Tinnitus: Does it Lead to Impairments in Metacognitive Functions and the Theory of Mind Skills?

Original Investigation

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Abstract

Objective: This study aimed to investigate theory of mind skills and metacognitive functions in patients with tinnitus compared to healthy controls

Methods: This prospective study included patients diagnosed with tinnitus at our otolaryngology and Head and Neck Surgery clinic and healthy controls matching their demographic characteristics. Patients diagnosed with tinnitus at our otolaryngology and head and neck surgery clinic, along with healthy controls matched for demographic characteristics, were included in the study. All participants completed the Reading the Mind in the Eyes Test (RMET), the metacognition questionnaire (MCQ-30), the Beck Depression Inventory (BDI), and the Tinnitus Handicap Inventory (THI). The relationship between the scales applied to the patient group regarding tinnitus was evaluated using Spearman's and Pearson's correlation tests.

Results: A total of 90 individuals diagnosed with tinnitus and 70 healthy controls participated in the study. There was no statistically significant difference in BDI scores between the groups (p>0.05). However, in the MCQ-30, the cognitive awareness subscale and the total score were significantly higher in the tinnitus group (p=0.003 and p=0.041, respectively). Additionally, RMET performance was lower in tinnitus patients compared to healthy controls (p=0.002). Certain subscales of the MCQ-30 showed a moderate positive correlation with THI.

Conclusion: Based on these findings, we suggest that evaluating tinnitus patients from a psychiatric perspective, providing psychosocial support, and assisting them in improving their communication skills could be beneficial.

Keywords: Tinnitus, cognition, emotions, cognition disorders, psychological distress, depression, anxiety

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Introduction

The Theory of Mind (ToM) is defined as the ability to understand and perceive one's own and others' mental states (1). Another definition states that it refers to the ability to predict and understand the unobservable mental states of individuals, such as desires, emotions, beliefs, intentions, and motivations (2). ToM is a developmental skill that starts in early childhood and continues to develop and progress into adolescence, young adulthood, and adulthood (1,3). With advancing age, the development and progression of ToM skills enable individuals to have a better understanding of new, unexpected, and ambiguous situations and emotions (3). Recent research has shown that ToM skills have two different dimensions: emotional and cognitive. Emotional ToM skills involve the ability to make inferences about how others feel, while cognitive ToM skills involve the ability to reason about how others think (4). Given these descriptions, ToM skills are a complex field of study that involves various disciplines such as developmental psychology, education, psychiatry, and neurology (1-3).

Metacognition is defined in the field as "thinking about thinking" (5). Although this definition is limited to the person's own mental state and her/his own thoughts, it actually includes the thoughts of others (6). The closely related concept of the ToM, examined under the same title, is the ability to understand other people's feelings, thoughts, and intentions. It was first put forward in 1978 by Premack and Woodruff (2) in studies conducted with chimpanzees (1,2). It was then used in studies on children's cognitive processes. Later, this concept was developed and considered as a mechanism that provides adaptation to the social environment. It has also been studied clinically in children with autism, frontal lesions, and frontotemporal dementia patients (7-10). There are many tests used to assess the ToM. Implied test, deception test, metaphor and irony comprehension, picture sorting, and lastly, the reading the mind test that has been used frequently in recent years (11-13).

Based on all this information, in our study, we aimed to examine the ToM model, which is a model that has been studied in diseases such as dementia which could be related to the temporal lobe of the brain in tinnitus patients. Tinnitus is the perception of sound without any external stimulus (14). Temporary and reversible tinnitus can occur frequently in communities (15). However, persistent tinnitus is a highly distressing condition that can cause significant discomfort and even lead to stress (16). This study was planned based on the hypothesis that this distressing bodily complaint may affect individuals' ToM skills and lead to the emergence of dysfunctional metacognitive beliefs in the course of the disease. We examined ToM skills and metacognitive functions in patients with tinnitus by comparing them with healthy controls, which has not been previously investigated in the literature.

Methods

Ethical Procedure

After obtaining approval from the Tokat Gaziosmanpaşa University Ethics Committee holding the (number: 22-KAEK-175, date: 25.08.2022), the study was conducted in accordance with the Declaration of Helsinki guidelines.

