Development and psychometric exploration of a semi-structured clinical interview for Misophonia

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ABSTRACT

Misophonia is a newly described disorder associated with significant emotional distress, functional impairment, and a wide range of mental health problems (e.g., mood, anxiety, and personality disorders). Although recent studies have begun to validate self-report measures of misophonia, no psychometrically validated interviews have been developed. To advance a scientific understanding of misophonia, rigorously developed semi-structured interviews are needed as a complementary measurement approach to self-report inventories. Accordingly, the aim of this study was to develop and begin preliminarily validating a semi-structured clinical interview for misophonia. We took an iterative, grassroots approach to item generation and interview development involving key stakeholders (i.e., misophonia sufferers, experts in the field). Initial psychometric analyses from the current sample ($n = 30$) evidenced excellent preliminary estimates for internal consistency, convergent, discriminant, and predictive validity. Results from this study provide preliminary support for the Duke Misophonia Interview, and we recommend that this interviewer-rated measure be iteratively developed and refined using larger and more diverse samples.

Misophonia is a disorder marked by decreased tolerance, as well as sensory and emotional over-responsivity to repetitive sounds ("triggers") and related stimuli (Edelstein et al., 2013; Jastreboff & Jastreboff, 2002, 2014; Schröder et al., 2013; Swedo et al., 2021; Wu et al., 2014). Triggers are typically human-produced, pattern-based oral and/or nasal noises (e.g., throat clearing, chewing, slurping, sniffing) or can be environmentally produced (e.g., pen clicking, keyboard typing, dog drinking), and are not attributable to aversive acoustic features such as volume or pitch (Brout et al., 2018; Swedo et al., 2021; Taylor, 2017). Although auditory triggers are most common in misophonia, individuals may also report distress in response to visual triggers (e.g., leg shaking, foot tapping, fan spinning; Swedo et al., 2021), as well as visual reminders of auditory triggers (e.g., watching someone open the refrigerator).

The intensity of emotional reactions to triggers is expressed across a range of affective responses (e.g., anger, anxiety, disgust, rage) and physiological reactivity (e.g., muscle tension, increased heart rate, heightened galvanic skin response; Edelstein et al., 2013; Jastreboff & Jastreboff, 2001; Rouw & Erfanian, 2018). Individuals responding to misophonic triggers report difficulty disengaging their attention from

the sounds, as well as aversive and negative thoughts (e.g., "I hate this person" or "I can't stand it"), sometimes accompanied by urges toward aggression (Jastreboff & Jastreboff, 2001; Swedo et al., 2021). Common behavioral responses include glaring at or mimicking the person producing the sound, verbal agitation or aggression, and infrequent physical aggression, all of which adversely impact interpersonal functioning (Jastreboff & Jastreboff, 2001). In additional to interpersonal aggression and conflict, escape and avoidance behavior functions to prevent exposure to and distress from misophonic cues.

Intolerance of possible triggering contexts (e.g., family meals and restaurants, certain workplaces) may lead to diminished confidence and ability to regulate emotions over time (Rouw & Erfanian, 2018; Wu et al., 2014). For example, among participants recruited from online support groups with misophonia, 78% reported spending over an hour each day thinking about misophonic sounds and reported moderate to extreme interference in social and/or academic and work life (e.g., strained relationships, social isolation, inability to perform important work tasks, to keep jobs; Rouw & Erfanian, 2018; Swedo et al., 2021). The level of impairment and distress associated with misophonia makes clear the importance of both developing and utilizing evidence-based

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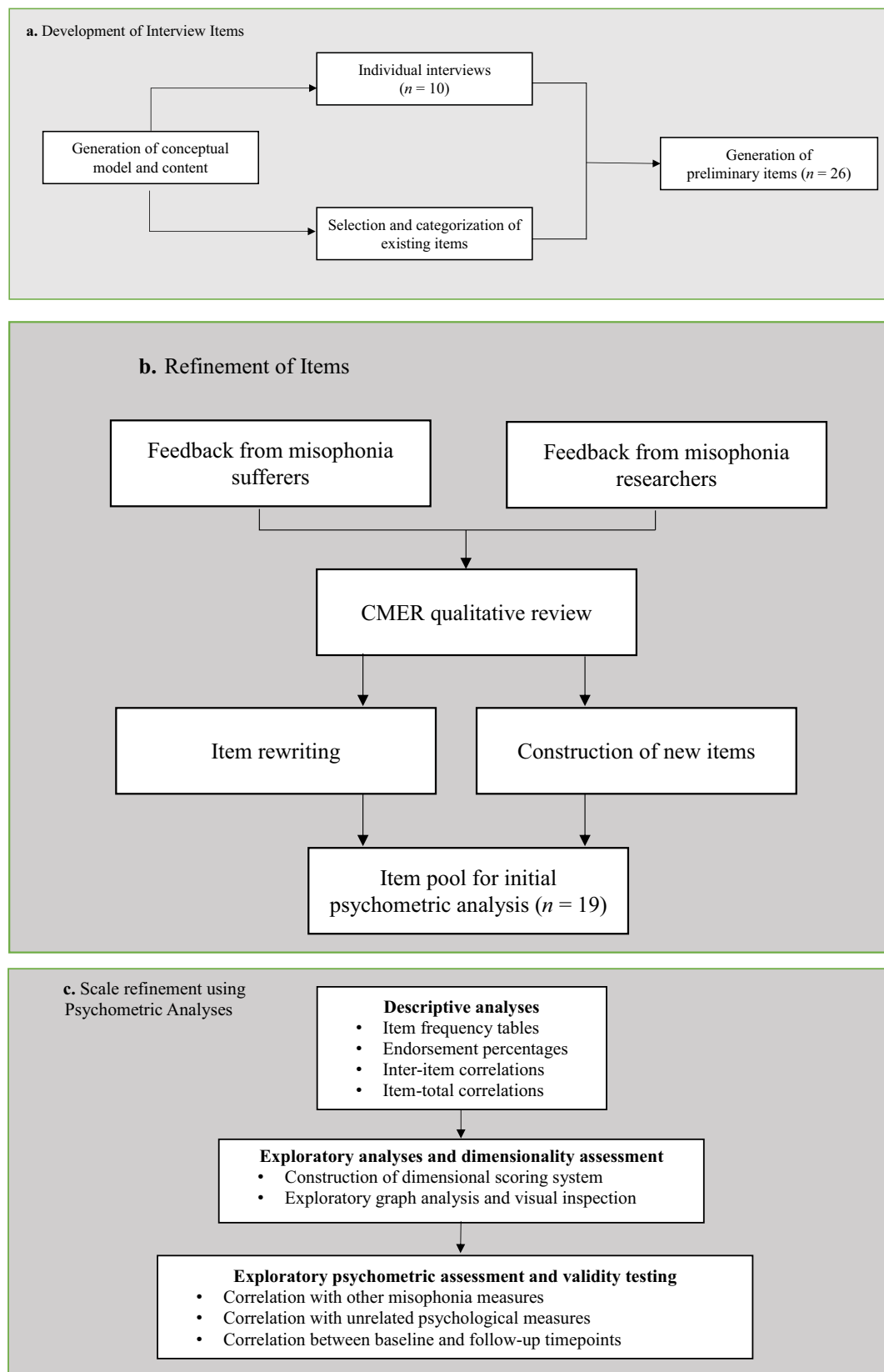*E-mail address:* rachel.guetta@duke.edu (R.E. Guetta).

