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Misophonia: A Need for audiologic diagnostic guidelines

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Abstract:
Purpose: The goal of this commentary is to present to audiologists the recent consensus definition of misophonia along with current clinical measures useful for audiologists in the diagnosis of misophonia. Up and coming behavioral methods that may be sensitive to misophonia are highlighted. Finally, a call is put out for translational audiologic research with the goal of developing diagnostic criteria for misophonia.
Method: The approach to the consensus definition is described, as well as the main characteristics of misophonia agreed upon by the expert panel. Next, available clinical measures that may be useful to audiologists for the diagnosis of misophonia are presented, followed by a brief review of current behavioral assessment methodology that still requires research to determine sensitivity and specificity to misophonia symptomatology. This discussion leads to the need for establishment of audiologic diagnostic criteria in misophonia, especially when differentiating from hyperacusis.
Conclusions: While the consensus definition for misophonia is an excellent first step in obtaining expert agreement on the descriptors of misophonic triggers, reactions, and behavior, clinical research is critical in developing criteria for misophonia as a specific sound tolerance disorder.

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Misophonia: A Need for audiologic diagnostic guidelines

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Key Words

Misophonia

Misophonia Consensus Definition

diagnostic techniques

The Misophonia Consensus Definition

Misophonia is a perceptual disorder that is gaining increased awareness across the fields of neuroscience, psychiatry, behavioral psychology, and audiology. However, conclusions as to the underlying etiology and effective management of misophonia suffer from inconsistent definitions of this disorder in the literature. For instance, some authors define misophonia as 'hatred of sound' resulting in anger (Schroder et al.[1]), while others consider it to be a reaction to patterns of sound in certain settings (Jastreboff and Jastreboff[2]). To clarify the definition of this disorder for research and clinical purposes, the Misophonia Research Fund (MRF), an organization supported by The REAM Foundation and in partnership with the Milken Institute's Center for Strategic Philanthropy, invited a panel of 15 professionals with specialties in the fields

of neuroscience, psychology, neuropsychology, behavioral psychology, psychiatry, and audiology to develop a consensus definition of misophonia (Swedo et al.[3]). Consensus was achieved using a modified Delphi method, which consisted of four rounds of voting on misophonia-related statements drawn from 68 references in the literature. Eighty percent agreement among the consensus team was required for inclusion of identifiers and descriptors in the definition. The general description of the consensus definition is included below:

> Misophonia is 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 behavioral 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. Trigger stimuli are often repetitive and primarily, but not exclusively, include stimuli generated by another individual, especially those produced by the human body. Once a trigger stimulus is detected, individuals with misophonia may have difficulty distracting themselves from the stimulus and may experience suffering, distress, and/or impairment in social, occupational, or academic functioning. The expression of misophonic symptoms varies, as does the severity, which ranges from mild to severe impairments. Some individuals with misophonia are aware that their reactions to misophonic trigger stimuli are disproportionate to the circumstances. Misophonia symptoms are typically first observed in childhood or early adolescence (Swedo et al.[3]).

Notably, the consensus definition characterizes misophonia as a *sound tolerance disorder* in which distinct sounds and/or related sensory input (such as visual imagery) elicit strong negative emotional, physiological, and behavioral reactions not typically observed in the general

population. This designation differs from the opinion of other experts, who have stated that misophonia should be classified as a psychiatric disorder, with diagnostic criteria as such (Schroder et al.[1], Dozier et al.[4]; Jager et al.[5]). According to the consensus definition, sensory input that evokes atypical negative responses to sound is termed a 'trigger', and is usually generated by another entity (e.g., a family member), specifically but not limited to the human body (e.g., chewing versus mechanical sounds). Triggers may initiate intense emotional responses of distress and subsequent difficulty functioning in everyday life (Guzik et al.[6]), with such responses lying along a spectrum of severity. Please refer to Swedo et al.[3], for the complete consensus definition.

This expert definition clarifies several points concerning triggers, associated symptomatology, and resulting behavioral impairments in individuals with misophonia, as well as emphasizes the importance of differential diagnosis from similar pathologies (e.g., obsessive compulsive-related disorders and hyperacusis). For instance, misophonic responses may be triggered by auditory inputs and other sensory stimuli present concurrent with the auditory event. These emotional responses can include many different manifestations, such as anger, irritation, and disgust (Jager et al.[5]). Responses may also be moderated by external factors, or context, including the environment in which the trigger is presented, the patient's relationship with the source of the trigger, and the sense of control over the aversive stimulus (Edelstein et al.[7]; Siepsiak et al.[8]). Finally, it is important to consider misophonia in relation to comparable disorders, particularly for therapeutic intervention purposes. Patterns of psychiatric disorders across a varied range have been found to be highly comorbid with misophonia (Rosenthal et al.[9]). The most reported have been mood disorders, such as anxiety and depression (Jager et al.[5]; Guzik et al.[6]; Rosenthal et al.[9]). These conditions may require medication and/or specific

