Mimicry in misophonia: A large-scale survey of prevalence and relationship with trigger sounds

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Abstract

Background

Misophonia is often referred to as a disorder that is characterized by excessive negative emotional responses, including anger and anxiety, to "trigger sounds" which are typically day-to-day sounds, such as those generated from people eating, chewing, and breathing. Misophonia (literally 'hatred of sounds') has commonly been understood within an auditory processing framework where sounds cause distress due to aberrant processing in the auditory and emotional systems of the brain. However, recent evidence from brain imaging showing involvement of the motor system while listening to trigger sounds suggests that it is the perception of action (e.g., mouth movement) of the trigger person, and not the sounds per se, that drives the distress in misophonia. Since observation or listening to sounds of actions of others are known to prompt automatic mimicry/imitations in perceivers, we hypothesized that mimicking the action of the trigger person may be prevalent in misophonia. Apart from a few case studies and anecdotal information, a relation between mimicking and misophonia has not been systematically evaluated.

Method

In this work, we addressed this limitation by collecting data on misophonia symptoms and mimicry behaviour using online questionnaires from 676 participants.

Results

Analysis of these data shows that (i) the tendency to mimic varies in direct proportion to misophonia severity assessed using a self-reported questionnaire, (ii) compared to other human and environmental sounds, trigger sounds of eating and chewing are more likely to

trigger mimicking, and (iii) the act of mimicking provides relief from distress to most people with misophonia.

Conclusion

This study shows that mimicry is widely prevalent in misophonia and is elicited by the most common trigger sounds of eating and chewing. The data provides support to the model that misophonia is not a disorder of sound-processing but rather its basis lies in social perception.

Keywords

misophonia, mimicry, social cognition

Introduction

Misophonia, literally 'hatred of sounds', is a disorder characterized by strong negative behavioral and physiological emotional responses to certain specific sounds which we come across frequently in our day-to-day life (Jastreboff and Jastreboff, 2001; Kumar et al., 2014; Brout et al., 2018; Swedo et al., 2022). In typical cases of misophonia, these 'trigger sounds' tend to be sounds of eating, drinking, breathing, and chewing produced by other people. The emotional response to trigger sounds includes feelings of anger, irritation, anxiety, and disgust accompanied by a strong urge to escape from the situation in which trigger sounds are produced. Since trigger sounds are common and almost inescapable in social situations, misophonia has debilitating effects on occupational, family, and social life. A person with misophonia, for example, might not have a meal or share a common space with other family members, avoid using public transport for travel, and will tend to avoid social situations at their workplace. This social isolation, particularly in severe cases of misophonia, has a high impact on mental health, and cases of suicide or suicide attempts have been reported in the academic literature (Siepsiak et al., 2022) and media (Nauman, 2017), with up to 20% of people with misophonia indicating they have had thoughts of suicide (Rouw and Erfanian, 2018). Although the exact prevalence of misophonia is not known due to a lack of any comprehensive epidemiological study, a few studies (Wu et al., 2014; Zhou et al., 2017; Naylor et al., 2021) targeting specific populations (i.e., students) have reported a prevalence of anywhere between 5 and 20%.

The mechanism of misophonia remains largely unknown. A dominant paradigm to understand misophonia currently is the 'auditory processing framework', in which misophonia is considered a disorder of sound processing (Jastreboff and Jastreboff, 2001; Jastreboff and Jastreboff, 2015).In this framework, trigger sounds cause aberrant processing in the

auditory/emotion processing parts of the brain which subsequently drives the emotional response in those with misophonia (via a currently unknown mechanism). The fact that many typical trigger sounds are generated by other people, is completely ignored in the auditory framework, as is the fact that the context in which trigger sounds are produced is largely social, and that people with misophonia can be triggered by particular individuals (e.g., close family members or someone familiar) but not by others. In other words, the current auditory-focussed model of misophonia employs a 'detached' framework where sounds are isolated from the social context in which they typically occur. There is now overwhelming evidence that the brain processes social signals in a different way to non-social signals (for reviews see (Adolphs, 2010; Molapour et al., 2021)). For example, brain imaging in social cognitive neuroscience has shown that specialized cognitive processes implemented in dedicated brain structures are employed to extract socially relevant information such as faces (Kanwisher et al., 1997), voices (Belin et al., 2000), the body as a whole (de Gelder et al., 2010), and other 'higher order' social information such as mental states of other people (Frith and Frith, 2006). In other words, these brain structures become active only in response to sensory stimulation in social situations and they work differently or are 'silent' when dealing with non-social sensory input. This has important implications for misophonia: emphasis only on the auditory/sound dimension while completely ignoring or delinking the 'social' aspect of misophonia may hinder progress in understanding the perceptual/cognitive processes and underlying brain mechanisms.

