1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

The Berlin Misophonia Questionnaire (BMQ): Development and validation of a symptom-oriented diagnostical instrument for the measurement of misophonia

Nico Remmert^{1*}, Katharina Maria Beate Schmidt¹, Patrick Mussel¹, and Michael Eid¹

¹ Department of Psychology, Freie Universität Berlin, Berlin, Germany

* Corresponding author

E-mail: n.remmert@fu-berlin.de

19 **Abstract**

20 Misophonia is a clinical syndrome which is characterized by intense emotional and
21 physical reactions to idiosyncratic sounds. However, its psychometric measurement is still in
22 the early stages. This study introduces the development of a self-report instrument, the Berlin
23 Misophonia Questionnaire (BMQ), and addresses the limitations of current psychometric
24 measures by integrating contemporary empirical findings and the latest criteria of misophonia.
25 A cross-sectional online study was conducted using data of 952 affected as well as non-
26 affected individuals. The results of confirmatory factor analyses, the assessment of internal
27 consistency, and an extensive construct validation procedure scrutinizing the nomological
28 network of misophonic symptoms supported the reliability and validity of the developed
29 scales. Through the presented symptom-oriented modelling approach, every facet of
30 misophonia is clearly and separately measurable and can be assigned to the criteria. The final
31 BMQ-R consists of 77 items in 21 scales, which were selected using a probabilistic item
32 selection algorithm (Ant Colony Optimization). The strength of the BMQ-R is the
33 comprehensive measurement of misophonic emotional and physical responses. The
34 instrument allows for distinguishing between behavioral, cognitive, and emotional
35 dysregulation; the measurement of clinical insight and significance; as well as discerning
36 reactive and anticipating avoidance strategies. This study offered several improvements to the
37 measurement of misophonia by providing a reliable and valid multidimensional measurement
38 of misophonic symptoms which we hope will stimulate further research on misophonia.

39

Introduction

Misophonia is a relatively new and still little investigated clinical syndrome that is characterized by severe affective, physiological, and behavioral symptoms triggered by the perception or anticipation of specific, typically human-induced sounds, for instance people eating or drinking noisily or sniffing [1,2,3]. Individuals with misophonia experience intense symptoms and decreased tolerance to innocuous soft sounds rather than ordinarily disturbing sounds (e.g., emesis or microphone feedback [4]) [5]. Typical misophonic reactions are relatively independent of acoustic characteristics (e.g., volume), rather being mainly determined by the subjective meaning of sounds [2,6] and by the contextual information involved [7]. Several researchers have pointed out that other sensory information constitute sources of triggers which include visual [8,9], but also tactile and olfactory information about the sound [10]. However, it remains unclear whether these other sources of sensory information independently elicit misophonic symptoms or are merely involved in the misophonic reaction [11].

Clinical characteristics

The upsurge of misophonia research in the last decade has also put forth insight into clinical picture and specific symptoms. Individuals with misophonia experience intense irritation, anger, distress, disgust, and anxiety in response to specific sounds [1,7,12,13]. Further, aversive psychophysiological symptoms related to high levels of arousal and stress have been reported, for example, tachycardia, sweating, pressure, and impaired respiration [11,14]. The intense impulsive and emotional response is accompanied by a perceived loss of control which potentially manifests itself as behavioral outbursts [1,3]. Typical coping behavior is characterized by proactive avoidance of potentially triggering situations or

64 escaping such situations [1-3,14]. The symptoms cause significant distress and severe
65 functional impairment in individuals' interpersonal and occupational lives [1,10,15].

66 While there is a growing body of literature empirically characterizing misophonia, no
67 formal classification has been added to ICD-11 or DSM-V yet. According to Brout et al. [2],
68 the lack of a consensual classification results from the unclarified issue whether misophonia is
69 a transdiagnostic condition or whether it is a separate syndrome. Auditory intolerance and
70 characteristic misophonic symptoms can be observed among several other disorders covering
71 tinnitus and hyperacusis [16], obsessive-compulsive disorders [8] and autism spectrum
72 disorders [17]. Further research is necessary to elucidate psychopathological comorbidities of
73 misophonia and to substantiate misophonia as a unique syndrome.

74 Regardless of the disagreement about misophonia's status as a distinct syndrome,
75 Schröder et al. [3] proposed the first set of diagnostic research criteria for misophonia which
76 have been revised and validated in a follow-up study ([1], see Table 1 for the revised criteria).
77 Many researchers consider these criteria to be premature (e.g., [18, 19]), since there are
78 several unclarified issues regarding misophonia symptoms and eliciting triggers. Criticism
79 also incorporates different uncertainties regarding the syndromal breadth, a severity threshold,
80 the diagnostic validity [18] and the investigated non-representative sample [19]. Nevertheless,
81 we believe the criteria facilitate further rigorous research on misophonia and the development
82 of empirically verifiable measurement models and instruments.

83

84 **Table 1. Revised Diagnostic Criteria for Misophonia**

Criterion description
A. Preoccupation with a specific auditory, visual or sensory cue, which is predominantly induced by another person. It is required that oral or nasal sounds are a trigger.
B. Cues evoke intense feelings of irritation, anger and/or disgust of which the individual recognizes it is excessive, unreasonable or out of proportion to the circumstances.
C. Since emotions trigger an impulsive aversive physical reaction, the individual experiences a profound sense of loss of self-control with rare but potentially aggressive outbursts.
D. The individual actively avoids situations in which triggers occur or endures triggers with intense discomfort, irritation, anger or disgust.
E. The irritation, anger, disgust or avoidance causes significant distress and/or significant interference in the individual's day-to-day life. For example, it is impossible to eat together, work in an open office space or live together.
F. The irritation, anger, disgust and avoidance are not better explained by another disorder, such as an Autism Spectrum Condition (e.g. a general hypersensitivity or hyper arousal to all sensory stimuli) or Attention Deficit Hyperactivity Disorder (e.g. attention problems with high distractibility in general).

The listed criteria are adopted according to Jager et al. [1].

86 **Psychometric Approaches**

87 Despite the necessity for scientific methods to measure symptoms of misophonia, few
88 papers investigating its psychometric properties exist [13]. Two instruments are frequently
89 used in scientific research. One is the Amsterdam Misophonia Scale (A-MISO-S; [3]) which
90 is an interview-based instrument that was constructed in line with the proposed diagnostic
91 criteria. Neither in the original nor in the revised version of the instrument (AMISOS-R; [1])
92 did the authors provide a report of its psychometric properties. The second instrument, the
93 Misophonia Questionnaire (MQ; [10]) is a self-report instrument developed to measure
94 sensitivity and reactions to trigger sounds as well as the severity of sound sensitivity. Despite
95 initial promising psychometric properties of the scale, a thorough investigation of the validity
96 is pending.

97 Recently, two new self-report questionnaires have been published. The MisoQuest
98 [20] is a unidimensional questionnaire which is based on the criteria proposed by Schröder et
99 al. [3]. Due to its underlying unidimensional structure and economic number of items, the
100 instrument is rather a screening than a comprehensive measure of symptoms. Good
101 psychometric properties have been shown. However, only the anger reaction is measured
102 which means that other emotional misophonic responses are not considered.

103 The second recently published instrument is the multidimensional Selective Sound
104 Sensitivity Syndrome Scale (S-Five; [19,21]) which comprises two independent sections: the
105 experiences (S-Five-E) and the triggers (S-Five-T) section. Applying a rather inductive
106 development process, five different subscales emerged for the S-Five-E: internalising
107 appraisals, externalising appraisals, sense of emotional threat, outbursts, and impact. The S-
108 Five-T section measures the individual's emotional response to 37 specific sounds. Extensive
109 examinations demonstrated good psychometric properties.

110 With the rapidly increasing interest in misophonia in the past years, psychometrically
111 sound measurement instruments have become indispensable. Although three instruments with

reports on psychometric properties have been developed, there is no comprehensive diagnostic instrument covering and multidimensionally modelling the latest revised diagnostic criteria by Jager et al. [1]. The MisoQuest [20] has focused on unidimensionally modelling the criteria drafted by Schröder et al. [3]. However, from a theoretical and methodological perspective, the different criteria are unlikely to be unidimensional as they comprise different facets of the construct.

The S-Five [19,21] facilitates the assessment of individuals' appraisals and symptom severity, rendering the instrument a valuable clinical tool. However, the S-Five does not incorporate some important characteristics of misophonia: it only models the perceived threat when individuals cannot avoid specific sounds, thus neglecting escape and anticipatory avoidance behavior which have widely been described for misophonia [1,2,14]. Moreover, the S-Five does not distinguish between the emotional, cognitive, and behavioral aspects of dysregulation and it omits aspects of clinical insight (i.e., recognition of excess or disproportionality).

Consequently, there is a necessity for a comprehensive diagnostic instrument incorporating every symptom and mapping every criterion separately to allow reliable and valid diagnoses in terms of the proposed criteria. On this basis, researchers will be able to scrutinize phenomenological, etiological, and interventional aspects of the condition in a rigorous manner. Furthermore, it will allow for testing hypotheses regarding psychopathological comorbidities and relationships of misophonia with other disorders and with personality traits.

Berlin Misophonia Questionnaire

The Berlin Misophonia Questionnaire (BMQ; [22]) is a multidimensional German self-report instrument to measure misophonic symptoms originally based on the diagnostic criteria by Schröder et al. [3]. It comprises two parts: (a) a condition part measuring the extent

of disturbance attributed to internally or externally produced sound classes (i.e., groups of sounds which share subjective meaning or specific features) and general sound intolerance symptoms (henceforth denoted as ‘GSIS’), and (b) the symptoms part with six scales which correspond to the diagnostic criteria. The deductive construction rationale targeted the development of items for each of the six defined criteria in a reflective latent measurement model. A psychometric analysis revealed good to excellent internal consistencies of the subscales and mostly acceptable measurement models [22]. However, the models require several optimizations, and approaches for further development have been determined in the current literature. Regarding evidence on validity, variance-analytical and correlative results with respect to (mal-)adaptive anger regulation strategies, anger-traits, and anger control as well as sound sensitivity symptoms have been demonstrated in a previous study [22].

Present Study

The present study addresses the outlined research gaps regarding the assessment of misophonia by further developing and optimizing the BMQ. The revised diagnostic criteria by Jager et al. [1] provide the basis for this advancement. The fact that the criteria could not be assessed unidimensionally as well as current findings in the empirical literature suggest a more symptom-oriented modelling approach of misophonic symptoms. For this purpose, specific symptom scales were determined to map the criteria one to one. This also allows to delineate dysregulation domains, different avoidance strategies, dimensions of clinical insight and a comprehensive assessment of separable emotional and physical reactions for the first time. Subsequently, we introduce this symptom-oriented modelling approach in detail and describe the construct validation of the BMQ.

Symptom-oriented modelling approach

Jager et al. [1] describe an aversive emotional and physical reaction to the presence or anticipation of specific sounds. Therefore, two separate models were specified for the reaction to present and anticipated sounds, respectively. Additionally, modification indices of the first version of the BMQ [22] as well as corresponding theoretical considerations suggest a distinction between specific emotional and physical responses for both subscales [1,7,12,13]. More specifically, items representing either anger or physical reactions demonstrated substantial residual correlations. This distinction has also been shown in an *a posteriori* explorative factor analysis of the data. Rather than modelling the criteria unidimensionally, a more symptom-oriented approach is hypothesized to better delineate sub-aspects of the aversive emotional and physical response. Jager et al. [1] list irritation, anger, disgust, and an impulsive physical reaction as different aspects of the misophonic response. Whereas Brout et al. [2] and others also emphasize the importance of anxiety reactions for the presence of sounds, Jager et al. [1] restrict anxiety to the anticipatory response. We thus specify each specific response separately in different measurement models so that subscales for irritation, anger, disgust, anxiety, and physical reactions are differentiated, each subdivided into anticipatory and present. Beside a clearer measurement of the criteria, the benefit of this approach is the option to regard accessory symptoms. For instance, according to Jager et al. [1], it is optional to experience any of the proposed emotional reactions, which is now considered.

Jager et al. [1] only describe a general loss of self-control with potential aggressive outbursts. A recent study, however, has shown that different facets of dysregulation are correlated with overall misophonic symptoms [23]. This may represent an extension of the suggested general loss of control. Also Dozier et al. [24] describe emotional and thought dysregulation as a criterion of misophonia. We therefore propose to distinguish cognitive,

emotional, and behavioral dysregulation in the measurement of misophonia. In this vein, aggressive outbursts are predominantly incorporated in the facet behavioral dysregulation.

To further consider the accessory nature of symptoms defined by Jager et al. [1], formerly jointly measured symptoms are accordingly measured separately. This includes the criteria B. (recognition of excessive, unreasonable or disproportionate reactions to cues) and E. (significant distress or interference in the daily life) (for details see Table 1) being separated into (1) recognition of excess and (2) recognition of disproportionality as well as (3) significant distress and 4) interference in the individual's daily life (functional impairment).