behavioral therapy that is outside of the audiologist's scope of practice. Within the audiologist's scope of practice, it is critical that misophonia be differentially diagnosed from the auditory disorders of hearing loss, tinnitus, recruitment, phonophobia, and, most of all, hyperacusis (Jastreboff and Jastreboff[2]; Tyler et al.[10]). For example, the general description of the Misophonia Consensus Definition could also characterize hyperacusis, as both are sound tolerance disorders and involve an intense emotional, behavioral, and physiologic response to sound. Intervention options for sound tolerance disorders include cognitive behavioral therapy, sound therapy, and tinnitus retraining therapy (Jastreboff and Jastreboff[2]; Henry et al.[11]). Clearly, diagnosis and management of misophonia requires a multi-disciplinary approach in which psychiatrists, psychologists, and audiologists come together. However, little guidance is provided in the literature regarding the *audiologic* diagnostic criteria for misophonia.

Diagnosing Misophonia as an Audiologist

The consensus definition states that neither misophonia's presence nor severity appear related to the patient's pure-tone sensitivity, although it is unclear what bearing hearing loss may have on this percept (Aazh et al.[12]). While tinnitus is a very different percept from misophonia, i.e., a phantom 'ringing' in the ears, significant comorbidity exists between the two pathologies (Jastreboff and Jastreboff[2]), especially as tinnitus severity increases (Aazh et al.[12]). Similarly, as previously stated, hyperacusis appears to be highly comorbid with misophonia (Jastreboff and Jastreboff[2]; Aazh et al.[12]). While the consensus definition does not explicitly clarify the difference between hyperacusis and misophonia, hyperacusis has been described as an individual experiencing "physical discomfort or pain" in response to sound levels typically tolerable for much of the population (Henry et al.[11]; Baguley[13]; Fackrell et al.[14]). Misophonia is considered to

consist of an intense emotional response to specific sounds, regardless of intensity level (Swedo et al.[3]; Henry et al.[11]; Palumbo et al.[15]). For example, an individual with hyperacusis might react negatively to *any* sound presented above a set intensity level, while an individual with misophonia might respond negatively to *distinct* types of sounds at any intensity. However, it has been suggested that four subtypes of hyperacusis exist: loudness, annoyance, fear, and pain (Tyler et al.[10]; Salvi et al.[16]). According to this categorization, misophonia could fall into the subtypes of annoyance or possibly fear, as these emotions are commonly seen in misophonics (Tyler et al.[10]; Henry et al.[11]; Salvi et al.[16]). Salvi and colleagues[16] state that the distinguishing point of difference between these two disorders is loudness intolerance, and that misophonia may be an instance of annoyance and fear hyperacusis without the loudness component. In considering these definitions, it appears that if hyperacusis is present, misophonia may then be classified as annoyance and/or fear hyperacusis. If hyperacusis is not present, misophonia may be a unique diagnosis. Due to the similarities between these sound intolerance disorders, there is a significant need for research in the field to determine whether these two conditions are unique or related subtypes.

Such comorbidities make it very difficult for audiologists to disentangle and identify misophonia as a clinical diagnosis. While the recent consensus definition does not recommend clinical measures that may be useful for audiologists in misophonia assessment, research has indicated that various behavioral and audiometric tools may be sensitive to this disorder. The following discussion highlights current clinical measures, from general to specific, that are sensitive to misophonia and will also detect comorbid audiologic disorders such as tinnitus and hyperacusis (Figure 1). This model further identifies behavioral and physiologic measures suggested by the literature to be sensitive to misophonia (highlighted in yellow), but which still

require rigorous research to determine diagnostic efficacy. For a review of an exhaustive and exemplary audiologic misophonia test battery, please see Pellicori[17].

