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Evaluation of Attention and Verbal Memory Functions of Individuals with Misophonia

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WHAT IS ALREADY KNOWN ON THIS TOPIC?

- *Individuals with misophonia have poor attentional performance under symptom provocation.*
- *Individuals with misophonia have poor recall performance in verbal memory.*

WHAT THIS STUDY ADDS ON THIS TOPIC?

- *In this study conducted on a clinical sample without symptom provocation, working memory, phonetic fluency and verbal memory functions were found to be normal in patients with misophonia.*
- *Verbal fluency and selective attention are impaired in patients with misophonia.*
- *Patients with misophonia have high levels of depression, anxiety and stress*

ABSTRACT

Objective: The aim of this study was to evaluate the attention and verbal memory performances of individuals with symptoms of misophonia.

Methods: The study included 70 participants: 30 with misophonia and 40 controls without misophonia. The Depression Anxiety Stress Scale (DASS-21), Misophonia Questionnaire, Digit Span Test (DST), Verbal Fluency Test (VFT), Stroop Test (ST), and Verbal Memory Processes Scale (VMPS) were applied to the participants.

Results: The depression, anxiety, and stress scores of the misophonia group were statistically significantly higher than the control group ($P < .05$). The misophonia group performed poorly compared with the control group on 2 tests assessing attention (semantic fluency and ST-number of incorrect) ($P < .05$). No difference was found between the groups in cognitive areas such as simple attention, working memory, phonetic fluency, and verbal memory.

Conclusion: Misophonia has a limited effect on attention functions. This effect was not observed in verbal memory. More comprehensive studies are needed to determine the effects of misophonia on attention, and memory.

Keywords: Attention, cognition, misophonia, verbal memory

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INTRODUCTION

Misophonia is a condition characterized by selective sound sensitivity to certain sound patterns and the display of negative emotional and behavioral responses to these stimuli.[1] Trigger sounds include repetitive sounds typically produced by someone else, such as chewing, mouth smacking, yawning, snoring, paper crunching, and foot tapping.[2] To avoid experiencing negative emotions such as distress, disgust, and anger, people with misophonia exhibit avoidance behaviors such as using sound-reducing methods (e.g., covering their ears, listening to music), avoiding eating with others, leaving the environment, and not entering environments where they think there are triggering sounds.[3] Avoidance behaviors prevent affected people from fulfilling their work or academic duties, limit their interaction with others, and cause significant disruptions in interpersonal relationships.[4]

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The typical periods of onset of misophonia are early childhood and adolescence, although it can also occur later in life.[5,6] The fact that common diagnostic criteria and assessment approaches for misophonia have not yet been determined makes it difficult to obtain accurate epidemiologic data.[7] However, studies on misophonia show that the prevalence varies between 3% and 25%.[7-9] It is suggested that the actual prevalence of misophonia may be higher because it can be seen together with hearing and psychiatric disorders and can even be confused with hearing disorders.[7] It is not known exactly what factors cause misophonia and what mechanisms play a role in the maintenance of misophonia. However, it has been suggested that organic, hereditary, neurologic, and psychological factors are effective, and a number of models have been put forward regarding the formation of misophonia.[10,11]

Although significant progress has been made in the etiology and clinic of misophonia, little is known about its cognitive processes. Some of the few studies examining cognitive functions in misophonia were conducted with misophonic triggers.[12-14] In these studies, it was found that individuals with misophonia had lower attention performance in the presence of triggers. In 1 study, participants completed a Stroop task while exposed to misophonic trigger sounds and universally unpleasant sounds. Participants performed poorly on the Stroop task in the misophonic trigger condition but performed normally in the universally unpleasant sound condition.[12] Similarly, Frank et al[13] found that misophonics had difficulties in sustaining attention in their studies under symptom provocation conditions. However, the authors claimed that symptom provocation alone did not explain the observed group difference and that it could be due to a neuropsychological problem. However, different results have also been reported in the same experimental condition. Simner et al[15] found that individuals with misophonia paid more attention to detail and performed better on an attention-demanding task as symptoms worsened. Some studies examining cognitive functions in misophonia were conducted without symptom provocation. Eijsker et al[16] found that misophonics had similar response inhibition abilities to controls. In another recent study by Abramovitch et al[17], individuals with misophonia were subjected to comprehensive neuropsychological testing without symptom provocation. Researchers have found that individuals with misophonia perform significantly worse than controls on tests related to verbal memory recall.

