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TECHNICAL REPORT

Dissociable effects of hyperacusis and misophonia severity imply different mechanisms of decreased sound tolerance

Rebecca Smees[a], Julia Simner[a], Derek J. Hoare[b] and Jamie Ward[a]

[a]School of Psychology, University of Sussex, Brighton, United Kingdom; [b]NIHR Nottingham Biomedical Research Centre, Hearing Sciences, Mental Health and Clinical Neurosciences, School of Medicine, University of Nottingham, Nottingham, United Kingdom

ABSTRACT

Objective: It is thought that decreased sound tolerance can be subdivided into distinct types including misophonia (involving specific trigger sounds) and hyperacusis (broader in profile). However, there are few established methods for differentially assessing these disorders and this is complicated by the fact that some measures (e.g. the HQ Hyperacusis Questionnaire) were developed before the concept of misophonia was accepted.

Design/Study sample: We took a group of $N = 119$ participants with misophonia (varying in severity) and asked them about the presence of hyperacusis (based on a scoping review definition).

Results: Scores for some items on the HQ were correlated with scores for misophonia severity (e.g. social impact of sound) and others with scores for hyperacusis (e.g. ability to concentrate in noise). Similarly, some trigger sounds were more indicative of hyperacusis (e.g. dishes being stacked) and others were more indicative of misophonia in the absence of hyperacusis (e.g. chewing).

Conclusions: These double dissociations provide compelling evidence for separable forms of sound intolerance. Moreover, our research suggests that a single-item question about hyperacusis is associated with other characteristics of hyperacusis, even when assessed 18 months later.

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Hyperacusis; misophonia; differential diagnosis; questionnaire

Introduction

An intolerance of sounds can occur in the presence of other hearing abnormalities (such as tinnitus or hearing loss) but can also be found for some people in the general population with no other auditory abnormality (Baguley and Hoare 2018; Paulin, Andersson, and Nordin 2016; Sheldrake, Diehl, and Schaette 2015). Decreased sound tolerance is more prevalent in certain neurodevelopmental disorders (e.g. autism spectrum disorder; Ren et al., 2021; Williams, et al. 2021) even where there is no reason to suspect audiological problems as a root cause, and decreased sound tolerance may also be comorbid with psychological problems (e.g. anxiety), which potentially have an exacerbating effect (e.g. Andermane et al., 2023a).

The term 'hyperacusis' has historically been used as a general umbrella term to denote lower tolerance to sounds, across multiple possible aetiologies. Patients with hyperacusis typically report everyday sounds as feeling too loud, and when presented with pure tones, judge them to be uncomfortable at a lower loudness level than people without hyperacusis (Aazh and Moore 2017). ICD-10 describes hyperacusis as 'an abnormally disproportionate increase in the sensation of loudness in response to auditory stimuli of normal volume.' (World Health Organization 1993). Some people with hyperacusis also report that sounds induce pain, although this is neither a universal nor defining characteristic (Williams, Suzman, and Woynaroski 2021). Questionnaires such as the Hyperacusis Questionnaire (HQ) have been developed as a self-report measure of the symptomatology of sound tolerance and the extent to which sound intolerance affects daily living, as an indicator of clinical severity (Khalfa et al. 2002). Despite the name, however, we suggest that the HQ should today be considered as a measure of a *mixed* class of sound intolerances, including – but crucially not limited to – hyperacusis. We show how the HQ assesses both hyperacusis and another condition, misophonia, and suggest this has arisen simply from a historical shift in the semantic boundaries of the word 'hyperacusis'.

There has been significant recent interest in the idea that decreased sound tolerance can be subdivided into distinct types, such that the term hyperacusis has recently come to be restricted to one profile with a second profile (misophonia) alongside (Swedo et al. 2022). Notably, Jastreboff and Jastreboff (2002) proposed the term misophonia to denote decreased tolerance to specific trigger sounds, largely eating sounds such as chewing and repetitive sounds such as tapping. In this conceptualisation, hyperacusis is essentially the residual sounds outside this category, much broader in nature, but largely sounds with high amplitude or frequency, and easily construed as 'too loud'. A recent Delphi consensus definition of misophonia described it as 'a disorder of decreased tolerance to specific sounds or stimuli associated with such sounds. These stimuli, known as "triggers", are experienced as unpleasant or distressing and tend to evoke strong negative emotional, physiological, and behavioural responses that are not seen in most other people. Misophonic responses do not seem to be elicited by the loudness of auditory stimuli, but rather by the specific pattern or meaning to an individual.' (Swedo et al. 2022).