Inclusion and Exclusion Criteria

This study was conducted prospectively. Patients diagnosed with tinnitus with normal otoscopic examination and normal hearing were informed about the study at the university hospital otolaryngology and head and neck surgery clinic. Those with pure tone thresholds <26 decibels (dB) at 4 frequencies (0.5, 1.0, 2.0, 4.0 kHz) were defined as having normal hearing. Signed informed consent forms were obtained from patients who agreed to participate in the study. The study included individuals who had received medical treatment and did not benefit, volunteered to participate, could read and write, could fill out the forms, and sign the written consent form. Individuals with sensorineural/conductive or mixed hearing loss, abnormal otoscopic examination, poor general condition, abnormal blood tests in the last six months, known psychiatric illness, alcohol/substance use disorder, neurodegenerative disease, and mental disabilities were excluded from the study. The same psychiatrist interviewed all patients. Patients with psychiatric disorders such as major depressive disorder, anxiety disorders, and body dysmorphic disorder, which could also be the cause of tinnitus, were also excluded. The healthy control group was selected from individuals who could match the tinnitus patient group in terms of age and gender with no psychiatric illness and/or alcohol/substance use disorder and had no tinnitus.

Data Collection Tools

During the initial interview with the participants, informed consent forms were signed, and demographic data forms were filled out. Subsequently, the Beck depression inventory (BDI), the metacognitive questionnaire (MCQ-30), the Reading the Mind in the Eyes Test (RMET), and the tinnitus handicap inventory (THI) were administered.

Demographic Data Form: This is a form created by the researchers in line with the objectives of the study. It includes personal demographic information such as age, marital status, education, and employment status. It also includes clinical assessment questions regarding previous and current psychiatric treatment, alcohol/substance use, and the presence of any medical condition requiring medical treatment.

Beck Depression Inventory: Developed by Beck et al. (17) to assess the presence and severity of depressive symptoms, BDI is a self-report scale consisting of 21 items that are scored on a scale of 0-3. The calculated total score is evaluated, and a higher total score indicates a greater level of depressive symptoms (18).

Metacognitive Questionnaire: The long form of the questionnaire was developed by Wells and Cartwright-Hatton (19) in 1997, followed by the development of a 30-item short form in 2004. The questionnaire examines the presence of worrying and intrusive thoughts, their causes, benefits, and drawbacks. Each item is scored on a scale of 1-4 and is evaluated in five subscales. An increase in the calculated total score indicates an increase in metacognitive activities (20).

Reading the Mind in the Eyes Test: Developed by Baron-Cohen et al. (6) in 1997 to assess individuals' ability to recognize emotions. The original version of the test includes 36 pictures with different facial expressions. The individual selects the expression that best describes the picture among the given options. The validity and reliability study of the scale was conducted in Turkish by Yıldırım et al. (21) in 2011. In the Turkish adaptation, the number of pictures was determined as 32. The individual undergoing the test selects the item which they believe best describes the expressions they see in the pictures based on their current mental/psychological state (21).

Tinnitus handicap inventory: This scale evaluates the extent to which tinnitus affects patients' mental, occupational, social, emotional, and physical functions and their treatment satisfaction. The Turkish validity and reliability study was conducted by Aksoy et al. (22) in 2007.

Statistical Analysis

The data was studied using the statistical software SPSS for Windows 20 (IBM Corp. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY). Demographic variables such as age, marital status, and education were presented as mean±standard deviation and percentage (%). The Chi-square test was used for the analysis of these data and clinical variables. For the analysis of the scores of the BDI, MCQ-30, and RMET scales used in the study, the tests of significance for the difference between two means and Mann-Whitney U tests were employed. The relationship between the scales applied to the patient group regarding tinnitus was evaluated using Spearman's and Pearson's correlation tests. A p-value less than 0.05 was considered statistically significant.

Results

Demographic Data Distribution of Participants:

A total of 120 patients diagnosed with tinnitus were interviewed for the study, and 90 patients who met the inclusion criteria were included. The patient group consisted of 48 females (53.33%) and 42 males (46.66%). The mean age of the patient group was 45.80±13.39 years, while the control group had a mean age of 41.88±12.53 years (p=0.062). Out of the patient group, 65 individuals (72.22%) were married, while 26 individuals (28.88%) had never married or were divorced. None of the participants in the patient group or the healthy control group had a current or previous diagnosis of psychiatric illness. The demographic data of the participants is presented in Table 1.