A symptom-oriented optimization was implemented regarding avoidance behavior so that avoidance is separated into (1) reactive avoidance and (2) anticipatory avoidance. Reactive avoidance involves quitting the situation and the reduction or prevention of auditory perception in the moment of confrontation with triggers. In contrast, anticipatory avoidance is defined by safety behavior like preparatory or planned avoidance of potential trigger sounds. Although this distinction is not made in the criteria by Jager et al. [1], there is a common distinction for mental disorders between escape and avoidance in the strict sense, which should be considered when measuring avoidance behavior [25].

The symptom-oriented approach increases the number of subscales, but allows for a much clearer assessment of misophonia considering each symptom, respectively. Moreover, the approach is an improvement to the conventional usage of sum scores or G-factors in clinical measures (e.g., [26]). An outline of the proposed diagnostic model and symptom-oriented scales can be found in Fig 1.

Fig 1. Outline of the symptom-oriented scales and exemplary items.

Construct validity in the assessment of misophonia

Evidence on the construct validity of psychological scales is a principal component of every scale development process [27]. To continue and extend the construct validation of the

BMQ we investigated the nomological network of the constructs and state specific theory-driven or literature-based validation hypotheses on that account. For each misophonic symptom at least one convergent construct was chosen to demonstrate hypothesized intercorrelations.

Aversive reactions to the presence or anticipation of sounds

A central aim of the validation is to show that different aversive misophonic reactions can be psychometrically differentiated. Despite being partially similar [28], anger and irritation are defined as distinct but correlated constructs since current literature suggest a differentiation of anger and irritation [29]. In contrast to anger, Toohey and DiGiuseppe [30] define irritation as a reactive mood characterized by physiological arousal and increased sensitivity to sensory stimuli, especially typically less disturbing stimuli. It is further suggested to define irritation as the vulnerability for negative emotions, predominantly anger, frustration, and annoyance [29]. We thus hypothesize misophonic anger reactions to display a strong positive correlation with misophonic irritation reactions. Moreover, a strong positive correlation of misophonic irritation with misophonic physical reactions is expected. However, in the sense of a nomological network, we assume convergent irritation measures to display a larger positive correlation with misophonic irritation than with misophonic anger. Convergent anger measures, in turn, are assumed to correlate more strongly in the positive direction with misophonic anger than with misophonic irritation. Further, we hypothesize moderate to strong positive correlations between misophonic anger, anger dispositions, aggressive outbursts, external appraisals, verbal, and physical aggression as well as hostility. Hostility has also been demonstrated to strongly correlate with irritation [29], so we likewise assume this relationship for misophonic irritation reactions.

Regarding misophonic disgust, we expect strong positive correlations with the respective convergent measure of disgust. For misophonic anxiety we expect strong positive correlations with both somatic and cognitive anxiety symptoms.

Since the physical misophonic reaction is not specific to any emotional response but largely caused by it, strong positive correlations with each emotional misophonic response are hypothesized. Additionally, somatic anxiety symptoms are assumed to show a strong positive correlation with physical misophonic responses.

Clinical insight

Recognition of excess and disproportionality is referred to the detection and labelling of mental states and behavior as pathological [31], here pertaining to misophonia. This conceptual classification of insight is defined to be a meta-cognitive process [32] and an aspect of self-knowledge involving information about defense mechanisms and coping strategies [33]. Therefore, we hypothesize recognition of excess and disproportionality to be positively correlated with illness coherence. Illness coherence is defined as the extent to which an individual comprehends their illness and is a central aspect of the cognitive representation of an illness [34]. Individuals who tend to recognize excessive or disproportional behavior are hence assumed to better comprehend their misophonia symptoms. Further, individual's internal and external appraisals of misophonic symptoms (i.e., reflecting symptom attribution) are assumed to display a strong positive correlation with the recognition of excess and disproportionality, whereas external appraisals are expected to be less correlated since misophonia is considered ego dystonic [35].

Exploring the nomological network, it is likely that any form of misophonic distress or functional impairment and any form of dysregulation or avoidance behavior is positively correlated with the recognition of excess and disproportionality since this information is involved in the cognitive process leading to the respective recognition.

Dysregulation

General misophonic dysregulation and its specific subfacets (behavioral, cognitive, and emotional dysregulation) are assumed to positively correlate with convergent general dysregulation and difficulties in impulse control, difficulties in goal-directed behavior, and

limited access to emotion regulation strategies. Since limited access to emotion regulation strategies, in terms of content, reflects emotional dysregulation, it is hypothesized to correlate more strongly with misophonic emotional dysregulation than with other subfacets. Further, difficulties in impulse control are assumed to correlate more strongly with behavioral misophonic dysregulation and misophonic outbursts, whereas difficulties in goal-directed behavior are assumed to correlate more strongly with cognitive misophonic dysregulation.

Avoidance behavior

We hypothesize reactive and anticipatory misophonic avoidance behavior to be strongly correlated with a convergent measure of avoidance of sounds in daily life. Further, behavioral experiential avoidance is assumed to have a strong positive correlation with reactive and anticipatory avoidance behavior. Additionally, we assume that the more individuals experience intense aversive emotional and physical responses to the presence of sounds, the more they show misophonic avoidance behavior since this is a central coping mechanism [1,14]. This is especially assumed for reactive avoidance in contrast to anticipatory avoidance which is hypothesized to be reflected through lower correlations of aversive emotional and physical reactions with anticipatory avoidance behavior.

Clinical significance

Misophonic distress is assumed to strongly correlate with aversive emotional and physical misophonic responses as well as with convergent misophonic impact and overall symptom burdening. Misophonic functional impairment is hypothesized to strongly correlate with different dimensions of functional impairment defined by the World Health Organization [36] (cognition, interaction with others, life activities, household, and participation in social life) and overall symptom burden.

Aims of the study

Our aims are to introduce a methodologically robust and revised version of the BMQ which incorporates contemporary empirical findings and new approaches to modelling criteria of misophonia. A more symptom-oriented approach was chosen to better delineate sub-aspects of the criteria and hence realize a clearer measurement of symptoms. Further, the aim is to continue and extend the previous psychometric study of the BMQ scales. We thus investigated the factor structure, internal consistency, and construct validity of the revised BMQ scales in an extensive validation study. We finally aim to provide a better comprehension of the multidimensional nature of self-reported misophonic symptoms in form of a nomological network and to give insight into the validity of the diagnostic criteria.

Materials and methods

Study Overview

The study is structured in two parts. First, we translated and pretested some of the validation instruments since neither German versions nor equivalent alternatives were available. At the same time, we developed and pretested revised sound classes for the measurement of sound disturbance. Secondly, the BMQ-R was jointly administered with the translated and additional validation instruments in the main study which we describe in the following. Further information on the pretest is available in S1 text.

Data protection guidelines were met, and participants gave informed consent before completing the survey. The study was approved by the Ethics Committee at the Department of Education and Psychology of the Freie Universität Berlin, Germany (document number: 029/2020).

Development of the item pool

For the symptoms part, we tested 120 items in total. These items are partly taken from the first version of the BMQ, which consists of 42 items [22]. An additional set of 21 items from the former item pool were selected to ensure an adequate length of the symptom-oriented scales. Moreover, 57 new items were constructed since the original item pool did not include enough items for each scale.

The original items of the GSIS scale were rephrased to slightly increase item difficulty as indicated in former analyses [22]. Also, the items from the symptoms part were rephrased to generically refer to sounds in plural instead of a specific sound. The original instructions and items referred to the most disturbing sound which we extended since the experienced symptoms can vary by sound and are therefore better captured in plural.

The first version of the BMQ contained two additional scales measuring the extent to which individuals feel burdened by and sensitive to different sound classes when being *externally* or *internally* produced (e.g., “people eating” or “nasal sounds”). Qualitative results from the first study on the BMQ [22] suggest a revision of the sound classes so that an overlap of the different classes is prevented. Therefore, new sound classes were qualitatively derived from the indication of different specific sounds by each individual in the study. The new sound classes were included in the pretest of this study (see S1 text). The former two scales are no longer considered scales but content areas incorporating items separately measuring the disturbance of different (revised) sound classes. This is because it is not plausible to assume a latent variable underlying the disturbance of sound classes and we support the consideration of individual scores for different sound classes.

Measures

Berlin Misophonia Questionnaire Revised (BMQ-R)

Like the BMQ [22], the BMQ-R is divided into two parts. The condition part consists of 21 items measuring the disturbance of internally or externally produced sound classes and four items measuring GSIS which are rated on a 6-point rating scale (0 = *does not apply at all* to 5 = *completely applies*). The symptom part comprises 20 symptom-oriented scales which can be assigned to their corresponding diagnostic criteria by Jager et al. [1]. In total, the symptom part comprises 120 items which are rated on a 6-point rating scale (0 = *does not apply at all* to 5 = *completely applies*), whereas items on the disturbance of sound classes are rated on a different 6-point rating scale (0 = *not disturbing at all* to 5 = *maximally disturbing*).

Selective Sound Sensitivity Syndrome Scale (S-Five; [19]): Experiences

Section (S-Five-E)

The S-Five is a self-report instrument measuring misophonic symptoms which comprises two sections: the experiences (S-Five-E) and the feelings (S-Five-F) section. For pragmatic reasons, we only included the S-Five-E section which consists of 25 items in five subscales: internalising appraisals, externalising appraisals, sense of emotional threat, outbursts, and impact. The items are rated on an 11-point rating scale (0 = *not at all true* to 10 = *completely true*). Since there is only an English version of this instrument, the S-Five-E was translated to German using the TRAPD procedure [37]. For more information on this procedure, see the description and results of the pretest. Good internal consistency estimates have been reported for the subscales ($\alpha = .83 - .88$) and the measure demonstrates diverse evidence on construct validity, for example a strong correlation with a convergent measure of misophonia ($r = .64$) [21].

MisoQuest [20]

Based on the diagnostic criteria by Schröder et al. [3], the MisoQuest is a screening instrument of misophonia encompassing 14 unidimensional items. Agreement to each item is rated on a 5-point rating scale (1 = *strongly disagree* to 5 = *strongly agree*). Since there is

only a Polish version of this instrument, the scale was translated to German using the TRAPD procedure [37]. The estimated internal consistency of the scale is excellent ($\alpha = .96$) [20]. Further, differential validity is substantiated by large mean differences on the MisoQuest between individuals with and without a Misophonia diagnosis ($d = 2.13$) [20].

Aggression Questionnaire (AQ; [38])

The German version of the original Aggression Questionnaire was used [39]. Four dimensions of aggression are operationalized: 1) physical and 2) verbal aggression, 3) anger and 4) hostility. The scale comprises 29 items which are rated on a 4-point rating scale (1 = *does not apply* to 4 = *fully applies*). Internal consistency estimates for the scales range from $.62 \leq \alpha \leq .82$ [39]. Regarding evidence on construct validity, the scales demonstrate high correlations with a convergent measure of anger expression ($r = .56 - .73$) [39].

Disgust Propensity and Sensitivity Scale Revised (DPSS-R; [40]): Disgust Propensity scale

The DPSS-R reduced-item version [40] is a two-dimensional measure of disgust encompassing the dimensions disgust propensity (henceforth denoted as ‘DP’) and disgust sensitivity. It consists of 12 items regarding the frequency of physical and emotional symptoms of disgust which are rated on a 5-point rating scale (1 = *never* to 5 = *always*). For this study, only the DP items are used (six items). DP reflects how easily an individual is disgusted whereas disgust sensitivity refers to the emotional impact of disgust rendering this dimension dispensable for our purposes. Since there is only an English version of this instrument, the scale was translated to German using the TRAPD procedure [37]. The internal consistency of the DP scale is good ($\alpha = .83$) [40]. Correlative results demonstrate evidence for concurrent validity regarding disgust-relevant symptoms of phobias ($r = .32 - .39$) [40].

State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA; [41])

The STICSA is a measure of cognitive and somatic state trait anxiety. Only the trait scales were used which consist of 21 items rated on a 4-point rating scale (1 = *not at all* to 4 = *very much so*). The inventory differentiates two factors. The first factor reflects cognitive symptoms (10 items), whereas the second factor reflects somatic symptoms of anxiety (11 items). Both factors demonstrated good internal consistency ($\alpha = .88$) [41]. Since there is only an English version of this test, the scale was translated to German using the TRAPD procedure [37]. There is supporting evidence for the validity of the inventory, for example high correlations with a similar state anxiety measure ($r = .53 - .63$) [41].

Brief Irritability Test (BITe; [29])

The BITe is a 5-item unidimensional measure of irritability minimalizing the innate overlap with related constructs (e.g., anger or depression). Items are rated on a 6-point rating scale (1 = *never* to 6 = *always*). For this study, the German version was used [42]. The BITe demonstrates good internal consistency ($\alpha = .88$) and evidence on convergent validity (e.g., high correlations with self-report scales of irritability) yet being lower but still highly correlated with anger [29].