CONTACT Jamie Ward jamiew@sussex.ac.uk School of Psychology, University of Sussex, Falmer, Brighton, BN1 9QH, UK
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Several questionnaires have been developed to diagnose misophonia (Rosenthal et al. 2021; Simner, Rinaldi, and Ward 2024; Wu et al. 2014). However, the extent to which they may also assess hyperacusis is unknown. Similarly, measures such as the HQ (Hyperacusis Questionnaire) were developed before the concept of misophonia became accepted and it is uncertain whether the HQ assess hyperacusis as a distinct entity in the more recent sense, or whether it assesses a generic sound intolerance (akin to the more historical interpretation of the term). A recent scoping definition of hyperacusis in its contemporary restrictive sense, formed by reviewing the extant literature, defined it as 'everyday sounds feel overwhelming, loud, intense, or painful that do not bother other people in the same way' (Fackrell et al. 2017). In the present study, this definition served as a 'ground truth' with which to assess the performance of other measures. But it is worth noting that a Delphi consensus definition of hyperacusis provided a much broader conceptualisation: 'A reduced tolerance to sound(s) that are perceived as normal to the majority of the population or were perceived as normal to the person before their onset of hyperacusis' (Adams et al. 2021). This consensus definition, produced amongst clinicians, is similar to its historical meaning and does not straightforwardly capture a distinction between hyperacusis and misophonia.

The aim of our study was to take a measure of misophonia (the Sussex Misophonia Scale, SMS; Simner, Rinaldi, and Ward 2024) and a measure of hyperacusis (based on the scoping review definition) and to determine the extent to which other measures (such as the HQ) differentially assess hyperacusis or misophonia. Our sample was recruited from a previous study of participants with misophonia with a range of severities, who were also asked about hyperacusis (reporting it to various degrees based on the scoping review definition). To pre-empt our findings, we show that some items on the HQ are indicative of misophonia severity and others of hyperacusis. Similarly, some trigger sounds are more indicative of misophonia (e.g., swallowing, chewing) and others are more indicative of hyperacusis (e.g. barking). These double dissociations across several measures provide compelling evidence that these two clinical constructs have distinct features.

Method

Participants

Participants with complete datasets comprised 119 adults aged 18-70 years (mean age = 44.8, S.D. = 14.3; 79.0% female, 18.5% male, 2.5% non-binary). All had self-identified as having misophonia and had been recruited and tested for misophonia as part of previous research (Andermane et al., 2023a), as detailed below. Specifically, they had joined our participant pool following a BBC radio interview on misophonia was aired on May 18, 2021, during which listeners were invited to contact us. All participants agreed that the following statement applied to them 'Misophonia: When sounds (e.g. crunching) consistently cause extreme emotions like anger or disgust which does not bother other people in the same way.' They were heterogeneous in terms of severity of misophonia as indicated by the total score on the SMS (mean = 83.7, S.D. = 23.1, range = 37-139) where a score of > 50.5 is an optimised cut-off for binary classification (Simner, Rinaldi, and Ward 2024). For the hyperacusis screener (see below), 47% (66/119) of our sample reported that this applied to them ($N = 26$ 'definitely does apply', $N = 40$ 'may apply', $N = 27$ 'don't think it applies', $N = 26$ 'definitely does not apply'). The participants did not undertake an audiological assessment but they were required to indicate that they had no known hearing loss as this was an exclusion criterion for the study.

The study was approved by the Sciences and Technology Cross-Schools Research Ethics and Governance Committee of the University of Sussex (reference: ER/JAMIEW/32).

Materials and procedure

Our initial assessment of misophonic participants used the Sussex Misophonia Scale, SMS, and a hyperacusis screener (see Andermane et al. 2023a). This latter was based on the definition of hyperacusis arising from the scoping review: 'Hyperacusis: When everyday sounds feel overwhelming, loud, intense, or painful that do not bother other people in the same way'. Participants indicated their level of agreement with this statement on a four-point Likert scale ('This definitely does NOT apply to me', 'I don't think this applies to me', 'This may apply to me', 'This definitely DOES apply to me'). The SMS is a two-part questionnaire, firstly presenting 48 specific triggers for misophonia (e.g. chewing sounds) with a checkbox judgement and, secondly, 39 Likert-type questions about the associated experiences of people with misophonia (e.g., feelings, behaviours, life consequences) (Simner, Rinaldi, and Ward 2024). The 48 potential triggers for misophonia are grouped into eight categories (e.g. 'I hate … the sound of people eating') followed by sub-category items (e.g. 'crunchy foods (e.g. apples)', 'crispy snacks', 'chewing' etc.). In creating the SMS, three sounds that were initially included ('car engines', 'house and car alarms', and 'sirens (e.g. ambulance)') were discarded as they were assumed to reflect hyperacusis. Here we test that assumption because the current participants had these extra items included. The 39 Likert-type items (e.g. 'I avoid going to work because of difficulties with sounds') are rated on a five-point Likert scale and coded from 0–4 (Never, Hardly Ever, Sometimes, Often, Always), with the total score ranging from 0–156. Simner, Rinaldi, and Ward (2024) showed that a cut-off value of 50.5 on the SMS has 'excellent' discriminative ability between misophonics and non-misophonics (area-under-curve, AUC = 0.91). The SMS also has strong convergent validity, with scores being correlated with those for other misophonia questionnaires such as the MQ ($r = 0.78$), DVMSQ ($r = 0.85$), and AMISO-S ($r = 0.81$) – see Supplementary Material.