Fig. 1. a. Development of Interview Items
b. Refinement of Items
c. Scale refinement using Psychometric Analyses.

a. Example of past-month item

Item 4: Intrusive thoughts, perseveration and/or rumination about prior misophonic sounds.

In the past month, have you had unwanted thoughts about prior instances of (BOTHERSOME SOUNDS)? Or in other words, thoughts about sounds or your reaction to the sounds about sounds in the past?

Can you give me some examples?

How long do these thoughts stay with you after the sounds have stopped? (In seconds, minutes, hours, days?)

How much effort does it take to get rid of those thoughts? (What kinds of things do you do to get rid of the thoughts?)

How many times have you had these distressing thoughts that stick with you in the past month? # of times _____

On a scale from 1 to 10 (where 1 is _____ and 10 is _____), how much do these unwanted thoughts about past sounds bother you? SUDS rating: _____

Distress: Minimal __ Clearly Present __ Pronounced __ Extreme __

To what extent have these thoughts caused problems in your life in the past month? At work/in school? How about in your relationships?

Dimensional rating:
__ 0 *Absent*
__ 1 *Mild (subthreshold)*
__ 2 *Moderate (threshold)*
__ 3 *Severe (elevated)*
__ 4 *Extreme (incapacitating)*

Dimensional rating = frequency / distress intensity

Moderate = at least 1-2 X day, more days than not / distress clearly present, some difficulty dismissing intrusive thoughts

Severe = several X day, more days than not / pronounced distress, considerable difficulty dismissing intrusive thoughts hours or days later

Impairment rating:
__ 0 *No impairment*
__ 1 *Subthreshold*
__ 2 *Clinical impairment*

b. Example of global impact item

Item 18: Impairment to self-concept; negative attitudes or beliefs about the self as related to misophonia or misophonic reactions.

Over your lifetime, have your misophonia symptoms impacted the way you view yourself or feel about yourself?

[If not clear:] *How do you feel about the fact that you are more upset by these sounds compared to other people?*

Have you had any negative feelings such as guilt, shame, or regret about your misophonia symptoms or misophonia reactions?

Have you ever hesitated from discussing your misophonia symptoms with others?

[If so]: *Why is that?*

__ 0 *Absent*

__ 1 *Mild / minimal distress*

__ 2 *Moderate / distress present, but maintains balanced self-image*

__ 3 *Severe / considerable distress, difficulty maintaining positive self-image*

__ 4 *Extreme / incapacitating distress with immense difficulty maintaining positive self-image*

Fig. 2. a. Example of past-month item
b. Example of global impact item.

assessments that characterize misophonia and treatments that alleviate relevant symptoms.

As the term "misophonia" was coined in the early 2000s (Jastreboff & Jastreboff, 2001), many questions remain regarding onset, etiology, course, biological, genetic, and behavioral mechanisms, phenotypic and syndromal boundaries with other psychiatric and medical conditions (Taylor, 2017). Central to answering these outstanding questions is the development and validation of empirically derived assessments that adequately capture the heterogeneity of misophonic symptom presentations.

1. Utility of a clinical interview

Recent studies have begun to validate self-report inventories assessing symptoms and features of misophonia. For example, the Misophonia Questionnaire (Wu et al., 2014), Amsterdam Misophonia Scale (Naylor et al., 2020), Misophonia Response Scale (Dibb, Golding, & Dozier, 2021), MisoQuest (Siepsiak et al., 2020), and Duke Misophonia Questionnaire (DMQ; Rosenthal et al., 2021) each have shown preliminary psychometric validation, and, collectively, provide promising new tools to help clinicians and researchers characterize misophonia. Despite the value of self-report assessment measures (e.g., brief, accessible, convenient), however, there are inherent problems with relying solely on these measurement approaches.

The focus of most self-report measures has been on types of triggers (e.g., oral, nasal, environmental, etc.), symptoms (e.g., physiological, emotional, and behavioral responses), and subjective appraisals of functional impairment (e.g., social, occupational, academic). Although such narrow focus is sensible in the context of brief measurement, little attention has been given to a more holistic understanding of the scope of affective, cognitive, behavioral, and physiological processes that occur in response to triggers, or to how misophonia affects one's self-concept. It is important to move beyond subjective assessment of triggers, symptoms, and impairment in order to obtain a more comprehensive understanding of an individual's experience of misophonia. In doing so, assessment can improve treatment by informing how to flexibly apply interventions capable of targeting of idiographic problems using nomothetically derived and empirically supported processes of change (e.g., cognitively, behaviorally, or physiologically-focused interventions).

Existing instruments also have weaknesses common among self-report measures, including response biases (e.g., acquiescence or nay-saying biases), variable and nonspecific interpretations of questions, and reductive responses, all of which can be partially overcome using semi-structured clinical interviews (e.g., Widiger & Saylor, 1998). For example, when administering a semi-structured interview, responses can be followed with probes and prompts in order to enhance the precision and accuracy of responses. Integrating follow-up questions in clinical interviews allows the interviewer to (a) clarify contextual details underlying questions/responses, (b) address ambiguous responses or participant uncertainty, (c) confirm the frequency, intensity, and duration of individual symptoms, and (d) situate symptom severity within the context of both the individual (idiographically) and what is empirically and clinically considered subthreshold versus threshold (nomothetically). Collectively, the advantages of using semi-structured interviews offer greater precision, scope, and treatment utiity than brief self-report inventories in the measurement of misophonia.

2. Current study

The primary aim of the present study was to develop and conduct exploratory psychometric analyses of a new semi-structured clinical interview to assess misophonia in adults. The a priori goals were to create and evaluate items representing an individual's: (a) current frequency of being affected by misophonic triggers, (b) degree of responding to triggers across affective, physiological, cognitive and behavioral domains of functioning, (c) social and occupational

impairment caused by misophonia over one's lifetime, as well as (d) impact of misophonia on beliefs about the self. These items were generated rigorously using qualitative and quantitative approaches in the initial validation of the Duke Misophonia Questionnaire (DMQ; for details, see Rosenthal et al., 2021). The present interview was developed to complement the DMQ and other self-report measures of misophonia, with the intention of being administered in both research and clinical settings to comprehensively characterize the heterogenous nature of misophonia.