Distribution of Quantitative Variables of Participants:

For the analysis of RMET and MCQ-30 scores, both of which followed a normal distribution, a test of the significance of the difference between the two means was used. The number of correct answers on the RMET was found to be significantly lower in the patient group compared to healthy controls (p=0.002). The total score of MCQ-30 and the sub-dimension score of cognitive awareness were higher in healthy controls (p=0.047 and 0.003, respectively). For the analysis of BDI values which did not follow a normal distribution, the Mann-Whitney U test was used. No statistically significant difference was found between the patient and control groups (p=0.084). The analysis of the quantitative variables of the groups is presented in Table 2.

Logistic Regression Analysis:

In the multivariate logistic regression model, it was found that only the RMET had a significant effect on tinnitus (p=0.003). No significance was found for the other scales applied. The results of the multivariate logistic regression analysis of the patients are presented in Table 3.

Results of Correlation Analysis:

According to the results of Spearman's correlation analysis, there was a moderate positive correlation between BDI and MCQ-30 cognitive confidence and uncontrollability sub-dimensions in the patient group. Moderate correlations were found between the scores of THI and BDI, and of MCQ-30 uncontrollability danger and MCQ-30 need to control thoughts (Table 4).

Discussion

In our study where we examined the executive functions and metacognitive functions of individuals suffering from tinnitus, we found that the cognitive performance of the patients was reduced regardless of differences in depression scores. Additionally, we identified that the patients had impaired metacognitive functions in certain areas.

In the available literature, it has been reported that individuals with tinnitus struggle to cope with their condition, and there is an increased frequency of psychological complaints

Table 1. Demographic characteristics of participants

	Patient group with tinnitus n=90	Healthy control group n=70	P-value
Age (Mean±SD)	45.80±13.39	41.88±12.53	0.062
Gender (n)	48/42	44/26	0.293
(Female/male) (%)	(53.33/46.66)	(62.85/37.14)	
Marital status	65/13/12	30/33/7	**<0.001**
(Married/single/other) (%)	(72.22/14.44/13.33%)	(42.85/47.14/10)	
Educational level			
Basic literacy	7 (7.77%)	6 (8.57%)	
Primary school graduate	40 (44.44%)	10 (14.28%)	**0.010**
High school graduate	22 (24.44%)	16 (22.85%)	
University graduate	21 (23.33%)	37 (52.85%)	
University student	0	1 (1.42%)	
Working status (%)			
Full-time employment	23 (25.55%)	33 (47.14%)	
Irregular income job	7 (7.77%)	7 (10%)	**<0.001**
Unemployed	3 (3.33%)	3 (4.28%)	
Homemaker	35 (38.88%)	12 (17.14%)	
Student	6 (6.66%)	12 (17.14%)	
Retired	16 (17.77%)	3 (4.28%)	

Data are presented as n (%)

SD: Standard deviation

Table 2. Analysis of quantitative variables within the groups

	Patient group with tinnitus (n=90)	Healthy control group (n=70)		P-value
MCQ-30	Mean±SD	Mean±SD	F	
Positive belief	12.43±4.97	12.10±4.37	1.763	0.679
Cognitive confidence	13.45±5.62	12.05±4.80	1.639	0.115
Uncontrollability-danger	16.68±6.07	16.18±5.65	0.414	0.622
Cognitive awareness	18.24±4.72	15.92±4.14	**2.073***	**0.003***
The need to control the thoughts	12.08±3.82	10.97±3.24	3.040	0.071
Total score	72.66±16.43	67.36±14.88	**0.961***	**0.041***
RME	15.50±5.16	18.28±4.96	**0.618***	**0.002***
	Median	**Median**	**Z**	
BDI	12.29 (8.00±21.00)	11.48 (7.00±16.01)	-.1.481	0.139

The significance test for the difference between two means is shown in the top section of the table, while the Mann-Whitney U test in the lower section. The values provided in the top section of the table represent mean±standard deviation, while the values given in the lower section represent median values *p<0.05