Two further questionnaires relating to hyperacusis were administered 18 months later, using Qualtrics (Provo, UT) and taking around 30 minutes to complete. The 18 month time lag means that any association between our initial assessment of hyperacusis and misophonia and these later measures presumably reflects enduring traits. Both later measures purport to measure hyperacusis. However, the first (HQ; Khalfa et al. 2002) was created before the narrowing of its definition. The HQ consists of 14 items answered on a four-point Likert scale (No, Yes a little, Yes quite a lot, Yes a lot) and the individual items are shown in Table 1. Total scores are calculated by summing across items (coded from 1 to 4) although here we also analyse at the item level. We also used relevant items from a second, more recent hyperacusis questionnaire. The CORDS (Coordination of Rare Diseases at Sanford) hyperacusis questionnaire, reported by Williams et al. (2021), contains various items related to hyperacusis and loud sound exposure. There is no known way of collapsing items (e.g. into factors or total scores) and so we analyse them separately. The following items were used noting that we changed the subject from 'the participant' to 'you' (e.g. the wording of the original question was 'Are everyday sounds unbearably

Table 1. Correlations between the HQ items (HQ1 to HQ14) and independent measures of hyperacusis and misophonia, with differences in correlation noted.

	Correlation r (p) with Hyperacusis screener	Correlation r (p) with SMS total score	Difference in correlation t (p)	Interpretation M = Misophonia H = Hyperacusis
HQ1: Do you ever use earplugs or earmuffs to reduce your noise perception? (Do not consider the use of hearing protection during abnormally high noise exposure situations)	0.16 (0.09)	0.44 (<.001)	2.52 (0.013)	M ≫ H
HQ2: Do you find it harder to ignore sounds around you in everyday situations?	0.30 (0.001)	0.44 (<.001)	1.30 (0.196)	M = H
HQ3: Do you have trouble reading in a noisy or loud environment?	0.32 (<.001)	0.08 (0.379)	2.04 (0.044)	H ≫ M
HQ4: Do you have trouble concentrating in noisy surroundings?	0.30 (0.001)	0.03 (0.76)	2.32 (0.022)	H ≫ M
HQ5: Do you have difficulty listening to conversations in noisy places?	0.26 (0.004)	0.14 (0.130)	1.02 (0.310)	H > M
HQ6: Has anyone you know ever told you that you tolerate noise or certain kinds of sound badly?	0.20 (0.032)	0.52 (<.001)	2.99 (0.003)	M ≫ H
HQ7: Are you particularly sensitive to or bothered by street noise?	0.44 (<.001)	0.10 (0.295)	3.07 (0.003)	H ≫ M
HQ8: Do you find the noise unpleasant in certain social situations? (e.g., Nightclubs, pubs or bars, concerts, firework displays, cocktail receptions)	0.37 (<.001)	0.15 (0.104)	1.91 (0.059)	H > M
HQ9: When someone suggests doing something (going out, to the cinema, to a concert etc) do you immediately think about the noise you are going to have to put up with?	0.15 (0.099)	0.50 (<.001)	3.18 (0.002)	M ≫ H
HQ10: Do you ever turn down an invitation or not go out because of the noise you would have to face?	0.14 (0.142)	0.50 (<.001)	3.32 (0.001)	M ≫ H
HQ11: Do noises or particular sounds bother you more in a quiet place than in a slightly noisy room?	−0.11 (0.216)	0.33 (<.001)	3.82 (<.001)	M ≫ H
HQ12: Do stress and tiredness reduce your ability to concentrate in noise?	0.15 (0.113)	0.14 (0.132)	0.06 (0.954)	M = H
HQ13: Are you less able to concentrate in noise towards the end of the day?	0.12 (0.195)	−0.07 (0.467)	1.54 (0.127)	M = H
HQ14: Do noise and certain sounds cause you stress and irritation?	0.25 (0.007)	0.39 (<.001)	1.26 (0.210)	M = H

loud to the participant?'). The questions we administered were as follows:

- Are everyday sounds unbearably loud to you? [Yes; No]
- Select types of loud sounds that significantly hurt. (Select all that apply) [Baby crying/children squeeling; Birdsong; Crowds; Dishes being stacked; Dog barking; High pitch voices; Lawnmower; Music (loud concert); Music (religious service); Motorcycle; Power tools; Restaurants; Siren; Sporting events; Street noise; Telephone conversation; Telephone ringing; Toilet flushing; TV/Radio; Vacuum Cleaner; None]
- In the past twelve (12) months, approximately how often have you experienced pain in one or both ears? [Never; Once a month; 2–3 times per month; Once a week; Every day; Continuously]. Contingent on an answer other than 'never' the following three additional questions were asked:
  - When you experienced ear pain, was it as a result of being around a loud sound? [Yes; No]
  - When you experienced ear pain as a result of an event, how long after the event did the pain begin? [Immediately; After a few hours; The next day; A few days later; Weeks later; Not applicable]
  - When you experience ear pain from environmental sounds, what type of pain do they [sic] experience? [Dull ache; Burning pain; Throbbing pain; Sharp pain; Stabbing pain; Not applicable; Other ______]
- Please indicate your history of music exposure. (Select all that apply) [Attended many loud concerts; Listened to very loud music via ear buds; Musician (played professionally or as a hobby); Other ___]
- Do you have a history of loud noise exposures? [Yes; no]
- Did any prior noise exposures leave you with temporary tinnitus (ringing in the ear) or temporary hearing loss? [Yes; no]
- Have you had traumatic impulse noise exposures (blasts, gun fire, etc.)? [Yes; no]
- Do you have any of the following conditions? (Select all that apply) [Impacted wisdom teeth; Sensitive teeth; Teeth grinding (Bruxism); Temporomandibular Joint Disorder (TMJ); None; Other: __________]
- What type of ear protection do you use to avoid certain sounds? (Select all that apply) [Ear muffs; Ear plugs; None; Other ______]
- How many hours a day do you wear ear protection? [1–2; 3–4; 5–8; 9–12; 13–16; 16–24; None]

Analyses

For the SMS a total score is obtained from the second part (39 Likert questions) by summing the responses (0–4 scale). The first part of the SMS, selection of triggers (from a list of 48), is not part of the quantitative assessment of misophonia but is used in a secondary analysis exploring how trigger profiles may differ between participants with and without hyperacusis, noting that we excluded five 'other' items (e.g. 'other repetitive sounds') leaving a final set of 43 (e.g. as shown in Figures 3, S2 and S3).

The method of Steiger (1980) was used to compare two correlations within the same sample of participants (r_{12} and r_{13}) and considering the degree of relationship between the two measures (r_{23}). In our case, we are comparing the correlations between items on the hyperacusis measures (HQ, CORDS) against the SMS (r_{12}) and hyperacusis screener (r_{13}), where r_{23} is the correlation between SMS total and hyperacusis screener itself. The t- and p-values were obtained using the Excel calculator of Zaiontz (2014), shared in Supplementary Material, and can also be obtained in R using the r.test function in the Psych package (Revelle 2017).

Results

We remind the reader that our participants were all self-declared misophonics, additionally screened by the SMS (misophonia scale), a hyperacusis screener (based on the scoping definition), and two other measures of hyperacusis (HQ; CORDS).

Overall HQ

The mean HQ total score for our misophonic group was 24.3 (± 7.2) which compares against published population norms of 15.0 (± 6.7) from Khalfa et al. (2002). This corresponds to a significant difference ($t = 11.67$, $p < .001$) and a large effect size (Hedge's $g = 1.35$). Using Khalfa et al.'s (2002) threshold (>28 score): 30% of our misophonic sample would be classified as having hyperacusis (36/119), if we were to base this classification solely on the HQ. Applying Meeus et al.'s (2010) slightly more lenient threshold (>26 score) would raise the percentage classified as having hyperacusis to 39.5% (47/119). The correlation between the HQ total and the SMS total was a moderate and significant ($r = 0.49$, $p < .001$). Nonetheless, we remind the reader that the HQ was devised before the refinement of the historical term 'hyperacusis' into two sub-classes of misophonia and (modern-use) hyperacusis. As such, it is not surprising that a high portion of misophonics score highly on the HQ.

The correlation between the HQ total and scores for the hyperacusis screener question was moderate and significant ($r = 0.41$, $p < .001$), while the correlation between scores for the hyperacusis screener question and the SMS total score was weak and not significant ($r = 0.13$, $p = 0.177$).

Item-level HQ correlations

The correlations between responses to individual items on the HQ (HQ1 to HQ14) and (a) level of agreement with the hyperacusis screening question and (b) the total SMS score were determined. Our aim was to determine the extent to which individual questions in the older HQ tapped into (modern uses of the terms for) hyperacusis and misophonia. The difference between these correlations was therefore used to determine whether the items correlated significantly more highly with one construct than another. The results are shown in Table 1. Scores for three items were correlated with hyperacusis significantly more than with misophonia (H≫M), and scores for five items were correlated significantly more with misophonia than hyperacusis (M ≫ H). Scores for two items were significantly correlated with hyperacusis but not misophonia, although the difference in correlations was not significant (H > M). There were four items for which misophonia and hyperacusis could not be discriminated (M = H): scores for two items correlated with both, and scores for two were correlated with neither. In summary, whilst the total HQ score does not reliably distinguish between hyperacusis and misophonia individual items showed differential sensitivity. Hyperacusis questions were related more to sound-based distraction and background noise, whereas misophonia questions were related more to social impacts of sound. Most significant differences between correlations survived correction for multiple comparisons using the False Discovery Rate (only HQ3 did not).