As in any audiologic appointment, a case history is essential. This is where the clinician may first observe specific patient complaints regarding sound tolerance and gain insight into the etiology of sound tolerance disorders (e.g., noise exposure, hearing loss, etc.). Detection of tinnitus, hyperacusis, and misophonia begins with the patient's self-report. Next, questionnaires ranging from the evaluation of overall sound tolerance to specific misophonic symptomatology are critical. The Sound Tolerance Interview and Questionnaire Instrument (STIQI; Sherlock and Formby[18]) was developed to obtain information on the patient's sound tolerance that may predict success for amplification, but scored questions focus on both aided and unaided conditions and include queries that touch on sound intensity, sound triggers, characteristics of triggers, and tinnitus. Thus, this questionnaire may be useful in determining sound tolerance in the domains of hyperacusis, misophonia, and tinnitus for both patients with hearing loss and normal thresholds. Another example is the Sound Sensitivity Symptoms Questionnaire (SSSQ; Aazh et al.[19]) which consists of questions on emotions and physical sensations elicited by sound. Following a sound tolerance report, the patient should also complete a tinnitus questionnaire, such as the Tinnitus Handicap Inventory (THI; Newman et al.[20]) or the Tinnitus Functional Index (TFI; Henry et al.[21]). A tinnitus questionnaire will establish whether tinnitus is present and comorbid with misophonia. If so, a separate psychometric tinnitus assessment may be conducted for the patient if they are participating in a research study or clinical trial (Henry and Meikle[22]; Jin and Tyler[23]), but this approach is not recommended outside of research practices or for clinical care (Tunkel et al.[24]). Similarly, a hyperacusis questionnaire will determine if this disorder is present and comorbid with misophonia, which may inform the intervention approach to focus on sensitivity

to both intensity levels of sound and the type of sound itself. Examples of hyperacusis assessments include the Modified Khalfa Hyperacusis Questionnaire (Khalfa et al.[25]) the Hyperacusis Impact Questionnaire (HIQ; Aazh et al.[19]), and the Inventory of Hyperacusis Symptoms (IHS; Greenberg and Carlos[26]). Finally, symptoms specific to misophonia may be assessed via the Amsterdam Misophonia Scale (A-MISO-S; Schroder et al.[1]) the Duke Misophonia Questionnaire (DMQ; Rosenthal et al.[27]), or the Misophonia Questionnaire (MQ; Wu et al.[28]), to name a few. Clearly, there are a plethora of surveys that may be implemented to ascertain whether misophonia and comorbid disorders are present, with only a few examples listed. Guidelines presented in Schroder et al.[1] and Dozier et al.[4] for misophonia diagnostic criteria may prove helpful, but at present it is appropriate for the clinician to use their judgement in building a battery of clinical questionnaires (Pellicori[17]). A suggestion from the author is to ensure that the chosen instrument has been psychometrically evaluated and validated (all presented examples are validated excluding the STIQI). Furthermore, it should be noted that the proposed model of multiple questionnaires ranging from general sound tolerance to misophonia allows the clinician to obtain a holistic picture of the patient that will aid in intervention while also providing converging evidence that will point to symptomatology unique to misophonia. At this point, if misophonia is indicated, a referral to a psychiatrist and psychologist is warranted. These professionals will assess whether there are comorbid psychiatric disorders and determine whether medical intervention, as well as behavioral, is required.

While not clinically standardized, some audiometric measures may provide behavioral indicators of sound tolerance disorders, especially in patients with normal thresholds. Figure 1 highlights these approaches to illustrate that additional research is needed to better understand the clinical utility of such measures, whereas questionnaires have already been validated. For

example, there is some evidence that extended high-frequency pure-tone testing (above 8 kHz) may reveal significantly better thresholds in patients with misophonia (Pellicori[17]). Similar findings have been observed in adults with normal thresholds and minimal tinnitus. For instance, adults who have THI scores at 6 or above tend to present with an extended high-frequency pure-tone average (at 10, 12.5, and 16 kHz) of better than 15 dB HL in the worse ear (Campbell et al.[29]). Therefore, these individuals may experience a heightened awareness of sound as reflected by extended high-frequency thresholds (Campbell et al.[29]). Another metric, loudness discomfort levels (LDLs) or uncomfortable loudness levels (ULLs; Aazh and Moore[30]), may be significantly decreased in both hyperacusis and misophonia (Jastreboff and Jastreboff[2]; Pellicori[17]; Aazh et al.[19]). In hyperacusis, LDL values may lie between 60-85 dB HL, less than the typical 100 dB HL value, while the range is more variable in misophonia (Jastreboff and Jastreboff[2]; Sherlock and Formby[31]). Thus, LDL measures are useful in indicating whether hyperacusis is also present and comorbid with misophonia, but would not indicate whether these two conditions are distinct. Another promising behavioral approach specific to misophonia assessment investigated in one recent study is the determination of trigger threshold. It would be hypothesized that triggers might have a lower threshold than other stimuli in a patient with misophonia. Such an approach was implemented by Savard et al.[32] using stimuli embedded in background noise at varying signal-to-noise ratios. While the authors did not find a significant difference between the threshold of trigger stimuli for participants with low and high misophonic tendencies, participants with high misophonic tendencies reported increased negative emotions for trigger stimuli above threshold. These findings suggest that a modified trigger-threshold method performed in quiet, using audio-visual stimuli, or presented in various contexts could provide a useful tool in misophonia assessment. For example, several researchers have shown that negative

emotions for misophonic triggers are decreased when the auditory trigger is incongruent with visual stimuli (e.g., lip smacking with a ball bouncing) or the source is unknown (Siepsiak et al.[8]; Edelstein et al.[33]; Samermit et al.[34]). Thus, measurement of trigger threshold may be significantly decreased when context is congruent as compared to incongruent. This approach would be based upon the patient's reported triggers, allowing for personalized testing that cuts across the variability triggers for this population (Jager et al.[5]). Open-source audio-visual databases containing misophonic stimuli are useful for such research purposes (Samermit et al.[34], https://osf.io/3ysfh/; Benesch et al.[35], https://zenodo.org/record/7109069#.Y9QK8lLMLz8)

