Recommended Procedure

Determination of uncomfortable loudness levels

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General foreword

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Contents

1. Introduction

The purpose of this document is to describe the Recommended Procedure for determining an uncomfortable loudness level (ULL). The objective of this test is to identify the minimum level of sound that is judged to be uncomfortably loud by the individual. The terms loudness discomfort level (LDL) and ULL are sometimes used synonymously; the preferred term is ULL.

This document supersedes the recommended procedure British Society of Audiology (BSA) Determination of Uncomfortable Loudness Levels (2011). Revisions include a more detailed description of steps in the procedure, use of alternative stimuli, ULLs in tinnitus and hyperacusis, and a description of self-report questionnaire measures of loudness tolerance or sensitivity. The ULL procedure once again appears in its own document, primarily to enable more efficient review of this procedure independently to that for pure-tone audiometry. The reader is referred to the Recommended Procedure for Pure-Tone Audiometry (BSA, 2018) for general recommendations regarding calibration, equipment, test environment and individual preparation.

The ULL is mainly performed to provide information for use in more complex hearing aid verification, counselling of individuals, or in research situations. ULLs should be performed by experienced clinicians who will take everyone's history and clinical presentation into consideration and use their clinical judgment to guide how the test is performed. This Recommended Procedure may require modification when testing special populations, such as children and individuals with tinnitus or hyperacusis; the tester will also require greater competency. Any modification shall be recorded with the results.

The term 'shall' is used in this document to refer to essential practice, and 'should' is used to refer to desirable practice.

Unless stated otherwise, the procedure described here represents the status of the current evidence base, considering other factors that influence desirable procedure, as interpreted by the Tinnitus & Hyperacusis Special Interest Group & the Adult Rehabilitation Interest Group of the BSA in consultation with its stakeholders. The document was developed in accordance with BSA (2016).

Shared Decision-making

It is implied throughout this document that the individual should be involved in shared decision-making when undertaking audiological intervention, receiving subsequent information, and understanding how it will impact on the personalisation of care. Personal preferences should be considered, and the role of the clinician is to enable a person to make a meaningful and informed choice. Audiological interventions bring a variety of information for both the clinician and the

individual that can be used for counselling and decision-making regarding technology and anticipated outcomes.

2. General considerations

2.1 Limitations of the test

It is important to recognise that the pure-tone stimuli typically used in ULL testing may not reflect the stimuli from which the individual may experience discomfort. There is also debate in the literature regarding the value of ULL testing in hearing aid fitting and the assessment of tinnitus and hyperacusis. As with other subjective tests, loudness judgements can vary over time, and according to the instructions used by the tester (Formby et al., 2017; Fackrell and Hoare, 2018). Strong adherence to standard wording is required to ensure test-retest reliability.

ULLs are affected by various factors including the choice of stimulus, the instruction given to the patient, and the psychophysical method used. Whilst some studies have shown considerable inter-subject variability (Anari et al, 1999), ULLs for pure tones in normal subjects are generally reported to be in the range 90 – 105 dB HL (Punch et al, 2004; Sherlock and Formby, 2005). In their detailed literature review, Punch and colleagues (2004) concluded that test methods and instructions have a more significant effect on ULLs than the type of stimulus.

Bornstein and Musiek (1993) reported how a simple difference in instruction can affect results. Individuals were asked to identify a loudness level at which they would choose 'not to listen for any period of time', or a loudness level that they 'would choose not to listen for 15 minutes or longer'. ULLs generated using the 'not to listen for any period of time' were 9 dB higher than those using the 'not to listen for 15 minutes or longer' instruction.

ULLs *can* be very reproducible but it is important to know the impact of instruction on the estimate. A consistent test procedure is required for comparable estimates over time or between individuals.

2.2 Cautions

Due to the risks involved in exposing patients to high levels of sound, it is recommended that this test only be conducted when clearly indicated, rather than being routinely performed. It is important that a careful history is undertaken to guide the process and to assess any potential risks. Individuals should be informed of the value of measuring ULLs (e.g., counselling, hearing aid fitting, and changes over time due to treatment), that they may find the ULL test uncomfortable, and that tinnitus may be triggered or aggravated; verbal consent for the test should be gained. Particular care shall be taken with an individual reporting tinnitus, unusual distress from loud

sounds, or exhibiting symptoms of hyperacusis (decreased tolerance or increased sensitivity to everyday sounds) or related conditions; ULLs should only be carried out when there is a clear clinical benefit and only by an experienced clinician. Multi-item questionnaire measures (see Appendix A) are a safer alternative for these individuals. Additional care should be taken in certain populations where informed consent is harder to obtain; reliance on fewer measured points, and/or reduced maximum testing levels are advised.