The development of the clinical interview was scaffolded by assessment standards for creating new interview measures (Watson, 1990; Watson et al., 1991), including: (a) correspondence with proposed diagnostic criteria in order to promote generalizability and external validity; (b) inclusion of both dichotomous and continuous ratings to provide critical information about presence or absence of the condition in addition to dimensional characterization of severity; (c) ability to be trainable among paraprofessionals in order to contribute a scalable and broadly useful instrument; and (d) adequate reliability and validity. We also referenced several widely used and psychometrically validated clinical interviews, including the Clinician-Administered PTSD Scale for *DSM*-5 (CAPS-5; Weathers et al., 2018) and the Anxiety Disorders Interview Schedule for *DSM*-5 (ADIS-5; Brown & Barlow, 2014), and incorporated principles articulated by the creators of these instruments.

Firstly, we aimed to craft clear and concise questions. Secondly, we incorporated behavioral anchors derived from clinical experience with misophonia sufferers in the community and pilot data into the rating system in order to improve reliability and reduce rater bias (Blake et al., 1995). We also created dimensional ratings for symptoms that integrate both frequency and intensity in order to capture a more individualized symptom presentation and provide clinically useful information to researchers and clinicians alike. Such granular analysis of symptom severity affords an idiographic and flexible account of misophonia. For example, one individual may experience relatively frequent but mildly distressing misophonia symptoms, whereas another may experience less frequent symptoms but markedly more distress. This division of frequency and distress into a dimensional severity score may bolster the treatment utility of the assessment (Hayes et al., 1987; Weathers et al., 2018). Lastly, we incorporated interview questions that assess both current symptomatology and global impact and we were careful to use clear wording to distinguish between time frames.

3. Methods

All study procedures were approved by an IRB and all participants provided informed consent before beginning study procedures. Developed at Duke University's Center for Misophonia and Emotion Regulation, the Duke Misophonia Interview (DMI) was developed in two phases and was designed to overcome the limitations of existing measures of misophonia. In Phase 1, the interview items were generated using a literature review, responses to an initial version of the interview from both misophonia experts and a pilot sample of 10 misophonia sufferers, and iterative feedback from professionals. Phase 2 involved exploratory psychometric assessment among a larger sample of misophonia sufferers ($n = 30$). A summary of the methodology used to develop the DMI is depicted in Fig. 1a-c. Details of each element in this flowchart are described below.

3.1. Phase 1a: development of interview

3.1.1. Literature review to identify candidate items

To identify candidate items for the interview, a comprehensive literature search for existing proposed diagnostic criteria and tools to assess misophonia was conducted. Proposed diagnostic criteria identified were from Schröder et al. (2013) and Dozier et al. (2017). None of these proposed criteria have been empirically tested, and as such, none of the offered criteria have been widely accepted. Items from the

Table 1

DMI scoring.

DMI item	Total Score	Current Severity score	Current Impairment Score	Global Impact Score
Rating system	Sum of dimensional (0-4) ratings	Sum of dimensional (0-4) ratings	Sum of continuous (0-2) ratings	Sum of continuous (0-4) ratings
Score range	0 to 76	0 to 52	0 to 26	0 to 16
1. Presence of recurring, bothersome sounds.	--			
2. Negative thoughts during misophonic triggers.	--	--	--	
3. Intrusive thoughts about prior misophonic sounds.	--	--	--	
4. Negative emotions before onset of misophonia sounds.	--	--	--	
5. Negative emotions during misophonic sounds.	--	--	--	
6. Negative emotions after misophonic sounds.	--	--	--	
7. Anxiety about future misophonia sounds and reactions.	--	--	--	
8. Feeling misunderstood or detached from others due to misophonia.	--	--	--	
9. Physiological reactions to misophonic triggers.	--	--	--	
10. Hypervigilance for misophonic triggers.	--	--	--	
11. Verbal or physical aggression in response to sounds.	--	--	--	
12. Deliberate efforts to avoid situations, people, places.	--	--	--	
13. Need or desire to escape from triggering situations.	--	--	--	
14. Self-destructive behavior (i.e., self-harm) to cope with misophonia.	--	--	--	
15. Interference in relationships.	--			--
16. Interference in work, school, or other areas of everyday life.	--			--
17. Time spent thinking about, responding to, or avoiding misophonia cues.	--			
18. Impairment from misophonia to self-concept.	--			--
19. Global subjective distress.	--			--

DMI = Duke Misophonia Interview.

Schröder et al. group reflected in the interview include assessing the presence or absence of sensitivity to sounds, affective sensitivity, avoidance, distress and impairment (2013). Items from the Dozier et al. group integrated into the interview included assessing the source of the misophonic triggers, physiological and affective responses to triggers during and after the misophonic response, and interference in work, school, and interpersonal functioning. Measures identified included the Misophonia Questionnaire (MQ; Wu et al., 2014), Amsterdam Misophonia Scale (A-MISO-S; Schröder et al., 2013), Misophonia Assessment Questionnaire (MAQ; Johnson, 2014), Misophonia Activation Scale (MAS-1; Fitzmaurice, 2010), Misophonia Physiological Response Scale (MPRS; Bauman, 2015), Misophonia Coping Responses Scale (MCR; Johnson, 2014), and Misophonia Emotional Responses Scale (MER; Dozier, 2015). All items across these measures were reviewed and constructs (e.g., emotional, behavioral, physiological) were consolidated into semi-structured interview questions. These steps resulted in an initial pool of 26 candidate interview items.

3.1.2. Creation of individual interview

Next, a semi-structured interview was developed to ensure that the included items would comprehensively capture the current experience of individuals with misophonia. Features of the interview included (a) dichotomous (present/absent) responses for each individual symptom in the past month, (b) separate ratings for symptom frequency and intensity, culminating in a dimensional rating, (c) prompts, follow-up probes, and behavioral anchors for each dimensional rating scale in order to increase reliability (Blake et al., 1995), (d) functional impairment ratings for each past-month symptom, and (e) several questions assessing global (lifetime) impact of misophonia on the individual. See Fig. 2a-b for examples of interview items.

The first question established presence or absence of trigger sounds, as well as frequency and distress of the sounds. The next series of questions assessed cognitive, emotional, physiological, and behavioral

misophonic responses. The last several questions assessed impact of misophonia on relationships, school, work, and important hobbies, beliefs about the self, and overall quality of life across the individual's lifetime.

3.1.3. Scoring of the DMI

3.1.3.1. Dichotomous ratings for current symptoms. Prompts for each item began with a description of the symptom to assess presence or absence, and if the respondent endorsed the symptom, all follow-up prompts in the item were administered. If the respondent did not endorse presence of the given symptom, the interviewer moved on to the next symptom and the item was scored as a 0.