Misophonia is not currently included in any medical or psychiatric diagnostic classification. For this reason, in cognitive studies, misophonia and control groups are determined using misophonia scales. The participants in the study who constituted the misophonia group consisted of a clinical sample who presented to the Otorhinolaryngology and Psychiatry outpatient clinic with symptoms of misophonia. Given the conflicting findings in studies on attention and memory processes in misophonia, the scope of existing studies was expanded with a clinical sample. The principal objective of this study was to evaluate the impact of misophonia symptoms on attention and verbal memory. A secondary objective was to investigate the relationship between cognitive function and sensitivity to trigger sounds and emotional and behavioral responses. It was hypothesized that individuals presenting with misophonia symptoms would demonstrate impaired performance on tasks assessing attention and verbal memory when compared with the control group.

MATERIAL AND METHODS

Participants and Procedures

The research is a cross-sectional study in which the attention and verbal memory performances of participants with misophonia symptoms were evaluated by the Department of Otorhinolaryngology and Psychiatry, Şişli Hamidiye Etfal Training and Research Hospital, University of Health Sciences. The research was conducted with 70 people, 30 with misophonia, and 40 healthy (controls group, without misophonia) individuals. . Control group participants were selected from among hospital staff and their relatives who were invited to participate in the study. The diagnosis of misophonia was made by an experienced psychiatrist based on the criteria proposed by Schröder et al.[6] All participants' current and previous health problems, psychiatric diagnoses, medication use, and alcohol or substance use were obtained through a semi-structured interview by the same psychiatrist. At the same time, patients with misophonia underwent detailed eardrum examinations and hearing tests by an ear, nose, and throat physician.

The inclusion criteria for the study were determined as having clinical symptoms of misophonia, being aged 18-65 years, at least a primary school graduate, and volunteering to participate in the study. The exclusion criteria for the study were middle ear or inner ear pathology, illiteracy, mental retardation, psychotic disorder, bipolar disorder, dementia, major medical illness, head trauma, and psychoactive substance abuse. Exclusion criteria for neuropsychological testing included language difficulties that would prevent understanding of instructions, neuropsychological evaluations within the last 6 months, and borderline intellectual disability. The data collection process was conducted between March 2024 and July 2024.

The Depression Anxiety Stress Scale (DASS-21), Misophonia questionnaire, Digit Span Test (DST), Verbal Fluency Test (VFT), Stroop Test (ST), and Verbal Memory Processes Scale (VMPS) were applied to the participants. The administration of the neuropsychological tests and scales took approximately 1 hour. After the purpose and method of the study were explained, written informed consent was obtained from each participant. Ethics committee approval was received for the research from the Üsküdar University Clinical Research Ethics Committee (Approval no: 61351342/2024-34, Date: February 26, 2024).

Assessments Tools

Sociodemographic Data Form: The form contained questions about the participants' age, education, marital status, smoking, alcohol and substance use, income level, history of psychiatric disease, history of other medical diseases, and whether they had hearing loss/tinnitus. The form was prepared by the researchers.

Depression Anxiety Stress Scale: Depression Anxiety Stress Scale is a shortened version of the DASS-42 scale developed by Lovibond and Lovibond.[18] The scale, consisting of a total of 21 items, is used to evaluate depression, stress, and anxiety levels. It consists of 3 subscales: depression, anxiety, and stress. Each subscale consists of 7 items, which are scored between 0 and 3. Increasing scores from the subscales indicate increased levels of depression, anxiety, and stress. The Turkish standardization of the scale was performed by Sarıçam.[19]

Misophonia Questionnaire: This questionnaire measures misophonia symptoms, emotions, and behaviors developed during exposure to the triggering sound.[20] The scale consists of 3 parts. The first part comprises 7 items and questions sensitivity to triggering sounds. The second part consists of 10 items in total and questions the intensity of emotions and behaviors that occur after exposure to triggering sounds. The first 2 sections consist of a 5-point Likert-type response category ranging from 0 to 4 points, from "definitely not true" (0) to "always true" (4). The scores obtained from the 17 items in these 2 sections vary between 0 and 68, and the higher the score, the higher the symptoms, emotions, and behaviors of misophonia. The items in the last section of the scale provide information about the severity of misophonia and are not included in the scoring. The person is asked to rate their general sound sensitivity on a scale of 1-15. Individuals who score 7 or higher in this section are considered to have clinical symptoms of misophonia. The Turkish validity and reliability study was conducted by Sakarya and Çakmak.[21]

