

For any issues with this document, please contact your library.

---

Title: Contemporary clinical trials.

ArticleTitle: Acceptance and commitment therapy versus progressive relaxation training for misophonia: Randomized controlled trial protocol, interventions, and audiological assessments.

ArticleAuthor: Bowers, Emily M

Vol: Online ahead of print. Date: 2024 Aug 23 Pages: 107671

OCLC - 56090329; ISSN - 15592030; LCN - 2005214330;

Publisher: New York, N.Y. : Elsevier, 2005-

Source: Entrez:PubMed

Copyright: CCG

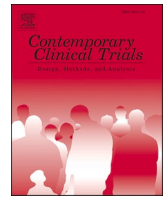
---

## NOTICE CONCERNING COPYRIGHT RESTRICTIONS:

The copyright law of the United States [[Title 17, United StatesCode](#)] governs the making of photocopies or other reproductions of copyrighted materials.

Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specific conditions is that the photocopy is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

This institution reserves the right to refuse to accept a copying order if, in its judgment, fulfillment of that order would involve violation of copyright law.



# Acceptance and commitment therapy versus progressive relaxation training for misophonia: Randomized controlled trial protocol, interventions, and audiological assessments

Emily M. Bowers<sup>a,\*</sup>, Mercedes G. Woolley<sup>a</sup>, Karen Muñoz<sup>b</sup>, Julie M. Petersen<sup>a</sup>, Michael P. Twohig<sup>a</sup>

<sup>a</sup> Department of Psychology, Utah State University, 2810 Old Main Hill, Logan, UT 84322, United States of America

<sup>b</sup> Department of Communicative Disorders and Deaf Education, Utah State University, 1000 Old Main Hill, Logan, UT 84322, United States of America

## ARTICLE INFO

### Keywords:

Misophonia  
Acceptance and commitment therapy  
Randomized controlled trial  
Methodology

## ABSTRACT

**Background:** Misophonia is a disorder characterized by an intense emotional reaction to specific sounds, often leading to significant distress and impairment in daily functioning. Acceptance and commitment therapy (ACT) is a promising psychotherapy for treating misophonia, but has only been previously tested in case studies. This paper presents a protocol for the first randomized controlled trial (RCT) assessing the efficacy and feasibility of ACT supplemented by audiological interventions for misophonia versus progressive relaxation training (PRT).

**Methods:** The outlined protocol is a RCT with 60 adults with misophonia. After undergoing a comprehensive psychological and audiological evaluation, participants were randomly assigned to ACT ( $n = 30$ ) or PRT ( $n = 30$ ). All participants completed clinician-administered and self-report assessments at baseline, post-intervention, 3-month follow-up, and 6-month follow-up. The primary outcome was misophonia severity and impairment measured via clinical interview. Secondary outcomes included disgust, anger, sensory sensitivities, well-being, distress, and psychological flexibility.

**Discussion:** This paper outlines the rationale of using ACT supplemented by audiological methods for misophonia with the novel therapeutic target of enhancing psychological flexibility. The results of this randomized controlled trial will help determine if ACT is an efficacious and acceptable treatment for misophonia. This trial will also help clarify active psychological mechanisms of misophonia, and assess whether this combination of psychological and audiological services can effectively help individuals with misophonia.

Misophonia is a disorder characterized by an intense emotional reaction to specific sounds such as breathing or repetitive tapping, often evoking anger, disgust, and anxiety [1]. To cope with misophonia-related distress, individuals may turn to avoidance, affecting relationships and quality of life [2]. Despite 4.6 % of individuals reporting clinical levels of misophonia [3], treatment research is nascent [4].

Due to the recent recognition of misophonia as a disorder<sup>1</sup> [1], few intervention studies exist. Moreover, the research on misophonia has been siloed across multiple disciplines, including audiology, neuroscience, occupational therapy, psychiatry, and psychology, with each field seeking to characterize and develop treatments for misophonia [4].

Recent findings highlight the unique neurological characteristics of misophonia [5], distinguishing it from other disorders and underscoring the need for specialized treatment approaches. With the research still in its infancy, experts advocate for interdisciplinary approaches to advance treatment development for misophonia [1].

Audiologists were the first to investigate an intervention for misophonia using tinnitus retraining therapy [6], which aims to desensitize individuals to trigger sounds by pairing them with neutral noise. However, the efficacy of tinnitus retraining therapy for misophonia is uncertain due to lack of controlled trials. Audiologic treatments for misophonia involve making life-style modifications and using noise-

\* Corresponding author.

E-mail address: [emily.bowers@usu.edu](mailto:emily.bowers@usu.edu) (E.M. Bowers).

<sup>1</sup> Misophonia is not currently recognized as a disorder in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM). However, a Delphi consensus definition study by Swedo et al. [1] suggests that the term “disorder” more accurately describes misophonia than other terms such as “condition” or “syndrome”, as it appropriately captures the negative impact of misophonia on individuals' lives.

<https://doi.org/10.1016/j.cct.2024.107671>

Received 17 June 2024; Received in revised form 12 August 2024; Accepted 22 August 2024

Available online 29 August 2024

1551-7144/© 2024 Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.

cancelling methods to reduce the impact of the sounds. Audiological interventions for misophonia are distinct from psychological treatments in that they primarily focus on modifying the auditory stimuli, though they may incorporate traditional behavioral approaches to achieve this aim. According to one study, individuals with misophonia endorsed audiological interventions (e.g., noise cancellation) as being most preferred method to manage their symptoms [7]. Still, these individuals were dissatisfied with current treatment options, underscoring the need for more interdisciplinary approaches that emphasize audiological, psychological, and neurological perspectives to meet the needs and preferences of individuals with misophonia.

Research on psychological treatments for misophonia has focused on cognitive-behavioral therapy (CBT), using techniques including attentional shifting, counterconditioning, and exposure therapy [8–10]. The only randomized controlled trial (RCT) published to date involved 54 adults with misophonia, comparing group-based CBT to a waitlist; clinical improvement was found in 37 % of participants in the intervention compared to 0 % in the waitlist [11]. In their review of the extant treatment literature, Mattson et al. [4] argued that while CBT addresses maladaptive misophonic reactions through cognitive methods, exposure therapy, and emotion regulation, these strategies may be less effective for the intense, immediate reactions to triggers like anger and disgust. Moreover, exposure approaches for misophonia have been called into question given many individuals with misophonia perceive exposure to be an inappropriate method to address their symptoms [7]. Instead, interdisciplinary interventions focusing on managing distress and adaptive approaches may be better suited to address the unique aspects of the disorder [4]. It is evident that more comprehensive and varied treatment studies are necessary to develop effective integrated interventions for misophonia.