3.1.3.2. Dimensional severity ratings for current symptoms. Each past-month symptom included both frequency and distress ratings, which got converted into a single, dimensional severity rating (Weathers et al., 2018). First, symptom frequency was recorded directly as reported by the individual, and distress was captured using a subjective unit of distress (SUDS) rating from 1 to 10. Respondents were asked to generate personally-relevant behavioral anchors, with 1 being the level of distress during a moment or event that represented the calmest the individual had been in their life and 10 being the level of distress during a moment or event that represented the height of distress in their life. This allowed the respondent to situate the distress from each misophonia symptom within the context of their life stressors more broadly. Distress was rated as "*minimal*" (SUDS rating 1–3), "*clearly present*" (SUDS rating 4–5), "*pronounced*" (SUDS rating 6–8), or "*extreme*" (SUDS rating 9–10).

Next, derived from psychometrically validated, clinician-rated scoring rules (Weathers et al., 1999; Weathers et al., 2018), frequency and distress ratings were converted into a 5-point severity rating (0 = *absent*, 1 = *mild*, 2 = *moderate*, 3 = *severe*, 4 = *extreme*). Behavioral

Table 2
Descriptive statistics for DMI items.

DMI item	Percent endorsed ($n = 30$)	M	SD	Minimum	Maximum
1. Presence of recurring, bothersome sounds	100%	2.4	0.86	1	4
2. Negative thoughts during misophonic triggers.	100%	1.9	0.80	1	4
3. Intrusive thoughts about prior misophonic sounds.	30.0%	0.37	0.62	0	4
4. Negative emotions before onset of misophonia sounds.	86.7%	1.47	0.86	0	4
5. Negative emotions during misophonic sounds.	100.0%	2.60	0.97	1	4
6. Negative emotions after misophonic sounds.	76.7%	1.70	1.24	0	4
7. Anxiety about future misophonia sounds and reactions.	76.7%	1.17	0.87	0	4
8. Feeling misunderstood or detached from others due to misophonia.	73.3%	1.40	1.10	0	4
9. Physiological reactions to misophonic triggers.	93.3%	1.87	1.04	0	4
10. Hypervigilance for misophonic triggers.	80.0%	1.53	1.14	0	4
11. Verbal or physical aggression in response to sounds.	93.3%	1.47	0.82	0	4
12. Deliberate efforts to avoid situations, people, places.	76.7%	1.53	1.14	0	4
13. Need or desire to escape from triggering situations.	96.7%	2.20	1.06	0	4
14. Self-destructive behavior (i.e., self-harm) to cope with misophonia.	20.0%	0.37	0.81	0	4
15. Interference in relationships.	96.7%	2.23	0.90	0	4
16. Interference in work, school, or other areas of everyday life.	86.7%	1.93	1.23	0	4
17. Time spent thinking about, responding to, or avoiding misophonia cues.	100%	2.27	1.02	1	4
18. Impairment from misophonia to self-concept	93.3%	1.93	0.98	0	4
19. Global subjective distress	100%	2.50	0.86	1	4

DMI = Duke Misophonia Interview; M = mean; SD = standard deviation.

anchors were provided next to each severity rating option for the interviewer to refer to. For example, a moderate severity rating for most items required symptom frequency to be at least once a day over the past month and for distress to be clearly present.

3.1.3.3. Continuous ratings for current impairment. After collecting frequency and distress ratings for each past-month symptom, the interviewer followed prompts to ask about the extent to which that symptom had impacted their relationships with others, their ability to work or quality of work, as well as any other adverse impact on their day-to-day life that month. Impairment was rated by the interviewer on a 3-point Likert scale (0 = *no functional impairment* to to 2 = *functional*

impairment), based on the rating system derived in the Structured Clinical Interview for *DSM-5* (SCID-5; First, 2014). Impairment ratings incorporated information such as behavioral observations of the respondent, information gained earlier within that item and throughout interview, and judgment based on respondent reporting style.

3.1.3.4. Continuous ratings for global impact. After the assessment of past-month symptoms, the interview included several items about the overall impact of misophonia on relationships, school and occupation, self-concept and image, and subjective distress over one's lifetime. Each of these items were rated on a 5-point Likert scale from 0 (absent) to 4 (extreme). Global impact ratings incorporated factors such as degree of subjective distress, behavioral observations and information gained throughout interview, and judgment regarding reporting style.

3.1.3.5. Outcome scores. The interview yielded four scores: (a) total DMI score (a sum of all dimensional severity ratings for each past-month symptom and continuous ratings for each global impact item), (b) current severity score (a sum of all dimensional severity ratings for each past-month symptom), (c) current impairment score (a sum of all continuous impairment ratings), and (d) global impact score (a sum of all continuous lifetime effect ratings). A summary of the division of items and DMI outcome scores is depicted in Table 1.

3.1.3.6. Pilot study. Participants were individuals with misophonia ($n = 10$) and were included if they were between the ages of 18 and 65, did not meet criteria for current mania, anorexia nervosa, or psychosis as determined by formal diagnostic interviewing via the Structured Clinical Interview for the *DSM*-5 (SCID-5; First, 2014), and scored a mean item score of 2 or greater on the Misophonia Symptom Scale and Misophonia Emotions and Behaviors Scale and a score of 7 or higher on the Severity Scale of the Misophonia Questionnaire (Wu et al., 2014).

3.2. Phase 1b: refinement of initial item pool

3.2.1. Feedback on item wording, structure, and applicability from misophonia sufferers

In addition to responding to the interview items themselves, the same participants as in Phase 1a ($n = 10$) provided free response feedback on each item and offered changes or additions to the interview, including length, content, scoring criteria, wording of instructions, and comprehensibility of items. Participant feedback was discussed by the study team, and changes were incorporated to enhance accessibility and/or clarity of the instructions. Items flagged as confusing or redundant were either removed or condensed.

3.2.2. Feedback from experts

The iterated interview was sent to several clinicians and professional experts. Expert feedback was reviewed and incorporated by the study team. Changes included clarifying instructions and including additional relevant items (e.g., functional impairment items for each misophonic symptom).

3.2.3. Study team qualitative review

As the final step in Phase 1, members of the study team reviewed the iterated interview and made additional refinements to increase clarity and specificity of the interview items. This included further collapsing and/or parsing questions and further simplification of instructions and response options. After completion of all Phase 1b modifications, 19 items were prepared for Phase 2 data collection and initial psychometric analyses.

3.3. Phase 2: scale refinement using preliminary psychometric analyses

Phase 2 involved administering the DMI to a larger sample to further

Table 3
Item-total statistics for DMI items.