3. Instructions

Prior to testing, the tester shall explain the procedure to, and obtain informed verbal consent from the individual or person responsible for the individual. The tester shall inform the individual that they can stop the test at any point (e.g., if (s)he finds the stimuli uncomfortably loud) and explain how to signal to the tester if they want to stop.

The exact instructions given have a considerable effect on the outcome of the test. It is also important that clear and accurate instructions are given, taking into account possible communication difficulties (e.g., hearing impairment and language capability). Instructions should be given verbally. Written instructions can also be provided and should be used where there is doubt that the individual has understood the verbal instructions. The following instructions or equivalent should be used:

> "I now want to measure the level at which sounds become so loud that they are uncomfortable for you, so I am going to slowly and steadily increase the level of sounds that I present to you. Please press the button as soon as the sound reaches a level of loudness that you feel is so loud that it has become uncomfortable. This is not an endurance test; please don't wait until you can't cope with the sound any further before pressing the button. You should press the button only when the sound becomes so loud it is uncomfortable; but make sure you do press as soon as the sound reaches that level. If at any stage you are unhappy to continue, please raise your hand."

The test shall not proceed if there is doubt that the individual understands the instructions. This should be checked by asking the individual to repeat their interpretation of the instructions given. When there is any doubt, the tester should check thoroughly with the individual and, if necessary, carefully repeat the instructions.

Unlike pure-tone audiometry, the individual can be told which ear is to be tested before starting.

4. Determining the ULL

4.1 Environment

The ULL test is usually performed in the same environment in which the audiogram has been performed.

4.2 Stimulus

The usual stimulus is a pure tone. While tones may not be the most relevant stimulus, as noted in Section 2.1, the use of alternative stimuli is not recommended at this time given the absence of reference levels for calibration or clinical indication (Ricketts, Bentler and Mueller, 2017).

The tester, or person responsible for the test, shall consider for each individual her/his potential risk from sound exposure and balance this against the potential clinical benefits obtained from ULL testing.

The test should be conducted on one ear at a time. The number of frequencies tested should be the minimum required to provide the information required, and will be determined by the individual's history, clinical presentation, and audiogram (e.g. see Section 4.4).

4.3 Procedure

The tester shall:

1. Monitor the individual's face throughout the test and monitor the individual for the signal to stop testing. It does not matter if the individual can see what the tester is doing; this may actually be helpful. Cease testing immediately if the individual shows any sign of distress or flinching; then ask if the sound was uncomfortable. Ask the individual if they want to continue and if appropriate, reinstruct and retest as below. Testing shall also be ceased if it becomes clear to the tester that the individual does not understand the test procedure.

2. Use the same order of frequencies as for the audiogram. Start testing at 60 dB HL or at the individual's hearing threshold level for that ear at that frequency, whichever is highest. For individuals with tinnitus or hyperacusis start at threshold (Note the caution for this population - see section 2). Start with the better/non pathology ear, if known.

3. Present a 1-second-long tone, followed by at least a 1-second quiet period. Increase the stimulus by 5 dB and present the stimulus in the same manner. Repeat this process. Cease testing immediately if the individual responds, if the individual shows any sign of distress

or flinching or if an appropriate maximum level has been reached (see Section 4.4). For the first response, the tester should affirm that the patient found that stimulus level to be uncomfortably loud and would not like it to be raised any higher in intensity.

4. It does not matter if the presentation of the tones is rhythmical; this may actually be helpful. Sufficient time (2-5 seconds), using sensitive professional judgement, shall be provided between presentations for the individual to respond, which may be greater for some individuals than others.

5. The level of the tone at which the individual responds is the ULL. If the test is terminated because the individual flinches before making a formal response, that level can also be taken as the ULL if the individual confirms that the last tone, but not the previous tone, was uncomfortable.

6. Clarify after the first ULL is recorded that the individual responded to a sound that reached their uncomfortable loudness level and repeat the measurement if the sound was not at that level.