Digit Span Test: The DST is used to assess simple attention and working memory. It consists of 2 parts: forward number range and backward number range. In the forward number range, the participant is asked to repeat a list of spoken numbers 1 second apart in the same order. In the backward number range, the participant is asked to repeat the numbers spoken 1 second apart from the last to the first. The forward number range consists of 3-8-digit numbers, and the backward number range consists of 2-7-digit numbers. Normative data were collected within the scope of the Bilnot battery.[22]

Verbal Fluency Test: The VFT is used to evaluate complex attention functions such as fluency and sustaining attention. It consists of 2 parts: semantic and phonemic. In the semantic fluency section, the person is asked to produce as many animal names as possible in 1 minute. In the phonemic fluency section, the person is asked to say as many words as possible, except for proper nouns and derived words, starting with the letters K, A, S and given 1 minute for each letter. Proper nouns, perseverations, and out-of-category words are recorded. The norms of the VFT were collected as part of a Master's study.[23]

Stroop Test: The ST evaluates the ability to change perceptual setups under changing demands and disruptive effects, information processing speed, and focused attention.[24] In the form used in the study, the participant was asked to say the colors in the boxes in the first stage. In the second stage, the reader was asked to read the words written in colored pencils, and the time was recorded. In the third stage, the words written in color were asked to be read without reading the colors they were written in, but the color names were asked to be said, and the time was recorded. Responses in which the participant noticed and corrected the mistake were recorded as spontaneous corrections, and errors made without correction were recorded as errors. The time difference between the second and third sections was calculated as the interference time. The reliability and validity analyses of the test were conducted, and normative data were collected within the scope of the Bilnot battery.[22]

Verbal Memory Processes Scale: The VMPS is a multi-faceted examination of verbal learning and memory.[25] In the test, 15 words are read to the participant who is asked to say the words remaining in their memory. This is the part related to immediate memory. The words spoken by the participant are noted, but no clue is given for the words they cannot remember. In the second trial, the same words are read in the same order, and the participant is asked to repeat the words they remembered along with the words they had said before, without any order. If the participant, who has a total of 10 attempts, says all the words at an earlier stage, 15 full points are given for the remaining attempts. The learning score is obtained by summing the answers in 10 trials. After approximately 30-45 minutes, long-term memory is assessed, and the participant is asked to repeat the previously presented words as far as they remain in their memory. The words remembered constituted the participant's spontaneous recall score. For the unrecognized words, the participant is asked to recall the correct word from the distractor and target word list on the back of the test, and the recognized words are recorded in the recognition section.[25]

Statistical Analysis

The Statistical Package for Social Sciences version 21.0 software (IBM Corp.; Armonk, NY, USA) was used for statistical analysis and calculations. The conformity of the continuous variables in the study to normal distribution was evaluated graphically and using the Shapiro–Wilk test. It was determined that none of the continuous variables, except the SA-Animal counting score and the K.A.S score, were normally distributed. The Mann–Whitney *U* test was used to compare the sub-dimensions and total scores of the Misophonia Questionnaire (MQ), DASS-21, DST, ST, VFT, and VMPS. The independent samples *t*-test was used to compare VFT-Animals and K.A.S scores between groups. In the correlation analysis between misophonia scale scores and DASS-21, DST, ST, VFT, and VMPS tests sub-dimensions and total scores, the Spearman non-parametric correlation coefficient was given. Statistical significance level was accepted as $P < .05$.