Difficulties in Emotion Regulation Scale (DERS; [43])

The DERS is a multidimensional operationalization of emotion regulation comprising six subscales of which three were used in the present study: 1) impulse control difficulties, 2) difficulties engaging in goal-oriented behavior, and 3) limited access to emotion regulation. These subscales consist of 19 items in total, of which 15 were chosen regarding their content validity to match the purpose intended. The items are rated on a 5-point rating scale regarding the experienced frequency (1 = *almost never* (0-10%) to 5 = *almost always* (91-100%)). We used the German version by Gutzweiler and In-Albon [44] which demonstrated good internal consistency estimates for the used scales ($\alpha = .88 - .91$). Further, evidence for construct validity was shown through medium to high correlations with internalising or externalising problem behavior in their respective direction ($r = .29 - .64$) [44].

Noise Avoidance Questionnaire (NAQ; [45])

The NAQ is a German self-report instrument measuring the avoidance of sounds in daily life. It comprises 25 items of which 10 items state specific situations that might be avoided (e.g., restaurants or concerts). The remaining 15 items refer to specific behaviors related to sound avoidance. Therefore, only the more behavior-oriented items were chosen which are rated on a 5-point rating scale (0 = *never* to 6 = *very often/always*). The authors could not provide the German items of the questionnaire so that the English items were naïvely translated. Since the statements are short and concise, no compromising translational effects are assumed. The scale demonstrated good psychometric properties. Internal consistency is excellent ($\alpha = .96$) and convergent validity evidence has been demonstrated through high correlations with a measure of sound intolerance ($r = .61$) [45].

Brief Experiential Avoidance Questionnaire (BEAQ; [46])

The BEAQ is a 15-item unidimensional measure of experiential avoidance behavior and a reduced-item version of the Multidimensional Experiential Avoidance Questionnaire (MEAQ; [47]). For this study, only items from the former Behavioral Avoidance subscale of the German version [48] were chosen which reflect situational avoidance of physical discomfort and distress. This has two reasons: First, the German unidimensional version did not demonstrate sufficient fit to the data [48] yet the Behavioral Avoidance subscale of the MEAQ appears to be stable and a core dimension [47], and second, only this content area is of importance for the present study. Items are rated on a 6-point rating scale (1 = *strongly disagree* to 6 = *strongly agree*). The internal consistency of the BEAQ is good ($\alpha = .87$) and it demonstrated high correlations with convergent measures of avoidance [48].

World Health Organization Disability Assessment Schedule 2.0 [36]

The WHODAS 2.0 is a generic clinical instrument based on the International Classification of Functioning, Disability and Health (ICF; [49]) which measures the impact of

a given health condition in terms of functioning in six domains of life: Cognition, mobility, self-care, getting along, life activities, and participation. Since mobility and self-care appear to be irrelevant for misophonia, these domains were not applied. The German self-report 36-item version (27 items after discarding the two domains) was used. The degree of difficulty individuals have performing the indicated activities is rated on a 5-point rating scale (1 = *none* to 6 = *extreme or cannot do*). Internal consistency for mental health applications is excellent for the domains ($\alpha = .92 - .94$) [36]. Evidence for convergent validity has been demonstrated by high correlations with construct-related measures [36].

Illness Perception Questionnaire Mental Health (IPQ-MH; [50]): Illness

Coherence scale

The IPQ-MH is an adapted version of the Illness Perception Questionnaire Revised (IPQ-R; [34]) measuring dimensions of the individual's perception of their mental health problem. The Illness Coherence scale used in the study comprises six items measuring the extent of an individual's comprehension regarding their mental health problem. Items are rated on a 5-point rating scale (1 = *strongly disagree* to 5 = *strongly agree*). The German version of the IPQ-R [51] was used and adapted in line with Wittman et al. [50] by replacing the term '*illness*' with '*problem*' in each item. Good internal consistency is reported ($\alpha = .83$) [50]. Further, illness coherence is positively correlated with stigma indifference in patients with obsessive-compulsive disorder ($\tau = .24$) [52].

Procedure

The cross-sectional study comprised two tracks to which participants are assigned according to a specified cutoff of the GSIS scale from the BMQ-R. Participants with a sum score greater than 12 completed the track for potentially affected individuals. The cut-off was pragmatically chosen considering that a sum score of 12 means average agreement on the four

items. In this track, participants were instructed to think about the most disturbing or burdensome noises when filling in the complete survey. On the other hand, we assume that individuals who mainly disagree with general sound intolerance items (GSIS sum score < 13) are likely to not have a cognitive representation of disturbing or burdening sounds or are incapable of designating such sounds. Thus, we instructed those participants to think about the most frequently mentioned sounds of people affected by misophonia which were taken from a previous study [22]. More specifically, eating noisily, swallowing, and sniffing were chosen as instructed sounds. The instructions also restricted participants to only consider auditive information of the sounds since it has not sufficiently been substantiated which impact other sensory information have on misophonia symptoms. Items were presented randomly in their respective content area. The instructions for the validation instruments have been contextualized to minimize within-person inconsistency and between-person variability when responding to items [53] if necessary. We therefore set a frame of reference which guarantees that participants consistently considered the presence or impact of the chosen or given sounds so that generic validation instruments match the misophonic contextualization. This step has important implications: minimizing within-person inconsistency and between-person variability leads to higher reliability and validity when responding to generic items [53].

Inclusion Criteria and Item Omissions

We included affected as well as non-affected individuals aged 16 or older. To ensure data quality, we only included individuals who correctly answered at least 80% of instructed items, which are supposed to assess participants' attention [54]. Further, we checked for consecutive response patterns (response pattern index; [55]), excluding participants with more than 30% consecutive answers.

Item omissions are assumed to be missing at random (MAR). Hence, we address this issue by using full information maximum likelihood estimation in specified measurement

models whenever applicable. However, for pragmatic reasons, we decided to discard participants with more than 50% missing responses for each scale, respectively. Thus, model specification consistently incorporates the maximal number of participants available according to the exclusion criteria (i.e., the number of participants used varies by scale as indicated).

Model specification, model fit evaluation, and reliability estimation

First, the subscales of the BMQ-R were jointly modelled according to the respective content area (in line with the diagnostic criteria). Hence, correlated first-order factor models were specified for the respective symptom-oriented scales. Specified models were optimized with respect to the total number of items and model fit with different item selection algorithms (see item selection procedure). Subsequently, a complete model with every symptom-oriented scale was specified to evaluate model fit and check for cross-loadings, thus ensuring a clear measurement of the scales.

Secondly, validation instruments were modelled according to the results of the pretest or original factor structure. For unidimensional scales, item selection procedures were applied to achieve acceptable model fit. By doing so, we carefully considered minimalizing the loss of content through item reduction. All deviations from the original scales are thoroughly described in the results.

To take non-normality into account and categorical indicators, the weighted least square mean and variance adjusted (WLSMV) estimator with ordered categories is used. It has been shown that robust categorical least squares estimation performs better than maximum likelihood estimators in these cases [56]. For the S-Five-E with continuous indicators we used maximum likelihood estimation with robust (Huber-White) standard errors

[57, 58] and a scaled test statistic to address nonnormality of the data. The R package “lavaan” (version 0.6-9; [59]) was used for all model specifications.

Model fit was evaluated using the χ^2 -test and common standards of fit index cutoffs (RMSEA close to .06, SRMR close to .08, Mc (McDonald’s Centrality) close to .90 [60]) as well as a CFI (Comparative Fit Index) close to .97 and a TLI (Tucker-Lewis Index) close to .97 [61]. For models with ordinal indicators the scaled model fit statistics were used. Moreover, ECVI (Expected Cross Validation Index) was chosen to compare non-nested models.

Reliability of the scales was estimated in terms of internal consistency with model-based McDonald’s ω [62]. Further, 95% confidence intervals were calculated via using bias-corrected and accelerated bootstrap with a bootstrapping sample size of $B = 1000$.

Item Selection Procedure

Items were selected using a probabilistic item selection algorithm (Ant Colony Optimization (ACO) algorithm; [63]). This algorithm is based on the food foraging behavior of ants harnessing virtual “pheromones” to guide the selection towards solutions with good psychometric properties. An adaption of the *MAX-MIN* Ant System by Stützle and Hosos [64] was used as implemented in the R package “stuart” (version 0.9.1-9000, [65]). Moreover, a hold-out-validation ACO algorithm [66] with a modified model fit criteria function is applied. Data is accordingly split in half into a calibration and a validation sample. With respect to the model fit criteria function, we used a combination of the RMSEA, SRMR, and CFI unless otherwise specified. The benefit of this ACO-approach is that the developed models are robust and economic. When possible, a brute force algorithm was used which allows to evaluate every possible item combination to obtain the best combinatorial solution.

Participants

We based our sample sizes on Monte Carlo simulations performed in previous studies [67]. Yuan and Bentler [67] suggested a sample size greater than 400 participants for continuous nonnormal data with missing responses and MLR estimation. A similar reference point was suggested by Forero et al. [68] for ordinal data and WLSMV estimation ($N \geq 200 - 500$). Therefore, we decided to collect data of at least 500 individuals assuming a dropout rate of 20%. Participants were recruited in Germany via online posts on social media (Facebook and Instagram) and university mailing lists. Specific groups of individuals identifying as having misophonia as well as unspecific groups were chosen. Psychology students received course credit as an incentive. The total sample comprises individuals who completed the first GSIS scale of the BMQ-R $N = 952$ after excluding participants according to the defined criteria. $N = 621$ (65.2%) individuals completed the symptom part of the BMQ-R and $N = 601$ the complete survey (63.1%).

Since the BMQ-R is the central questionnaire under investigation, we report participants' characteristics for the complete BMQ-R symptom scales. Most participants (86.7%) were female, and seven individuals indicated non-binary gender. The mean age was $M = 33.85$ years ($SD = 11.19$, range 16 to 69) with no evidence for differences between gender ($t(943) = 0.58, p = .57$). 29.9% of participants were students. Further, 32.7% of participants had a university degree and 45.5% had at least a high school equivalent qualification. A majority had a partner or was married (66.6%), whereas 27.0% did not have a partner or were living separated. 30.1% of participants were employed either part-time or marginally, 38.7% were employed full-time, and 12.0% unemployed.

Results

Factorial Validity

General Sound Intolerance and Sound Classes

Only 6.7% of participants had/showed a GSIS sum score lower than 13 (chosen score for non-affected individuals), whereas more than half of the sample indicated the highest score of 20 (49.8%). The mean GSIS sum score was $M = 18.05$ ($SD = 3.13$) with males indicating lower scores ($t(131.64) = -2.99, p < .01$). These results suggest that the sample mainly comprises potentially affected individuals. The three most disturbing sound classes were “people eating” ($M = 3.89, SD = 1.60$), “nasal sounds” ($M = 3.34, SD = 1.64$), and “drinking people” ($M = 3.20, SD = 1.84$), whereas “animal sounds” were considered the least disturbing sound class ($M = 0.98, SD = 1.46$).

The GSIS scale showed good fit to the data ($\chi^2_s(2) = 17.91, p < .01, CFI_s = 1.00$, $TLI_s = .99$, $RMSEA_s = .07$ [.04 - .11], $SRMR = .02$, $Mc = 1.00$). The internal consistency was estimated at $\omega = .84$.

Aversive Reactions to the Presence of Sounds

The hold-out-validation ACO algorithm yielded 19 items (out of 28) in five subscales. The selected model showed good fit to the data and was invariant between calibration and validation sample ($\Delta\chi^2(95) = 99.06, p = .37$). Results of the factor analyses for the symptom part are given in Table 2. The subscales demonstrated good to excellent internal consistencies at $.85 \leq \omega \leq .91$, except for irritation reaction ($\omega = .69$). Reliability estimates for the scales of the BMQ-R are given in Table 3.

584 **Table 2. Results of Confirmatory Factor Analyses for the Symptom Part of the BMQ-R**

Model	Goodness of fit statistics								
	χ^2_s	df	$\frac{\chi^2_s}{df}$	CFI _s	TLI _s	RMSEA _s (90%-CI)	SRMR	Mc	ECVI
Aversive Reactions to the Presence of Sounds – Five-factor correlated model	637.20***	142	4.49	.98	0.97	.07 (.06 - .07)	.05	0.85	0.83
Aversive Reactions to the Anticipation of Sounds – Five-factor correlated model	68.54***	25	2.74	1.00	1.00	.05 (.04 - .07)	.02	1.00	0.26
Correlated Trait-Correlated-Method Minus One Model	946.93***	357	2.65	.98	0.98	.05 (.05 - .06)	.05	0.75	1.84
Clinical Insight – Two-factor correlated model	68.84***	19	3.62	1.00	1.00	.06 (.05 - .08)	.02	1.00	0.18
Dysregulation – Four-factor correlated model	384.29***	98	3.92	.99	0.98	.06 (.06 - .07)	.03	0.93	0.57
Dysregulation – Bifactor S-1 model	298.65***	89	3.36	.99	0.99	.06 (.05 - .07)	.03	0.97	0.51
Avoidance Behavior- Two-factor correlated model	54.66***	19	2.88	1.00	1.00	.05 (.04 - .07)	.03	1.00	0.18
Clinical Impact – Two-factor correlated model	91.18**	53	1.72	1.00	1.00	.03 (.02 - .05)	.02	1.01	0.31
Joint Model – Fifteen-factor correlated model ^a	3296.23***	1785	1.85	.98	0.98	.04 (.04 - .04)	.04	0.59	5.84

$N = 611-789$. χ^2_s = scaled χ^2 -value; CFI_s = scaled Comparative Fit Index; TLI_s = scaled Tucker-Lewis Index; RMSEA_s = scaled Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; ECVI = Expected Cross Validation Index; Mc = McDonald's Centrality Index. ^a $N = 575$.