Acceptance and Commitment Therapy (ACT) is a promising psychological intervention for misophonia, using techniques that provide an adaptive framework for engaging with distressing stimuli from a present-centered, non-judgmental perspective [4]. Mindfulness and acceptance-based strategies have shown preliminary efficacy in treating misophonia symptoms. In three case studies combining Dialectical Behavior Therapy and ACT strategies, individuals with misophonia learned to approach their reactions with openness and acceptance while re-engaging in meaningful activities [12–14].

The foundation of ACT is built on two core principles. The first is functional contextualism, which assesses psychological actions by considering their context and function [15]. This perspective seeks to foster effective behaviors that encourage individuals to engage in meaningful life activities, rather than controlling negative internal experiences. In this way, ACT complements audiological interventions by promoting behavioral adjustments that help minimize the effects of misophonic triggers, thereby allowing individuals to apply these strategies adaptively.

The second foundational element of ACT is relational frame theory (RFT), a model of language and cognition proposing that humans interpret experiences through learned relationships, not direct experience. Through an RFT lens, ACT addresses the maladaptive ways individuals with misophonia interpret their emotional and physiological responses to triggers. ACT does not aim to reduce misophonia symptoms directly, but addresses the meanings and contexts individuals associate with these triggers. The goal is to enhance psychological flexibility, enabling individuals to stay present and act in line with their values, even in the face of challenging thoughts, emotions, or sensations [16]. This focus on psychological flexibility allows individuals to move away from trying to control or avoid trigger sounds and towards engaging in a meaningful life.

As a cognitive-behavioral method that emphasizes process over symptoms, ACT aligns with transdiagnostic, or “process-based,” therapies. These are gaining interest as potential treatments for misophonia, particularly because they address underlying emotional difficulties and overlapping symptoms that occur with psychological comorbidities, a

common reality for those with misophonia [17]. Emerging frameworks like the Unified Protocol [18] show promise in trials and case studies [9,19]. By transcending traditional diagnostic categories to focus on psychological flexibility and integrating adaptive audiological strategies, ACT offers a comprehensive approach for those struggling with misophonia.

The current paper aims to address the gap in the misophonia literature by outlining the rationale and methodology of a RCT designed to investigate the efficacy of ACT, supplemented by audiological strategies. Comparison of psychological interventions for misophonia to active treatment is rare. This study uses progressive relaxation training (PRT) as an active control. Extant CBT interventions for misophonia commonly include relaxation exercises in order to reduce physiological arousal in response to trigger sounds. Approximately one third of all case studies, open trials, and RCTs for misophonia include relaxation techniques [20]. While relaxation techniques may be effective in reducing immediate psychological responses, they may not address the full breadth of psychological challenges associated with misophonia such as avoidance and social difficulties. ACT aims to help individuals manage their emotional responses to trigger sounds in a more adaptive manner long-term.

By conducting a trial which evaluates the effects of ACT supplemented by audiological strategies for misophonia, this study seeks to determine whether targeting psychological processes that promote psychological flexibility are effective for the long-term reduction and maintenance of misophonia symptoms relative to PRT. Through integrating psychological and audiological approaches, this trial seeks to provide a comprehensive treatment framework for individuals with misophonia. This study will also explore the role of audiological assessments to contribute to a more nuanced understanding of misophonia using an interdisciplinary approach.

## 1. Methods

This project is funded by the Misophonia Research Fund. The trial is registered on [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT05601284) as well as on the open science framework (OSF; [https://osf.io/9mwpd/?view\\_only=f7789c49dffe4a829cc6e504daac4bdc](https://osf.io/9mwpd/?view_only=f7789c49dffe4a829cc6e504daac4bdc)) and all procedures have been approved by a university Institutional Review Board.

### 1.1. Aims & predictions

This trial has four objectives. First, we will test the efficacy of ACT supplemented with audiological approaches, compared to PRT, for decreasing misophonia symptoms. We predict that the ACT intervention will be superior to PRT in decreasing clinician-rated misophonia symptoms. Second, we will evaluate the maintenance of treatment effects over time. We predict the ACT intervention will be effective at improving misophonia, anger, disgust, sensory sensitivity, quality of life, and distress over the course of treatment and will maintain gains at three- and six-month follow-ups as compared to PRT. Third, we will assess mechanisms of therapeutic change in self- and clinician-rated misophonia symptom severity. We predict individuals who complete the ACT intervention will report increased psychological flexibility at post-treatment and at three- and six-month follow-ups, compared to those who received PRT. Lastly, we will examine the acceptability of ACT intervention for misophonia. We predict both ACT and PRT interventions will have adequate treatment acceptability and credibility.

### 1.2. Recruitment & participants

Participants were eligible if they were 18 years of age or older, seeking treatment for misophonia, and met a clinical cut-off for misophonia (total score of 20 or higher on the Duke Misophonia Interview (DMI; [21])). Psychological comorbidity was allowed, unless it involved severe psychological or neurological impairment (e.g., profound neurological impairment, suicidality, mania, or psychosis) exceeding

misophonia as the primary presenting problem.

Recruitment for the total sample ( $N = 60$ ) was completed within one year from November 2022 to November 2023 (see Fig. 1 for enrollment timeline). Initially, we planned to recruit using various methods including provider referrals, flyers, online postings on relevant websites and social media, targeted emails, and newspaper ads. However, an unexpectedly high response from Facebook advertisements and paper flyers rendered additional recruitment methods unnecessary. Consequently, we increased our initial sample size from 40 to 60 participants. The final sample included 60 adults with misophonia; the majority self-identified as White (98.3 %), heterosexual (76.7 %), women (70 %) with an average age of 33.8 ( $SD = 12.18$ ; see Table 1).

### 1.3. Procedures

Participants completed an online screening questionnaire which included study consent, age, interest in participation, and the Misophonia Questionnaire (MQ; [22]). Participants who met inclusion criteria with elevated MQ severity scores (above 5, indicating at least mild impairment) were contacted for an intake appointment (see Fig. 2 for participant flow). Next, the independent study evaluator, a graduate student supervised by a psychologist, administered the DMI [21], the Diagnostic Interview for Anxiety, Mood, and Obsessive-compulsive and Related Neuropsychiatric Disorders (DIAMOND; [23]), and the Clinical Global Impression Scale (CGI; [24]). Co-morbid diagnoses were recorded and included in consideration of whether misophonia was the primary presenting problem (i.e., the most impairing and/or distressing compared to other psychological symptoms). Eligible participants then completed a battery of self-report questionnaires (see Measures section).