Using an integrated 'framework', where both trigger sounds and their social source are considered together, a different picture of misophonia emerges. Since the trigger sounds, for example someone eating/chewing, are associated with an action (e.g., orofacial movement) of another person, it could be the case that misophonic distress is due to the perceived action of others and not due to the sound per se, which is a by-product of that action. In social cognition and neuroscience, it is well known that mere observation or hearing the sounds of actions of other leads to 'mirroring' or 'mimicking' of the same actions by the perceiver without any intention or awareness to do so (Chartrand and van Baaren, 2009; Heyes, 2011; Chartrand and Lakin, 2013). The mechanism behind mimicry is commonly understood within the framework of a 'perception-action' link, which posits that perceiving the action of others automatically activates representations of that action in the perceiver which, in turn, executes movements that are congruent to the perceived actions. With respect to brain function, the 'perception-action' link is instantiated as communication between sensory areas and the motor areas of the brain. With emphasis on action of the trigger-person, could it be that the perception-action link is relatively stronger in misophonia which is activated by the sight or sounds of action? Initial evidence for activation of the perception-action link and 'mirroring' of

actions in misophonia was provided by a recent study (Kumar et al., 2021) from our group. The study, using functional magnetic resonance imaging (fMRI), demonstrated that in the resting state, when no explicit stimuli are presented, people with misophonia, who had eating/chewing sounds as their dominant triggers, show stronger connectivity (compared to control subjects) of auditory and visual cortex to a part of the pre-motor cortex involved in the movement of orofacial muscles (movement of mouth, lip, tongue etc). An implication of the stronger resting state connectivity is that the orofacial motor cortex may be 'primed' to respond strongly to auditory and visual stimulation arising from the (orofacial) actions of others. This was supported by the study showing that activation of the orofacial motor cortex was stronger, specifically for trigger sounds (mostly orofacial in nature) in misophonia.

One implication of the evidence from our neuroimaging data is that mimicry should be widely present in the misophonia population. With respect to misophonia, there are anecdotal reports of people mimicking the actions of the trigger person, but the effect has not attracted much attention within misophonia research, except for a couple of case reports. In a report of two misophonia subjects (Hadjipavlou et al., 2008), one subject who had eating /chewing sounds as triggers had urges to mimic the sounds by moving their lips and mouth. In another study, Edelstein et al. (2013) reported 6 out of 11 subjects (55%) having a tendency to mimic the sounds. Within the 'auditory framework' mimicry is difficult to explain, whereas the social/action framework suggests mimicry would be present in people with misophonia.

To address the relation between misophonia and mimicry, we asked more than 600 participants to complete online questionnaires relating to their misophonia severity and their tendency to mimic the sounds/action of the trigger person. More specifically we explored the following: (i) with increasing misophonia severity, how likely people with misophonia are to mimic, (ii) whether the act of mimicking relates to a particular set of trigger sounds (i.e., social), and (iii) what effect mimicking has on individuals with misophonia. Our data suggest that the tendency to mimic is associated with misophonia severity and that the act of mimicking provides relief. The current data, along with results from our neuroimaging study, provide support for a social cognition-based model of misophonia.

Method

Participants

Participants for the study were recruited either by advertisements on internet websites/social media platforms that served the purpose of being misophonia support groups: 'sounds like misophonia' (https://soundslikemisophonia.com/); 'Allergic to Sound'

(https://allergictosound.com/), or by sending emails to volunteers registered with the Institute of Neuroscience at Newcastle University (UK). A total of 816 participants took part in completing the online questionnaire. However, in guidance with exclusion criteria, participants were removed from analysis if they: (i) did not give informed consent ($n = 20$), (ii) were under the age of 18 years ($n = 106$), or (iii) if the data were duplicated ($n = 14$). Data from a final total of 676 participants (505 (74.7%) females, 166 (24.6%) males and 5 (0.7%) 'other'/ 'preferred not to disclose gender') were entered into the analysis. Participants were aged between 18 and 81 years ($mean = 38.39$ years, $SD = 16.10$). Participants were asked if they had any other neurological/psychological disorder besides misophonia, 453 (67%) reported 'no', 203 (30%) reported 'yes', and 20 (3%) 'preferred not to say'. Meaning over half of the participants did not indicate having any other neurological/psychological disorders outside of their misophonia. An incentive was offered to participants where they could enter a prize draw to win one of three £20 Amazon vouchers for their participation.

Materials

A set of questionnaires using Google forms were created and an online link to these was made available on internet websites/social media or by email. As part of a larger research program to collect behavioural symptoms in people with misophonia, subjects completed a range of questionnaires designed to assess social, emotional, and physiological impacts of misophonia. In the current study, data from only two questionnaires, (i) Misophonia Questionnaire (MQ) (Wu et al., 2014) and (ii) a newly developed Iowa Mimicry Questionnaire (IMQ), is analysed and reported.

