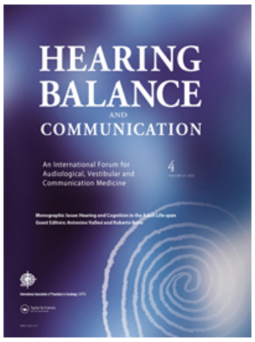

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ORIGINAL ARTICLE

Assessment of temporal auditory processing in individuals with misophonia

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ABSTRACT

Objective: Misophonia is characterised by abnormal reactions to certain sounds such as sounds of eating, breathing, nose sniffing. Misophonia can be seen in individuals with normal hearing or hearing loss. The aim of this study to evaluate central auditory processing in misophonia patients with temporal processing tests, such as the Frequency Pattern Test (FPT), Duration Pattern Test (DPT), and Gaps-in-Noise Test (GIN).

Methods: Thirty patients with misophonia and 30 healthy control subjects were included in this study. The pure tone audiometry test, tympanometry test, and acoustic reflex test were administered to all participants. The DPT, FPT, and GIN tests were conducted with all participants.

Results: There was no significant difference in the DPT scores between the two groups for both ears ($p > .05$). There was no significant difference in the FPT scores between the two groups for both ears ($p > .05$), and there was no significant difference in the GIN scores and GIN threshold ($p > .05$).

Conclusions: There was no difference between the healthy individuals and the misophonia patients when the temporal process of central auditory processing was evaluated.

KEYWORDS
Central auditory processing; misophonia; frequency pattern test; gaps-in-noise; duration pattern test

Introduction

Misophonia is a disorder that is characterized by abnormal reactions to certain sounds. It was first defined by Jastreboff [1]. Misophonia is usually caused by bodily sounds, such as the sounds of eating, breathing, nose sniffing, whistling, lip smacking, and finger or foot tapping. It can also be caused by pen tapping, pen clicking, gum popping, clock ticking, noise from an airplane, train, or engine, and animals. Among them, eating and breathing are the sounds most often associated with misophonia [2,3]. Misophonia can cause pain or tightness in the head, arms, and chest. Diaphoresis, dyspnoea, tachycardia, hypertension, and hyperthermia can also occur [3]. Misophonia most often occurs throughout childhood and adolescence [4]. Misophonia can be seen in individuals with normal hearing or hearing loss [1].

In a study by Schröder et al. with 20 patients with misophonia and 14 control individuals, the brain's early auditory processing system was examined. They found that there were no differences for the P1 and P2 components between the control and misophonia groups, but the mean amplitude of the N1 component was significantly diminished in the misophonia group. It has been suggested that diminished N1 amplitude in misophonia patients may be due to impairment in auditory processing or psychiatric comorbidity or using psychotropic medicine [5].

Auditory temporal processing may be defined as the perception of the temporal characteristics or the alteration of durational characteristics of a sound within a restricted or defined time interval [6]. Temporal processing tests, such as the Frequency Pattern Test (FPT), Duration Pattern Test (DPT), and Gaps-in-Noise Test (GIN), are very important in the evaluation of central auditory processing [7].

The aim of this study was to evaluate auditory processing with the FPT, DPT, and GIN in patients with misophonia.

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Materials and methods

Ethical considerations

The study was approved by the Institutional Review Board (77192459-050.99-E.634), and informed consent was obtained from each individual. The study was done in accordance with the Declaration of Helsinki.

Subject selection

Misophonia Assessment Questionnaire (MAQ) was applied to the students and staff of Karabuk university. Detailed anamnesis was taken from the individuals with the complaint of misophonia according to MAQ. Also, the conditions mentioned in Table 1 were taken into consideration to diagnose misophonia in the individuals with the complaint of misophonia (Table 1) [8]. Thirty patients who presented with the complaint of misophonia and 30 healthy control subjects were included in this study. Individuals with systemic, neurological, or otological disorders as well as audiological complaints, such as tinnitus and hearing loss, were excluded from the study.