DMI Item	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Squared multiple correlation	Cronbach's Alpha if item deleted
1. Presence of sounds.	30.43	107.70	0.68	0.91	0.89
2. Negative thoughts during triggers.	30.93	110.20	0.58	0.81	0.89
3. Intrusive thoughts about prior sounds.	32.47	114.88	0.40	0.66	0.90
4. Negative emotions before sounds.	31.37	110.93	0.49	0.78	0.89
5. Negative emotions during sounds.	30.23	103.43	0.82	0.91	0.88
6. Negative emotions after sounds.	31.13	109.02	0.39	0.73	0.90
7. Anxiety about future sounds.	31.67	120.51	−0.04	0.80	0.91
8. Feeling detached.	31.43	104.40	0.66	0.89	0.89
9. Physiological reactions to triggers.	30.97	109.28	0.47	0.69	0.90
10. Hypervigilance for triggers.	31.30	108.84	0.44	0.65	0.90
11. Verbal or physical aggression.	31.37	114.31	0.32	0.79	0.90
12. Efforts to avoid.	31.30	103.94	0.66	0.71	0.89
13. Need or desire to escape.	30.63	102.93	0.76	0.91	0.88
14. Self-destructive behavior.	32.47	112.26	0.45	0.71	0.89
15. Interference in relationships.	30.60	107.28	0.67	0.95	0.89
16. Interference in work or school.	30.90	106.71	0.49	0.75	0.90
17. Time spent on misophonia.	30.57	107.43	0.58	0.78	0.89
18. Impairment to self-concept	30.90	106.02	0.67	0.90	0.89
19. Global subjective distress	30.33	107.54	0.69	0.83	0.89

DMI = Duke Misophonia Interview.

assess feasibility and acceptability of the measure and to begin exploratory psychometric analysis of the interview.

3.3.1. Participants

Phase 2 sample ($n = 30$) was recruited via the same methods as Phase 1. Sample size for this exploratory psychometric study was based in the law of central tendency, which posits that a sample size of 30 provides parameter estimates with small to medium effect sizes (Krithikadatta, 2014). Thirty percent of the current sample ($n = 9$) was randomized to a follow-up visit in order to compute a preliminary estimate of test-retest reliability and predictive validity of the DMI.

3.3.2. Measures

3.3.2.1. Misophonia questionnaire (MQ; Wu et al., 2014). The MQ is a brief, 17-item self-report scale divided into three subscales: the Misophonia Symptom Subscale, the Misophonia Emotions and Behaviors Subscale, and the Impairment Subscale. A cut score of 7 ("Moderate") or higher on the Impairment Subscale indicates clinically significant misophonia symptomology. Initial validation of the MQ demonstrated good internal consistency ($\alpha = 0.86$–0.89; Wu et al., 2014). Reliability for the MQ total score in the current sample was acceptable ($\alpha = 0.72$; 95% CI [0.55, 0.85]).

3.3.2.2. Amsterdam Misophonia Scale (A-MISO-S; Schröder et al., 2013). The A-MISO-S is a 6-item semi-structured interview that assesses the following: (1) amount of time occupied by misophonia symptoms; (2) interference in social functioning from misophonia; (3) level of general distress (irritation, anger, disgust) the misophonia symptoms cause the individual; (4) level of effort for the individual to resist or divert attention from misophonia impulses (i.e. sound-related thoughts); (5) how much control the individual feels they have over their misophonia-related thoughts; and (6) how much an individual avoids misophonia situations. In the current study, this measure was administered as a self-report questionnaire rather than an interview. Scores from 0 to 4 are considered subclinical misophonic symptoms, 5–9 mild, 10–14 moderate, 15–19 severe, and 20–24 extreme. A good internal consistency of 0.81 was reported (Naylor et al., 2020). Reliability of the A-MISO-S total score in the current sample was adequate ($\alpha = 0.68$; 95% CI [0.46, 0.83]).

3.3.2.3. Brief symptom inventory (BSI-18; Derogatis, 2001). The BSI-18 is an abridged version of the 53-item BSI developed to identify self-reported clinically relevant psychological symptoms. The BSI-18 is a checklist developed as a screen for symptoms ranging from depression, panic, to anxiety. Each symptom is rated on a five-point Likert scale with responses ranging from 0 ("Not at all") to 4 ("Extremely"), with total scores ranging from 0 to 72. Higher total scores indicate higher global psychological distress. Initial validation of the BSI-18 total score demonstrated good internal consistency ($\alpha = 0.89$; Zabora et al., 2001). Reliability for the BSI-18 total score in the current sample was excellent ($\alpha = 0.91$; 95% CI [0.86, 0.95]).

3.3.2.4. Centrality of Religiosity Scale (CRS; Huber & Huber, 2012). The CRS is a 15-item self-report scale assessing the significance of spirituality in individuals' lives, and was included to assess for discriminant validity. The measure was designed to measure five dimensions of religiosity: (1) Intellect, (2) Ideology, (3) Public practice, (4) Private practice, and (5) Experience. The CRS demonstrated good internal consistency ($\alpha = 0.73$ to 0.83; Abbasi-Asl et al., 2019). Reliability for the CRS in the current sample was good ($\alpha = 0.83$; 95% CI [0.73, 0.91]).

3.3.2.5. Marlowe-Crowne Social Desirability Scale (MCSD; Reynolds, 1982). This 13-item tool utilizing a true-false response format that assess the impact of social desirability, the tendency to report answers in a way that individuals deem to be socially acceptable. The MCSD was included to assess for discriminant validity. Total scores range from 0 to 13, with higher scores indicating a social desirability response tendency. The MCSD was validated in a large college sample and evidenced acceptable reliability $\alpha = 0.76$; Reynolds, 1982). Reliability for the MCSD in the current sample was good ($\alpha = 0.83$; 95% CI [0.72, 0.91]).

3.3.3. Data analytic plan

Data analyses were conducted in SPSS version 27 (IBM Corp, 2020). Descriptive statistics were calculated for all measures administered, including tests of normality. Acceptability and feasibility ratings for the DMI were also evaluated. We assessed presence or absence of each DMI interview item using a rule of severity score rating ≥ 1 to examine

Table 4
Inter-item Bivariate Correlations for Total Scores ($\alpha = 0.91$).