The MQ consists of three parts, the first part being the Misophonia Symptom Scale which is designed to examine the specific sound categories that a person with misophonia is sensitive to, for example, eating, repetitive tapping and throat sounds, among others. The second part is the Misophonia Emotions Scale, which examines the emotional and behavioural responses associated with misophonia symptoms. Each question in these two parts is scored on a 5-point Likert scale from 'Not true at all' (0) to 'Always true' (4). The third and final part is the Misophonia Severity Scale, which allows participants to provide a rating of their overall sensitivity to sounds on a scale from 0 to 15 (please note that the original questionnaire in Wu et al (2014), used a scale from 1 to 15. We included '0' in the scale to indicate 'no sensitivity at all'). A brief description of what numbers from 0 to 15 is meant to represent in relation to severity was given to help inform participants how to rate their sound sensitivity. For example, '0 to 3; Minimal within range of normal or very mild sound sensitivities ("I spend little time resisting or being affected by my sound sensitivities. Almost no or no interference in daily activity").

The IMQ was developed in our lab to assess prevalence of mimicry and its effect on perceived distress in misophonia. The IMQ consists of a set of five questions which were scored on a 5-point Likert scale from 'Never' (0) to 'Always' (4). The first question ("Do you ever start mimicking the action or sound of the trigger person?") addressed the incidence of mimicking. The remaining four questions, which were answered only if the answer to the first question was in the affirmative, assessed the automaticity/self-control over mimicry and the relief, if any, that arises from the act of mimicking The IMQ is provided in Appendix 1.

Procedure

This study was approved by the Newcastle University Ethics Committee. The questionnaires were constructed and hosted using Google Forms. An information page was first displayed to the participants, which briefed them about what the questionnaire entailed and the necessary inclusion criteria, such as the requirement to be 18 years old or above to take part in the study. Consent was then obtained via a Yes/No question. In conformity with data protection ethics, anonymity of personal data was maintained by a randomly assigned ID. Participants were reminded of their right to withdraw from the study at any time and were provided with the contact details (email) of the lead researcher in case of any query from them. Participants then completed the questionnaires, which comprised 64 questions in total that took approximately 20 minutes to complete. When finished, participants received a debrief screen thanking them for their participation and directing them to contact, if needed, the researcher via email.

Statistical Analysis

Statistical analysis was performed using IBM SPSS (28.0; IBM Corp, 2017), MATLAB (version R2020a, MathWorks), and JASP (Version 0.16; JASP Team, 2021).

To assess if the severity of misophonia predicts the prevalence of mimicry, we employed binomial logistic regression with mimicking (yes/no) as a response variable and severity of misophonia (range 0 to 15) as the explanatory variable. We also explored whether the tendency to mimic depends on any particular sound category. To assess this, we used a multivariable logistic regression with mimicking (yes/no) as a response variable and the distress experienced on 7 different sound categories (people eating, repetitive tapping, rustling, nasal sounds, throat sounds, consonant/vowels, environmental sounds) as explanatory variables.

Misophonia scores for different sound categories tend to be correlated: somebody triggered by eating sounds could also be triggered by nasal/throat sounds and other related sounds as well. A multivariate analysis using principal component analysis (PCA) can take into consideration the correlation among variables and aims to find common latent variable/s underlying the measured variables. We ran PCA with promax rotation on the data consisting of 8 variables (distress on 7 sound categories and mimicry) from 676 participants. Component loadings > 0.5 were considered meaningful and significant.

Results

The distribution of the misophonia severity scores (mean = 7, standard deviation = 2.85) in our sample of participants ($n = 676$) is shown in Figure 1A.

Figure 1B shows the distribution of different trigger types in the current data set. Eating sounds are the dominant trigger type, which is consistent with previous studies (Kumar et al, 2014; Rouw and Erfanian, 2017).
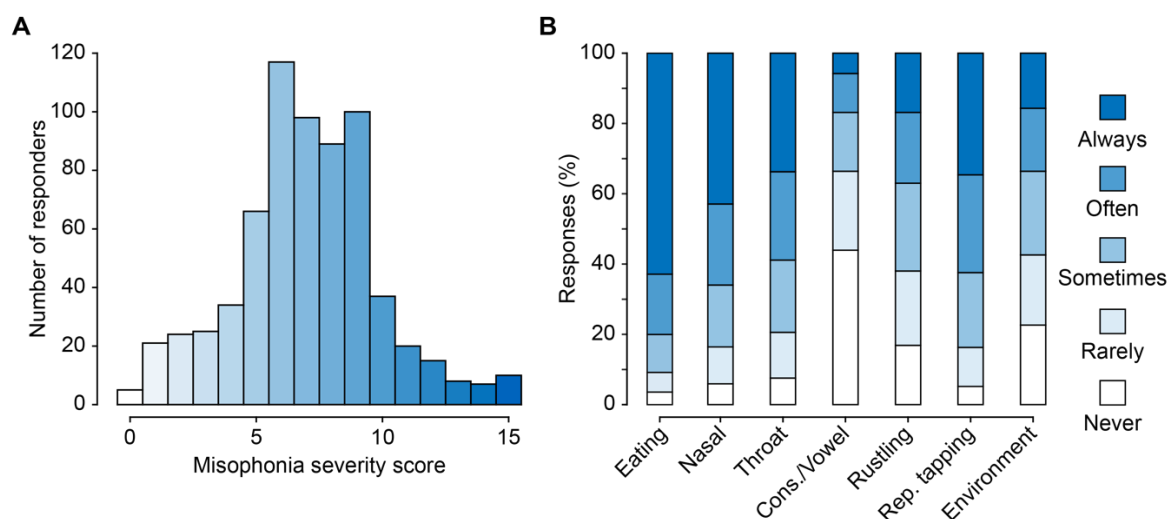