** $p < .01$. *** $p < .001$

586 **Table 3. Reliability Estimates for the BMQ-R Scales**

Model/Scale	ω (95%-CI)	Model/Scale	ω (95%-CI)
General Sound Intolerance Symptoms (GSIS) ^a	.84 (.81 - .87)	Recognition of Disproportionality	.90 (.88 - .92)
Aversive Reactions to the Presence of Sounds		Dysregulation	
Anger Reactions	.90 (.89 - .92)	General Dyregulation	.91 (.89 - .92)
Irritation Reactions	.69 (.63 - .73)	Behavioral Dysregulation	.86 (.83 - .88)
Disgust Reactions	.91 (.90 - .92)	Cognitive Dysregulation	.87 (.83 - .90)
Anxiety Reactions	.85 (.82 - .86)	Emotional Dysregulation	.87 (.85 - .88)
Physical Reactions	.88 (.86 - .90)	Avoidance Behavior	
Aversive Reactions to the Anticipation of Sounds		Reactive Avoidance	.72 (.67 - .75)
Anger Reactions	.93 (.91 - .94)	Anticipatory Avoidance	.93 (.92 - .94)
Irritation Reactions	.87 (.84 - .89)	Clinical Significance	
Disgust Reactions	.87 (.84 - .89)	Distress	.94 (.93 - .95)
Anxiety Reactions	.90 (.87 - .92)	Functional Impairment	.95 (.93 - .96)
Physical Reactions	.84 (.80 - .87)		
Clinical Insight			
Recognition of Excess	.91 (.90 - .92)		

$N = 611-789$. ω = McDonald's Omega [62]. 95%-confidence intervals were calculated via bias-corrected and accelerated bootstrapping with a bootstrapping sample size $B = 1000$.

Aversive Reactions to the Anticipation of Sounds

Since the anticipation of sounds elicits less aversive reactions than the presence of sounds [22] and therefore tends to be rather subordinate in the assessment of misophonic reactions, we decided to develop an ultra-short model comprising 10 items in five subscales through a hold-out validation brute force algorithm. The model demonstrated excellent fit and was strongly invariant between calibration and validation sample, but some intercorrelations were too high which indicates difficulties in discerning the constructs. A second ACO algorithm with an adapted criterion function minimizing the relevant intercorrelations was applied. The selected model showed good fit to the data and was still strongly invariant across the hold-out validation samples ($\Delta\chi^2(50) = 45.05, p = .67$). Internal consistency estimates were good to excellent for all subscales at $.84 \leq \omega \leq .93$.

Beyond modelling reactions to the anticipation of sounds in a first-order factor model, these reactions can also be considered as method effects. Reactions to the anticipation and presence of sounds are understood as different individual perspectives on each emotional or physical misophonic reaction. A correlated trait-correlated method minus one [CTC(M-1)] model is an approach to consider the different methodological perspectives [69, 70]. The five different emotional and physical reactions are thus modelled as traits and the respective presence of sounds as trait-specific reference methods. Anticipation of sounds is modelled as one general residual method factor being uncorrelated with the defined trait reactions. The specified CTC(M-1) model showed good fit to the data.

Clinical Insight

A hold-out validation brute force algorithm was applied to select four items in two subscales, respectively (8 of 12 in total). The solution demonstrated excellent fit to the data but was only weakly invariant across the hold-out validation samples ($\Delta\chi^2(6) = 3.22, p = .78$). Internal consistency estimates for the two scales were $\omega = .90$ and $\omega = .91$.

Dysregulation

Four items per subfacet and four items for the general dysregulation facet (16 of 27 items in total) were selected using the ACO algorithm. The selected items were then modelled in a correlated first-order factor model which demonstrated good fit being strongly invariant across hold-out validation samples ($\Delta\chi^2(80) = 79.98, p = .48$). Internal consistency estimates ranged from $\omega = .86$ to $.91$.

Dysregulation is defined as a construct with specific domains [71, 43] and thus assumed to be best modelled in a G-factor model. However, as Eid et al. [72] point out, symmetrical bifactor (or G-factor) models are only reasonable when domains are at least interchangeable. As this is not true for dysregulation domains, we decided to apply a bifactor S-1 model with a directly measured G factor, instead [72]. The model showed good fit to the data. When controlling for general dysregulation, the correlation of the domains (specific factors) were as follows: behavioral and cognitive dysregulation ($r = .30$ [.21 - .39]), behavioral and emotional dysregulation ($r = .53$ [.46 - .60]), cognitive and emotional dysregulation ($r = .62$ [.56 - .69]).

Avoidance Behavior

For avoidance behavior, we decided to select four items in two subscales, respectively (8 of 14 items in total). A hold-out validation brute force algorithm was run which yielded a robust solution being strongly invariant across calibration and validation sample ($\Delta\chi^2(40) = 42.23, p = .37$). The measurement model demonstrated excellent fit to the data. Internal consistencies estimates for the two scales were $\omega = .72$ and $\omega = .93$.

Clinical Significance

Twelve items (out of 19) were selected through a hold-out validation ACO algorithm with a function additionally minimizing the latent correlation. The model demonstrated good fit to the data and was strongly invariant across the calibration and validation sample ($\Delta\chi^2(60)$

= 74.22 , $p = .10$). The correlation of the subscales was still very high ($r = .91$), however, the selected model was the best possible solution. Internal consistency estimates for the two scales were $\omega = .94$ and $\omega = .95$.

Joint Model

We analysed a joint model incorporating fifteen of the twenty symptom-oriented scales. Reactions to the anticipation of sounds were excluded since they are subordinate in the measurement of misophonia and are understood as another individual perspective on misophonic reactions to sounds (see the CTC(M-1) model). The joint model demonstrated good fit to the data. The good fit of the joint model is an evidence for the robustness and clarity of the symptom-oriented scales. An overview of the descriptive and psychometric properties of the final selected items for the BMQ-R are given in the table in S1 Table. We additionally analyzed the dimensionality of highly correlated subscales ($r > .80$) by comparing a one-factor model with a two-factor correlated model via likelihood-ratio tests , respectively. These results can be found in the table in S2 Table.

Construct Validity

To evaluate construct validity beyond the factor structure, we calculated latent intercorrelations between the symptom-oriented scales, and the GSIS scale, which are given in Table 4, as well as specific hypothesis-driven correlation matrices within their specific content area. Effect sizes were interpreted in line with Cohen [73]. Before reporting the results of the specific validation hypotheses, the GSIS scale from the BMQ-R condition part is scrutinized. Correlations between GSIS and the symptom-oriented scales were between $r = .41$ and $r = .85$, except for present irritation ($r = .93$). Further, the GSIS scale correlated to $r = .86$ with the MisoQuest screening scale.

662 **Table 4. Latent Intercorrelations and Reliability Estimates for the BMQ-R Symptom Part and General Sound Intolerance Symptoms**

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. Anger Pres.	(.90)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Irritation Pres.	.88	(.69)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Disgust Pres.	.55	.65	(.91)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Anxiety Pres.	.60	.73	.49	(.85)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Physical Pres.	.80	.86	.55	.83	(.88)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Anger Ant.	.75	.62	.46	.48	.59	(.93)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7. Irritation Ant.	.52	.56	.41	.48	.53	.83	(.87)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8. Disgust Ant.	.40	.47	.89	.44	.48	.58	.59	(.87)	-	-	-	-	-	-	-	-	-	-	-	-	-
9. Anxiety Ant.	.59	.69	.39	.87	.73	.57	.62	.46	(.90)	-	-	-	-	-	-	-	-	-	-	-	-
10. Physical Ant.	.67	.69	.50	.71	.85	.84	.86	.67	.80	(.84)	-	-	-	-	-	-	-	-	-	-	-
11. Disprop.	.67	.63	.39	.39	.59	.47	.36	.31	.44	.47	(.90)	-	-	-	-	-	-	-	-	-	-
12. Excess	.83	.83	.49	.64	.77	.63	.54	.43	.70	.68	.83	(.91)	-	-	-	-	-	-	-	-	-
13. Gen. Dys.	.70	.69	.38	.46	.57	.54	.41	.32	.51	.55	.57	.70	(.91)	-	-	-	-	-	-	-	-
14. Behav. Dys.	.80	.70	.48	.51	.66	.64	.47	.40	.51	.58	.66	.75	.68	(.86)	-	-	-	-	-	-	-
15. Cogn. Dys.	.78	.84	.52	.56	.68	.59	.52	.44	.59	.62	.62	.79	.71	.63	(.87)	-	-	-	-	-	-
16. Emot. Dys	.83	.88	.52	.73	.83	.64	.58	.45	.74	.73	.67	.94	.70	.76	.81	(.87)	-	-	-	-	-
17. React. Avoid.	.71	.79	.57	.65	.76	.55	.52	.53	.67	.69	.56	.72	.62	.63	.75	.79	(.72)	-	-	-	-
18. Ant. Avoid.	.58	.60	.39	.59	.61	.46	.44	.37	.68	.61	.41	.57	.49	.50	.62	.67	.83	(.93)	-	-	-
19. Distress	.81	.85	.49	.74	.81	.70	.61	.44	.78	.78	.64	.86	.66	.69	.81	.90	.76	.69	(.94)	-	-
20. Funct. Imp.	.72	.79	.46	.73	.73	.62	.55	.46	.78	.71	.57	.78	.61	.69	.69	.81	.74	.71	.91	(.95)	-
21. GSIS	.85	.93	.53	.56	.73	.65	.53	.41	.56	.64	.65	.77	.68	.74	.79	.83	.78	.63	.84	.75	(.84)

$N = 611-789$ for grey shaded cells, which represent intercorrelations within symptom areas, and reliability estimates. All intercorrelations across symptom areas were estimated based on $N = 588-616$. Pres. = Presence; Ant. = Anticipation; Disprop. = Disproportionality; Gen. Dys. = General Dysregulation; Behav. Dys. = Behavioral Dysregulation; Cogn. Dys. = Cognitive Dysregulation; Emot. Dys. = Emotional Dysregulation; React. Avoid. = Reactive Avoidance; Ant. Avoid. = Anticipatory Avoidance; Funct. Imp. = Functional Impairment; GSIS = General Sound Intolerance Symptoms. Dysregulation is herein specified in a correlated first-order CFA instead of a bifactor S-1 model. McDonald's ω [62] based on the respective confirmatory factor analyses are in parentheses on the diagonal. Correlations $> .80$ are in bold. All correlations were significant at $p < .001$.

Aversive reactions to the presence or anticipation of sounds

As hypothesized, present anger and irritation reactions displayed a strong positive correlation ($r = .88$) as well as present irritation with physical reactions ($r = .86$). Moreover, present physical reactions displayed strong positive correlations with each misophonic emotional reaction to the presence of sounds ($r = .55 - .86$). A similar pattern could be observed for anticipatory reactions: irritation correlated to $r = .83$ with anger and to $r = .86$ with physical reactions. For anticipatory physical reactions, high correlations with each misophonic emotional reaction to the anticipation of sounds were observed ($r = .67 - .86$). Regarding intercorrelations between present and anticipatory misophonic reactions, the same emotional reactions correlated higher than different emotional reactions, except for physical reactions. Anticipatory physical reactions were equally correlated with present physical reaction compared to anticipatory anger and irritation reactions.

To further scrutinize the construct validity of emotional and physical misophonic reactions, convergent measures were correlated, respectively. For anger reactions, convergent anger, verbal aggression, physical aggression, and hostility were assessed with the AQ. The first-order factor model had to be optimized through a hold-out validation ACO algorithm. Therefore, 21 out of the 27 items were selected to achieve acceptable fit to the data. Reliability estimates were still similar to the original scale. Further, two scales from the S-Five-E were used (externalising appraisals and outbursts). The complete S-Five-E model showed acceptable model fit compared to the pretest. With respect to irritation, the BITE was used as a convergent measure which demonstrated excellent model fit. Latent intercorrelations for anger and irritation reactions with convergent measures are given in Table 5. Present and anticipatory misophonic anger correlated to $r = .74$ respectively $r = .64$ with misophonic outbursts whereas present and anticipatory irritation correlated to $r = .59$ respectively $r = .50$ with misophonic outbursts. Externalising appraisals correlated marginally lower with irritation and anger reactions ($r = .45 - .60$). Regarding convergent anger,

691 correlations with present and anticipatory anger were $r = .53-.58$ and with irritation $r = .43 -$
692 $.50$. In contrast, present and anticipatory irritation correlated with convergent irritation to $r =$
693 $.57$ respectively $r = .49$, whereas present and anticipatory anger correlated to $r = .62$
694 respectively $r = .49$. Furthermore, verbal aggression, physical aggression, and hostility
695 correlated moderately with present and anticipatory anger ($r = .27 - .41$). For anticipated
696 misophonic irritation a similar pattern could be observed ($r = .20 - .43$). On average, present
697 anger was only marginally higher correlated with convergent anger and aggression measures
698 than present irritation ($\bar{r} = .48$ vs. $\bar{r} = .44$) and anticipated anger correlated higher than
699 anticipated irritation ($\bar{r} = .46$ vs. $\bar{r} = .38$).