SD: Standard deviation, MCQ-30: Metacognitive questionnaire, RME: Reading the Mind in the Eyes Test, BDI: Beck Depression Inventory

and disorders among these individuals (23-25). It has been shown that individuals who perceive tinnitus as a significant source of stress experience increased depressive symptoms and have higher rates of major depressive disorder (24). At the same time, as the difficulty in recognizing one's emotions increases, the negative impact of tinnitus on one's life also increases (26). Furthermore, it has been observed that some patients exhibit a significant increase in suicidal ideation and suicide attempts (25). The presence of tinnitus, as well as the psychological complaints it causes, has been reported to decrease the quality of life for these patients (27). The common result found in all these studies in the literature is that patients have difficulty in adapting to the presence of tinnitus. In our study, we found that although the depression scores of the patients did not increase, their cognitive performance was reduced. In other words, we observed that higher-level cognitive awareness such as thinking about thinking, social communication skills, recognizing emotions

Table 3. Impact of scales on tinnitus in the multivariate logistic regression model

	β	Sig.	Odds Ratio	95% confidence interval for the odds ratio	
				Lower	Upper
BDI	0.015	0.375	1.015	0.982	1.050
RME	-0.108	**0.003***	0.898	0.837	0.963
MCQ-30					
Positive belief	-0.004	0.971	0.996	0.818	1.213
Cognitive confidence	0.104	0.266	1.110	0.924	1.334
Uncontrollability-danger	-0.008	0.935	0.992	0.823	1.196
Cognitive awareness	0.170	0.080	1.185	0.980	1.432
The need to control the thoughts	0.077	0.496	1.081	0.865	1.350
Total score	-0.038	0.668	0.963	0.810	1.145

*p<0.05, BDI: Beck Depression Inventory, RME: Reading the Mind in the Eyes Test, MCQ-30: Metacognitive questionnaire

Table 4. Correlation analysis results

	BDI	MCQ-PB	MCQ-CC	MCQ-UD	MCQ-CA	MCQ-NCT	MCQ-total	RME	THI
BDI	1	0.086	**0.325***	**0.475***	-0.051	**0.287***	**0.347***	-0.024	**0.302***
MCQ-PB	0.086	1	0.072	0.191	**0.511***	**0.389***	**0.640***	-0.008	-0.066
MCQ-CC	**0.325***	0.072	1	**0.411***	0.054	**0.271***	**0.558***	-0.200	0.095
MCQ-UD	**0.475***	0.191	**0.411***	1	0.230*	**0.486***	**0.714***	-0.035	**0.290***
MCQ-CA	-0.051	**0.511***	0.054	**0.230***	1	**0.527***	**0.648***	0.006	-0.048
MCQ-NCT	**0.287***	**0.389***	**0.271***	**0.486***	0.527*	0.1	**0.750***	-0.096	**0.232***
MCQ-total	**0.347***	**0.640***	**0.558***	**0.714***	0.648*	0.750*	0.1	-0.087	0.141
RME	-0.024	-0.008	-0.200	-0.035	0.006	-0.096	-0.097	1	-0.070
THI	**0.302***	-0.066	0.095	**0.290***	-0.048	**0.232***	0.144	-0.070	1

Pearson and Spearman correlation analysis tests were used in the calculations. The table presents the "r" values

*p<0.05, BDI: Beck Depression Inventory, MCQ: Metacognitive questionnaire, PB: Positive belief, CC: Cognitive confidence, UD: Uncontrollability/danger, CA: Cognitive awareness, NCT: Need to control the thoughts, RME: Reading the Mind in the Eyes Test, THI: Tinnitus handicap inventory

from facial expressions, and being aware of what is on other people's minds had decreased (1,6). The fact that the patients' depression scores did not increase could be due to many reasons such as the scale we used, our control group, the patient group, and the use of a self-report scale, which is not consistent with the literature in this sense. RMET, which has been used as a test material reflecting metacognitive abilities in a broader sense, such as recognizing emotions from facial expressions and solving mental states, has been widely used in many studies (9-12). It has been shown that a deterioration in metacognitive abilities was associated with impaired social communication skills. In other words, a deterioration in metacognitive abilities is related to impaired social functioning and interpersonal relationships (6,9-12,21). Given these findings, it is believed that the impairment of metacognitive abilities in patients suffering from tinnitus could also affect their social performance, as well as their academic and occupational achievements. In the tinnitus group, we observed that the level of marriage was higher, the level of education was lower, and homemakers were in the majority, but it is not possible to make a clear conclusion. In our study, while the patients' depression scores did not increase, we found that their cognitive performance was reduced. The presence of tinnitus alone had an impairing effect on their cognitive performance. Further, it was determined that RMET performance could be a predictor for tinnitus. The findings of our study indicate that the metacognitive abilities of patients are impaired, and this impairment could also affect their social skills and serve as a precursor to the disease. However, since our study is the first of its kind in this area, the data obtained needs to be supported by further research.