Figure 1: A. Distribution of misophonia severity scores across all participants (n = 676). B. Distribution of different trigger types across all participants (n = 676).

Figure 2A shows the relation between the likelihood of mimicry and misophonia severity using univariate logistic regression. The probability to mimic increased as a function of misophonia severity (X^2 (1, $n = 676$) = 47.42, $p < .001$; Figure 2A). The model explained 9% (Nagelkerke R^2) of the variance and correctly classified 59.8% of cases, with an odds ratio (OR) of 1.219.

After confirming the relation between mimicry and overall misophonia severity we explored whether mimicking was associated with triggers of a particular type. Multivariable logistic regression was performed, with mimicking as a response variable and sensitivity on seven different sound categories as explanatory variables. Results of this model are shown in Table 1. Overall, the model could successfully predict the outcome in 59% of cases (X^2 (1, $n = 676$) = 40.86, $p < .001$) and explained 7.8% (Nagelkerke R^2) of the variance. Sensitivity for eating sounds was the greatest predictor of mimicry (OR = 1.341; $p = .001$) followed by sensitivity for consonant/vowel sounds (OR = 1.154; $p = 0.046$). No other sound category had a significant relationship with mimicking. Plots of odds ratio for each sound category with 95% confidence intervals are shown in Figure 2B.

Table 1. Multivariable logistic regression, predicting the likelihood of mimicry occurrence as a function of misophonia distress for different sound categories.

							95% CI for Exp(B)	
	B	*SE*	Wald	*df*	*p*	OR	LL	UL
Eating	.294	.092	10.099	1	.001**	1.341	1.119	1.607
Repetitive Tapping	-.141	.091	2.401	1	.121	.868	.726	1.038
Rustling	.061	.078	.601	1	.438	1.062	.912	1.238
Nasal	.185	.100	3.410	1	.065	1.203	.989	1.463
Throat	.012	.091	.018	1	.894	1.012	.846	1.211
Consonant/Vowel	.143	.072	3.989	1	.046*	1.154	1.003	1.328
Environment	-.073	.071	1.077	1	.299	.929	.809	1.067

If p-value is less than .05 (*), less than .01 (**), and less than .001 (***).
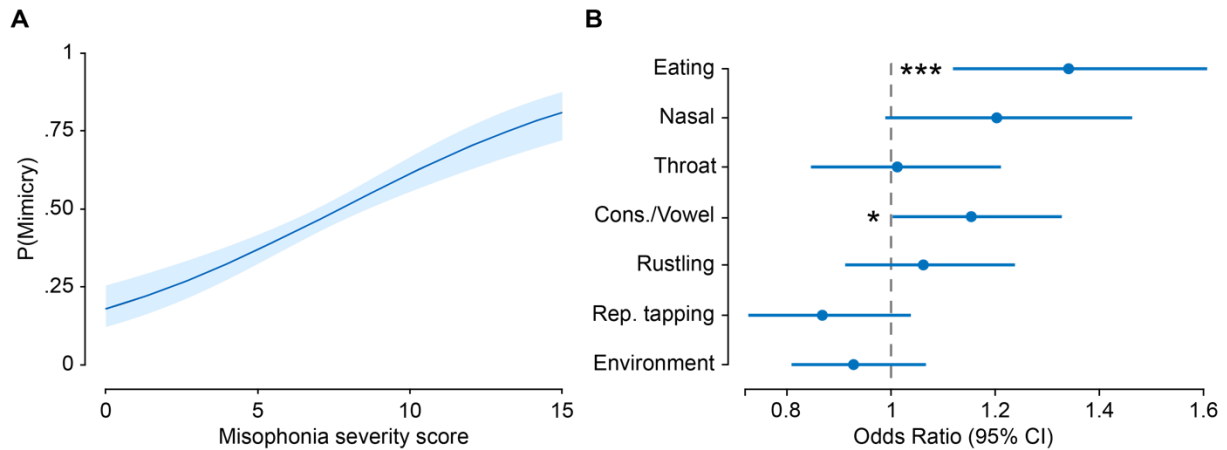
Figure 2: A. Univariate logistic regression showing the probability to mimic in relation to misophonia severity score. B. Odds Ratio (OR) with 95 % confidence limits for different trigger sound categories.