Study protocol

The pure tone audiometry test, tympanometry test, and acoustic reflex test were administered to all participants. To assess middle ear function, a tympanometry test was conducted with the AZ26 Impedance Audiometer (Interacoustics). The DPT, FPT, and GIN tests were conducted with all participants. These tests were conducted with The Madsen Astera 2 (GN Otometrics, Taastrup, Denmark) computerized audiometer device and TDH-39 supra-aural headphones with 50 dB nHL intensity level and wav. format. Pure tone audiometry at any frequency with 250–8000 Hz <20 dB HL was considered normal hearing. All of the participants had normal hearing. VAS (The visual analog scale) score were used to evaluate the severity of misophonia. The VAS score ranges from 0 to 10. The MAQ questionnaire consists of 21 questions. In scoring, each question ranges from 0 to 3 and the total score is calculated over 63 points.

Duration pattern test

The duration pattern is made up of three tones with 1000 Hz and two 300 msec intertone intervals [9]. The tones are either 250 ms (short) or 500 ms (long) in duration. There are a total of 66 patterns in long (L) and short (S) duration sounds. There is a 6 s gap between each pattern. In all participants, the test was started from the right ear and 66 patterns were performed sequentially. The participants were asked to define the sounds in terms of being short or long (LLS, LSL, LSS, SLL, SLS, SSL). The pattern test was considered wrong when the sounds in the pattern were misinterpreted or reversed. The first six patterns were given as an exercise to the participants, and the score was not included in the calculation. The total score was calculated over 60 patterns, and the test was applied sequentially to both ears (Table 2).

Frequency pattern test

The frequency pattern is made up of three 150 ms and two 200 ms tones. The tones are composed of two sounds with frequencies of 880 Hz (low frequency) and 1122 Hz (high frequency). There are a total of 60 patterns in three rows of these sounds, and there is a 6 s gap between the patterns. The

Table 1. Proposed diagnostic criteria for misophonia.

1- A specific sound produced by a human leads to irritation and disgust, which can turn into anger.
2- This anger creates a feeling of profound loss of self-control with rare but aggressive outbursts.
3- Patients know that the anger or disgust is irrational and excessive and also accept that it is not commensurate with the provoking stress factor.
4- The individual tries to avoid the misophonic state. If it cannot be avoided, intense discomfort, anger, or disgust are experienced.
5- Anger, disgust, or avoidance of the trigger sound cause serious distress or serious interference with the person's daily life. For example, it can make it difficult for a person to perform important tasks at work, make new friends, attend classes, or interact with others.
6- The person's anger, disgust, and avoidance are not better explained by another disorder, such as obsessive-compulsive disorder (e.g. disgust in someone with an obsession about contamination) or post-traumatic stress disorder (e.g. avoidance of stimuli associated with a trauma related to threatened death, serious injury or threat to the physical integrity of self or others).

Table 2. The number of correct answers of duration patterns and frequency patterns were given.

	Right ear			Left ear		
	Misophonia group	Control group	*p* Value	Misophonia group	Control group	*p* Value
Duration patterns	56 (44–60)	56 (40–60)	0.800[b]	60 (36–60)	56 (44–60)	0.278[b]
Frequency patterns	33.50 ± 10.47	36.60 ± 6.85	0.180[a]	33.70 ± 10.01	37.46 ± 8.27	0.118[a]

[a]*T*-test, Mean ± SD.
[b]Mann Whitney-*U* test, median (min–max).

participants were asked to define the sounds in terms of being high frequency (H) and low frequency (L) with six combinations of three sequences (LHL, LLH, LHH, HLH, HLL, HHL). When the participants answered incorrectly, the order of the sounds in the pattern was considered incorrect. The first 10 patterns were given as an exercise to each individual, and the score was not included in the calculation. The total score was calculated over 50 patterns, and the test was applied sequentially to both ears (Table 2).