RESULTS

Demographic Characteristics and Clinical Data

A total of 70 participants were included in the study, 30 with misophonia and 40 without misophonia. No statistically significant difference was found between the groups in terms of age, sex, and duration of education. The MQ-trigger, MQ-reaction, and MQ-total scores of those with misophonia were statistically significantly higher than those of the control group ($z = 6.837$, $P < .001$, Cohen's $d = 3.38$, $z = 7.064$, $P < .001$, Cohen's $d = 4.11$, and $z = 7.007$, $P < .001$, Cohen's $d = 4.18$, respectively). The DASS-21 depression, DASS-21 anxiety, DASS-21 stress scores, and DASS-21 total score of those with misophonia were found to be significantly higher than the control group ($z = 4.010$, $P < .001$, Cohen's $d = 0.99$, $z = 5.030$, $P < .001$, Cohen's $d = 1.39$, $z = 4.718$, $P < .001$, Cohen's $d = 1.49$, and $z = 4.691$, $P < .001$, Cohen's $d = 1.36$, respectively). Demographic characteristics and scale data of the participants are presented in detail in Table 1.

Neuropsychological Findings

The neuropsychological test findings of the groups are given in Table 2. No statistically significant difference was found in the forward digit span and backward digit span scores of those with misophonia compared with the control group ($P > .05$). It was found that the mean ST-incorrect number of patients with misophonia was statistically significantly higher than the control group ($z = 2.053$, $P = .040$, Cohen's $d = 0.43$). No statistically significant difference was found between the groups in the other dimensions of the ST, namely interference time and correction scores ($P > .05$). It was determined that the mean VFT-animal scores of those with misophonia were statistically significantly higher than the control group ($t = 2.715$, $P = .009$, Cohen's $d = -0.70$). In the VFT section of verbal fluency, no

Table 1. Demographic and Clinical Characteristics of the Groups

	Misophonia (n = 30)		Control (n = 40)			
	n	(%)	n	(%)	z	P
Sex						
Female	20	(45.5)	24	(54.5)	$X^2 = 0.326$	.568
Male	10	(38.5)	16	(61.5)		
Education					$X^2 = 0.089$	.957
Primary school	2	(50.0)	2	(50.0)		
High school	6	(42.9)	8	(57.1)		
University	22	(42.3)	30	(57.7)		
	Mean ± SD	Median (Min-Max)	Mean ± SD	Median (Min-Max)	z	P
Age	28.00 ± 8.92	25.5 (18-52)	27.83 ± 8.23	24.0 (20-50)	0.048	.962
MQ trigger	18.03 ± 4.57	19.0 (6-28)	4.25 ± 3.94	3.5 (0-16)	6.837	**<.001**
MQ reaction	26.30 ± 7.49	26.0 (9-38)	3.43 ± 3.71	2.0 (0-14)	7.064	**<.001**
MQ total	44.33 ± 10.81	45.0 (15-66)	7.68 ± 7.13	5.0 (0-27)	7.007	**<.001**
DASS-21 depression	9.50 ± 5.72	9.5 (1-20)	4.30 ± 5.03	2.0 (0-19)	4.010	**<.001**
DASS-21 anxiety	8.50 ± 5.72	7.0 (0-20)	2.45 ± 3.00	1.5 (0-11)	5.030	**<.001**
DASS-21 stress	11.90 ± 6.13	13.5 (0-20)	4.40 ± 4.29	4.0 (0-18)	4.718	**<.001**
DASS-21 total	29.90 ± 16.06	32.5 (3-59)	11.40 ± 11.90	8.0 (0-48)	4.691	**<.001**

DASS-21, depression, anxiety and stress scale-21; MQ, misophonia questionnaire; *z*, Mann–Whitney *U* test.

statistically significant difference was found between the groups ($P > .05$). No significant difference was found between the groups in VMPS-immediate memory, total learning, delayed recall, recognition, and total recall ($P > .05$).

Findings Regarding Correlation Analysis

A positive correlation was found between MQ-trigger and DASS-21-depression, anxiety, stress, and total scores ($r = 562$, $P < .01$, $r = 475$, $P < .01$, $r = 501$, $P < .01$, and $r = 549$, $P < .01$, respectively). A similar relationship existed between MQ-reaction and DASS-21-depression, anxiety, stress, and total scores ($r = 499$, $P < .01$, $r = 522$, $P < .01$, $r = 567$, $P < .01$, and $r = 615$, $P < .01$, respectively). Again, a positive correlation was found between MQ-total and DASS-21-depression, anxiety, stress, and total scores ($r = 583$, $P < .01$, $r = 561$, $P < .01$, $r = 597$, $P < .01$, and $r = 662$, $P < .01$, respectively). No statistically significant relationship was found between the MQ-trigger, MQ-reaction, and MQ-total scores, and the DST, ST, VFT, and VMPS ($P > .05$). On the other hand, there was a positive relationship between DASS-21-anxiety and DASS-stress and VMPS-recognition ($r = 379$, $P < .5$, $r = 380$, $P < .5$, respectively). A negative correlation was found between DASS-21-total scores and VMPS-delayed recall ($r = -367$, $P < .5$). Significant relationships were found between neuropsychological variables (Table 3).