To identify patterns of relationship between mimicry and different sound categories, we performed principal component analysis on 8 variables: mimicry and the severity score on 7 sound categories. The PCA revealed two components which explained 56.6% of the variance. Loadings of the two components are shown in Figure 3. Notably, orofacial related trigger sounds such as, eating, nasal, and throat sounds loaded significantly onto the second component whereas environmental and non-orofacial sounds, such as repetitive tapping and rustling, loaded significantly onto the first component. Importantly, 'mimicry', loaded onto the same component as orofacial sounds thus highlighting that mimicry and distress for orofacial sounds are more strongly associated with one another in relation to misophonia, compared to other types of trigger sounds.
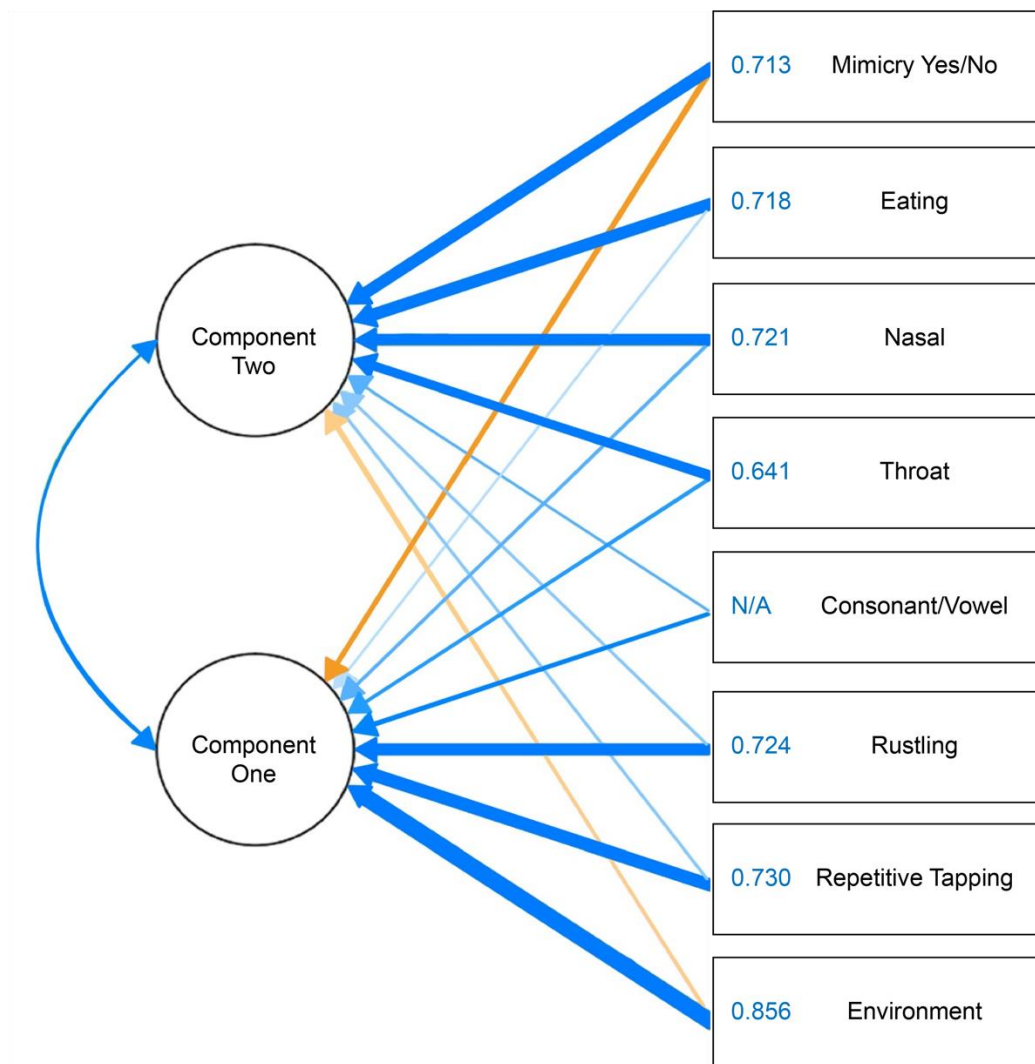
Figure 3. Principal component analysis with promax rotation. The two components are represented by circles and the different variables are represented by boxes. Values within boxes and the thickness of arrows going from variables to a component represent the strength of loading on the two components. Blue indicates positive loading and orange indicates negative loading; the loading values displayed in the boxes are the positive direction loadings (blue arrows) corresponding to the larger of the two loadings. Only loading values greater than 0.5 are shown.