700

701 **Table 5. Latent Intercorrelations for Misophonic Anger and Irritation Reactions with Convergent Measures**

Measure	1	2	3	4	5	6	7	8	9	10	11
1. BMQ-R: Anger Presence	(.90)	-		-	-	-	-	-	-	-	-
2. BMQ-R: Anger Anticipation	.75	(.93)		-	-	-	-	-	-	-	-
3. S-Five-E: External Appraisals	.58	.55	(.92)								
4. S-Five-E: Outbursts	.74	.64	.54	(.87)	-	-	-	-	-	-	-
5. AQ: Anger	.58	.53	.46	.67	(.82)	-	-	-	-	-	-
6. AQ: Verbal Aggression	.36	.35	.39	.46	.78	(.63)	-	-	-	-	-
7. AQ: Physical Aggression	.28	.27	.30	.60	.54	.58	(.78)	-	-	-	-
8. AQ: Hostility	.36	.41	.40	.43	.70	.70	.45	(.79)	-	-	-
9. BMQ-R: Irritation Presence	.88	.62	.60	.59	.50	.35	.20	.38	(.69)	-	-
10. BMQ-R: Irritation Anticipation	.52	.83	.45	.50	.43	.25	.20	.43	.56	(.87)	-
11. BITe: Irritation	.62	.56	.48	.58	.72	.48	.37	.62	.62	.49	(.90)

$N = 586$ - 639 . BMQ-R = Berlin Misophonia Questionnaire Revised; S-Five-E = Selective Sound Sensitivity Syndrome Scale Experiences; AQ = Aggression Questionnaire; BITe = Brief Irritability Test. McDonald's ω [62] based on the confirmatory factor analyses of the respective scales are in parentheses on the diagonal. Intercorrelations of the BMQ-R subscales are adopted from Table 4 and hence $N = 588$ - 616 .

All correlations were significant at $p < .001$.

The disgust propensity scale from the DPSS-R was used. A CFA demonstrated acceptable model fit. Disgust propensity correlated highly positively with misophonic disgust reactions to the presence of sounds ($r = .72$) and to the anticipation of sounds ($r = .68$) which is higher than the average cross-emotional intercorrelation of misophonic disgust scales ($\bar{r} = .51$). Anticipatory disgust and present disgust correlated to $r = .89$ [.85 - .92].

For misophonic anxiety reactions, cognitive and somatic anxiety symptoms measured with the STICSA as well as threat measured by the S-Five-E were used as convergent constructs. Furthermore, physical misophonic symptoms were correlated with somatic anxiety since somatic anxiety symptoms measured by the STICSA are not necessarily specific to anxiety. The STICSA 18-item model from the pretest demonstrated good fit to the data. Latent intercorrelations for misophonic anxiety and physical reactions with convergent measures are given in Table 6. Present and anticipatory misophonic anxiety correlated strongly with perceived threat ($r = .76$ and $r = .80$) as well as with somatic anxiety symptoms ($r = .73$ and $r = .70$) and cognitive anxiety symptoms ($r = .61$ and $r = .66$). On the other hand, physical reactions to the presence or anticipation of sounds were higher correlated with somatic anxiety ($r = .89$ and $r = .78$) compared to cognitive anxiety ($r = .62$ and $r = .63$). Further, present physical reactions were similarly correlated with perceived threat compared to present anxiety ($r = .77$ respectively $r = .76$) whereas anticipatory physical reactions had a lower correlation ($r = .73$) compared to anticipatory anxiety ($r = .80$). Present and anticipatory anxiety correlated to $r = .85$ [.84 - .90].

Table 6. Latent Intercorrelations for Misophonic Anxiety and Physical Reactions with Convergent Measures

Measure	1	2	3	4	5	6	7
1. BMQ-R: Anxiety Presence	(.85)	-	-	-	-	-	-
2. BMQ-R: Anxiety Anticipation	.87	(.90)	-	-	-	-	-
3. S-Five-E: Threat	.76	.80	(.92)	-	-	-	-
4. STICSA-T: Cognitive Anxiety Symptoms	.61	.66	.67	(.91)	-	-	-
5. STICSA-T: Somatic Anxiety Symptoms	.73	.70	.70	.69	(.87)	-	-
6. BMQ-R: Physical Presence	.83	.73	.77	.62	.89	(.88)	-
7. BMQ-R: Physical Anticipation	.71	.80	.73	.63	.78	.85	(.84)

$N = 565-617$. BMQ-R = Berlin Misophonia Questionnaire Revised; STICSA-T = State-Trait Inventory for Cognitive and Somatic Anxiety - Trait Scales. McDonald's ω [62] based on the confirmatory factor analyses of the respective scales are in parentheses on the diagonal. Intercorrelations of the BMQ-R subscales are adopted from Table 4 with $N = 588-616$.

All correlations were significant at $p < .001$.

Clinical insight

To test convergent validity of the two clinical insight scales, correlations with internal appraisals and external appraisals from the S-Five-E as well as the illness coherence scale from the IPQ-MH were calculated. A CFA for the illness coherence scale demonstrated excellent fit of the model. Latent intercorrelations for recognition of disproportionality and excess with convergent measures are given in Table 7. Contrary to our hypotheses, illness coherence was moderately to highly negatively correlated with recognition of disproportionality and excess ($r = -.50$ respectively $r = -.45$). On the other hand, the scale internal appraisals (symptom attribution) displayed strong positive correlations with both recognition of disproportionality ($r = .63$) and excess ($r = .69$) whereas external appraisals were moderately correlated with recognition of disproportionality ($r = .32$) and excess ($r = .46$).

Table 7. Latent Intercorrelations for Recognition of Excess and Disproportionality with Convergent Measures

Measure	1	2	3	4	5
1. BMQ-R: Disproportionality	(.90)	-	-	-	-
2. BMQ-R: Excess	.83	(.91)	-	-	-
3. IPQ-MH: Illness Coherence	-.50	-.45	(.92)	-	-
4. S-Five-E: Internal Appraisals	.63	.69	-.42	(.93)	-
5. S-Five-E: External Appraisals	.32	.46	-.18	.40	(.92)

$N = 554$ - 696 . BMQ-R = Berlin Misophonia Questionnaire Revised; IPQ-MH = Illness Perception Questionnaire Mental Health; S-Five-E = Selective Sound Sensitivity Syndrome Scale Experiences. McDonald's ω [62] based on the confirmatory factor analyses of the respective scales are in parentheses on the diagonal. Intercorrelations of the BMQ-R subscales are adopted from Table 4 with $N = 696$.

All correlations were significant at $p < .001$.

Furthermore, high average correlations with dysregulation symptoms measured by the BMQ-R were observed for recognition of disproportionality ($\bar{r} = .63$) and for recognition of excess ($\bar{r} = .80$). Also, distress and functional impairment as measured by the BMQ-R were strongly correlated with both clinical insight dimensions ($r = .57$ - $.78$). Recognition of disproportionality and excess were strongly correlated with overall symptom burden measured by the MisoQuest ($r = .72$ respectively $r = .86$) as well as moderately to highly correlated with impact measured by the S-Five-E ($r = .45$ respectively $r = .62$).

Dysregulation

To validate misophonic dysregulation defined as a general construct with specific subfacets, scales from the DERS were chosen to show a convergent correlation pattern. More specifically, items from the scales impulse control difficulties, difficulties engaging in goal-oriented behavior, and limited access to emotion regulation were selected to measure behavioral, cognitive, and emotional dysregulation, respectively. One item comprises general dysregulation with respect to the content, which led to specifying an S•I-1 model [72] with this item as the reference factor and the other items as specific factors regarding their

dysregulation facet. To compare the results, a correlated first-order factor model without the general item (factor) was also specified. Both models demonstrated good fit to the data. For latent intercorrelations between these scales see Table 8. For the correlated first-order models, medium to strong correlations between general misophonic dysregulation and its facets with convergent measures of dysregulation were observed ($r = .45 - .65$, $\bar{r} = .62$). Behavioral dysregulation correlated highest with difficulties in impulse control ($r = .62$) and cognitive dysregulation correlated highest with difficulties engaging in goal-directed behavior. This clear pattern could not be observed for emotional dysregulation being highest correlated with general control difficulties and similarly with other DERS facets.

769 **Table 8. Latent Intercorrelations for Misophonic Dysregulation with Convergent Measures**

Measure	1	2	3	4	5	6	7	8
1. BMQ-R: General Dysregulation	(.91)	-	-	-		-	-	-
2. BMQ-R: Behavioral Dysregulation	.68	(.86)	-	-		-	-	-
3. BMQ-R: Cognitive Dysregulation	.71	.63	(.87)	-		-	-	-
4. BMQ-R: Emotional Dysregulation	.70	.76	.81	(.87)		-	-	-
5. DERS: General Control Difficulties	.54	.58	.57	.70	(.84) ^a			
6. DERS: Impulse Control Difficulties	.62	.62	.53	.61	.00 ^z	(.70)	-	-
7. DERS: Difficulties Engaging in Goal-Oriented Behavior	.49	.45	.64	.65	.00 ^z	.72	(.90)	-
8. DERS: Limited Access to Emotion Regulation	.47	.48	.57	.62	.00 ^z	.76	.84	(.91)

$N = 573$ - 587 . BMQ-R = Berlin Misophonia Questionnaire Revised; DERS = Difficulties in Emotion Regulation Scale.

Correlations are based on first-order factor analyses, except for correlations of the DERS: General Control Difficulties factor for which the bifactor S•I-1 model was used. McDonald's ω [62] based on the first-order confirmatory factor analyses of the respective scales are in parentheses on the diagonal. Intercorrelations of the BMQ-R subscales are adopted from Table 4 and hence $N = 708$.

^a McDonald's ω as defined in the bifactor S•I-1 model. ^z Correlations are per definition set to zero.

All correlations were significant at $p < .001$.

General control difficulties as defined in the S•I-1 model correlated highly with general dysregulation. However, their correlation with impulse control difficulties was higher than with general control difficulties.

Furthermore, outbursts as measured by the S-Five-E were strongly correlated with misophonic dysregulation. General dysregulation was correlated to $r = .63$ with outbursts. Regarding the dysregulation domains, outbursts were correlated to $r = .84$ with behavioral, $r = .56$ with cognitive and $r = .65$ with emotional dysregulation.

Avoidance behavior

For reactive and anticipatory avoidance behavior, the NAQ and the BEAQ (Behavioral Avoidance) scales were chosen to test convergent validity. Regarding the NAQ, a brute force hold-out optimization was applied since the unidimensional factor model demonstrated poor fit to the data. Eleven items were selected which led to a good model fit. With respect to the content, we carefully considered minimizing the loss of content through item reduction. McDonald's ω was similar to the internal consistency estimate from the development study of the NAQ ($\omega = .91$). The BEAQ subscale demonstrated good model fit and internal consistency ($\omega = .85$).

Avoidance of daily sounds as measured by the NAQ correlated strongly with both reactive misophonic avoidance ($r = .64$) and anticipatory misophonic avoidance ($r = .74$). Further, reactive and anticipatory avoidance were strongly correlated with behavioral avoidance ($r = .57$ respectively $r = .62$). We also tested the relationship between avoidance behavior and impeded avoidance as measured by the perceived threat scale of the S-Five-E which was strong for both reactive avoidance ($r = .76$) and anticipatory avoidance ($r = .70$).

Further evidence on construct validity could be demonstrated through a high average correlation of reactive avoidance with present aversive emotional and physical misophonic reactions measured by the BMQ-R ($\bar{r} = .70$) which was higher compared to anticipatory avoidance ($\bar{r} = .55$).

