Ages [Grouped]" factor group more difficult, as different papers made use of age ranges with different lengths, with an "age range" group of one paper sometimes overlapping two separate "age range" groups of another. Thus, to conduct a more refined analysis and comparison of VPTs obtained by multiple studies, including those included in the papers used in this review's analysis, an approach that future authors may opt to follow is to decrease the number of overall factors under consideration, in favour of increasing the number of categories contained in one or more other factors groups (e.g., instead of 8 categories for the "Ages [Grouped]", as was the case in this paper, authors could opt for 16 categories instead, if data allows for such).

Another alternative is for future authors to keep their focus on only a single category of a factor group (e.g., include only studies that employed the von Békésy method) while organizing data considering various categories of other factors (e.g., age, body locations) and frequency, to more clearly assess how they interact with each other. Additionally, authors

may also opt to include other factors in their reviews that, while not considered in the scope of this review, are known or suspected to affect our haptic perception, such as vibration direction (Morioka & Griffin, 2008) or the menstrual cycle (Espritt et al., 1997; Gescheider et al., 1984). The inclusion of other factors can lead to an improved understanding of how haptic perception, especially regarding vibrotactile perception and VPTs, works in the human body, as well as to find other potential avenues of study, including factors which have not been the focus of many studies. Other avenues for future reviews also include comparing how different parameters of the employed psychophysical methods, such as how the use of different step-sizes, change-rates, number of total reversals (i.e., how many peaks and throughs should occur before an assessment is concluded), or the use of a starting amplitude above or below the expected threshold level, among other parameters, can affect VPT results. Having access to information regarding how different parameter changes can influence results from the same psychophysical methodology would allow future researchers to take this information into account either while planning their research studies, or when comparing results between different studies, for more accurate and reliable comparisons.

Other limitations of the current review are related to how we conducted our searches. As mentioned in Chapter 2.1, searches for papers were only carried out on three of the main electronic databases that are currently available, namely Scopus, Web of Science, and PubMed; were limited to only reporting back papers published in English between 2012 and 2023; and only employed the search terms "vibration", "perception", "thresholds", "hands", and "fingers", together with Boolean operators. Thus, authors interested in conducting further systematic reviews based on this topic can also opt to collect papers from avenues other than those used in this review, such as other electronic databases or journals only available as physical media, or to collect papers published in languages other than English—such as Polish (see Harazin et al., 2004, and Zamysłowska-Szmytke et al., 2002)—, or to increase or

narrow the time frame during which papers were published, or to conduct searches using terms other than the ones we employed, including terms which are synonyms to those we employed, such as "oscillation" or "vibrotactile" in place of "vibration". While the term "vibration perception thresholds" is widely used throughout this literature, other terms, such as "vibrotactile perception thresholds", "vibration disappearance thresholds", "vibration detection thresholds", among others, are also found throughout various papers to refer to these thresholds, some of which were encountered during our searchers and included in the analyses of this review, such as Clemm et al. (2019), Lundström et al. (2018), Marcuzzi et al. (2019), Moshourab et al. (2017), Papetti et al. (2017), Pra et al. (2023), Shibata (2022, 2023), and Tamrin et al. (2016).

While the above recommendations were aimed towards authors who may wish to conduct future systematic reviews on the topic of VPTs, the following sections (Sections 5.2.1 to 5.2.6), in turn, present recommendations we offer to authors who may wish to conduct quantitative experimental studies involving the assessment of VPTs. The recommendations offered above, as well as the recommendations provided in Sections 5.2.1 to 5.2.6, are summarized in Table 12, with the latter being expanded upon in their respective sections.

Table 12 — Summary of recommendations for authors of future reviews on VPTs, as well as for authors of quantitative studies assessing VPTs.

Aspect	**Details**
Suggestions for future reviews	Future authors interested in conducting future reviews on VPT studies may choose to decrease the number of factors included in their review, in favour of increasing the number of categories in each of those factor groups. Future authors may choose to focus on a single category of a factor group while increasing the number of categories in each factor group, or the number of overall factors under consideration. Future authors may choose to include other factors in their reviews that are known or suspected to affect human haptic perception, but that were not included in the scope of this review.