Finally, we identified differences in specific domains of metacognitive functions in tinnitus patients compared to healthy controls. We also found that as the impact of tinnitus on patients' daily activities and lives increased, their metacognitive functions were more significantly impaired

in certain sub-dimensions. In a study conducted in this field, tinnitus patients were only evaluated with MCQ-30. The correlation between metacognitive beliefs and THI was studied. It was observed that the uncontrollability and danger sub-dimensions of metacognitive beliefs were moderately positively correlated with the THI (28).

It has been shown in previous studies that dysfunctional metacognitive beliefs are associated with difficulties in coping with chronic illnesses and can trigger the emergence of psychiatric disorders (29).

Dysfunctional metacognitive beliefs have been reported to be associated with mental distress, making it difficult for individuals to tolerate chronic illnesses and accept the illness, and even disrupting treatment adherence (29).

There is no study in the literature that compares tinnitus patients with healthy controls using the MCQ-30. In our results, like the findings of the study mentioned above, it was found that the THI and MCQ-30 were positively correlated with the uncontrollability and danger sub-dimensions (28). Only one article published in the literature states that tinnitus without hearing loss is protective for cognitive performance. This article evaluated cognitive performance (30). In literature, cognitive destruction is considered inevitable, especially in the presence of hearing loss. In our study, what we looked at was not cognitive performance, but high-level cognition, metacognition, thinking about thinking, or more importantly, social communication skills. From this perspective, tinnitus affects patients' daily lives more significantly, more dysfunctional metacognition comes into play, or the presence of dysfunctional metacognition increases the impact of tinnitus on their daily functioning. The fact that depressive symptoms and the presence of depression, known to affect both RMET performance and MCQ-30 results, did not influence our findings further enhanced the value of our results. In our results, the scores of the patients on BDI were not statistically different from those of the healthy controls.

When evaluating our study, certain limitations should be taken into account. First, the relatively small sample size represents a limitation. Additionally, the reliance on self-report scales, the lack of anxiety level assessments, and the absence of structured clinical interviews based on the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition) for psychiatric diagnosis further constrain the study's findings. Moreover, it was not possible to determine whether the lower educational level, marital status, and unemployment rate observed in the patient group were consequences of the disease or inherent characteristics of the study participants. These limitations restrict the generalizability of our findings. Therefore, further research with larger sample sizes and more comprehensive assessments is needed to strengthen the existing literature in this field.

Conclusion

In conclusion, we found that the cognitive performance of the individuals suffering from tinnitus was impaired compared to the healthy controls. We also identified that these patients had a higher prevalence of dysfunctional metacognition in certain domains. These findings suggest that individuals with tinnitus could be psychologically affected, and it would be beneficial to conduct mental assessments during the initial examination, provide psychological and social support to the patients, and assist them in improving their communication skills.

Ethics

Ethics Committee Approval: After obtaining approval from the Tokat Gaziosmanpaşa University Ethics Committee holding the (number: 83116987-553, date: 5.08.2022).

Informed Consent: Signed informed consent forms were obtained from patients who agreed to participate in the study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: E.K.Ç., Concept: E.K.Ç., F.Ö., Design: F.Ö., Data Collection and/or Processing: B.Y.E., Analysis and/or Interpretation: B.Y.E., Literature Search: E.K.Ç., F.Ö., Writing: E.K.Ç., F.Ö.

Conflict of Interest: The authors declare that they have no conflict of interest.

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Main Points

- Tinnitus constitutes a significant source of stress and may lead to impairment in cognitive performance and metacognitive abilities in patients.
- The current study showed that the cognitive performance of the individuals suffering from tinnitus was impaired compared to the healthy controls and that these patients had a higher prevalence of dysfunctional metacognition in certain domains
- It is believed that the impairment of metacognitive abilities could affect social performance, academic, and professional achievements.
- Providing psychological and social support to individuals with tinnitus may be beneficial in assisting them to improve their communication skills.

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