Other hyperacusis questions

The questions taken from Williams et al. (2021) were analysed in the same way. The results are shown in Table 2. Scores for one question were more sensitive to hyperacusis than misophonia (everyday sounds being loud), scores for two were equally related to hyperacusis and misophonia (pain, ear protection) and scores for the others were not significantly related to either. The SMS contains four questions relating to pain, but the association between misophonia severity and reports of pain in the last 12 months from CORDS remained significant ($r = 0.21$, $p = .021$) when these items were dropped.

Categorical dependent variables were analysed with chi-square taking a binary split of participants into misophonics with and without hyperacusis (as determined by the hyperacusis screening question). Figure 1 shows the level of endorsement for the CORDS trigger sounds contrasting misophonics with and without hyperacusis. There were 13 sounds (/20) that significantly distinguished between these groups, and in all cases this reflected greater levels of endorsement by those who reported hyperacusis. However, when considering a wider pool of triggers (those used in the SMS) there were some sounds that were more strongly endorsed as triggers by those reporting misophonia without hyperacusis (see below).

Those with hyperacusis were significantly less likely to have attended many loud concerts ($\chi^2(1) = 5.73$, $p = 0.017$) suggesting that hyperacusis modified behaviour in this sample (as opposed to hyperacusis being caused by loud concerts). Those with hyperacusis were significantly more likely to report sensitive teeth ($\chi^2(1) = 7.08$, $p = 0.008$). The fact that we found group differences in both directions argues against a simple response bias (over-reporting across all questions). The level of endorsement of these statements is shown in Figure 2

SMS trigger profile

Our earlier research included the hyperacusis screener question together with 51 triggers in the SMS: 48 were assumed to be related to misophonia and three to hyperacusis (Andermane et al., 2023a). Figure 2 shows the level of endorsement for different triggers ranked by group difference. Some triggers were significantly more endorsed by those reporting both misophonia and hyperacusis ($N = 5$, house and car alarms, car engines, repetitive barking, typing, sirens) and other triggers were significantly more endorsed by those reporting misophonia without hyperacusis ($N = 3$, lip smacking, swallowing, chewing). Thus, there was a double dissociation across trigger sounds. A similar pattern was found in a reanalysis of the full dataset reported by Andermane et al. (2023a) as reported in the supplementary material.

Table 2. Correlations between responses to the items from the CORDS hyperacusis questionnaire (Williams et al. (2021) and independent measures of hyperacusis and misophonia, with differences in correlation noted.

	Correlation r (p) with Hyperacusis screener	Correlation r (p) with SMS (total score)	Difference in correlation t (p)	Interpretation M = Misophonia H = Hyperacusis
Are everyday sounds unbearably loud to you?	0.49 (<.001)	0.25 (0.006)	2.20 (0.030)	H ≫ M
In the past twelve (12) months, approximately how often have you experienced pain in one or both ears?	0.23 (0.014)	0.28 (0.002)	0.46 (0.655)	M = H
When you experienced ear pain, was it as a result of being around a loud sound? (N = 44 as sub-question of the above)	0.23 (0.141)	0.04 (0.806)	0.93 (0.360)	M = H
Do you have a history of loud noise exposures?	−0.01 (0.916)	0.08 (.367)	0.77 (0.444)	M = H
Did any prior noise exposures leave you with temporary tinnitus (ringing in the ear) or temporary hearing loss?	−0.10 (0.382)	0.07 (0.558)	0.61 (0.542)	M = H
Have you had traumatic impulse noise exposures (blasts, gun fire, etc.)?	−0.11 (0.222)	−0.07 (0.427)	0.32 (0.750)	M = H
How many hours a day do you wear ear protection? (N = 92 as applies only to those who indicated this)	0.37 (p < .001)	0.50 (p < .001)	1.22 (0.225)	M = H