Following the clinical intake, participants underwent a comprehensive audiological assessment in the adjacent audiology clinic to rule out peripheral hearing deficits and provided a history of audiological problems (e.g., tinnitus, hyperacusis). Audiological tests were administered under the supervision of an audiologist. If participants were determined eligible following psychological and audiological assessments, they were enrolled and randomized to study condition. Excluded participants were referred to a more appropriate psychological or audiological treatment option.

Eligible participants were randomized to receive 10 weekly sessions, followed by 2 biweekly sessions, of ACT or PRT (12 individual sessions over 14 weeks). Within one-week post-intervention, participants completed a self-report survey and clinical interview with a masked independent evaluator using the DMI and CGI. Participants were asked

to complete the self-report surveys and clinical interview again at three- and six-month follow-up with the same masked evaluator. Participants were instructed to only report their current misophonia symptoms and to not disclose any information that may spoil their treatment condition. Following each follow-up point, the evaluator guessed the participant's treatment and rated their certainty to assess the success of evaluator masking (see [25]). Participants were compensated up to \$155 for completing all study assessments and questionnaires.

#### 1.3.1. Treatment standardization and fidelity

Study therapists included five doctoral students in clinical psychology and one psychologist (four cisgender women and two cisgender men). Four therapists administered both intervention conditions, two therapists delivered only ACT during the study. For training purposes, all therapists read the intervention manuals prior to beginning the study and attended an all-day ACT workshop. The clinical team met weekly throughout the duration of the intervention period to review clinical cases and discuss intervention procedures, supervised by the last author (M.T.), a psychologist.

All assessment and treatment sessions were recorded; 20 % ( $n = 144$ ) of sessions were randomly selected for review to assess integrity of implementation and treatment fidelity. Independent raters coded selected recordings for adherence to the protocol, quality of intervention, and therapist competence.

**1.3.1.1. Alternative procedures.** Due to the clinic's rural location (e.g., some participants lived over 1.5 hours away), intervention sessions and follow-up assessments were conducted both in-person and via telehealth on the HIPAA-compliant Zoom videoconferencing platform. In total, 53.0 % of ACT and 35.3 % of PRT sessions were conducted via Zoom.

### 1.4. Intervention

We will make the developed treatment manuals available free of cost on our website (<https://utahact.com>) in order to improve access to the treatment.

#### 1.4.1. ACT and audiological intervention

The intervention consisted of 12 individual ACT sessions, supplemented by audiological management, to target misophonia symptoms and related outcomes (e.g., functioning and quality of life). Each participant met with a research therapist for 50 minutes once a week; therapists received weekly supervision from a psychologist and support

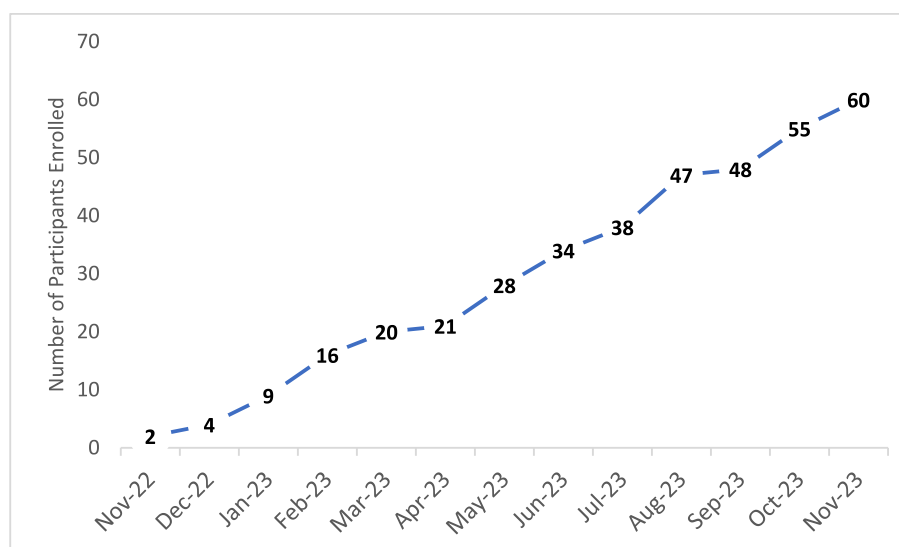


Fig. 1. Consistent participant enrollment over 12 months.

**Table 1**  
Participant sociodemographic characteristics.

	Full Sample (N = 60)		ACT Condition (n = 30)		PRT Condition (n = 30)	
	n	Valid %	n	Valid %	n	Valid %
Gender Identity						
Woman	42	70.0 %	20	66.7 %	22	73.3 %
Man	14	23.3 %	8	26.7 %	6	20.0 %
Non-Binary	3	5.0 %	2	6.7 %	1	3.3 %
Agender	1	1.7 %	0	0.0 %	1	3.3 %
Sexual Orientation <sup>1</sup>						
Asexual	3	5.0 %	0	0.0 %	3	10.0 %
Bisexual	4	6.7 %	2	6.7 %	2	6.7 %
Heterosexual/Straight	46	76.7 %	26	86.7 %	20	66.7 %
Pansexual	6	10.0 %	3	10.0 %	3	10.0 %
Queer	2	3.3 %	0	0.0 %	2	6.7 %
Age, M (SD)	33.80 (12.18)		34.97 (14.04)		32.63 (10.09)	
	Range = 18–67		Range = 20–67		Range = 18–50	
Ethnicity						
Hispanic or Latino	2	3.3 %	2	6.7 %	0	0.0 %
Race <sup>1</sup>						
Asian or Asian American	2	3.3 %	2	6.7 %	0	0.0 %
Black or African American	1	1.7 %	1	3.3 %	0	0.0 %
Native South American	1	1.7 %	1	3.3 %	0	0.0 %
White or White American	59	98.3 %	29	96.7 %	30	100.0 %
Religion						
Church of Jesus Christ of Latter-Day Saints	27	45.0 %	14	46.7 %	13	43.3 %
Jewish	1	1.7 %	1	3.3 %	0	0.0 %
Not Religious	28	46.67 %	14	46.7 %	14	46.7 %
Not listed	5	8.3 %	2	6.7 %	3	10.0 %
Household Income						
Less than \$20,000	4	6.7 %	3	10.0 %	1	3.3 %
\$20,000–\$39,999	9	15.0 %	3	10.0 %	6	7.3 %
\$40,000–\$59,999	4	6.7 %	2	6.7 %	2	6.7 %
\$60,000–\$79,999	8	13.3 %	4	13.3 %	4	13.3 %
\$80,000–\$99,999	6	10.0 %	3	10.0 %	3	10.0 %
\$100,000 or more	24	40.0 %	12	40.0 %	12	40.0 %
Unknown	5	8.3 %	3	10.0 %	2	6.7 %
Marital Status						
Divorced	3	5.0 %	1	3.3 %	2	6.7 %
Living with a partner	5	8.3 %	4	13.3 %	1	3.3 %
Married	34	56.7 %	18	60.0 %	16	53.3 %
Single	18	30.0 %	7	23.3 %	11	36.7 %
Employment Status						
Employed full-time	26	43.3 %	14	46.7 %	12	40.0 %
Employed part-time	17	28.3 %	9	30.0 %	8	26.7 %
Retired	2	3.3 %	2	6.7 %	0	0.0 %
Student	10	16.7 %	2	6.7 %	8	26.7 %
Unemployed	2	3.3 %	1	3.3 %	1	3.3 %
Other	2	3.3 %	2	6.7 %	0	0.0 %