DMI Item	1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18	19
1. Trigger sounds	1																	
2. Thoughts during	.51	1																
3. Rumination	.17	.29	1															
4. Emotions before	.49	.72	.25	1														
5. Emotions during	.78	.57	.31	.56	1													
6. Emotions after	.51	.32	.20	.23	.33	1												
8. Detached	.41	.24	.39	.12	.58	.45	1											
9. Physiological	.49	.44	.29	.23	.39	.48	.29	1										
10. Hypervigilance	.06	.29	.20	.34	.26	.24	.26	.18	1									
11. Aggression	.61	.18	.06	.12	.33	.35	.02	.40	.02	1								
12. Avoid	.52	.36	.45	.44	.67	.22	.49	.30	.36	.35	1							
13. Escape	.52	.67	.31	.57	.72	.41	.58	.46	.48	.21	.57	1						
14. Self-harm	.48	.06	.21	.19	.46	.18	.41	-.02	.19	.25	.42	.19	1					
15. Relationships	.46	.27	.15	.21	.51	.13	.57	.37	.35	.36	.48	.38	.31	1				
16. Work/school	.19	.17	.13	.10	.41	-.10	.45	.21	.37	.07	.27	.27	.27	.73	1			
17. Time	.31	.29	.17	.25	.46	.09	.55	.13	.44	.14	.47	.62	.34	.54	.46	1		
18. Self-concept	.49	.52	.39	.32	.52	.21	.41	.30	.37	.30	.37	.44	.42	.68	.54	.30	1	
19. Global distress	.33	.37	.29	.28	.58	.15	.51	.31	.39	.20	.39	.57	.32	.74	.65	.47	.74	1

Note. DMI = Duke Misophonia Interview
———— = Current Severity score ($\alpha = .86$)
– – – – = Global Impact score ($\alpha = .88$)

patterns of endorsement rates. Prevalence rates were also used to flag potential items to eliminate in future iterations of the interview. Given the preliminary nature of this study, confidence intervals are presented to point estimates and significance testing throughout the results (Cooper, 2018).

3.3.3.1. Internal reliability. To refine the DMI using exploratory psychometric analyses, we examined means and standard deviations for each individual item, as well as for each DMI outcome score. We calculated total and summary scores on the DMI and evaluated internal consistency and inter-scale correlations in order to describe the relationships between assessed constructs and further explore conceptual groupings of the DMI outcome scores. Cronbach's alphas were computed for all interview items (total DMI score), as well for the three subscores (current symptom severity, current impairment, and global impact scores). In addition, confidence intervals were calculated for the coefficient alphas (Cooper, 2018). Item-total correlations were examined for all outcome scores. Items with item-total correlations less than 0.30 were removed from subsequent analyses (Brzoska & Razum, 2010; Cristobal et al., 2007; De Vaus, 2004; Maltby et al., 2007; Pedhazur & Schmelkin, 2013).

3.3.3.2. Test re-test reliability. We evaluated one month test-retest reliability among the 30% of the sample ($n = 9$) that was randomized to a follow-up visit in order to quantify test consistency over time. Bivariate correlations were computed between baseline and follow-up timepoints for DMI outcome scores.

3.3.3.3. External validation using existing measures. Concurrent validity was examined by estimating correlations with external measures of misophonia and symptoms of broader psychopathology. Pearson bivariate correlations were conducted between DMI total score and subscores with the MQ and A-MISO-S for measures of misophonia, as well as the BSI-18 for a measure of general psychopathology.

3.3.3.4. Discriminant validity. Discriminant validity was examined among the same 30% of the sample ($n = 9$) by estimating correlations with external constructs. Pearson bivariate correlations were conducted between DMI total score and the CRS and the MCSD, as neither religiosity nor social desirability are constructs with theoretical overlap with misophonia.

3.3.3.5. Predictive validity. Predictive validity was examined by estimating correlations with external constructs. Pearson bivariate correlations were conducted between the DMI total score and subscores with the MQ, A-MISO-S, and BSI.

4. Results

4.1. Descriptive statistics

Most participants in the current sample identified as female ($n = 23$, 76.6%), White ($n = 27$, 90%), and non-Hispanic ($n = 27$). The average age of the sample was 35.90 years ($SD = 12.67$). Forty percent of participants indicated they were single, never married ($n = 12$), had completed college ($n = 12$), and had a salary range of above \$40,000 ($n = 17$, 57%).

The total scores for the MQ, A-MISO-S, BSI-18, CRS, and MCSD were all within normal distribution. Skewness ranged from 0.05 to 1.12; kurtosis ranged from -0.93 to 1.9 (Gravetter & Wallnau, 2014; Trochim & Donnelly, 2006). The mean score on the MQ Symptom Scale was 21.60 ($SD = 4.87$) and on the MQ Emotions and Behavior Scale was 25.60 ($SD = 5.79$), suggesting that on average participants marked responses between "sometimes true" and "often true" when asked how often they were sensitive to various potential sound triggers, and how often they experienced certain emotional and behavioral responses to these triggers. Responses to the MQ Impairment Scale ($M = 8.73$, $SD = 1.82$) suggest that on average the sample reported "moderate sound sensitivities." Twenty-nine participants (96.67%) reported "clinically significant symptoms" on the MQ (i.e., ≥ 7 on the impairment subscale

Table 5
Inter-item bivariate correlations for DMI impairment score ($\alpha = 0.86$).

DMI Item	2	3	4	5	6	8	9	10	11	12	13	14
2. Thoughts during	1											
3. Rumination	0.43	1										
4. Emotions before	0.49	0.40	1									
5. Emotions during	0.44	0.24	0.50	1								
6. Emotions after	0.53	0.05	0.57	0.52	1							
8. Detached	0.45	0.21	0.45	0.65	0.54	1						
9. Physiological	0.37	0.09	0.14	0.39	0.20	0.31	1					
10. Hypervigilance	0.22	0.30	0.10	0.43	−0.01	0.37	0.20	1				
11. Aggression	0.31	−0.02	0.21	0.49	0.60	0.41	0.11	0.41	1			
12. Avoid	0.15	0.22	0.29	0.45	0.28	0.64	0.21	0.39	0.49	1		
13. Escape	0.52	0.25	0.49	0.52	0.43	0.76	0.26	0.32	0.29	0.52	1	
14. Self-harm	0.17	−0.11	0.06	0.38	0.14	0.33	−0.04	0.34	0.32	0.35	0.12	1

DMI = Duke Misophonia Interview.

(Wu et al., 2014). The mean total score on the A-MISO-S was 13.87 ($SD = 3.10$), suggesting that on average participants marked responses between "mild" and "moderate" when asked about the frequency, interference, and distress, as well as levels of resistance, control, and avoidance of misophonic cues in the past week. Responses to the BSI-18 ($M = 13.83$, $SD = 10.51$) suggest that on average participants had mild anxiety, depression, and/or somatization symptoms. Acceptability and feasibility ratings for the DMI were, on average, both rated between "very acceptable" and "extremely acceptable" ($M = 4.63$, $SD = 0.56$ and 0.62, respectively).

4.2. Prevalence of DMI item endorsement

To examine endorsement of DMI interview items, we computed frequencies of all 19 items. Current misophonia items on the DMI were endorsed by 100% of the current sample (symptom presence defined by severity rating ≥ 1; Table 2), suggesting strong face validity of the DMI items.