Aspect	Details
	Future authors may choose to conduct literature searches in electronic databases other than those used in this study, using either the same search terms used in this review, or synonyms of those terms, or also search for papers published in languages other than English.
Reporting methods and instruments	Authors should, within reason, provide detailed information about their methods, and instruments, as well as relevant information regarding participants' characteristics and the context of the interaction during assessments. This can facilitate the organization, cataloguing, and comparison of VPT data from multiple studies.
Reporting units of measurement	Authors should report VPT data using units of measurement that can be converted to other relevant units, with said conversions relying on either the information disclosed in their manuscript, or information easily accessible elsewhere. Authors should inform readers if their reported VPT values refer to either peak, peak-to-peak, or root-mean-squared measurements.
Reporting statistics	Mean VPT and standard deviation values should also be provided when authors mainly report and analyse median VPT values. Alternatively, authors can also provide enough information—namely sample minimum, median, and maximum, as well as quartiles 1 and 3, and the number of data points—, either on the manuscript or as supplementary material, to enable other authors to estimate mean and standard deviation values for each combination of factors that were studied.
Provide separate data	When data about different levels of the same variable are combined and presented as one, authors should also provide data from each level separately, either in the manuscript or as supplementary material.
Impact of various factors on VPT measurements	Authors should keep in mind that various factors involved with VPT assessments, such as the choice of psychophysical method, can significantly affect VPT results. Thus, when comparing threshold results from multiple sources, care should be given to the various factors in common between said sources, as differences in one factor may result in measured thresholds being higher or lower than thresholds presented in another source assessed under similar conditions.
Suggestions for future quantitative studies	Future authors may choose to conduct studies assessing VPTs while employing less often used combinations of factors.

5.2.1. Reporting methods and instruments

While calculated median VPTs generally increased as frequency also increased (see Figure 2), the impact of various factors—be it factors considered and factors not considered in this review, such as vibration direction (Morioka & Griffin, 2008) or the phase of the menstrual cycle (Espritt et al., 1997)—is also apparent, as exemplified by the wide dispersion

of mean VPTs for some frequencies. This is especially noticeable at frequencies at which more variations of experimental protocols and instruments have been used to carry out assessments with a larger variety of subjects. This, then, makes it difficult, if not impossible, to arrive at a single VPT value, for each given frequency, that takes all factors involved into account, while also maintaining enough confidence in its validity and reliability. Thus, it is paramount that authors, when reporting VPT data, provide as much information as possible regarding not only the employed methods and instruments, but also regarding their participants' characteristics and interaction conditions, as such information is essential to not only organize and catalogue VPT data for future use cases, but also for clarity and a more complete understanding of the context of their results.

5.2.2. Reporting units of measurement

In terms of reporting the threshold data itself, authors should consider the units in which they provide their data, and should opt for measurement units that can be converted to other relevant units with the information provided in their reports (e.g., frequency, contact pressure). For example, as mentioned in Section 3.1, Hatzfeld et al. (2016) reported the results from their "Experiment I" in force units, namely N, and while N values can be converted to acceleration, as we did not have access to the mass information associated with these results, the authors of this review did not believe they could accurately carry out these conversions. Thus, having access to enough information to allow for full confidence in carrying out unit conversions is critical for comparing results from different studies that might report results under different units of measurement. Furthermore, authors should disclose if the reported VPT results refer to either peak, peak-to-peak, or root-mean-square values, as values from one type of measurement need to be correctly converted to the other(s) for proper comparisons.

5.2.3. Reporting statistics

When authors report their main findings in a manuscript as median VPT values, they are advised to either also provide mean and standard deviation values, or to also provide enough information from the five-number summary to fit into any of the scenarios identified in Shi et al. (2023), either in the manuscript itself or as supplementary material—as was the case in Gerhardsson et al. (2013) and Ye and Griffin (2013). Doing so allows for mean and standard deviation values to be estimated from the median, thus increasing the amount of data available for comparisons such as those conducted in this review.