DISCUSSION

This study examined cognitive functions such as attention, working memory, verbal fluency, resistance to interference, and verbal memory in individuals with misophonia. In the study, measurements were made using neuropsychological tasks consisting of objective

Table 2. Neuropsychological Tests: Attention and Verbal Memory

	Misophonia (n = 30)		Control (n = 40)			
Neuropsychological Tests	Mean ± SD	Median (Min-Max)	Mean ± SD	Median (Min-Max)	t; z	P
DST—forward	6.27 ± 1.08	6.5 (4-8)	6.10 ± 1.10	6.0 (4-8)	$z = 0.695$	.487
DST—backward	4.50 ± 1.07	4.0 (2-7)	4.63 ± 1.12	4.0 (3-7)	$z = 0.132$	.895
ST—interference time (s)	31.67 ± 13.19	29.0 (1-64)	34.50 ± 20.70	31.0 (1-139)	$z = 0.285$	.776
ST—number of incorrect	1.37 ± 2.86	0.0 (0-13)	0.45 ± 1.41	0.0 (0-8)	$z = 2.053$	**.040**
ST—number of corrections	1.30 ± 1.78	0.5 (0-7)	1.80 ± 2.19	1.0 (0-8)	$z = 0.986$	.324
VFT—aemantic fluency—animal names	22.47 ± 6.54	23.0 (6-33)	26.20 ± 4.31	26.5 (15-35)	$t = 2.715$	**.009**
VFT—phonetic fluency: K–A–S	41.27 ± 14.33	38.5 (18-71)	46.85 ± 11.80	47.5 (20-75)	$t = 1.786$	.078
VMPS—Immediate memory	6.53 ± 1.61	6.0 (4-12)	6.53 ± 1.69	6.0 (4-11)	$z = 0.188$	.851
VMPS—total learning score	120.60 ± 15.91	125.0 (79-147)	124.13 ± 14.81	128.5 (79-144)	$z = 0.932$	.351
VMPS—delayed recall	12.17 ± 1.86	12.0 (6-15)	12.33 ± 1.79	13.0 (7-15)	$z = 0.486$	.627
VMPS—recognition	2.60 ± 1.40	3.0 (0-6)	2.50 ± 1.39	2.0 (0-6)	$z = 0.389$	.627
VMPS—total recall	14.77 ± 0.93	15.0 (10-15)	14.83 ± 0.71	15.0 (11-15)	$z = 0.354$	.723

DST, digit span test; ST, stroop test; *t*, independent samples *t*-test; VFT, verbal fluency test; VMPS, verbal memory processes scale; *z*: Mann–Whitney *U* test.