Gaps-in-Noise Test

The GIN consists of a total of 30 broadband noises of 6 s in length. There is a 5 s gap (rest time) between each noise. Within this noise, there are gaps ranging in length from 2 to 20 ms (2, 3, 4, 5, 6, 8, 10, 12, 15, and 20 ms). The number of gaps in the noise ranges from 0 to 3 (0, 1, 2, 3). There are a total of 60 gaps, each of which has six gaps. The participants were asked to listen carefully to the noise and to say it out loud when they felt the gaps in the noise. The test was explained in detail, and each patient underwent three noise exercises. The GIN score and the gaps-in-noise threshold (GINT) were determined for each ear at the end of the test. In order to calculate the GINT, four correct shortest answers of the six gaps were required. In addition, for each ear, the gaps in the noise heard by the individual were collected and the number of gaps heard was calculated (Table 3).

Statistical method

The statistical analysis was performed using SPSS 19.0 software (SPSS Inc., Chicago, IL, USA). In order to evaluate the age variable between the groups, the Mann-Whitney *U*-test was applied. The chi-square test was used to evaluate the gender variable between the groups. Pearson correlation test was used to evaluate the relationship between VAS, MAQ, and central auditory processing tests when the data were distributed normally. The spearman correlation test was used when the data were not distributed normally.

Results

The mean age of the 30 patients with misophonia was 25.10 ± 7.80 (18–49) years. There were 20 (66.66%) females and 10 (33.33%) males. The mean age of the 30 control subjects was 23.57 ± 8.74 (18–50) years. Nineteen (63.33%) were female and 11 (36.66%) were male. There was no difference between the two groups in terms of age and gender ($p = 0.205$, $p = 0.787$, respectively).

Fourteen (46.66%) of the 30 individuals with misophonia were irritated especially by mouth mouth-smacking sounds, seven (23.33%) by breathing sounds, four (13.33%) by creaking sounds, three (10.00%) by heeled shoe sounds, one (3.33%) by sniffle sounds, and one (3.33%) by hand rubbing sounds.

There was no significant difference in the DPT scores between the two groups for both ears ($p > 0.05$). There was no significant difference in the FPT scores between the two groups for both ears ($p > 0.05$), and there was no significant difference in the GIN scores and GINT ($p > 0.05$) (Tables 2 and 3).

The mean MAQ score was 29.06 ± 9.71 and VAS score was 8 (6–10) in patients with misophonia. There was no correlation between VAS, MAQ score and the DPT, the FPT, the GIN scores ($p > 0.05$) (Table 4).

Discussion

Recent studies have reported a high incidence of misophonia. In a study conducted with 483 undergraduate students, it was found that 22.8% had misophonia [10]. In addition, it was reported that the rate of those who were annoyed by throat sounds was 19.5%, and the rate of people who were irritated by the rustling of paper was 16.1% [4]. The exact mechanism of misophonia has not yet been elucidated. It has been suggested that misophonia may be caused by connections between the auditory and limbic systems at cognitive and subconscious levels. Another hypothesis is that high activation in the autonomic nervous system and limbic system may cause excessive reactions to ordinary sounds [1].

Table 3. The value of GINT (the gap-in-noise threshold) and the number of correct answers of the gap-in-noise score were given.

	Right ear			Left ear		
	Misophonia group	Control group	*p* Value	Misophonia group	Control group	*p* Value
Gap-in-noise score	40.53 ± 4.68	40.93 ± 5.19	0.755[a]	40.66 ± 4.49	40.73 ± 5.17	0.958[a]
GINT	5 (4–8) ms	5 (4–8) ms	0.706[b]	6 (4–8) ms	5 (4–8) ms	0.643[b]

[a] *T*-test, Mean ± SD.
[b] Mann Whitney-*U*-test, Median (min-max).

Table 4. The relationship between gap-in-noise, frequency patterns and duration patterns with the visual analog scale and Misophonia Assessment Questionnaire.