5.2.4. Provide separate data

Another important aspect is related to how works, such as Harazin et al. (2013) and Kuroki et al. (2016), only report VPT results after combining data obtained from different levels of the same independent variable. In these two works, the authors assessed VPTs at different fingers of the same participants but reported VPTs only as an average of all locations. Such combinations make the process of conducting analyses, like the ones conducted in this review, more difficult, and thus these two works were excluded during our content analysis process.

While statistical data from different levels of the same independent variable can be combined and reported as only one level, we nevertheless recommend that authors also provide data for each level separately, either in the manuscript itself or as supplementary material. This is especially relevant when VPTs were reportedly assessed from different hand locations or frequencies, but are only reported after data has been combined, and are not accompanied by statistical test results justifying this combination. Providing separate information for each level can thus help other authors conduct better comparisons between various results from both the same and different papers, as they will have more flexibility regarding how to organize and compare data, enriching analyses like those conducted in this review.

5.2.5. Consider the impact of various factors on VPT measurements

Throughout the 24 studies included in this review's data analysis, experimental methods included in the "von Békésy" category of the "Psychophysical method [Grouped]" factor group were, by and large, the most often used, being found in 13 papers. However, the method category with which VPTs were assessed for a larger number of different frequencies was the "2AFC" category, corresponding to data gathered with either a two-answer or two-alternative forced choice task, following any rule or paradigm. VPT data was gathered from 17 different frequencies using methods in this group, while methods in the "von Békésy" category were used to gather data from 11 different frequencies. Similarly, methods in the "Staircase" category were also used to collect data from 11 different frequencies. In contrast, however, when considering the combinations of all factors, as presented in Section 4.10, those included in the "von Békésy" category are far more prevalent (319 unique combinations) than those included in the "2AFC" category (34 unique combinations) or the "Staircase" category (11 unique combinations). The latter two method categories employ intermittent stimulation during their procedures, i.e., the type of stimulation given preference by ISO 13091-1 (International Organization for Standardization, 2001), in contrast to the von Békésy method's constant stimulation. This difference in usage might be due to the inherent difference in time-cost of both approaches, as the von Békésy method allows for a set time limit to be established for each condition, while methods employing intermittent stimulation usually require a set number of events (i.e., reversals) to occur before ending a condition (Morioka & Griffin, 2002). However, as reported by Morioka and Griffin (2002), the choice of method might have an impact on VPT results gathered at some frequencies, even from the same participants. Thus, this information should be kept in mind when comparing results obtained by different studies, as some VPT results might have been assessed through methods, such as the psi-marginal adaptative algorithm, that may potentially yield higher

VPT results than other methods, such as the von Békésy method, even if these differences only occur at certain frequencies. Nonetheless, regarding the former, readers should also consider that the psi-marginal adaptative algorithm was only employed to assess VPTs in 1 of the 24 papers included in the analysis of this review, Held et al. (2021), and so the higher VPT results obtained by this method at 250 Hz and 500 Hz, in comparison to the results obtained by other methods also employed to conduct assessments at this frequency, were only associated to the other factor group categories associated to the data of this paper, such as the "[0.2,0.5] N" and "[6,10] mm" categories for the "Pressure [Grouped]" and "Probe size [Grouped]" factor groups, respectively. Given this, this method may yield VPT results that are more similar to those obtained by other methods when conditions are similar for other factors, or even when it is made to follow a different form, rule, or step-size than those employed by Held et al. (2021), which may be a topic of interest for future authors.

5.2.6. Suggestions for future quantitative studies

It is also clear that many combinations of different groups of factors, such as different methods and probe sizes, have not been used in tandem very often, if at all, when carrying out VPT assessments. Thus, their use in future studies might be a worthwhile effort to increase our knowledge regarding the effects of their interactions on VPT measurements.