<sup>1</sup> Categories not mutually exclusive.

from an audiologist as appropriate. Initial sessions provided psychoeducation and audiological interventions, while subsequent sessions emphasized ACT skills to enhance psychological flexibility when encountering trigger sounds and related contexts (see Table 2 for summary of session content).

Session 1 introduced the auditory-limbic theory, provided feedback from the audiological assessment, and discussed information about misophonia and the treatment rationale. Session 2 focused on audiological interventions, referred to as functional adaptations, which involved strategies to modify the environment and reduce the experience of trigger sounds, without promoting nonfunctional avoidance behaviors. These audiological interventions (e.g., rearranging spaces to minimize exposure to specific triggers, playing background music during dinner, wearing headphones while commuting), aim to change the trigger sound itself and are similar to techniques in habit reversal

training (i.e., if a participant is reasonably able to change or improve their environment to support coping with symptoms, they should; [26]). The audiological components of the intervention targeted a distinct mechanism (e.g., the trigger sound) compared to the consequent ACT skills which target psychological flexibility, yet both approaches share a common goal: to increase functionality of the participant. Session 2 also introduced values, helping the participant connect therapy to what is most meaningful to them. An emphasis was placed on valued action during environmental adaptations (e.g., what is the function behind the adaptation—is it to engage in something meaningful or an avoidance behavior?) in order to begin building psychological flexibility. Effective communication skills based in audiological and psychological theory were also shared.

Sessions 3 and 4 introduced the concept of creative hopelessness, exploring how the efforts to control misophonia may have interfered with the participant's life. The therapist and participant collaboratively brainstormed which strategies were effective over the short term and long term, or perhaps were ineffective. Psychological acceptance, also referred to as willingness, was introduced as an alternative approach to natural, though futile, attempts to control or eliminate misophonia symptoms. Behavioral management in session 3 and 4 included check-ins regarding functional adaptations and strategies for managing trigger sounds (e.g., use of headphones in conjunction with ACT skills).

Sessions 5 and 6 focused on noticing cognitive fusion and practicing defusing from misophonia-related cognitions and self-concepts. Metaphors such as passengers on the bus or the chessboard were utilized in session in addition to experiential exercises. Sessions 7 was dedicated to developing present moment awareness and mindfulness skills in order to reduce physical reactions to sounds (e.g., clenched jaw) and expand awareness of the surrounding environment in the presence of trigger sounds (i.e., reduce hyperfocus on trigger sounds). Participants reflected on how misophonia triggers may pull them away from the present and began to develop awareness of environmental triggers in order to enhance implementation of the behavioral component of treatment.

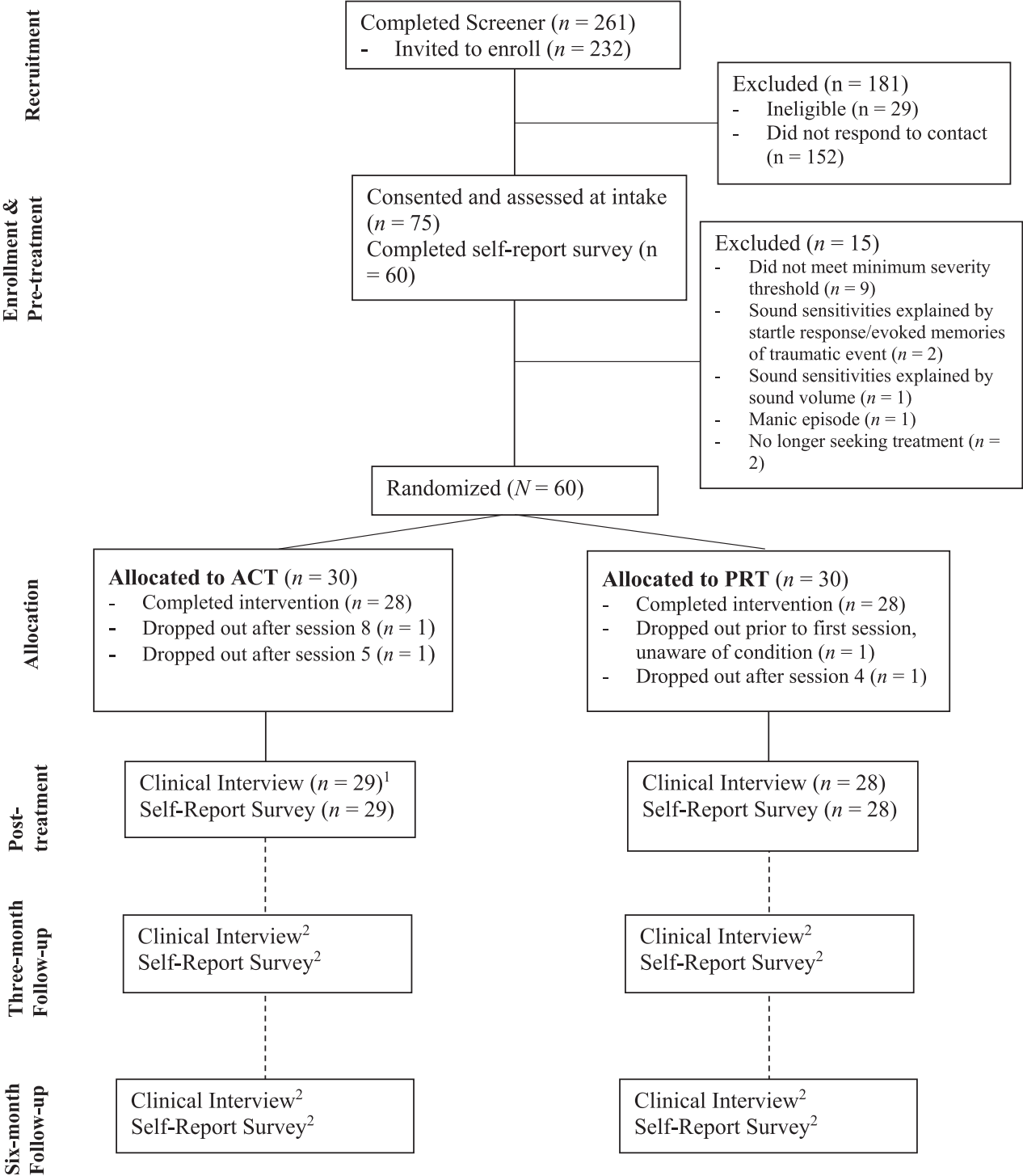
Sessions 8–10 included values clarification and strategies to enhance valued action (e.g., interpersonal effectiveness skills for managing conflict related to noise). These sessions were intentionally designed to include more flexible content, depending on the participant's needs (i.e., if an individual was still experiencing significant cognitive fusion, defusion skills would be revisited). Sessions 8–10 also implemented ACT-based exposure, where participants practiced willingly experiencing cognitions and emotions that arise from misophonia triggers. If a participant's misophonia triggers were specific to sounds from people or environments that could not be replicated in a therapy session, exposures were aimed at enhancing psychological flexibility with any uncomfortable sensation (e.g., anxiety, disgust).