Clinical significance

Construct validity for misophonic distress and functional impairment was assessed by correlations with different dimensions of functional impairment measured by the WHODAS 2.0 as well as overall symptom burdening as measured by the MisoQuest and misophonic impact measured by the S-Five-E. The WHODAS 2.0 first-order factor model showed acceptable fit to the data. For latent correlations between misophonic distress and functional impairment with convergent measures see Table 9. Correlations with WHODAS 2.0 scales were calculated based on maximum likelihood robust estimation with full information likelihood to address the substantial number of missing values for these scales. Misophonic impact correlated strongly with distress ($r = .76$) and functional impairment ($r = .84$). Overall symptom burden as measured by the MisoQuest was strongly correlated with both distress ($r = .90$) and functional impairment ($r = .85$). With respect to impairment domains by the WHODAS 2.0, functional impairment was most strongly correlated with impairment in participation in society ($r = .75$) and impairment in getting along with people ($r = .61$), whereas impairment in household activities was moderately correlated ($r = .44$). Distress demonstrated a similar pattern, although on average being less highly correlated. More specifically, impairment in participation in society is correlated to $r = .64$, impairment in getting along with people to $r = .53$ and impairment in household activities to $r = .37$.

816 **Table 9. Latent Intercorrelations for Misophonic Distress and Functional Impairment with Convergent Measures**

Measure	1	2	3	4	5	6	7	8	9
1. BMQ-R: Distress	(.94)	-	-	-	-	-	-	-	-
2. BMQ-R: Functional Impairment	.91	(.95)	-	-	-	-	-	-	-
3. S-Five-E: Impact	.76	.84	(.90)	-	-	-	-	-	-
4. WHODAS 2.0: Cognition	.48	.51	.54	(.86)	-	-	-	-	-
5. WHODAS 2.0: Getting Along with People	.53	.61	.66	.81	(.82)	-	-	-	-
6. WHODAS 2.0: Household Activities	.37	.44	.43	.66	.71	(.96)	-	-	-
7. WHODAS 2.0: Work or School Activities	.45	.52	.58	.71	.72	.63	(.93)	-	-
8. WHODAS 2.0: Participation	.64	.75	.77	.71	.84	.68	.74	(.91)	-
9. MisoQuest	.90	.85	.73	.54	.56	.36	.46	.63	(.93)

$N = 585-640$. BMQ-R = Berlin Misophonia Questionnaire Revised; S-Five-E = Selective Sound Sensitivity Syndrome Scale Experiences; WHODAS 2.0 = World Health Organization Disability Assessment Schedule 2.0. McDonald's ω [62] based on the confirmatory factor analyses of the respective scales are in parentheses on the diagonal.

All correlations were significant at $p < .001$.

Discussion

This study described the development and optimization of the BMQ and reported an extensive examination of its psychometric properties through structural analyses, reliability assessment and correlative analyses for the purpose of testing construct validity. We further presented a symptom-oriented modelling approach for the measurement of the diagnostic criteria of misophonia proposed by Jager et al. [1], which enables a clear and meaningful assessment of misophonic symptoms. Within this framework previous items from the first version as well as newly constructed items were tested in a large sample comprising affected as well as non-affected individuals. An algorithmic hold-out validation item selection procedure enabled the robust and effective composition of 20 symptom-oriented scales which encompass 73 items in six criteria-oriented content areas: (1) aversive reactions to the presence and (2) anticipation of sounds, (3) clinical insight, (4) dysregulation, (5) avoidance behavior, and (6) clinical significance. About 38% of the original items remained in the final BMQ-R.

With respect to the factorial validity, all developed symptom-oriented models showed good to excellent fit to the data. Accordingly, the models demonstrate a clear and meaningful assessment and distinction of misophonic symptoms. A joint model comprising the essential 15 symptom scales is a preliminary evidence of the robustness and clarity of the factorial structure. Still, misspecifications of the model are evident for some items. This mostly concerns the items pAX02 (anxiety), ED03 (emotional dysregulation), pDR02 (disgust), RD01 (recognition of disproportionality), and aAB01 (anticipatory avoidance). For example, item pAX02 (“These sounds cause thoughts that scare me.”) shows several cross-loadings, e.g., on the factors distress, anger, and behavioral dysregulation. Also item pDR02 (“I experience disgust when I hear these sounds.”) shows several cross-loading, e.g., on the factors functional impairment and physical reactions to the presence of sounds. Further

developments of the questionnaire should particularly scrutinize these five items. Nevertheless, these findings show evidence for the overall structure of the BMQ-R and represent an improvement compared to the first version. Additional analyses on the dimensionality of highly correlated scales as shown in the table in S2 Table lead to the same conclusion.

The assessment of the internal consistency demonstrated good psychometric properties of the developed scales. Estimates of ω ranged from .82 to .95 except for irritation reactions to the presence of sounds and reactive avoidance behavior ($\omega = .69$ and $\omega = .72$).

To assess the construct validity, several correlative hypotheses regarding convergent measures of the respective scales were investigated, and results can be interpreted in a nomological network. One of the central aims of the validation was the distinction between different aversive misophonic reactions as reported in the literature [1,7,12,13]. Because anger and irritation are related, yet different constructs [29], a distinction for misophonia is likewise crucial to the measurement of these emotional reactions. Results demonstrated partial evidence for this distinction through stronger associations of anger reactions with misophonic outbursts, convergent anger, and physical aggression. Contrary to our predictions, misophonic anger correlated as high as misophonic irritation with a convergent irritation measure. Hence, our findings do not support a clear distinction between these constructs and raise questions about the theoretical distinction between irritation and anger in the measurement of misophonia. However, associations between irritation and other scales of the BMQ-R demonstrate that irritation is uniquely related to other misophonic symptoms compared to anger reactions (e.g., lower correlations with behavioral dysregulation and recognition of disproportionality as well as a higher correlation with the GSIS scale). We therefore argue that irritation reactions need to be further investigated in future studies but appear to be a vital

aspect of misophonic experiences. Dimensionality analyses also support the distinction between anger and irritation in the measurement of misophonia (see the table in S2 Table).

Regarding disgust, a clear convergent correlation with disgust propensity demonstrates evidence for the construct validity. Anticipatory disgust, however, was very strongly associated with present disgust ($r = .89$) and the scales were on average similarly correlated with other misophonic symptom scales ($\bar{r} = .49$ for present disgust and $\bar{r} = .46$ for anticipatory disgust). This result indicates construct validity but also shows that both constructs are not very distinct from each other. The CTC(M-1) model allowed us to quantify how much variance of the indicators can be accounted for by the method factor ‘anticipation’ by examining the specificities. For the two disgust indicators an average specificity of .16 was calculated. This means that substantial variance of the indicators is explained by the anticipation method factor and therefore supports the discriminant validity. The analysis of the dimensionality of the two scales also gives evidence for the distinction of anticipatory and present disgust (see the table in S2 Table).

For anxiety reactions, all validation hypotheses were corroborated. While Jager et al. [1] considered present anxiety reactions as subordinate, our results indicate that present anxiety reactions are substantially correlated to emotional dysregulation, avoidance, distress and functional impairment, rendering it an important dimension of misophonic experience. Present anxiety reactions were also moderately to strongly associated with other aversive misophonic reactions which emphasizes the importance of measuring this dimension. However, the high intercorrelation of present and anticipatory anxiety ($r = .87$) raises the question whether present anxiety truly measures present anxiety-related thoughts and not anticipatory thoughts in the presence of sounds. This is supported by the fact that the average intercorrelation with other misophonic symptoms apart from the aversive emotional and physical reactions were similar ($\bar{r} = .60$ for present anxiety and $\bar{r} = .62$ for anticipatory

anxiety). We therefore recommend further investigating the relationship between present and anticipatory anxiety focusing on the discriminant validity of these scales with respect to the source of anxious thoughts (future misophonic situations vs. perceived threat due to the sound itself). Nevertheless, we favor the usage of both dimensions since content-related validity respectively item wording suggests a sufficient distinction, specificity coefficients (as calculated in the CTC(M-1) model) for the two items were on average .09, and dimensionality analyses also support this distinction.

Physical misophonic reactions displayed strong positive correlations which were substantially higher with somatic anxiety symptoms than misophonic anxiety reactions. This clearly supports the convergent validity of physical reactions. We also observed strong positive associations of both present and anticipatory physical reactions with each emotional misophonic response. Because the physical reaction is not specific to any emotional response but largely caused by it, the high correlations were expected and hence support the construct validity. Likewise, we expected a large association between present and anticipatory physical reactions but the observed correlation was very high ($r = .85$) questioning the discriminant validity of the scales. However, the specificity coefficients (as calculated in the CTC(M-1) model) for the two anticipatory items were on average .30 indicating a substantial explanation of variance through the anticipation method factor. The analysis of the dimensionality of the two scales supports the two factor solution and therefore a distinction of anticipatory and present physical reactions.

The outcomes are heterogeneous for clinical insight. On the one hand, dimensions of clinical insight strongly correlated with internal appraisals of symptoms and moderately with external appraisals which demonstrates a clear convergent correlative pattern. Individuals who tend to internally attribute their symptoms are more likely to recognize excessive and disproportionate behavior. For external attributions, this relationship was weaker which is in

line with theoretical considerations since individuals recognize that their misophonic reactions are strong but the cause is attributed to the bad-mannered behavior of others. Accordingly, this effect especially manifests itself for the relationship of recognition of disproportionality and external appraisals. Contrary to our hypotheses, illness coherence was highly negatively instead of positively correlated with clinical insight dimensions. Hence, individuals less comprehending of their symptoms are more likely to recognize excessive behavior and disproportionality or vice versa. This might be explained by the fact that illness coherence displayed a strong positive correlation with personal control over symptoms [34,74]. Individuals less comprehending of their symptoms are hence more likely to perceive less personal control over their symptoms. Our data also support this relationship since misophonic dysregulation facets (as an expression of loss of control) display a moderate negative correlation with illness coherence ($r = -.31$ to $-.36$). On that account, the observed negative relationship between illness coherence and recognition of excess and disproportionality supports the convergent validity of these scales, albeit not expected. A further examination of the construct validity of the clinical insight dimensions is necessary. However, to our knowledge, no suitable insight scale directly measuring the intended insight dimensions exists.

Modelling misophonic dysregulation through the inclusion of specific domains (behavioral, cognitive, and emotional dysregulation) allows for an extensive measurement of misophonic dysregulation and loss of control. The specified correlated first-order model demonstrated the adequacy of such a distinction for misophonic symptoms and simultaneously incorporated contemporary findings on misophonia in the recent literature. For behavioral and cognitive dysregulation, the convergent measure was correlated more strongly than other domains which supports the validity of these distinctions. For emotional dysregulation, however, the predicted pattern did not emerge. This is reflected through

stronger associations between emotional dysregulation and general control difficulties compared to limited access to emotion regulation. Emotional dysregulation is also similarly associated with the subfacets of the convergent DERS scale. These results raise the question whether emotional dysregulation is captured sufficiently by the BMQ-R. Regarding the content, the items mainly reflect intense emotional experience in the sense of loss of control over emotions which was exactly the intention. Further, emotional dysregulation has a substantially stronger association with emotional misophonic reactions ($\bar{r} = .69$) than the other dysregulation domains ($\bar{r} = .51-.61$). Future studies should consider alternative validation measures of emotional dysregulation that emphasize a loss of control over emotional experience to assess construct validity. Another piece of evidence on construct validity was demonstrated by strong associations with misophonic outbursts which comprise verbally and physically aggressive outbursts. As predicted, behavioral dysregulation correlated most strongly with outbursts. A more general criticism of the defined misophonic dysregulation is that the definition might be too broad and generic to capture the entire construct of misophonic dysregulation even though different dysregulation domains have been incorporated. Our treatment of dysregulation domains is a condensed derivation of dysregulation dimensions described by D'Agostino et al. [71] and Gratz and Roemer [43] as well as considerations by Dozier et al. [24] and misophonia-specific findings reported by Cassiello-Robbins et al. [23]. Dimensions that are not or only marginally included are 'decreased emotional awareness' and 'cognitive reappraisal difficulty' [71] as well as 'non-acceptance of emotions' [43]. Especially the latter two dimensions might be relevant in the assessment of misophonic dysregulation. We therefore advocate the examination of misophonic dysregulation in further studies. Nonetheless, the presented distinction of behavioral, cognitive, and emotional domains is a useful and valid approach to quantify misophonic dysregulation.

The validity of misophonic avoidance behavior could be clearly shown through high correlations with convergent sound avoidance and behavioral experiential avoidance. Since the NAQ largely comprises items assessing the anticipatory nature of sound avoidance, it is not surprising that we found higher correlations with anticipatory avoidance compared to reactive avoidance. Future research should focus on validating the scale reactive avoidance by measuring escape behavior more directly.

For misophonic distress and functional impairment, several strong correlations with convergent measures were observed. It could be shown that both functional impairment and distress were strongly related to misophonic impact, impairments in the participation of society and impairments in getting along with people. Also, overall symptom burden was strongly correlated with the two dimensions of clinical significance. The findings clearly support the convergent validity of clinical significance dimensions.

Beside the outlined improvements of the symptom part, the condition part, which comprises the GSIS scale and sound disturbance of specific sound classes, was also extended and revised. The GSIS model showed good fit to the data and good internal consistency. GSIS expectedly correlated moderately to strongly with other misophonic symptoms. However, the large association between GSIS and present misophonic irritation ($r = .93$) questions the incremental utility of such a screening scale. However, the average item difficulty of GSIS ($\bar{P}_i = 90.20$) compared to present irritation reactions ($\bar{P}_i = 76.37$) supports the usefulness of both scales. Additional analyses on the dimensionality of both scales support the distinction between GSIS and irritation (see the table in S2 Table). The usage of the GSIS scale as a screening prior to the application of the BMQ-R symptoms part is hence justifiable through measurement theoretical as well as substantive considerations regarding the item content.