4.3. Preliminary internal reliability

In order to explore preliminary internal reliability of the DMI, we calculated summary scores on the DMI interview and examined inter-item and item-total correlations, as well as Cronbach's alphas among DMI outcome scores. Internal reliability of the total DMI score was excellent: Cronbach's alpha coefficient for all 19 interview items was $\alpha = 0.90$ (95% CI [0.84, 0.95]). Item-total correlations among all interview items were strong, as all items except one had item-total correlations between 0.32 and 0.76 (see Table 3). Item #7, assessing worry for a lot of the time about future noises, had an item-total correlation of −0.04 and produced a higher Cronbach's alpha when the value was deleted. As such, Item #7 was excluded from remaining analyses; 18 of the 19 items were retained in subsequent analyses.

Inter-item correlations between each of the retained 18 items are displayed in Table 4. Mean total score of all retained 18 items on the DMI was 31.67 ($SD = 10.98$), out of a maximum of 72 points. Cronbach's alpha for the total DMI score was excellent ($\alpha = 0.91$; 95% CI [0.86, 0.95]; see Table 5), and average inter-item correlation (AIC) for the DMI was 0.36. Mean current severity score was 18.40 ($SD = 7.34$), out of a maximum of 48 points for the 12 items. Cronbach's alpha for the current severity score items was strong ($\alpha = 0.86$; 95% CI [0.78, 0.92]) and AIC was 0.33. Mean current impairment score was 10.30 ($SD = 6.57$), out of a maximum of 24 points for the 12 items. Cronbach's alpha for the current impairment score items was strong ($\alpha = 0.86$; 95% CI [0.78, 0.92]) and AIC was 0.33. Mean global impact score was 8.60 ($SD = 3.45$), out of a maximum of 16 points for the four items. Cronbach's alpha for the global impact score items was excellent ($\alpha = 0.88$; 95% CI [0.81, 0.93]) and AIC was 0.68. Further, inter-scale correlations between the DMI total score and current severity, current impairment, and global impact scores were all significant ($rs = 0.96, 0.74, 0.78$,

respectively, $ps < 0.001$). Correlations among the three scores were also significant (see Table 6).

Taken together, the (a) high endorsement of DMI interview items, (b) strong Cronbach's alphas across the four DMI outcome scores, (c) AICs for the DMI total, current severity, and current impairment scores within recommended range (Clark & Watson, 1995), and (d) inter-scale correlations between the DMI outcome scores provide preliminary evidence of internal reliability for the DMI.

4.4. Test re-test reliability

Test-retest reliability of the DMI was explored by computing bivariate correlations between DMI scores from the baseline assessment and the follow-up visit among the 30% of participants randomized to follow-up. Pearson correlation coefficients between the DMI total scores ($r = 0.95$, $p < .0001$; 95% CI [0.89, 0.99]), current severity scores ($r = 0.94$, $p < .0001$; 95% CI [0.86, 0.98]), current impairment scores ($r = 0.88$, $p = .002$; 95% CI [0.73, 0.97]), and global impact scores ($r = 0.995$, $p < .0001$; 95% CI [0.98, 0.99]) at both time points were all strongly and positively correlated. Consistent with large correlation coefficient effect sizes (Cohen, 1988), these findings support preliminary evidence of test re-test reliability for the DMI.

4.5. External validation

Next, to assess preliminary concurrent validity between the DMI and existing measures of misophonia, bivariate correlations were conducted. Pearson correlations indicated that the MQ total score and A-MISO-S total score in the current sample were positively correlated with each other ($r = 0.50$, $p = .005$). As hypothesized, preliminary evidence of convergent validity was observed in correlations between the MQ and DMI (see Table 7). Similarly, there was evidence of significant, positive correlations between the A-MISO-S and some DMI scores. In order to examine convergent validity between the DMI and general psychopathology, correlations were computed between the DMI and BSI-18. Bivariate correlations between BSI-18 and DMI total ($r = 0.42$, $p = .020$), current impairment ($r = 0.49$, $p = .006$), and global impact ($r = 0.54$, $p = .002$) scores were consistent with moderate correlation coefficient effect sizes (Cohen, 1988). DMI current severity score was not correlated with BSI-18 total score. Taken together, these results indicate preliminary evidence of concurrent validity for the DMI.

4.6. Discriminant validity

To examine preliminary discriminant validity, correlations were conducted between the DMI and the CRS and MCSD. Results suggest that the DMI was not significantly related to either religiosity ($r = 0.05$, $p = .912$) or social desirability ($r = −0.03$, $p = .868$). These findings suggest preliminary discriminant validity for the DMI.

Table 6
Inter-scale bivariate correlations of the DMI.

DMI Score	DMI total score (18 items)	DMI current severity scale (12 items)	DMI current impairment scale (12 items)	Global impact scale (4 items)
DMI total score (18 items)	1	0.96***	0.74***	0.78***
DMI current severity scale (12 items)	0.96***	1	0.75***	0.58***
DMI current impairment scale (12 items)	0.74***	0.75***	1	0.51**
Global impact scale (4 items)	0.78***	0.58***	0.51**	1

DMI = Duke Misophonia Interview.
** Correlation is significant at the 0.01 level (2-tailed).
*** Correlation is significant at the 0.001 level (2-tailed).

4.7. Predictive validity

Lastly, bivariate correlations were conducted between DMI at initial assessment visit and self-report measures of misophonia and general psychopathology for the subset of the sample that was randomized to the follow-up visit ($n = 9$). Pearson correlations indicated that DMI total score was positively correlated with MQ emotions and behavior subscale ($r = 0.81$, $p = .008$), MQ severity score ($r = 73$, $p = .025$; 95% CI [0.57, 0.95]) and A-MISO-S total score at follow up ($r = 0.71$, $p = .032$; 95% CI [0.34, 92]). DMI total score was not correlated with MQ total score at follow up or BSI-18 total score at follow up. These findings provide preliminary evidence of predictive validity of the DMI.

5. Discussion

The overarching aim of this study was to develop and begin to psychometrically validate a semi-structured clinical interview to assess misophonia in adults. In addition to establishing symptom presence, as well as severity and impairment in functioning from misophonia, we also incorporated items that capture a broad spectrum of responses to triggers across affective, cognitive, physiological, and behavioral domains. The interview assesses ways in which these response strategies are effective and/or ineffective, as well as dysfunctional beliefs related to misophonia. There were two phases of interview development. In Phase 1, interview items were generated and iteratively refined from both a scientific literature review and qualitative feedback from misophonia sufferers and experts. In Phase 2, a separate sample of adults was recruited to complete the DMI and other measures in order to assess exploratory psychometric properties. A third of participants were randomized to a follow-up visit in order to begin assessing test-retest reliability and predictive validity. Iterative analytic procedures (e.g., estimated item-total correlations) were used to derive proposed final DMI items. From the overall item pool, the final DMI consists of 18 items, and includes four outcome scores: (1) Total DMI score (all 18 items), (2) Current severity score (12 items), (3) Current impairment score (12 items), and (4) Global impact score (4 items).