After examining the prevalence of mimicry and its relationship with different sound categories, we sought to understand what role mimicry has on misophonic distress and whether it was 'automatic' or under voluntary control, utilizing the newly designed IMQ. In response to the question related to control of mimicry, 80.4% of participants reported that mimicking was under their control, and they performed it deliberately (those that responded 'sometimes', 'often' or

always'). In terms of the effect of mimicking on distress, 68% reported that mimicking provided relief from distress to triggers sounds and 60.4% reported that the act of mimicking makes them feel under control. Figure 4 shows the distribution of participant responses on the IMQ.
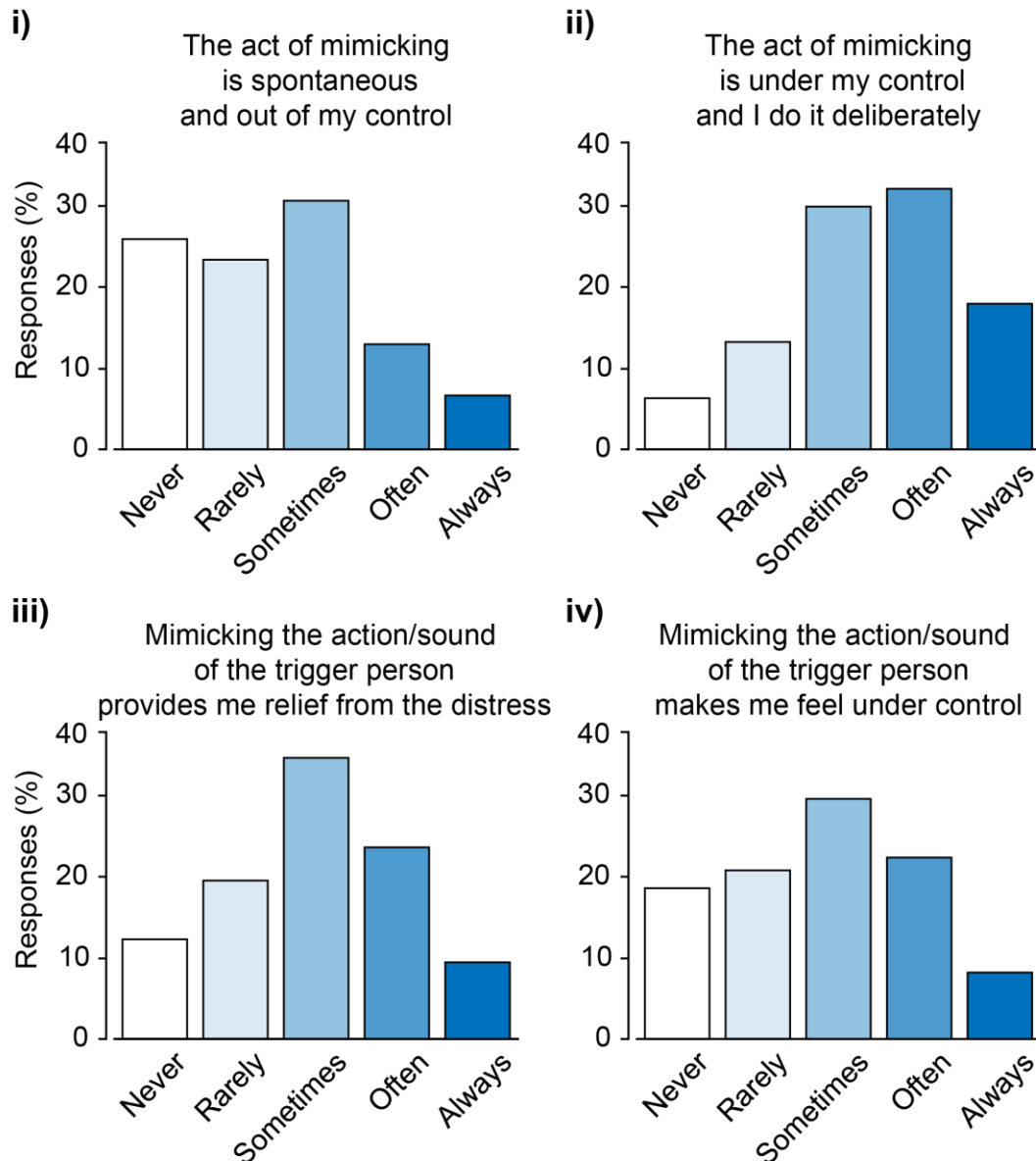
i)

The act of mimicking
is spontaneous
and out of my control

ii)

The act of mimicking
is under my control
and I do it deliberately

iii)

Mimicking the action/sound
of the trigger person
provides me relief from the distress

iv)

Mimicking the action/sound
of the trigger person
makes me feel under control

Figure 4: Response proportions for the IMQ.