Sessions 11 and 12 included a review of therapeutic skills learned. Session 12 also covered an ACT-based model of relapse prevention focusing on following one's values in the presence of trigger sounds and misophonia-related anger, disgust, and/or distress. These final two sessions were scheduled every other week to allow for additional time for the participants to practice their skills. Throughout treatment, ACT skills practice (e.g., approaching avoided scenarios, listening to trigger noises) was linked to the participant's goals and values.

#### 1.4.2. Progressive relaxation training

PRT consisted of 12 sessions of basic psychoeducation around misophonia and progressive relaxation training (PRT). The sessions of PRT followed a similar pattern to the ACT intervention. The first two sessions focused on psychoeducation around misophonia and the auditory system. The remaining 10 sessions integrated psychoeducation alongside PRT skills. As based on Bernstein et al. [27], sessions 2–4 focused on “16-muscle group” relaxation, sessions 5–6 focused on “7-muscle group” relaxation, sessions 7–8 focused on “4-muscle group” relaxation, and sessions 9–10 focused on relaxation counting methods and producing relaxation by recalling previous relaxation. Participants





**Fig. 2.** CONSORT diagram for participant flow.  
Note. <sup>1</sup> One participant who discontinued the intervention after session 8 provided post-data.  
<sup>2</sup> Data collection for 3-month and 6-month follow-up points is ongoing.

were encouraged to practice relaxation exercises twice per day over the course of the intervention to gain mastery releasing physical tension related to misophonia triggers. Sessions 11 and 12 were scheduled every other week and focused on relapse prevention and review of skills learned.

**2. Measures**

**2.1. Psychodiagnostic**

Participants were assessed for comorbid diagnoses with a structured diagnostic interview using the Diagnostic Interview for Anxiety, Mood, OCD, and Neuropsychiatric Disorders (DIAMOND; [23]).

**Table 2**  
Summary of session content and processes target in the ACT intervention.

Session	Description	Session Content
1	Psychoeducation and treatment overview	1. Psychoeducation about misophonia and the auditory system 2. Introduce treatment rationale 3. Set behavioral commitment: observe responses to misophonia-related triggers and self-monitor pattern(s)
2	Values and functional adaptations	1. Introduce values; connect therapy to values 2. Brainstorm and implement functional adaptations to the environment when trigger noises are present 3. Set behavioral commitment: practice choosing valued activities over misophonia
3 & 4	Creative hopelessness and acceptance	1. Introduce creative hopelessness/control as the problem, discuss how efforts to control misophonia have interfered with life 2. Practice thought experiments to experience the futility of controlling internal experiences (e.g., national anthem metaphor) 3. Introduce acceptance (“willingness”) as an alternative: tug of war with monster metaphor, “on paper” exercise 4. Set behavioral commitment: practice willingness to experience misophonia related distress
5 & 6	Cognitive defusion and self-as-context	1. Introduce cognitive defusion: passengers on the bus metaphor, “I’m having the thought that...”, naming misophonia 2. Introduce self-as-context: chessboard metaphor, observer meditation 3. Set behavioral commitment: practice engaging flexibly with internal experiences
7	Present moment awareness	1. Introduce present moment awareness and practice a mindfulness skill: attention as a spotlight metaphor, breathing exercises, sensory countdown 2. Set behavioral commitment: practice building present moment awareness
8–10	Values clarification, committed action, and exposure	1. Values clarification: sweet spot exercise, compass metaphor 2. Review skills for values engagement and committed action 3. Introduce values-aligned exposure, if relevant 4. Set behavioral commitment: practice skills relevant to misophonia and valued-activity
11 & 12	Overview and relapse prevention	1. Review of skills and treatment rationale 2. Relapse prevention plan 3. Set behavioral commitment to continue practicing skills post-treatment

2.2. Audiological measures

Audiological assessments were conducted using calibrated equipment in a soundproofed booth to ensure accuracy and reliability. Audiology testing included: (1) middle ear measures including otoscopy visualize ear canal and tympanic membrane, tympanometry to evaluate middle ear function, and acoustic reflex thresholds to assess integrity of auditory pathway, (2) pure tone audiometry to determine hearing level, (3) speech audiometry to measure speech recognitions thresholds, word recognition in quiet, and speech understanding in noise, (4) loudness discomfort levels to test for hyperacusis, (4) and distortion product

otoacoustic emissions. The audiological assessment also incorporated a self-report battery of measures assessing hyperacusis symptoms (Inventory of Hyperacusis Symptoms Survey; [28]) and tinnitus symptoms (Tinnitus and Hearing Survey; [29])

2.3. Outcome measures

The primary outcome measure for this trial was the DMI [21], a clinician-rated measure assessing misophonia severity and impairment. Participants also completed the Misophonia Questionnaire [22] to assess self-reported misophonia symptom severity. Other primary outcome measures include the self-report Disgust Propensity and Sensitivity Scale [30], Rage Outbursts and Anger Rating Scale [31], and the Adult Sensory Questionnaire [32]. For secondary outcomes, the Mental Health Continuum Short Form [33] measured quality of life, the Valuing Questionnaire [34] assessed progress and obstruction in regard to individual values, the Outcome Questionnaire-45 [35] measured general distress, and a self-report and clinician-rated version of the Clinical Global Impression scale [24] assessed broad improvement. We also assessed general anxiety, depression, and stress via the Depression, Anxiety, and Stress Scale [36] and OCD symptoms via the Dimensional Obsessive-Compulsive Scale [37].