Finally, there has been indication from one study that electrophysiology could serve as a useful objective measure of misophonia in the audiology clinic. Schroder et al.[36] presented participants with an auditory oddball paradigm while recording cortical auditory evoked potentials (CAEPs). They found that in participants who fit the diagnostic criteria for the misophonia, the N1 component in response to oddball tones was present at a significantly reduced amplitude in comparison to the control group. The authors surmised that this finding reflects a sensory deficit in the automatic processing of auditory stimuli, as the N1 is thought to represent mechanisms related to early attention in processing sound (Naatanen and Picton[37]). However, to our knowledge, there are no other studies examining cortical auditory evoked potential biomarkers in misophonia, making it unclear whether this finding is specific to misophonia or related comorbidities (Schroder et al.[36]). Other studies have also utilized physiologic measures, such as heart rate and galvanic skin response, to assess whether there exists a heightened autonomic condition during trigger presentations (Edelstein et al.[7]; Kumar et al.[38]). These physiologic assessments may also prove useful clinically.

A Need for Audiologic Diagnostic Guidelines

Due to the minimally researched audiologic assessment of misophonia, audiology clinics specializing in misophonia diagnosis have been left to the development of their own methodology (Aazh et al.[12]; Pellicori[17]). Thus, it is evident that there is a need for consensus on the audiologic diagnostic assessment and criteria for misophonia, including guidelines for distinguishing misophonia and hyperacusis. The current consensus definition on misophonia is an initial step toward defining the disorder rather than providing clinical guidance on assessment and treatment. However, as research on misophonia is growing at a rapid pace (Swedo et al.[3]), it would be helpful to have an evolving consensus definition that is reviewed every few years to identify appropriate diagnostic criteria, similar to other pathologies in medicine (Singer et al.[39]). At the same time, in order for there to be diagnostic criteria, translational research focused on the audiologic assessment of misophonia must be ongoing. As previously stated, this disorder has been designated as a sound tolerance disorder, putting it directly into the scope of practice for audiologists. As such, there is a call for clinical researchers to evaluate measures that will be sensitive and specific to misophonia. Such measures may help to inform targeted treatments that are suggested to be successful in sound tolerance disorders, such as cognitive behavioral therapy, sound therapy, and tinnitus retraining therapy (Jastreboff and Jastreboff[2]; Guzick et al.[6]). Post-treatment assessment may then indicate whether such treatment has been effective in altering trigger perception and associated physiologic responses. While the aforementioned behavioral measures have shown promise, replication and standardization is still necessary. In addition, objective physiological markers provided by the auditory brainstem response and cortical auditory evoked potentials remain to be explored. Finally, it is the opinion of the author that the next necessary step in the audiologic diagnosis of misophonia is to answer the question of

differentiation between misophonia and hyperacusis. Should these sound tolerance disorders be unique, or should misophonia be a subtype of hyperacusis when loudness intolerance is present? Are the underlying mechanisms similar or distinct (Jastreboff and Jastreboff[40])? What audiologic measures can be used or developed to provide differential diagnosis? Without translational research conducted by audiologists and auditory neuroscientists, clinicians will continue to struggle in providing evidence-based practice for this population.

Abbreviations

A-MISO-S	Amsterdam Misophonia Scale
CAEP	Cortical auditory evoked potential
DMQ	Duke Misophonia Questionnaire
HIQ	Hyperacusis Impact Questionnaire
IHS	Inventory of Hyperacusis Symptoms
LDL	Loudness discomfort level
MQ	Misophonia Questionnaire
MRF	Misophonia Research Fund
SSSQ	Sound Sensitivity Symptoms Questionnaire
STIQI	Sound Tolerance Interview and Questionnaire Instrument
TFI	Tinnitus Functional Index
THI	Tinnitus Handicap Inventory
ULL	Uncomfortable loudness level

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Conflict of Interest

None declared.

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Figure 1. A proposed model for current measures in misophonic assessment that may be used in the audiology clinic, in addition to standard audiologic assessment. The model begins with general sound tolerance assessment and moves to specific assessment of misophonic systems. The areas highlighted in yellow demonstrate possible clinical measures that may be sensitive to misophonia but require additional research.