6. Conclusion

Information regarding Vibration Perception Thresholds (VPTs) can be useful in various fields and applications. However, as these thresholds are affected by various factors, their values can vary greatly depending on the characteristics of each factor involved. Thus, when studying or using VPT data, thresholds for a given frequency should not be considered in the context of that frequency alone. Instead, they should be considered while considering as many of the factors involved in their assessment as possible. Our review showed that factors such as the subject's age, the pressure between the probe and the skin, what method was used

for these assessments, and body locations at which assessments were conducted are important and influence VPT results. For example, data gathered using a psi-marginal adaptative algorithm reported higher VPT results than the results reported using the other methods that were found across the analysed papers. By understanding how thresholds are influenced by specific combinations of factors, VPTs can be utilized more effectively, be it to simply enrich our current understanding of how the human body works and perceives the world around us, for diagnostical purposes, or to improve product development. For our understanding of the human body, VPT data allows researchers to better understand and predict how different factors, such as contact pressure or skin location, affect our sense of touch, allowing them to further build upon the works of Bolanowski et al. (1988), Johansson and Vallbo(1979b), and Vallbo and Johansson (1984), among many other researchers.

For diagnostical purposes, a greater collection and analysis of VPT data can promote the development of more robust assessment norms and corresponding normative data. As standards can be made to encompass more variations of factors, such as different probe sizes or assessment methods, other instruments can then be used to gather results that can still be compared to available normative data, broadening the scope of the assessment norms that are already available in standards such as ISO 13091-1 (International Organization for Standardization, 2001), with information from studies such as Ahn et al. (2013). In tandem, their corresponding normative data, such as the data available in ISO 13091-2 (International Organization for Standardization, 2003), when encompassing more combinations of factors, can help medical professionals carry out more informed diagnoses, as VPTs, which are an important tool during the diagnostical process of various pathologies, such as diabetes and hand-arm vibration syndrome, can vary within the same subject for a multitude of reasons, both related to them and the assessment procedure, which may lead towards false positives or negatives when not properly accounted for.

For product development, VPT data can guide researchers and developers towards the creation of more inclusive products, such as devices that adapt the intensity of their vibrational stimuli according to both the characteristics of their users and the situations they find themselves in, based on VPT data collected previously encompassing various combinations of factors, so that information, both of low and high importance, can always be delivered through haptics, without being uncomfortable. For all of these purposes and more, we anticipate that the information provided in this review, particularly in Section 4.10 and Table 11, can greatly contribute to each of them.

Declarations

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Declaration Of Competing Interest

The authors have no relevant financial or non-financial interests to disclose.

Ethics Approval

Not applicable.

Consent To Participate

Not applicable.

Consent For Publication

Not applicable.

Availability Of Data And Materials

All data related to this systematic review is available at the Open Science Framework (OSF), at the following URL: https://osf.io/ht8a4/?view_only=87b902b6571643f2b2d8cef1238ff316.

Code Availability

The code used to generate the categories for each factor group, to organize and analyse data according to each category, and to produce the plots presented in this manuscript, is available at the Open Science Framework (OSF), at the following URL: https://osf.io/ht8a4/?view_only=87b902b6571643f2b2d8cef1238ff316.

Open Practices Statement

Data and materials for this systematic review are available at https://osf.io/ht8a4/?view_only=87b902b6571643f2b2d8cef1238ff316. This review was not preregistered.

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Biographies

Emanuel Silva

Currently attending the Doctoral Program in Industrial and Systems Engineering (PDEIS) at the University of Minho's School of Engineering. Works mainly in the areas of Psychology, Psychophysics, and User Experience, with an emphasis on Human Engineering and Human-Machine Interfaces.

Isabel C. Lisboa

Isabel C. Lisboa holds a PhD in Basic Psychology from the University of Minho since 2011 and is currently a Postdoctoral Research Fellow at UNINOVA-CTS (NOVA University Lisbon). Isabel's research interests encompass various areas, including Perception &

Interaction, Developmental Psychology, Neurodevelopment, Social-Cognition, Clinical Psychology, Human Factors, Usability and Ergonomics.

Nélson Costa

Nélson Costa is an Ergonomics and Human Factors Professor at the University of Minho (Portugal). Coordinator of several international and national competitive research projects, he is also a member of the Organizing Committee of the International Symposium on Occupational Safety and Hygiene (SHO) since 2008.