4.4 Maximum Testing Levels

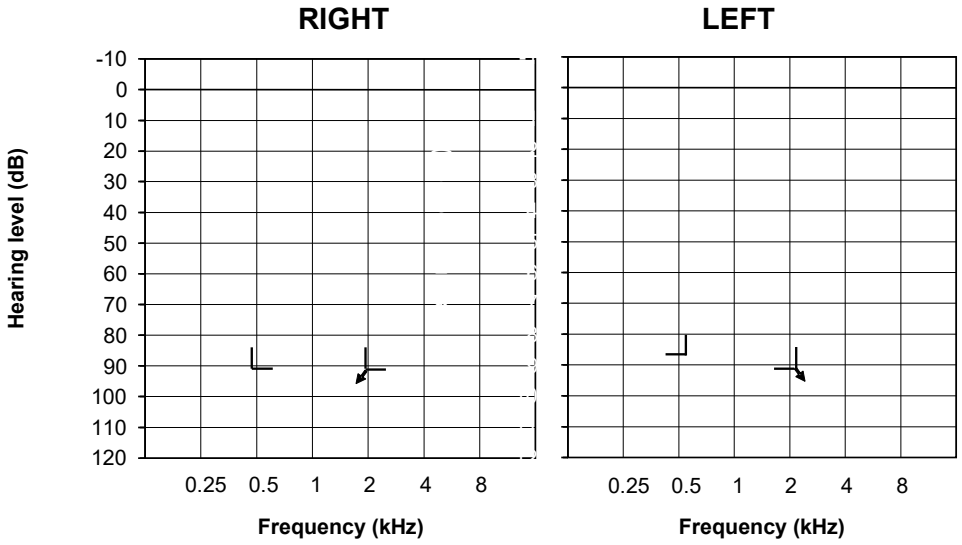
For subjects with mild to moderate hearing loss when ULL is being measured to identify a significantly reduced dynamic range then it is recommended that test stimuli do not exceed 90dB HL (lower boundary of normal see section 2.1). This ensures exposure to high sound pressure levels is minimised. However, it is acknowledged that there are special situations in complex patients with thresholds worse than this level where knowledge of the dynamic range can have a significant impact on management and hearing aid settings. An example would be someone with severe sloping hearing loss and subjective report of loudness discomfort. Careful testing of ULLs can determine the frequencies causing discomfort and inform the appropriate hearing aid adjustments. In such scenarios, justification for testing at levels > 90 dB HL should be documented and testing only carried out by an experienced audiologist.

4.5 Recording

See Figure 1 for the symbols used for recording ULLs. When the maximum recommended level, or the maximum output of the audiometer, is reached without the individual responding, the ULL is recorded as “greater than” this value. Any modifications to the procedure, use of alternative stimuli, or the change of behaviour taken to indicate the ULL should be documented with the audiogram.

Figure 1

Illustration of the symbols used to record ULLs on the audiogram. ULL is at 90 and 85 dB HL at 500 Hz on the right and left, respectively, and greater than 90 dB HL at 2000 Hz on both sides.



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Appendix A - Questionnaire measures of hyperacusis

Where decreased tolerance or increased sensitivity to sound is a suspected problem, multi-item questionnaires such as the Hyperacusis Questionnaire, Multiple-Activity Scale for Hyperacusis, or the German Questionnaire on Hypersensitivity to Sound, can be used to measure the impact it has on a individual.

Hyperacusis Questionnaire (HQ)

The Hyperacusis Questionnaire (HQ) was developed to quantify and characterise hypersensitivity to sound, but it also used as an outcome measure for changes in sound tolerance (Khalfa et al., 2002). Part 1 of the questionnaire consists of binary questions to collect general information on noise exposure history and auditory disorders. The second part of the HQ consists of 14 negatively worded questions scored as either: “no” (0 points), “yes, a little” (1 point), “yes, quite a lot” (2 points), or “yes, a lot” (3 points). The mean global score reflects the sum of all responses with a maximum score of 42, with higher scores reflecting greater sensitivity to sound. A score of 28 or more is generally taken to indicate the presence of significant hyperacusis. Some studies have compared ULLs to scores on the HQ. For example, Wallén and colleagues (2012) found that HQ scores and ULLs negatively correlated in those with intermediate and high levels of emotional exhaustion, but there was no correlation in those with low emotional exhaustion. HQ score have also been reported as influenced by sex and age.

The Multiple-Activity Scale for Hyperacusis (MASH)

The Multiple-Activity Scale for Hyperacusis (MASH) is a clinician-led questionnaire describing 15 activities for which individuals provide a score out of 10 to indicate their level of annoyance relative to that activity (Dauman and Bouscau-Faure, 2005). The questionnaire allows irrelevant questions to be deleted. A mean MASH score is calculated by summing all scored questions and dividing the total by the number of activities giving a possible range of 0–10.

German Questionnaire on Hypersensitivity to Sound (Geräuschüberempfindlichkeit; GÜF)

The German Questionnaire on Hypersensitivity to Sound (GÜF) is a questionnaire developed by Nelting and colleagues (2002). It is a brief tool (15 questions) to inform treatment needs (identify urgency) and treatment planning. The possible responses to each question are ‘not true’, ‘sometimes true’, ‘often’ or ‘always true’, scored 0-3 respectively to give a total score between 0 and 45, with greater total scores indicate a bigger problem. The GÜF has been translated into Spanish (test hypersensitivity to sound; THS) and English (Noise Avoidance Questionnaire; Bläsing and Kroener-Herwig, 2012), however the English version has not been subject to validation studies and has not yet been used in the clinics or research.