Table 3. Correlation Analysis

	M ± SD	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	18.03 ± 4.57	**.399***	**.698****	**.562****	**.475****	**.501****	**.549****	−.070	.111	−.265	−.130	.128	.004	−.015	.036	.065	−.003	.022	.061
2	26.30 ± 7.49	1.000	**.913****	**.499****	**.522****	**.567****	**.615****	.139	−.010	−.059	.154	.026	−.125	−.080	−.116	−.161	−.194	.235	.109
3	44.33 ± 10.81		1.000	**.583****	**.561****	**.597****	**.662****	.059	−.001	−.132	.011	.129	−.146	−.139	−.151	−.204	−.184	.219	.098
4	9.50 ± 5.72			1.000	**.664****	**.777****	**.880****	−.049	−.161	−.080	.262	−.099	−.134	−.237	−.133	−.260	−.286	.311	−.006
5	8.50 ± 5.72				1.000	**.866****	**.896****	.159	−.084	.127	.194	−.191	−.097	−.160	−.191	−.096	−.350	**.379***	−.005
6	11.90 ± 6.13					1.000	**.947****	.061	−.068	.110	.158	−.035	−.127	−.132	−.163	−.156	−.328	**.380***	.072
7	29.90 ± 16.06						1.000	.096	−.065	.001	.214	−.128	−.168	−.238	−.209	−.226	**−.367***	**.411***	.044
8	6.27 ± 1.08							1.000	**.462***	.093	.131	**−.374***	.265	.093	−.026	.005	−.003	.022	.104
9	4.50 ± 1.07								1.000	−.262	.031	**−.370***	.306	.312	.313	.288	.144	−.114	.202
10	31.67 ± 13.19									1.000	**.387***	.054	−.305	−.186	−.221	−.271	.096	−.077	.224
11	1.37 ± 2.86										1.000	−.262	−.026	−.097	.159	−.067	.,017	−.030	−.028
12	1.30 ± 1.78											1.000	−.092	−.132	.124	−.098	−.064	.063	−.096
13	22.47 ± 6.54												1.000	**.673****	**.437***	**.639****	.218	−.217	−.023
14	41.27 ± 14.33													1.000	**.569****	**.670****	**.505****	**−.481****	.222
15	6.53 ± 1.61														1.000	**.618****	**.385***	**−.367***	.160
16	120.60 ± 15.91															1.000	**.377***	−.357	.155
17	12.17 ± 1.86																1.000	**−.984****	**.461***
18	2.60 ± 1.40																	1.000	−.305
19	14.77 ± 0.93																		1.000

1. MQ-trigger; 2. MQ-reaction; 3. MQ-total; 4. DASS-21 depression; 5. DASS-21 anxiety; 6. DASS-21 stress; 7. DASS-21-total; 8. DST—forward; 9. DST—Backward; 10. ST—Interference time (s); 11. ST—Number of incorrect; 12. ST—Number of corrections; 13. VFT—Semantic fluency—animal names; 14. VFT—Phonetic fluency: K–A–S; 15. VMPS—Immediate memory; 16. VMPS—Total learning score; 17. VMPS—delayed recall; 18. VMPS—Recognition; 19. VMPS—Total recall.

*$P < .05$.

**$P < .01$.

and standardized tests frequently used in clinical settings. The scope of existing studies was aimed to be expanded by using a cross-sectional and comparative study design without symptom provocation. The main finding of the current study was that individuals with misophonia performed worse on tasks related to verbal fluency and selective attention compared with controls. On the other hand, those with misophonia performed similarly to the control group in the areas of simple attention, working memory, phonetic fluency, and verbal memory.

Attention and Executive Functions

In this study, no statistically significant difference was found between the groups in terms of forward digit span and backward digit span scores. Forward digit span is used to assess simple attention, and backward digit span is used to assess working memory. When looking at the test performances of those with misophonia, it can be said that simple attention and working memory capacity were normal. This finding of the study is also consistent with the results of a previous study. Abramovitch et al[17] found no statistically significant difference between the DST performances of those with misophonia and the control group in their study. Similar results were obtained in a study conducted with a clinical sample. It has been observed that patients with obsessive–compulsive disorder with misophonia have better simple attention and working memory performance than those without misophonia and that they perform close to healthy controls in these skills.[26]

The ST assesses the ability to change perceptual set-up, information processing speed, and focused attention in response to changing demands and under a disruptive influence.[24] In this study, no significant difference was found between the misophonia group and the control group in the ST-interference duration and ST-correction number sections. Although there was no significant difference in the duration of interference and the number of corrections, it was observed that the average interference duration of patients with misophonia was shorter than the control group and they made fewer corrections. However, a significant difference was found between the groups in terms of ST-incorrect numbers. Participants with misophonia made more errors than the control group. The misophonic group did not realize the mistakes they made during the test and did not correct them, so the interference times and number of corrections were low. Although mistakes are made unconsciously in the ST, it is possible for the participant to realize that they have made a mistake and correct it if they have mental flexibility. Also, noticing and correcting the error is a process that requires attention.[24] The findings of the ST show that cognitive flexibility and selective attention skills were affected in those with misophonia compared with the control group.