2.4. Process of change measures

Psychological flexibility was measured with the acceptance and action questionnaire Acceptance and Action Questionnaire-III [38], as well as a newly developed measure, the Misophonia AAQ (Miso-AAQ; in preparation). The Miso-AAQ was designed to measure psychological flexibility in the context of misophonia specifically.

2.5. Treatment credibility and acceptability

Credibility was measured after the second intervention session with the credibility/expectancy questionnaire [39]. Acceptability was measured at post-treatment with a version of the treatment evaluation inventory-short form [40].

2.6. Data analytic plan

Multilevel models (MLMs) will be used to evaluate between-group differences in outcomes over time. MLMs are repeated measure regressions that account for dependent observations (i.e., permits violation of assumption of independent data) by modeling specific sources of dependencies (random effects) and use all available data for the dependent variable of interest in analyses as opposed to listwise deletion. We will use MLMs to investigate the effect of ACT relative to PRT over time (at pre-treatment, post-treatment, and follow-ups) on the following outcomes: misophonia symptoms, anger, sensory sensitivity, quality of life, general distress, broad improvement, and psychological flexibility. We will statistically control for any possible improvements in general anxiety, depression, and OCD symptoms in analyses in order to control for co-morbidity and related change. We will also consider number of co-morbid diagnoses each participant has as a possible covariate, if appropriate.

Treatment acceptability and credibility will be evaluated using pre-established cut-off scores. Acceptability will be evaluated as a score of 21 or higher on the TEI-SF (indicating that ACT was more acceptable than not), a benchmark used in previous intervention research [41]. There are no established cutoffs for the CEQ, but scores of 6 or higher (on the 1–9 scale) will be used to indicate adequate credibility and expectancies.

3. Discussion

The present study describes the procedures and protocol of the first

RCT of ACT for misophonia, offering insights into psychological and behavioral treatment. ACT, rooted in a process-based approach, aims to enhance psychological flexibility by promoting acceptance of internal experiences and value-driven behavior. In contrast, PRT focuses on relaxation techniques to alleviate distress associated with trigger sounds. The outcomes of this study will contribute to our understanding of the treatment outcomes and mechanisms of change that underlie misophonia and related symptoms by following participants over a period of nine months from baseline to follow-up.

Utilizing ACT as a process-based approach is critical for addressing diverse psychological and emotional responses to trigger sounds. Process-based therapies, such as the unified protocol, have shown preliminary efficacy in treating misophonia in pilot trials, suggesting process-based therapies can address the underlying mechanisms of misophonia beyond symptom suppression [9,19]. Whereas the unified protocol targets emotion regulation, ACT targets psychological flexibility, and the results of this trial may offer clinicians an empirically supported intervention with a unique target that can help clients engage in valued-living while experiencing misophonia.

Moreover, the integration of psychological and audiological approaches lends the trial to create a more comprehensive framework for misophonia. Given the nascent stage of misophonia research and divergent perspectives within different disciplines, this interdisciplinary approach is essential. Traditionally, misophonia has been treated primarily within either audiological or psychological domains, but seldom through a combined interdisciplinary lens. Only one previous trial has incorporated a brief audiological screening assessing hyperacusis, hearing loss, and tinnitus prior to intervention for misophonia [11]. The inclusion of extensive audiological assessments alongside ACT allows for a more nuanced understanding of misophonia, incorporating both the auditory processing and emotional responses. The results of this trial will contribute to the process-based literature by examining intervention effects in a statistically powered and controlled study design.

Notably, telehealth became a significant aspect of this trial with nearly half of the sessions being conducted on Zoom. Offering a hybrid of in-person and virtual sessions improved accessibility and contributed to our recruitment success. In response to higher than anticipated recruitment volume, we increased our original sample size from 40 to 60 participants. Furthermore, study recruitment required fewer resources than anticipated, enabling us to reallocate funds to accommodate compensation for the additional 20 participants. The successful recruitment underscores the feasibility of misophonia intervention research and interest in treatment among those affected.

Although this study protocol has many strengths, such as an active control group and a multidisciplinary approach, there are limitations that provide opportunities for future research. First, the present sample lacks diversity, with the majority of participants self-identifying as White, which may limit the generalizability of findings to more diverse populations. Second, the inclusion criteria allowed individuals with various comorbid psychological conditions to participate. Although psychological comorbidities are common and reflect real-world clinical scenarios, there is a possibility the observed treatment effects could be confounded. Future research may benefit from more stringent diagnostic exclusion criteria to isolate the impact of the intervention on misophonia symptoms. Lastly, all clinicians delivering PRT in this study are also ACT therapists by training, potentially impacting the effects of PRT. Given the emphasis of building awareness of physical internal experiences (e.g., muscle tension and relaxation) in PRT, ACT and PRT share a slight overlap through fostering present moment awareness. Future studies may choose to incorporate an alternative active control group such as psychoeducation to account for intervention similarities.

In conclusion, this study outlines the first RCT of ACT for misophonia, representing one of the few RCTs conducted for misophonia. By emphasizing the interdisciplinary approach of psychological and audiological interventions, we outline the comprehensive nature of our study and its potential implications for advancing both research and clinical

practices for misophonia. The outcomes of this study will enhance our understanding of misophonia treatment, with the novel treatment target of psychological flexibility in this population.

## Financial disclosures

This project was funded by a grant from the Misophonia Research Fund. Dr. Twohig also receives royalties from New Harbinger, Oxford University Press, and Praxis CET.

## CRedit authorship contribution statement

**Emily M. Bowers:** Writing – original draft, Project administration, Methodology, Investigation, Conceptualization. **Mercedes G. Woolley:** Writing – review & editing, Writing – original draft, Methodology, Investigation. **Karen Muñoz:** Writing – review & editing, Supervision, Project administration. **Julie M. Petersen:** Writing – review & editing, Investigation, Conceptualization. **Michael P. Twohig:** Writing – review & editing, Supervision, Investigation, Funding acquisition, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