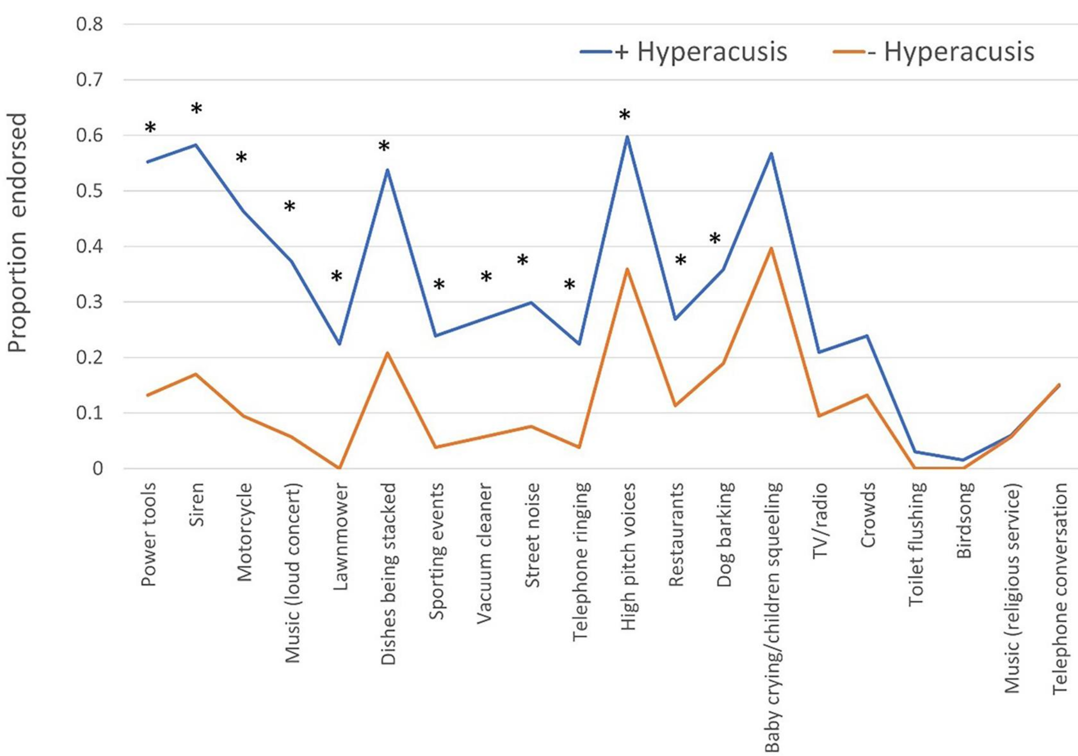

Figure 1. Proportion of sounds endorsed as 'loud sounds that significantly hurt' by a misophonic group according to the additional presence (+) or absence (-) of hyperacusis as determined by the hyperacusis screening question. * p <.05 (determined via chi-square test), noting that the leftmost eleven values survive FDR correction for multiple comparisons.

Discussion

The term hyperacusis was historically applied to all forms of decreased sound tolerances, across a range of aetiologies (with or without known hearing disorders) and presenting characteristics. The term misophonia was later introduced to designate a subtype linked to specific sound triggers, irrespective of loudness (e.g., chewing). Although this has been hypothesised for two decades, quantitative evidence for this distinction is extremely sparse. Current consensus definitions of hyperacusis, from clinicians, do not make a clear delineation between hyperacusis and misophonia (Adams et al. 2021) and some commonly used measures such as the HQ (Hyperacusis Questionnaire) were not designed with these subtypes in mind (Khalfa et al. 2002).

A recent summary of the field notes: 'the results of reported studies [on misophonia] are corrupted by the lack of exclusion from the evaluated group of subjects with hyperacusis.' (Page 5, Jastreboff and Jastreboff 2023). The approach taken here was to examine a sample of people with misophonia, varying in severity, who also presented with hyperacusis to varying degrees and to