992 **Limitations**

993 There are several limitations of the study that must be considered. Because our sample was
994 mainly drawn from social media groups, the study is not representative for the German
995 population. Further studies should therefore test the BMQ-R in a large representative sample.
996 The study length (*Mdn* = 43 minutes) might have decreased data quality due to exhaustion
997 effects, although the data quality examination should have minimized this effect. Another
998 shortcoming of this study is the small proportion of male participants (12.6%) which impairs
999 the comparability of results regarding gender. An extensive examination of measurement
1000 invariance (especially across gender, age, and sound classes) is indicated. From a
1001 methodological perspective, the applied probabilistic ACO item selection procedure might
1002 have been extended by using multiple runs with different criteria to ensure detecting a global
1003 best solution for the specific models. The study is also methodologically limited since all
1004 measures are self-report scales sharing method specific variance that artificially increases
1005 correlations of the constructs [75]. An extension in terms of multitrait-multimethod analyses
1006 is thus called for.

1007 For future research, it is important to replicate the factor structure in a more
1008 representative sample. An extended validation study especially investigating discriminant,
1009 differential and content validity is required. For the clinical or individual application of the
1010 BMQ-R, a large representative norming sample should be drawn. However, the large sample
1011 of this study provides initial comparative values for clinical practice. A clinical cutoff must be
1012 determined to analyze the sensitivity and specificity of the instrument and to classify affected
1013 individuals. To date, there is no instrument that measures temporal and transsituational
1014 stability as well as situational influences of misophonic symptoms. The latent state-trait
1015 theory provides an approach to develop a state-trait instrument [76] which certainly would be
1016 a scientifically beneficial extension of the BMQ-R.

1017 **Conclusions**

1018 Several limitations of previous and recent instruments [19-21] have been addressed.
1019 Previous misophonia instruments neglect important aspects of the experience of misophonia
1020 which are now incorporated. These aspects include the distinction between behavioral,
1021 cognitive, and emotional dysregulation; the measurement of impulsive physical reactions and
1022 clinical insight; as well as discerning reactive and anticipating avoidance strategies. A
1023 thorough and comprehensive assessment of misophonic emotional responses is unique to the
1024 BMQ-R. The study demonstrates improvements in misophonia measurement which allow for
1025 a reliable and valid measurement of the symptoms and therefore stimulate further misophonia
1026 research on different levels. Through the symptom-oriented modelling approach, a clearer
1027 measurement of the criteria is viable with the option to regard accessory symptoms. The
1028 presented evidence on the construct validity elucidated the multidimensional nature of self-
1029 reported misophonic symptoms and demonstrated the validity of the diagnostic criteria by
1030 Jager et al. [1]. Furthermore, the BMQ-R is not merely an instrument to assess the diagnostic
1031 criteria but a contemporary questionnaire which extends aspects of the criteria. This allows
1032 for both classifying individuals according to the criteria and assessing the wide range of
1033 misophonic symptoms to describe individuals and scrutinize relationships to other symptoms
1034 or traits. The symptom-oriented approach hence enables researchers to choose specific
1035 symptoms or scales of interest. These findings also diminish the criticism of the criteria
1036 regarding the syndromal breadth and the diagnostic validity [18] which also concern the
1037 BMQ-R. McKay and Acevedo [77] argue that the descriptive taxonomy of the criteria is
1038 atheoretical and hence suggest a definition of misophonia within the Research Domain
1039 Criteria initiative (RDoC; [78]) and the Hierarchical Taxonomy of Psychopathology (HiTOP;
1040 [79]) which allows for a dimensional perspective and model-based characterization of
1041 misophonia. The introduced measurement models enable a (multi-)dimensional assessment of

1042 misophonic symptoms and thus may contribute to the further examination of misophonia
1043 within the frameworks of RDoC and HiTOP with respect to self-report as one unit of analysis.
1044 Researchers may scrutinize the relationship between symptoms and higher-order dimensions
1045 of psychopathology and other pathological components and symptoms.
1046

1047 **Acknowledgements**

1048 We thank Kevin Sturm, Maik Hante, Rebecca Gruzman, Gloria Gierlach, Friedemann
1049 Trutzenberg, and Nicole Chantal Skerstupeit for their translations of the validation scales; and
1050 Taym Asalti for helpful comments and suggestions on our manuscript.

References

1. Jager I, de Koning P, Bost T, Denys D, Vulink N. Misophonia: Phenomenology, comorbidity and demographics in a large sample. *PLOS ONE*. 2020; 15(4). doi: 10.1371/journal.pone.0231390
2. Brout JJ, Edelstein M, Erfanian M, Mannino M, Miller LJ, Rouw R, et al. Investigating Misophonia: A Review of the Empirical Literature, Clinical Implications, and a Research Agenda. *Frontiers in Neuroscience*. 2018; 12(36). doi: 10.3389/fnins.2018.00036
3. Schröder A, Vulink N, Denys S. Misophonia: Diagnostic Criteria for a New Psychiatric Disorder. *PLOS ONE*. 2013; 8(1):1–5. doi: 10.1371/journal.pone.0054706
4. Cox TJ. The effect of visual stimuli on the horribleness of awful sounds. *Applied Acoustics*. 2008; 69(8):691–703. doi: 10.1016/j.apacoust.2007.02.010
5. Hansen H, Leber AB, Saygin ZM. What sound sources trigger misophonia? Not just chewing and breathing. *Journal of Clinical Psychology*. 2021: 1-17. doi: 10.1002/jclp.23196
6. Jastreboff PJ, Jastreboff MM. (2014). Treatments for Decreased Sound Tolerance (Hyperacusis and Misophonia). *Seminars in Hearing*. 2014; 35(2):105-20. doi: 10.1055/s-0034-1372527
7. Edelstein M, Monk B, Ramachandran VS, Rouw, R. Context influences how individuals with misophonia respond to sounds. *BioRxiv* [Preprint]. 2020 bioRxiv 292391 [cited 2021 Aug 04]: [37 p.]. Available from: <https://www.biorxiv.org/content/10.1101/2020.09.12.292391v1> doi: 10.1101/2020.09.12.292391

- 1074 8. Johnson PL, Webber TA, Wu MS, Lewin AB, Murphy TK, Storch EA. When selective
1075 audiovisual stimuli become unbearable: a case series on pediatric misophonia.
1076 Neuropsychiatry. 2013; 3(6):569–75. doi: 10.2217/npv.13.70
- 1077 9. Taylor S, Conelea CA, McKay D, Crowe KB, Abramowitz JS. Sensory intolerance:
1078 Latent structure and psychopathologic correlates. Comprehensive Psychiatry. 2014;
1079 55(5):1279-84. doi: 10.1016/j.comppsy.2014.03.007
- 1080 10. Wu MS, Lewin A, Murphy TK, Storch EA. Misophonia, Incidence, Phenomenology,
1081 and Clinical Correlates in an Undergraduate Student Sample. Journal of Clinical
1082 Psychology. 2014; 70(10):994-1007. doi: 10.1002/jclp.22098
- 1083 11. Edelstein M, Brang D, Rouw R, Ramachandran VS. Misophonia: physiological
1084 investigations and case descriptions. Frontiers in Human Neuroscience. 2013; 7(296):1–
1085 11. doi: 10.3389/fnhum.2013.00296
- 1086 12. McKay D, Kim SK, Mancusi L, Storch EA, Spankovich C. Profile Analysis of
1087 Psychological Symptoms Associated with Misophonia: A Community Sample.
1088 Behavior therapy. 2018; 49(2):286-94. doi: 10.1016/j.beth.2017.07.002
- 1089 13. Potgieter I, MacDonald C, Partridge L, Cima R, Sheldrake J, Hoare DJ. Misophonia: A
1090 scoping review of research. Journal of Clinical Psychology. 2019; 75(7):1203-18. doi:
1091 10.1002/jclp.22771
- 1092 14. Rouw R, Erfanian M. A Large-Scale Study of Misophonia. Journal of Clinical
1093 Psychology. 2018; 74(3):453-79. doi: 10.1002/jclp.22500
- 1094 15. Zhou X, Wu MS, Storch EA. Misophonia symptoms among Chinese university
1095 students: Incidence, associated impairment, and clinical correlates. Journal of
1096 Obsessive-Compulsive and Related Disorders. 2017; 14:7-12. doi:
1097 10.1016/j.jocrd.2017.05.001

- 1098 16. Jastreboff MM, Jastreboff PJ. Decreased sound tolerance and Tinnitus Retraining
1099 Therapy (TRT). *Australian and New Zealand Journal of Audiology*. 2002; 24(2):74–84.
1100 doi: 10.1375/AUDI.24.2.74.31105
- 1101 17. Lane SJ, Reynolds S, Dumenci L. Sensory Overresponsivity and Anxiety in Typically
1102 Developing Children and Children with Autism and Attention Deficit Hyperactivity
1103 Disorder: Cause or Coexistence? *American Journal of Occupational Therapy*. 2012;
1104 66(5):595–603. doi: 10.5014/ajot.2012.004523
- 1105 18. Taylor S. Misophonia: A new mental disorder? *Medical Hypotheses*. 2017; 103:109-
1106 117. doi: 10.1016/j.mehy.2017.05.003
- 1107 19. Vitoratou S, Hayes, C, Uglik-Marucha E, Gregory J. Selective Sound Sensitivity
1108 Syndrome Scale (S-Five): a psychometric tool for assessing misophonia. Summary on
1109 three waves of sampling and analysis. *PsyArXiv*. 2020a. doi: 10.31234/osf.io/4dzqn
- 1110 20. Siepsiak M, Śliwerski A, Dragan WŁ. Development and Psychometric Properties of
1111 MisoQuest—A New Self-Report Questionnaire for Misophonia. *International journal of*
1112 *environmental research and public health*. 2020; 17(5):1797-1811. doi:
1113 10.3390/ijerph17051797
- 1114 21. Vitoratou S, Hayes C, Uglik-Marucha E, Gregory J. Selective sound sensitivity
1115 syndrome scale (S-Five): assessment of the psychometric properties of a measurement
1116 tool for misophonia in a large sample of people identifying with the condition.
1117 Assessment. Forthcoming 2021
- 1118 22. Remmert N. Konstruktion und Validierung des Berliner Misophonie Fragebogens
1119 (BMF) zur Messung der Symptome auditiver Intoleranz distinkter Geräusche in der
1120 klinisch-psychologischen Forschung. B.Sc. Thesis, Freie Universität Berlin. 2017.
1121 Available from: <https://osf.io/9vfms/files/>

- 1122 23. Cassiello-Robbins C, Anand D, McMahon K, Guetta R, Trumbull J, Kelley, L, et al.
1123 The mediating role of emotion regulation within the relationship between neuroticism
1124 and misophonia: A preliminary investigation. *Frontiers in Psychiatry*. 2020; 11. doi:
1125 10.3389/fpsyt.2020.00847
- 1126 24. Dozier TH, Lopez M, Pearson C. Proposed Diagnostic Criteria for Misophonia: A
1127 Multisensory Conditioned Aversive Reflex Disorder. *Frontiers in psychology*. 2017;
1128 8:1975-77. doi: 10.3389/fpsyg.2017.01975
- 1129 25. Haskell, AM, Britton, PC, Servatius, RJ. Toward an assessment of escape/avoidance
1130 coping in depression. *Behavioural brain research*. 2020; 381. doi:
1131 10.1016/j.bbr.2019.112363
- 1132 26. Heinrich M, Zagorscak P, Eid M, Knaevelsrud C. Giving G a meaning: An application
1133 of the bifactor-(S-1) approach to realize a more symptom-oriented modeling of the Beck
1134 depression inventory–II. *Assessment*. 2020; 27(7):1429-47. doi:
1135 10.1177/1073191118803738
- 1136 27. Smith GT. On Construct Validity: Issues of Method and Measurement. *Psychological*
1137 *Assessment*. 2005; 17(4):396–408. doi: 10.1037/1040-3590.17.4.396
- 1138 28. Stringaris A. Irritability in children and adolescents: a challenge for DSM-5. *European*
1139 *child and adolescent psychiatry*. 2011; 20(2):61-6. doi: 10.1007/s00787-010-0150-4
- 1140 29. Holtzman S, O'Connor BP, Barata PC, Stewart DE. The Brief Irritability Test (BITe) A
1141 Measure of Irritability for Use Among Men and Women. *Assessment*. 2015; 22(1):101-
1142 15. doi: 10.1177/1073191114533814
- 1143 30. Toohey MJ, DiGiuseppe R. Defining and measuring irritability: Construct clarification
1144 and differentiation. *Clinical psychology review*. 2017; 53:93-108. doi:
1145 10.1016/j.cpr.2017.01.009