## References

- [1] S.E. Swedo, D.M. Baguley, D. Denys, L.J. Dixon, M. Erfanian, A. Fioretti, P. J. Jastreboff, S. Kumar, M.Z. Rosenthal, R. Rouw, D. Schiller, J. Simmer, E. A. Storch, K.R.V. Werff, C.M. Altimus, S.M. Raver, Consensus definition of Misophonia: a Delphi study, *Front. Neurosci.* 16 (2022) 841816, <https://doi.org/10.3389/FNINS.2022.841816/BIBTEX>.
- [2] M. Siepiak, M.Z. Rosenthal, D. Raj-Kozick, W. Dragan, Psychiatric and audiological features of misophonia: use of a clinical control group with auditory over-responsivity, *J. Psychosom. Res.* 156 (2022) 110777, <https://doi.org/10.1016/J.JPSYCHORES.2022.110777>.
- [3] L.J. Dixon, M.J. Schadeeg, H.L. Clark, C.J. Sevier, S.M. Witcraft, Prevalence, phenomenology, and impact of misophonia in a nationally representative sample of US adults, *J. Psychopathol. Clin. Sci.* 133 (5) (2024) 403–412.
- [4] S.A. Mattson, J. D'Souza, K.D. Wojcik, A.G. Guzik, W.K. Goodman, E.A. Storch, A systematic review of treatments for misophonia, *Personaliz. Med. Psychiatr.* 39–40 (2023) 100104, <https://doi.org/10.1016/J.PMIP.2023.100104>.
- [5] A.D. Neacsu, V. Szymkiewicz, J.T. Galla, B. Li, Y. Kulkarni, C.W. Spector, The neurobiology of misophonia and implications for novel, neuroscience-driven interventions, *Front. Neurosci.* 16 (2022) 893903, <https://doi.org/10.3389/fnins.2022.893903>.
- [6] M.M. Jastreboff, P.J. Jastreboff, Decreased sound tolerance and tinnitus retraining therapy (TRT) | the Australian and New Zealand journal of audiology, *Aust. N. Z. J. Audiol.* 24 (2) (2002) 74–84, <https://search.informit.org/doi/abs/10.3316/informit.830321871955412>.
- [7] E.E.A. Smith, A.G. Guzik, I.A. Draper, J. Clinger, S.C. Schneider, W.K. Goodman, J.J. Brout, M. Lijffijt, E.A. Storch, Perceptions of various treatment approaches for adults and children with misophonia, *J. Affect. Disord.* 316 (2022) 76–82, <https://doi.org/10.1016/j.jad.2022.08.020>.
- [8] A.B. Lewin, S. Dickinson, K. Kudryk, A.R. Karlovich, S.L. Harmon, D.A. Phillips, N. A. Tonarely, R. Gruen, B. Small, J. Ehrenreich-May, Transdiagnostic cognitive behavioral therapy for misophonia in youth: methods for a clinical trial and four pilot cases, *J. Affect. Disord.* 291 (2021) 400–408, <https://doi.org/10.1016/J.JAD.2021.04.027>.
- [9] K. McMahon, C. Cassiello-Robbins, A. Greenleaf, R. Guetta, E. Frazer-Abel, L. Kelley, M.Z. Rosenthal, The unified protocol for transdiagnostic treatment of emotional disorders for misophonia: a pilot trial exploring acceptability and efficacy, *Front. Psychol.* 14 (2023) 1294571, <https://doi.org/10.3389/FPSYG.2023.1294571/BIBTEX>.
- [10] A.E. Schröder, N.C. Vulink, A.J. van Loon, D.A. Denys, Cognitive behavioral therapy is effective in misophonia: an open trial, *J. Affect. Disord.* 217 (2017) 289–294, <https://doi.org/10.1016/J.JAD.2017.04.017>.
- [11] I.J. Jager, N.C.C. Vulink, I.O. Bergfeld, A.J.J.M. van Loon, D.A.J.P. Denys, Cognitive behavioral therapy for misophonia: a randomized clinical trial, *Depress. Anxiety* 38 (7) (2021) 708–718, <https://doi.org/10.1002/DA.23127>.