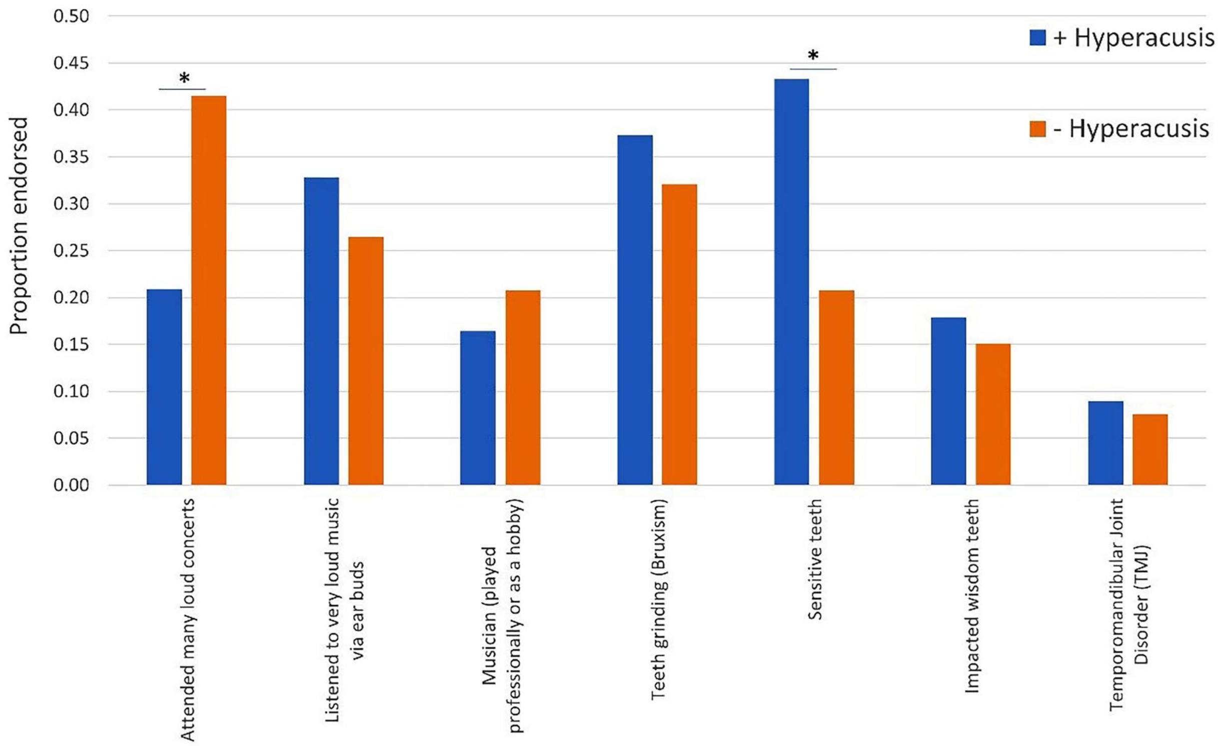

Figure 2. Proportion of endorsed options relating to history of music exposure and other conditions according to the presence (+) or absence (-) of hyperacusis as determined by the hyperacusis screening question. * $p < .05$.

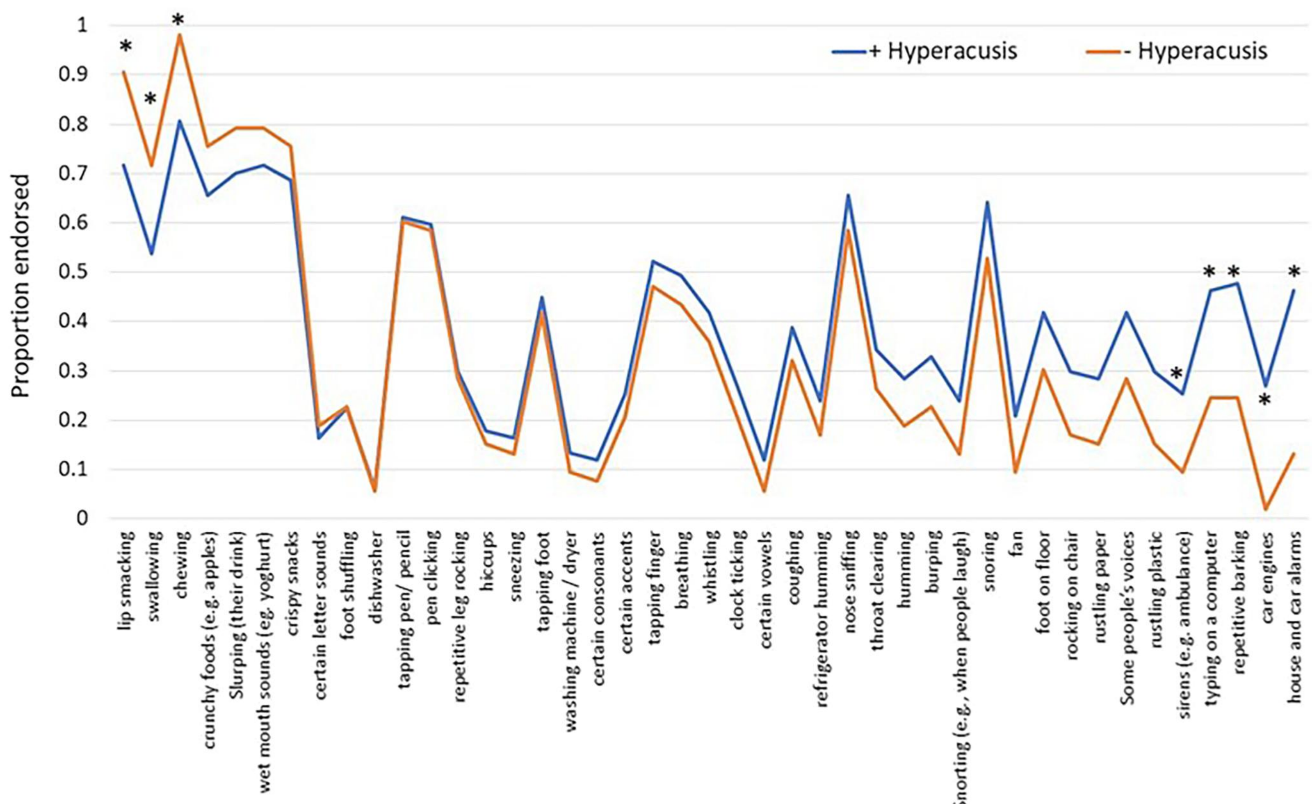

Figure 3. Proportion of trigger sounds endorsed by a misophonic group according to the additional presence (+) or absence (-) of hyperacusis as determined by the hyperacusis screening question. * p <.05 (determined via chi-square test).