	The Visual Analog Scale		Misophonia Assessment Questionnaire	
	p Value	*r*	*p* Value	*r*
Right ear				
Gap-in-noise	0.859[a]	0.3	0.250[b]	2.1
Frequency patterns	0.095[a]	−3.1	0.469[b]	1.3
Duration patterns	0.256[a]	−2.1	0.939[a]	−0.1
Left ear				
Gap-in-noise	0.147[a]	2.7	0.147[b]	1.4
Frequency patterns	0.064[a]	−3.4	0.311[b]	−1.9
Duration patterns	0.584[a]	−1.0	0.945[a]	0.1

[a]Spearman correlation
[b]Pearson correlation.

Schröder et al. described misophonia as a new type of psychiatric illness [8]. Conversely, Jastreboff et al. stated that very few of the patients with misophonia were accompanied by psychiatric disease [11]. In a study of 318 patients with misophonia, Jastreboff et al. reported that only seven (2.2%) had psychiatric disorders [1]. Jastreboff et al. also reported that misophonia patients had significant improvement with counselling and sound therapy [1].

In misophonia, patients react only to certain sounds at high or low-level dB, and they do not have problems even though they are at a higher dB level against other sounds. It has been stated that this may be due to problems between the auditory pathways and functional connections in other parts of the brain [11].

Although the mechanism of misophonia is not understood completely, psychoeducation and habituation via sound therapy as well as exposure and response prevention have been tried as treatments [12]. Jastreboff et al. showed that combined treatment consisting of counselling and sound therapy leads to significantly improved recovery from complaints. Another study reported that caffeine can aggravate misophonia symptoms, and alcohol can decrease misophonia symptoms [13].

Central auditory processing has special capabilities that enable people to analyze and interpret the sounds they hear [14]. Central auditory processes are responsible for some behavioural phenomena, such as location and lateralization of sound, auditory discrimination, auditory pattern recognition, auditory performance in the presence of competing acoustic signals, and temporal aspects of hearing (temporal resolution, temporal masking, temporal integration, and temporal patterning) [15,16].

It has been reported that temporal processing can be a component that forms the basis of many auditory processing abilities, such as the processing of verbal and non-verbal acoustic signals of language [17]. Temporal resolution, one of the subdivisions of the temporal process, is defined as the ability to detect rapid and sudden changes in sound stimuli and to distinguish between two acoustic stimuli in the shortest time interval [14].

The FPT and DPT are the most commonly used tests to assess temporal processing while evaluating auditory procedures [6]. The FPT and DPT assess the auditory processing function of the temporal cortex and are very sensitive in assessing auditory temporal cortex functions. These tests are used to detect impairment of the central auditory process rather than locating the lesion [18]. The FPT is mostly used to evaluate temporal patterning [16]. The FPT is sensitive to temporal processing deficits in both adults and children [16]. In the present study, there was no significant difference in terms of frequency pattern and duration pattern between the misophonia group and the control group.

Gap detection paradigms are most commonly used for temporal resolution [19]. It has been reported that gap detection is correlated with speech perception acuity and poor speech discrimination in the presence of noise [20]. The GIN was created for the clinical evaluation of gap detection [20]. It can be applied easily, demonstrating the sensitivity of auditory processing disorder in adults, and can be administered in clinics [16]. Musiek et al. found gap detection thresholds of 4.8 ms for the left ear and 4.9 ms for the right ear in the normal hearing group and 7.8 ms for the left ear and 8.5 ms for the right ear in the central auditory nervous system involvement group. In that study, the importance of the GIN in evaluating temporal resolution function was stated [6]. In the present study, there was no significant difference in terms of the GIN between the misophonia group and the control group.

The limitation of this study was that radiological tests could not be performed on these individuals. Therefore, otological pathologies that may cause misophonia-like symptoms, such as labyrinthine dehiscence, could not be excluded.

Conclusions

It was seen that there was no difference between the healthy individuals and the misophonia patients when the temporal process of central auditory processing was evaluated.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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