- [12] R.C. Kamody, G.S. Del Conte, Using dialectical behavior therapy to treat Misophonia in adolescence, *Prim. Care Compan. CNS Disorder*. 19 (5) (2017), <https://doi.org/10.4088/PCC.17L02105>.
- [13] J.M. Petersen, M.P. Twohig, Acceptance and commitment therapy for a child with Misophonia: a case study, *Clin. Case Stud.* 22 (3) (2023) 211–223, [https://doi.org/10.1177/15346501221126136/ASSET/IMAGES/LARGE/10.1177\\_15346501221126136-FIG 2.JPEG](https://doi.org/10.1177/15346501221126136/ASSET/IMAGES/LARGE/10.1177_15346501221126136-FIG 2.JPEG).
- [14] R.L. Schneider, J.J. Arch, Case study: a novel application of mindfulness- and acceptance-based components to treat misophonia, *J. Contextual Behav. Sci.* 6 (2) (2017) 221–225, <https://doi.org/10.1016/J.JCBS.2017.04.003>.
- [15] S.C. Hayes, L.J. Hayes, H.W. Reese, Finding the philosophical core: a review of Stephen C. Pepper's world hypotheses: a study in evidence, *J. Exp. Anal. Behav.* 50 (1) (1988) 97–111, <https://doi.org/10.1901/jeab.1988.50-97>.
- [16] C.W. Ong, E.H. Eustis, Psychological Flexibility. *The Oxford Handbook of Acceptance and Commitment Therapy*, 2023, pp. 169–181.
- [17] I. Jager, P. de Koning, T. Bost, D. Denys, N. Vulink, Misophonia: phenomenology, comorbidity and demographics in a large sample, *PLoS One* 15 (4) (2020) e0231390, <https://doi.org/10.1371/JOURNAL.PONE.0231390>.
- [18] D.H. Barlow, K.K. Ellard, C.P. Fairholme, Unified Protocol for Transdiagnostic Treatment of Emotional Disorders: Workbook, Oxford University Press, 2010.
- [19] N.A. Tonarely-Busto, D.A. Phillips, E. Saez-Clarke, A. Karlovich, K. Kudryk, A. B. Lewin, J. Ehrenreich-May, Applying the unified protocol for Transdiagnostic treatment of emotional disorders in children and adolescents to Misophonia: a case example, *Evid.-Based Pract. Child Adolesc. Mental Health* 8 (1) (2023) 133–147, <https://doi.org/10.1080/23794925.2022.2025631>.
- [20] Z.M. Rosenthal, Y. Shan, J. Trumbull, Treatment of Misophonia, *Adv. Psychiatr. Behavior. Health* (2023), <https://doi.org/10.1016/j.ypsc.2023.03.009>.
- [21] R.E. Guetta, C. Cassiello-Robbins, D. Anand, M.Z. Rosenthal, Development and psychometric exploration of a semi-structured clinical interview for Misophonia, *Personal. Individ. Differ.* 187 (2022) 111416, <https://doi.org/10.1016/J.PAID.2021.111416>.
- [22] M.S. Wu, A.B. Lewin, T.K. Murphy, E.A. Storch, Misophonia: incidence, phenomenology, and clinical correlates in an undergraduate student sample, *J. Clin. Psychol.* 70 (10) (2014) 994–1007, <https://doi.org/10.1002/JCLP.22098>.
- [23] D.F. Tolin, C. Gilliam, B.M. Wootton, W. Bowe, L.B. Bragdon, E. Davis, S. E. Hannan, S.A. Steinman, B. Worden, L.S. Hallion, Psychometric properties of a structured diagnostic interview for DSM-5 anxiety, mood, and obsessive-compulsive and related disorders, *Assessment* 25 (1) (2016) 3–13, <https://doi.org/10.1177/1073191116638410>.
- [24] W. Guy, ECDEU Assessment Manual for Psychopharmacology, US Department of Health, Education, and Welfare, Public Health Service, 1976.
- [25] J. Kolahi, H. Bang, J. Park, Towards a proposal for assessment of blinding success in clinical trials: up-to-date review, *Community Dent. Oral Epidemiol.* 37 (6) (2009) 477–484, <https://doi.org/10.1111/j.1600-0528.2009.00494.x>.
- [26] M.P. Twohig, J.M. Petersen, J. Fruge, C.W. Ong, J.L. Barney, J. Krafft, E.B. Lee, M. E. Levin, A pilot randomized controlled trial of online-delivered ACT-enhanced behavior therapy for trichotillomania in adolescents, *Cogn. Behav. Pract.* 28 (4) (2021) 653–668, <https://doi.org/10.1016/J.CBPRA.2021.01.004>.
- [27] D.A. Bernstein, T.D. Borkovec, H. Hazlett-Stevens, New Directions in Progressive Relaxation Training: A Guidebook for Helping Professionals, Greenwood Publishing Group, 2000. <https://psycnet.apa.org/record/2000-03365-000>.
- [28] B. Greenberg, M. Carlos, Psychometric properties and factor structure of a new scale to measure hyperacusis: introducing the inventory of hyperacusis symptoms, *Ear Hear.* 39 (5) (2018) 1021034, <https://doi.org/10.1097/AUD.0000000000000583>.
- [29] J.A. Henry, S.M. Theodoroff, C. Edmonds, I. Martinez, P.J. Myers, T.L. Zaugg, M. C. Goodworth, Sound tolerance conditions (hyperacusis, misophonia, noise sensitivity, and phonophobia): definitions and clinical management, *Am. J. Audiol.* 31 (3) (2022) 513–527, [https://doi.org/10.1044/2022\\_AJA-22-00035](https://doi.org/10.1044/2022_AJA-22-00035).
- [30] W.J.M. Van Overveld, P.J. De Jong, M.L. Peters, K. Cavanagh, G.C. Davey, Disgust propensity and disgust sensitivity: separate constructs that are differentially related to specific fears, *Personal. Individ. Differ.* 41 (7) (2006) 1241–1252.
- [31] C. Budman, B.J. Coffey, R. Shechter, M. Schrock, N. Wieland, A. Spigel, E. Simon, Aripiprazole in children and adolescents with Tourette disorder with and without explosive outbursts, *J. Child Adolesc. Psychopharmacol.* 18 (5) (2008) 509–515, <https://doi.org/10.1089/CAP.2007.061>.
- [32] B. Pfeiffer, M. Kinnealey, Treatment of sensory defensiveness in adults, *Occup. Ther. Int.* 10 (3) (2003) 175–184, <https://doi.org/10.1002/OTI.184>.
- [33] S.M.A. Lamers, G.J. Westerhof, E.T. Bohlmeijer, P.M. Ten Klooster, C.L.M. Keyes, Evaluating the psychometric properties of the mental health continuum-short form (MHC-SF), *J. Clin. Psychol.* 67 (1) (2011) 99–110, <https://doi.org/10.1002/JCLP.20741>.
- [34] M.F. Smout, M. Longo, S. Harrison, R. Minniti, W. Wickes, J.M. White, Psychosocial treatment for methamphetamine use disorders: a preliminary randomized controlled trial of cognitive behavior therapy and acceptance and commitment therapy, *Subst. Abuse* 31 (2) (2010) 98–107, <https://doi.org/10.1080/08897071003641578>.
- [35] M.J. Lambert, A.T. Gregersen, G.M. Burlingame, The Outcome Questionnaire-45, in: M.E. Maruish (Ed.), *The Use of Psychological Testing for Treatment Planning and Outcomes Assessment: Instruments for Adults*, 3rd ed, Lawrence Erlbaum Associates Publishers, 2004, pp. 191–234. <https://psycnet.apa.org/record/2004-14941-006>.
- [36] J.R. Crawford, J.D. Henry, The depression anxiety stress scales (DASS): normative data and latent structure in a large non-clinical sample, *Br. J. Clin. Psychol.* 42 (2) (2003) 111–131, <https://doi.org/10.1348/014466503321903544>.
- [37] J.S. Abramowitz, B.J. Deacon, B.O. Olatunji, M.G. Wheaton, N.C. Berman, D. Losardo, K.R. Timpano, P.B. McGrath, B.C. Riemann, T. Adams, T. Björgvinsson, E.A. Storch, L.R. Hale, Assessment of obsessive-compulsive symptom dimensions: development and evaluation of the dimensional obsessive-compulsive scale, *Psychol. Assess.* 22 (1) (2010) 180–198, <https://doi.org/10.1037/A0018260>.
- [38] C.W. Ong, B.G. Pierce, J.M. Petersen, J.L. Barney, J.E. Fruge, M.E. Levin, M. P. Twohig, A psychometric comparison of psychological inflexibility measures: discriminant validity and item performance, *J. Contextual Behav. Sci.* 18 (2020) 34–47, <https://doi.org/10.1016/J.JCBS.2020.08.007>.
- [39] G.J. Devilly, T.D. Borkovec, Psychometric properties of the credibility/expectancy questionnaire, *J. Behav. Ther. Exp. Psychiatry* 31 (2) (2000) 73–86, [https://doi.org/10.1016/S0005-7916\(00\)00012-4](https://doi.org/10.1016/S0005-7916(00)00012-4).
- [40] M.L. Kelley, R.W. Heffer, F.M. Gresham, S.N. Elliott, Development of a modified treatment evaluation inventory, *J. Psychopathol. Behav. Assess.* 11 (3) (1989) 235–247, <https://doi.org/10.1007/BF00960495/METRICS>.
- [41] M.P. Twohig, S. Hayes, A. Masuda, Increasing willingness to experience obsessions: acceptance and commitment therapy as a treatment for obsessive-compulsive disorder, *Behav. Ther.* 37 (1) (2006) 3–13.