Discussion

Examining the largest sample of misophonia participants to date, the aim of this study was to investigate the relationship between misophonia and mimicry. More specifically, three questions were addressed: (i) relationship between the likelihood to mimic as a function of

misophonia severity, (ii) whether the act of mimicking was related to a particular set of trigger sound categories (as defined by the MQ (Wu et al., 2014)), and (iii) what benefits, if any, mimicking provided to people with misophonia (identified through the IMQ).

Our results show that mimicry is widely prevalent in misophonia and that its likelihood increases with greater misophonia severity. This finding is consistent with results from a recent neuroimaging study from our group (Kumar et al, 2021), which for the first time hypothesized the role of 'mirroring' the action, and not the sounds per se, as the primary driving factor in misophonia. The neuroimaging study, by showing stronger resting state connectivity between auditory and visual cortex and the pre-motor area of the brain in misophonia, argued that watching or hearing action sounds (e.g., orofacial movement for eating/ chewing sounds) of the trigger-person results in driving the same part of the motor cortex that is involved in generating the perceived action. The current study, based on self-reported measures of how people with misophonia respond to and cope with triggers in daily life, provides support to the 'hyper-mirroring' hypothesis of misophonia.

The phenomenon of mimicry is ubiquitous in social interactions and has been a well-researched topic in social psychology and neuroscience (Prochazkova and Kret, 2017; Arnold and Winkielman, 2020; Palagi et al., 2020). Mimicry can be broadly divided into two categories: intentional and spontaneous. Intentional mimicry (sometimes also called imitation or emulation) involves explicit intention to copy and reproduce somebody else's actions. In a misophonia context, this would be the case when a person with misophonia, on seeing/hearing the actions (e.g., orofacial movement for eating/chewing sounds) of the trigger-person, deliberately repeats the observed action. Spontaneous mimicry, on the other hand, is the automatic reproduction of another individual's motor movements, behaviour, or facial expression without explicit intention or awareness to do so. For example, in a seminal study (Chartrand and Bargh, 1999) demonstrating spontaneous mimicry, a confederate manipulated her actions while interacting with participants: in different sessions, she either touched her face or shook her leg while both the confederate and participants were involved in an irrelevant task of describing pictures to each other. Analysis of video recording of the interaction showed that participants touched their face more in the presence of a face-touching confederate and wiggled their foot more in the presence of a foot-shaking confederate. Debriefing after the experiment showed that participants did not notice any 'odd' behaviour of the confederate and were not aware of their mimicking of the actions of the confederate implying that reproduction of the actions was implicit and unintentional. With respect to misophonia, spontaneous mimicry would occur if mere observation or listening to the trigger sounds of action automatically elicits a corresponding action (e.g., orofacial movements for eating/chewing sounds) in a person with

misophonia with them not knowing anything about it. Although not within the misophonia context, spontaneous mimicry has been shown in the domain of eating behaviour: people are more likely to take a bite of food or sip of a drink when their companion does so (Larsen et al., 2010; Hermans et al., 2012; Bell et al., 2019). Even the sounds of eating alone can elicit eating mimicry in the listener (Zin et al., 2015).

How does misophonia relate to mimicry? The basic premise of our argument is that misophonia is a result of increased spontaneous mimicry in response to the actions (e.g., orofacial movement) of the trigger-person that produce trigger sounds (e.g., eating/chewing sounds). The excessive spontaneous mimicry, which possibly arises due to the failure of contextual modulation (either amplified in excess or not suppressed enough by the contextual/situational settings) is then perceived as inappropriate in terms of interfering in a person's current goals and actions. This strong drive, initiated by an external source, to repeat the actions can be felt as violating or invading personal space or can lead to a sense of loss of self-control. This is consistent with people with misophonia describing their experience of trigger sounds as 'invasive', 'intrusive', 'insulting', 'violating' and 'offensive' (Rouw and Erfanian, 2018). There is also evidence that trigger sounds are perceived as interfering in one's current goals. In a study using a Stroop task, Daniels et al (2020) showed that people with misophonia are impaired in maintaining the current goals of the task specifically in the presence of trigger sounds. Since perceived interference, particularly when it is attributed to another social agent, can be a cause of anger (Izard, 1991), this also explains why anger, and in extreme cases, aggression could be a dominating emotional response in misophonia. One possible way to counter the covert drive for spontaneous mimicry is to overtly mimic the action of the trigger-person (e.g., orofacial movements in response to sounds of eating/chewing). The overt mimicry, in contrast to implicit and unintentional spontaneous mimicry, is intentional and done voluntarily as a coping mechanism to 'cancel out' the trigger sound. The reason why overt mimicry in misophonia can 'dampen' the response to the external trigger is that self-executed movement alone (with or without any sound generation, e.g. orofacial movement) done in synchrony with external movements can lead to predictions about the upcoming stimulus, much like an efference copy or corollary discharge making a prediction of the sensory consequences of self-generated actions (Blakemore et al., 2000), which is then compared with the actual stimulus and the discrepancy between the two (prediction error) is processed further. The amount of dampening of the trigger stimulus would depend on how accurately the self-action can predict the stimulus: the higher the accuracy of prediction, the lower the prediction error and thus the greater the relief provided by the overt mimicry. Moreover, the overt mimicry can provide an increased sense of self-control: rather than being a 'passive' recipient of the excessive drive to spontaneously mimic the actions of the trigger-