determine which of these two independent variables predicts performance on the HQ, as well as endorsement of sound triggers and other characteristics (e.g. sound-induced pain, and pain-related conditions). Participants' level of agreement to a researcher-derived definition of hyperacusis from a scoping review (Fackrell et al. 2017) was used as a ground truth. Responses to this single-item question are associated with other characteristics of (narrowly defined) hyperacusis, independently of misophonia, even when assessed 18 months later. For misophonia, we used a validated questionnaire (Simner, Rinaldi, and Ward 2024) which has good convergent validity, scores being correlated with other recently developed measures of misophonia. Although the total score for the HQ was correlated with both our measure of hyperacusis and our measure of misophonia, at the item level, there were double dissociations, some items tracking misophonia severity and others tracking hyperacusis. Misophonia was linked more to the social impacts of sounds, and hyperacusis more to the impact of noisy surroundings (e.g. on concentration). These aversions were both linked to avoidance behaviours: misophonics were more likely to report turning down social invitations because of the sounds (reported on the HQ), and those with hyperacusis were less likely to attend loud concerts (reported on the CORDS questions). Sound-induced pain was linked to both misophonia and hyperacusis, although people with hyperacusis reported more sensitive teeth. Tooth sensitivity is conventionally defined as brief episodes of sharp well-localized pain when teeth are subjected innocuous stimuli such as cold, air-currents or probing with a metallic instrument (Markowitz and Pashley 2008). Another candidate hearing disorder linked to jaw pain is Tensor Tympani Syndrome (Westcott et al. 2013).

One possible way of conceptualising the difference between misophonia and hyperacusis is that misophonia is narrow in terms of the range of sounds that elicit it and hyperacusis is broad (perhaps encompassing all sounds if they are loud enough). However, this idea remains largely untested, and our evidence suggests that the difference could also relate to the nature of the sounds themselves (rather than the number of sounds that typically act as triggers). There were some sounds (lip smacking, swallowing, chewing) that bothered people with 'pure misophonia' (i.e. without hyperacusis) more than those who had both. And there were other sounds that were linked to hyperacusis more than misophonia. These latter included prototypically loud sounds (e.g. sirens, power tools, lawnmowers) but also sounds that might not be considered so (e.g. typing on a keyboard). Note that responses to played sounds of typing were also predictive of hyperacusis, independently of misophonia, in a separate study (Andermane et al. 2023b). Research is needed that presents some of these sounds at different loudness levels to understand the relative contribution of these factors. Do sirens bother people with hyperacusis more than other people even when presented at a low level? Is the nature of the response (e.g. pain, anxiety) different? Is this the case for all sounds or are sirens and certain other sounds special in some way?

The status of painful responses to sound in hyperacusis and misophonia is also uncertain. Although pain has often been linked to hyperacusis, it is not considered a defining property. Our research suggests that the same may also apply to misophonia. In the present study reports of pain were correlated both with misophonia severity and hyperacusis (the correlations did not differ significantly in magnitude from each other). The same held true when a small number of items in the misophonia questionnaire that explicitly mentioned pain were dropped (e.g. 'It hurts when I hear certain sounds, even if it doesn't hurt other people'). Although pain appeared as a separate factor in the SMS questionnaire, the association with more conventional factors (e.g. intersocial reactivity) was strong (Simner, Rinaldi, and Ward 2024). Individual differences in responses to these pain questions are partially separable from the overall misophonia severity and hyperacusis status based on the ratings of sounds (Andermane et al. 2023b). Our speculation is that painful responses to sounds can be linked to both hyperacusis and misophonia and need not reflect one more than the other. Whether the presence of pain is simply related to severity or to some additional variable remains for future research to determine.

There are a number of limitations to be recognised. As participants were self-selected they may not be representative of decreased sound tolerances within either the general population or those recruited as a result of clinical diagnosis. Of course the latter group may themselves have distinct characteristics (e.g., co-comorbidities) that drives treatment seeking. Further studies should seek to replicate findings in opportunistic samples as well as contrasting against clinically diagnosed samples. Moreover, there are many definitions and ways of assessing both misophonia and hyperacusis and the extent to which the patterns observed here are tied to the specific measures used is uncertain. For example, hyperacusis could be measured in terms of lower loudness discomfort thresholds and other audiological assessments (e.g. speech-in-noise) may be informative. Definitions of these conditions are likely to evolve in light of new evidence, just as the original definition of hyperacusis was changed to recognise previously unclassified heterogeneity (now classified as misophonia).

Moving forwards, researchers interested in measuring hyperacusis (as distinct from misophonia) may use the subset of questions identified in the HQ rather than the entire scale (these are listed again in the Supplementary Material). Secondary datasets where the HQ can be split could also be reanalysed in light of the present results. Other measures are available that have been developed that target hyperacusis as a distinct entity to misophonia and are broadly in line with the research presented here (e.g. Aazh et al., 2022). This latter measure, the HIQ (Hyperacusis Impact Questionnaire), contains eight items. None relate specifically to the social impact of sounds but tend to relate to the ability to function (concentrate, relax, etc.) in noisy places.

In summary, the study provide evidence that misophonia and hyperacusis are at least partially dissociable entities with distinct profiles relating to trigger sounds and effects on real-world behaviour.

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No potential conflict of interest was reported by the author(s).

ORCID

Derek J. Hoare http://orcid.org/0000-0002-8768-1392

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