- 1146 31. David AS. Insight and Psychosis. *The British Journal of Psychiatry*. 1990; 156(6):798-
1147 808. doi: 10.1192/bjp.156.6.798
- 1148 32. David AS, Bedford N, Wiffen B, Gilleen J. Failures of metacognition and lack of
1149 insight in neuropsychiatric disorders. *Philosophical Transactions of the Royal Society*
1150 *B: Biological Sciences*. 2012; 367(1594):1379-90. doi: 10.1098/rstb.2012.0002
- 1151 33. Konstantakopoulos G. Insight across mental disorders: A multifaceted metacognitive
1152 phenomenon. *Psychiatriki*. 2019; 30(1):13. doi: 10.22365/jpsych.2019.301.13
- 1153 34. Moss-Morris R, Weinman J, Petrie K, Horne R, Cameron L, Buick D. The Revised
1154 Illness Perception Questionnaire (IPQ-R). *Psychology and Health*. 2002; 17(1):1-16.
1155 doi: 10.1080/08870440290001494
- 1156 35. Hadjipavlou G, Baer S, Lau A, Howard A. Selective sound intolerance and emotional
1157 distress: what every clinician should hear. *Psychosomatic Medicine*. 2008; 70(6):739-
1158 40. doi: 10.1097/PSY.0b013e318180edc2
- 1159 36. Üstün TB, Kostanjsek N, Chatterji S, Rehm J. Measuring health and disability: Manual
1160 for WHO disability assessment schedule WHODAS 2.0. World Health Organization;
1161 2010.
- 1162 37. Harkness J. Questionnaire Translation. In: Harkness J, van de Vijver F, Mohler P,
1163 editors, *Cross-cultural survey methods*; 2003. pp. 35-56.
- 1164 38. Buss AH, Perry M. The Aggression Questionnaire. *Journal of Personality and Social*
1165 *Psychology*. 1992; 63:452-59. doi: 10.1037/0022-3514.63.3.452
- 1166 39. Werner R, von Collani G. Deutscher Aggressionsfragebogen. Zusammenstellung
1167 sozialwissenschaftlicher Items und Skalen (ZIS); 2004. doi: 10.6102/zis52
- 1168 40. Fergus TA, Valentiner DP. The Disgust Propensity and Sensitivity Scale–Revised: An
1169 examination of a reduced-item version. *Journal of Anxiety Disorders*. 2009; 23(5):703-
1170 10. doi: 10.1016/j.janxdis.2009.02.009

- 1171 41. Ree MJ, French D, MacLeod C, Locke V. Distinguishing Cognitive and Somatic
1172 Dimensions of State and Trait anxiety: Development and validation of the State-Trait
1173 Inventory for Cognitive and Somatic Anxiety (STICSA). Behavioural and Cognitive
1174 Psychotherapy. 2008; 36(3):313–32. doi: 10.1017/S1352465808004232
- 1175 42. Krey E. Irritabilität im Kindes- und Jugendalter. Auswirkung des Zusammenhangs von
1176 Irritabilität und Resilienz auf Depressivität. M.Sc. Thesis, Ruhr-Universität Bochum.
1177 2017. Available from: <https://www.researchgate.net/publication/353609430>
- 1178 43. Gratz K. L., Roemer L. Multidimensional Assessment of Emotion Regulation and
1179 Dysregulation: Development, Factor Structure, and Initial Validation of the Difficulties
1180 in Emotion Regulation Scale. Journal of psychopathology and behavioral assessment.
1181 2004; 26(1):41-54. doi: 10.1023/B:JOBA.00000007455.08539.94
- 1182 44. Gutzweiler R., In-Albon T. Überprüfung der Gütekriterien der deutschen Version der
1183 Difficulties in Emotion Regulation Scale in einer klinischen und einer
1184 Schülerstichprobe Jugendlicher. Zeitschrift für Klinische Psychologie und
1185 Psychotherapie. 2018; 47(4):274-86. doi: 10.1026/1616-3443/a000506
- 1186 45. Bläsing L, Kröner-Herwig B. Self-reported and behavioral sound avoidance in tinnitus
1187 and hyperacusis subjects, and association with anxiety ratings. International journal of
1188 audiology. 2012; 51(8):611-17. doi: 10.3109/14992027.2012.664290
- 1189 46. Gámez W, Chmielewski M, Kotov R, Ruggero C, Suzuki N, Watson D. The Brief
1190 Experiential Avoidance Questionnaire: Development and initial validation.
1191 Psychological Assessment. 2014; 26(1):35-45. doi: 10.1037/a0034473
- 1192 47. Gámez W, Chmielewski M. Kotov R, Ruggero C, Watson D. Development of a
1193 measure of experiential avoidance: The Multidimensional Experiential Avoidance
1194 Questionnaire. Psychological Assessment. 2011; 23(3):692-713. doi: 10.1037/a0023242

- 1195 48. Schaeuffele C, Knaevelsrud C, Renneberg B, Boettcher J. Psychometric Properties of
1196 the German Brief Experiential Avoidance Questionnaire (BEAQ). Assessment. 2021.
1197 doi: 10.1177/10731911211010955
- 1198 49. World Health Organization. International Classification of Functioning, Disability, and
1199 Health: ICF. World Health Organization; 2001.
- 1200 50. Witteman C, Bolks L, Hutschemaekers G. Development of the illness perception
1201 questionnaire mental health. Journal of Mental Health. 2011; 20(2):115-125. doi:
1202 10.3109/09638237.2010.507685
- 1203 51. Gaab J, Latanzia-Bunschoten S, Sprott H. Illness Perception Questionnaire (deutsche
1204 Version). In: Bengel, J, Wirtz, M, Zwingmann, C, editors, Diagnostische Verfahren in
1205 der Rehabilitation. Hogrefe; 2008.
- 1206 52. Pedley R, Bee P, Wearden A, Berry K. Illness perceptions in people with obsessive-
1207 compulsive disorder; A qualitative study. PLOS ONE. 2019; 14(3):1-25. doi:
1208 10.1371/journal.pone.0213495
- 1209 53. Lievens F, De Corte W, Schollaert E. A closer look at the frame-of-reference effect in
1210 personality scale scores and validity. Journal of Applied Psychology. 2008; 93(2):268–
1211 79. doi: 10.1037/0021-9010.93.2.268
- 1212 54. DeSimone, JA, Harms, PD, DeSimone, AJ. Best practice recommendations for data
1213 screening. Journal of Organizational Behavior. 2015; 36(2):171-181. doi:
1214 10.1002/job.1962
- 1215 55. Meade AW, Craig SB. Identifying careless responses in survey data. Psychological
1216 Methods. 2012; 17(3):437-55. doi: 10.1037/a0028085
- 1217 56. Li CH. Confirmatory factor analysis with ordinal data: Comparing robust maximum
1218 likelihood and diagonally weighted least squares. Behavior research methods. 2016;
1219 48(3):936-49. doi: 10.3758/s13428-015-0619-7

- 1220 57. Huber PJ. The Behavior of Maximum Likelihood Estimates under Nonstandard
1221 Conditions. Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics
1222 and Probability. 1967; 5:221-233.
- 1223 58. White H. A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct
1224 Test for Heteroskedasticity. Econometrica. 1980:817-838. doi: 10.2307/1912934
- 1225 59. Rosseel Y. lavaan: An R Package for Structural Equation Modeling. Journal of
1226 Statistical Software. 2012; 48(2):1-36. doi: 10.18637/JSS.V048.I02
- 1227 60. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis:
1228 Conventional criteria versus new alternatives. Structural Equation Modeling. 1999;
1229 6(1):1-55. doi: 10.1080/10705519909540118
- 1230 61. Schermelleh-Engel K, Moosbrugger H, Müller H. Evaluating the Fit of Structural
1231 Equation Models: Tests of Significance and Descriptive Goodness-of-Fit Measures.
1232 Methods of Psychological Research Online. 2003; 8(2):23-74.
- 1233 62. McDonald RP. Test theory: A unified treatment. Lawrence Erlbaum Associates
1234 Publishers; 1999.
- 1235 63. Colorni A, Dorigo, M, Maniezzo V. Distributed Optimization by Ant Colonies. In
1236 Varela F, Bourgine P, editors. Proceedings of the First European Conference on Artificial
1237 Life. 1991. pp. 134-142.
- 1238 64. Stützle T, Hoos H. Max-Min Ant System. Future Generation Computer Systems. 2000;
1239 16(9):889-914. doi: 10.1016/S0167-739X(00)00043-1
- 1240 65. Schultze M. stuart: Subtests using algorithmic rummaging techniques (R package
1241 version 0.8.0). The Comprehensive R Archive Network; 2019. Available from:
1242 <https://CRAN.R-project.org/package=stuart>

- 1243 66. Schultze M. Constructing Subtests Using Ant Colony Optimization. Doctoral
1244 Dissertation, Freie Universität Berlin. Available from:
1245 <http://dx.doi.org/10.17169/refubium-622>
- 1246 67. Yuan K-H, Bentler PM. Three Likelihood-Based Methods for Mean and Covariance
1247 Structure Analysis with Nonnormal Missing Data. *Sociological Methodology*. 2000;
1248 30(1):165-200. doi: 10.1111/0081-1750.00078
- 1249 68. Forero CG, Maydeu-Olivares A, Gallardo-Pujol D. Factor Analysis with Ordinal
1250 Indicators: A Monte Carlo Study Comparing DWLS and ULS Estimation. *Structural*
1251 *Equation Modeling*. 2009; 16(4):625-41. doi: 10.1080/10705510903203573
- 1252 69. Eid, M. A multitrait-multimethod model with minimal assumptions. *Psychometrika*.
1253 2000; 65:241-261. doi: 10.1007/BF02294377
- 1254 70. Eid, M, Lischetzke, T, Nußbeck, F, Trierweiler, L. Separating trait effects from trait-
1255 specific method effects in multitrait-multimethod analysis: A multiple indicator
1256 CTC(M-1) model. *Psychological Methods*. 2003; 8; 38-60. doi: 10.1037/1082-
1257 989x.8.1.38
- 1258 71. D'Agostino A, Covanti S, Monti MR, Starcevic V. Reconsidering motion
1259 Dysregulation. *Psychiatric Quarterly*. 2017; 88(4):807-25. doi: 10.1007/s11126-017-
1260 9499-6
- 1261 72. Eid M, Geiser C, Koch T, Heene M. Anomalous results in G-factor models:
1262 Explanations and alternatives. *Psychological Methods*. 2017; 22(3):541-62. doi:
1263 10.1037/met0000083
- 1264 73. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. New York:
1265 Lawrence Erlbaum Associates Publishers; 1988.
- 1266 74. Cavelti M, Contin G, Beck EM, Kvrjic S, Kossowsky J, Stieglitz RD et al. Validation
1267 of the Illness Perception Questionnaire for Schizophrenia in a German-Speaking

- 1268 Sample of Outpatients with Chronic Schizophrenia. *Psychopathology*. 2012; 45(4):259-
1269 69. doi: 10.1159/000330262
- 1270 75. Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in
1271 behavioral research: A critical review of the literature and recommended remedies.
1272 *Journal of Applied Psychology*. 2003; 88(5):879-903. doi: 10.1037/0021-9010.88.5.879
- 1273 76. Steyer R, Schmitt M, Eid M. Latent state–trait theory and research in personality and
1274 individual differences. *European Journal of Personality*. 1999; 13(5):389-408. doi:
1275 10.1002/(SICI)1099-0984(199909/10)13:5<389::AID-PER361>3.0.CO; 2-A
- 1276 77. McKay D, Acevedo BP. Clinical characteristics of misophonia and its relation to
1277 sensory processing sensitivity: A critical analysis. In: Acevedo BP, editor. *The Highly*
1278 *Sensitive Brain*. Academic Press; 2020. pp. 165-185. doi: 10.1016/B978-0-12-818251-
1279 2.00007-2
- 1280 78. Insel T, Cuthbert B, Garvey M, Heinssen R, Pine DS, Quinn K, Sanislow C, Wang P.
1281 Research Domain Criteria (RDoC): Toward a New Classification Framework for
1282 Research on Mental Disorders. *American Journal of Psychiatry*. 2010; 167(7):748-51.
1283 doi: 10.1176/appi.ajp.2010.09091379
- 1284 79. Conway CC, Forbes MK, Forbush KT, Fried EI, Hallquist MN, Kotov R, et al. A
1285 Hierarchical Taxonomy of Psychopathology Can Transform Mental Health Research.
1286 *Perspectives on Psychological Science*. 2019; 14(3):419-436. doi:
1287 10.1177/1745691618810696
1288

1289 **Supporting information**

1290 **S1 Text. Pretest of the Berlin Misophonia Questionnaire (BMQ) main study**

1291 **S1 Table. Descriptive Statistics and Psychometric Properties of the BMQ-R Items**

1292 **S2 Table. Analyses of the Dimensionality of Highly Correlated BMQ-R Symptom-Scales**