person, the person with misophonia can now do the same action which is under their control. This is in agreement with subjective reports of several people with misophonia who describe their act of deliberate mimicking as a means of 'gaining control over the situation' (as told to the senior author in personal communication/discussion).

Our data show that the probability of mimicking increases with misophonia severity (Figure 1). When asked about the type of mimicry, 50.5 % (sum of 'sometimes', 'often' and 'always', Figure 4(i)) described their mimicry to be spontaneous and out of their control. About 80% (Figure 4(ii)) of people who reported mimicking, described their act as deliberate and voluntarily driven. As predicted by our model, intentional mimicry provides relief (reported by 68%, Figure 4(iii)) and makes the person feel under control (60.4 %, Figure 4(iv)).

Analysis using multivariable logistic regression showed that, out of all the different types of sound categories examined, sensitivity to eating sounds was the strongest predictor of mimicry (Table 1 and Figure 2). Multivariate analysis using PCA showed that eating/nasal/throat sounds and mimicry loaded onto the same component with high positive loadings implying a positive association between the component and these variables. The eating/nasal/throat sounds are orofacial (face/mouth) sounds involving movement of orofacial muscles and these sounds happen to be the dominant trigger sounds in misophonia (Schröder et al., 2013; Kumar et al., 2014; Jager et al., 2020). We understand there are trigger sounds which are of non-orofacial origins (Hansen et al., 2021) such as pen clicking, keyboard typing, and other environmental sounds. Although the questionnaire did not have mention of these specific sounds, it did include 'environmental sounds' as one of the categories and no mimicking effect was observed using either logistic regression or PCA. However, this category is very broad and whether mimicking is restricted to a specific example of this category needs further investigation. The questionnaire also contained a 'repetitive tapping sound' which is the closest possible to clicking pen/keyboard typing but no mimicking effect was observed. Although we did not find evidence of mimicking for non-orofacial sounds, the question remains open. One explanation is likely due to the under-representation of triggers of non-orofacial origin in the current sample size given the high prevalence of orofacial sounds as triggers. This would require a further study which balances representation of different trigger types in the sample. Interestingly, logistic regression analysis also showed consonant/vowel sounds significantly correlated with mimicry. Whether these sounds trigger reaction because of the speech/linguistic content or because these sounds are mouth sounds is not clear and their relation to mimicry needs further investigation.

What is the brain mechanism of excessive spontaneous mirroring in misophonia? There is evidence that a 'mirror neuron system' (MNS) which contains 'mirror-neurons' may underly mimicry in humans (Buccino et al., 2001; Rizzolatti and Craighero, 2004). Mirror neurons fire not only when the subject executes an action but also when the subject sees or hears the action performed by another individual, thereby creating a 'perception-action' link. In our recent study (Kumar et al., 2021), based on the findings of stronger coupling between auditory (and visual) cortex and orofacial motor cortex in people with misophonia, we argued for 'hyper-mirroring' as the basis of misophonia. This means that the perception of seeing or hearing another individual producing eating/chewing sounds is 'mirrored' in the orofacial motor cortex to a greater degree in people with misophonia compared to control participants. This hyper-mirroring then reproduces the action which manifests as (spontaneous) mimicry. Our brain model of 'hyper-mirroring' and prevalence of spontaneous mimicry in the current work are therefore consistent with each other.

In summary, our current work shows that mimicry is widely prevalent in misophonia and is elicited by the most common trigger sounds of eating and chewing. These data reinforce the idea of hyper-mirroring in misophonia proposed in our earlier work (Kumar et al., 2021). This idea proposed that it was the action of the trigger-person and not the sounds per se as the driving factor of distress in misophonia. By emphasizing the action of another social agent and not the sounds which are only a by-product of that action, the hyper-mirroring model recommends that misophonia should be understood within the framework of social perception and cognition, and not within an auditory framework that only considers the sound and ignores the social source from which it originates. These data thus have crucial implications for how we treat and interpret misophonia moving forward.

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