The DMI is the first semi-structured clinical interview for misophonia developed using iterative, grassroots methods integrating suggestions and feedback directly from key stakeholders (i.e., individuals with misophonia and experts in the field). Our approach to interview development was conducted to optimize interview accessibility and applicability in both research and clinical settings, and to limit investigator biases or assumptions about misophonia that could influence the inclusion or exclusion of interview items. This study suggests that the DMI includes reliable and valid scores reflecting a wide range of responses to misophonia. Intercorrelations between DMI scores indicated strong

relationships between constructs. For example, the current severity, current impairment, and global impact scores correlated strongly with DMI total score.

As hypothesized, the DMI was significantly positively correlated with extant self-report measures of misophonia, including the MQ (Wu et al., 2014) and A-MISO-S (Schröder et al., 2013), and a general measure of psychopathology (BSI; Derogatis, 2001), supporting the preliminary convergent validity of the DMI. Further, the DMI was not correlated with measures of religiosity and social desirability, two constructs with no a priori theoretical overlap with misophonia, suggesting preliminary discriminant validity of the DMI. Test-retest reliability between the two assessment timepoints were strong. Correlations between the DMI at baseline and the A-MISO-S as well as certain MQ subscales were significantly positively correlated, indicating preliminary adequate predictive validity of the DMI.

The full DMI may be used to assess misophonia symptoms, functional impairment, response patterns to triggers, beliefs associated with the disorder, and the global impact of misophonia symptomatology. In addition, DMI subscores can be utilized to investigate changes in specific processes during treatment for misophonia. Researchers and/or clinicians examining intervention outcomes on patterns of thinking and physiological responses in misophonia could use the DMI current severity score as an endpoint. Similarly, the impact of interventions on impairment could be investigated using the DMI impairment score.

The results of this study should be considered within the context of its limitations. First, it should also be noted that, despite the iterative, grassroots approach taken for item generation and inclusion, in light of the heterogeneity of misophonia, any given individual completing the DMI may report other features not captured by the DMI. Second, our sample in Phase 2 was largely homogenous (i.e., mostly White, female participants) and small ($n = 30$), which may limit the reliability and validity of the measure. The size of the subsample for test-retest and predictive validity ($n = 9$) may have inflated correlation coefficients through possible non-normality. Future research should replicate and extend our preliminary findings and evaluate the DMI using larger, more diverse clinical and general population samples which may provide useful insight into phenotypic differences on the DMI. Efforts to diversify future samples may include incorporating a demographic survey and prioritizing enrollment of underrepresented participants. The inclusion of comparison samples of non-misophonic participants may also function to validate the face validity of the interview items as discriminating between those with and without misophonia. Third, preliminary psychometric examination of the DMI was limited by not conducting inter-rater reliability. Validation studies of the DMI should include administration by multiple clinicians, researchers, and/or paraprofessionals, and include inter-rater reliability findings. Next, despite the enhanced precision and accuracy that semi-structured clinical interviewing is able to achieve, quantifying frequency, duration, and intensity of symptoms still may be vulnerable to response biases, variable interpretations of questions and limitations in respondents' ability to quantify subjective experience. For example, social desireability in presentation to the interviewer could lead to either under- or over-reporting; variable interpretations of what respondents' consider to be functionally impairing could limit validity. As such, laboratory-based behavioral paradigms to assess misophonia in addition to structured clinical interviews could help offset these limitations. Lastly, there were weak but positive correlations between the DMI scores with existing measures of misophonia, likely due to sample size and lack of power to detect stronger correlations. In the next phase of validation studies of the DMI, inclusion of other self-report measures of misophonia with stronger psychometric properties (e.g., DMQ; Rosenthal et al., 2021) is warranted.

5.1. Future directions

The consensus definition of misophonia (Swedo et al., 2021) was released after completion of the present study. Future iterations of the

Table 7
Bivariate correlations among DMI and existing measures of misophonia.

Variable	DMI total score	DMI current severity score	DMI current impairment score	DMI global impact score
MQ				
MQ total score	0.49**	0.39*	0.08	0.56**
MQ emotions and behavior subscale	0.58**	0.49**	0.22	0.59**
MQ severity score	0.33	0.20	0.18	0.55**
A-MISO-S	0.47**	0.33	0.20	0.65**

DMI = Duke Misophonia Interview; MQ = Misophonia Questionnaire; A-MISO-S = Amsterdam Misophonia Scale.
* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

DMI should ensure consistency with the recently published expert definition. Specifically, additions to the interview that reflect the consensus definition may include: more in-depth questions about influences on misophonic reactions (e.g., perceived degree of control over stimulus), attentional reactions (e.g., hyperfocus or obsession), and coping strategies to manage misophonia. Relatedly, additional input from interdisciplinary subspecialties (e.g., audiology, occupational therapy, neuroscience, otolaryngology) should be considered in future iterations to continue limiting investigator bias, and increasing accessibility, feasibility, and clinical utility of the DMI.

Additional future directions for the interview may include creation of a shorter version. DMI administration in this study took between 45 and 90 min. A briefer version of the DMI may be preferred in some contexts, especially so that DMI administration could fit within a standard psychotherapy session. One approach to shortening the DMI may be removing items with low rates of endorsement. For example, Items #3 (rumination about prior sounds) and #14 (self-harm) were endorsed by less than 30% of the current sample, indicating preliminary empirical basis for removal. Further research using larger samples is needed to reliably identify items for removal based on this criterion. In addition to developing a briefer version of the DMI for adults, adaption of the DMI to individuals under the age of 18 is warranted, as emerging evidence highlights that the onset of misophonia may be during childhood (Jager et al., 2020). In addition to iterative changes to the interview and adaptations of the DMI, future studies should focus on training paraprofessionals to administer the DMI in order to increase both clinical and research utility.

5.2. Conclusions

The DMI was developed as the first semi-structured clinical interview for misophonia to overcome the limitations of existing measures for this new disorder. Although preliminary, initial results evaluating the DMI satisfy the majority of proposed interview standards (Watson, 1990), including correspondence with proposed diagnostic criteria, inclusion of both dichotomous and continuous ratings, and adequate reliability and validity. Though validation and research on the integration of the DMI into varied clinical and research settings is needed, preliminary findings suggest the DMI may have excellent internal consistency, test re-test reliability, convergent validity, discriminant validity, and predictive validity. This study offers promising preliminary evidence for a clinically and empirically useful tool to understand misophonia, a new and understudied disorder.

CRediT authorship contribution statement

Rachel Guetta: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration. **Clair Cassiello-Robbins:** Methodology, Validation, Data curation, Writing – review & editing. **Deepika Anand:** Methodology, Writing – review & editing. **M. Zachary Rosenthal:** Conceptualization, Methodology, Resources, Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

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