In the literature, there are studies revealing that individuals with misophonia perform poorly in selective attention when exposed to triggering sounds.[14] Another study found that stronger misophonia symptomatology was directly related to the Stroop effect.[12] However, there are also studies showing that those with misophonia pay more attention to details.[15] In a study using the Stop Signal Task, response inhibition in individuals with misophonia without misophonic provocation was found to be similar to controls, and they were found to prefer accuracy rather than speed during the task.[16] In this study, individuals with misophonia preferred speed rather than accuracy, unlike the other study. The findings show that individuals with misophonia have impaired selective attention even without symptom provocation.

The VFT assesses executive control skills as well as sustaining attention because participants are required to access and retrieve words from their vocabulary stores, focus on the task while doing so, avoid perseveration, and select words with certain restrictions.[27] The findings regarding verbal fluency suggest that those with misophonia have problems retrieving information from semantic memory stores and sustaining attention compared with controls. This result is consistent with previous research conducted without symptom provocation. Semantic fluency was found to be affected in individuals with misophonia, whereas phonetic fluency was preserved.[17] One study using the Attention Network Test found that individuals with misophonia had difficulty maintaining alertness and sustaining attention during an attention task.[13]

When looking at experimental designs in studies examining attentional functions in misophonia, trigger sounds are presented during attention tasks. Trigger sounds in misophonia are typically known to include repetitive sounds produced by another individual.[28] However, animal sounds, repetitive movements not associated with any auditory trigger, and visual triggers such as scratching have also been reported.[20] The combination of auditory and visual stimuli aggravates misophonia symptoms and causes more intense symptoms.[29] This complex nature of trigger sounds may be a possible reason for the conflicting findings in the literature. Emotional reactions such as anger, disgust, and anxiety are also likely to affect attention performance when faced with triggering stimuli in individuals with misophonia. Therefore, in this study, no disturbing stimuli were given to the participants during the neuropsychological tests. Accordingly, there was no stimulus that could distract their attention during the evaluation. The findings in this condition indicate that there may be a structural problem with attention.

Verbal Memory Skills

In this study, the VMPS was used to evaluate the verbal memory performance of the participants. No statistical difference was found between the patients with misophonia and the control group in terms of immediate memory, total learning, reaching the criterion, highest learning, delayed recall, recognition, and total recall scores. It has been observed that people with misophonia can learn words presented to them, encode them in short-term memory, transfer them to long-term memory, and have no difficulty in retrieving the information. However, there are very few studies evaluating the memory performance of people with misophonia. In a 2-stage study conducted with a total of 55 patients with misophonia, no statistical difference was found between the memory performance of the misophonia group and the control group.[30] Unlike our findings, individuals with misophonia were found to have significantly lower performance in the recall section of verbal memory compared with the controls.[17] It has been found that misophonics pay more attention to details and perform better in auditory imagery than controls.[15] The reason why no significant difference was found in verbal memory processes in the study may be a result of those with misophonia being able to image words presented to them auditorily.

The current study has several limitations that should be addressed in future research. First, the sample size is small and therefore the representativeness of the sample is low. Small samples also reduce the power of statistical analyses. Second, the cross-sectional design of the study creates limitations in revealing cause-effect relationships. Finally, comprehensive tests were not used to assess attention and memory. These limitations should be taken into consideration when evaluating the findings of the current study. Replication and

expansion of future studies with larger samples and heterogeneous groups will be beneficial for research in this area. Examining the effects of misophonia on other cognitive and emotional processes and conducting longitudinal study designs may be potential areas of study.

In conclusion simple attention, working memory, phonetic fluency, and verbal memory performances of individuals with misophonia, without triggering stimuli, were similar to those without misophonia. Performance decreases were found in semantic fluency and selective attention. It was believed that the study will contribute to the literature because the cognitive processes of misophonia have been studied very little. There is information that neurologic, psychiatric, genetic, and audiologic factors may play a role in the etiology of misophonia. It is believed that considering misophonia in a multidimensional manner and conducting research in collaboration with different disciplines will contribute to a better understanding of the nature of misophonia. The study adds a new dimension to what is known about misophonia's attention and memory functions. Expanding the literature on the subject and increasing awareness of misophonia may lead individuals with this problem to seek treatment and improve their quality of life. It may also pave the way for future research to develop effective treatment approaches.

Data Availability Statement: Data are available from the first author or corresponding author on reasonable request.

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Informed Consent: Written informed consent was obtained from each participant who participated in this study.

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