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Research paper

Psychological mediators of chronic tinnitus: The critical role of depression

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ABSTRACT

Background: Maintenance of chronic tinnitus has been proposed to result from a vicious cycle of hypervigilance occurring when a phantom sound is associated with anxiety and limbic system overactivity. Depression, obsessive-compulsiveness, illness attitudes and coping strategies are known to impact tinnitus, but their relationship with the vicious cycle is unknown. As such, we aimed to identify psychological mediators of the vicious cycle. We also examined the relationship between coping strategies and any identified mediators to facilitate the translation of our research to treatment settings.

Methods: We comprehensively assessed a heterogeneous community sample of 81 people with chronic tinnitus who completed measures assessing their tinnitus and psychological wellbeing. Specifically, we examined the mediating role of depressive symptoms, illness attitudes, and obsessive-compulsiveness in the vicious cycle.

Results: While the predicted relationship between tinnitus handicap and anxiety was observed, this was fully mediated by depressive symptoms. In addition, we identified avoidant behaviours and self-blame as maladaptive coping strategies in people with chronic tinnitus and depressive symptoms, identifying potential new treatment targets.

Limitations: This work requires replication in a clinical cohort of people with chronic tinnitus, and further investigations of the role of coping strategies.

Conclusions: These results extend our understanding of the complex role of psychology in the experience of tinnitus, highlighting the importance of depressive symptoms that may be underpinned by functional disruption of specific neurocognitive networks. We have also identified depressive symptoms and maladaptive coping strategies as new treatment targets to improve the health wellbeing of people with chronic tinnitus.

1. Introduction

Chronic tinnitus is the experience of a phantom ringing, buzzing or hissing sound in the ears or head. Tinnitus is a significant public health issue that has substantive economic impact, with burden of disease calculations rating tinnitus ahead of prostate cancer and HIV/AIDS in Europe (Maes et al., 2013; World Health Organisation, 2011). Prevalence estimates for chronic tinnitus typically fall between 10% and 15% of the general population (Henry et al., 2005), although the sound of tinnitus has the potential to be experienced by 83% of people when in a silent room (Del Bo et al., 2008). The psychological impact of tinnitus is well recognised. 90% of chronic sufferers report life-style issues such as poor sleep, social withdrawal and interference with work, and 70% report emotional difficulties including suicidal thoughts, confusion and worry, creating a key platform for raising awareness of the condition as a global health problem (Tyler and Baker, 1983). Despite the prevalence and impact of tinnitus there remains no definitive cure or accepted understanding of the mechanisms that underpin the onset or maintenance of the condition.

The majority of early research investigated neurophysiological mechanisms for tinnitus at the level of the inner ear and peripheral auditory pathways (Eggermont and Roberts, 2004). The role of higher cortical factors was subsequently recognised, including neuroplastic changes in auditory and prefrontal cortices that may serve to maintain tinnitus (Schecklmann et al., 2013). Most recently, psychological factors have been considered, not just in terms of the comorbidity of tinnitus, but as fundamental mechanisms that drive the maintenance of tinnitus (McKenna et al., 2014). An initial psychological model proposed that high arousal or anxiety, and the subsequent negative emotional attachment to the sound, was the core mechanism underpinning a failure to habituate to the tinnitus sound (Hallam et al., 1984). This concept has since been incorporated into most models where it is central

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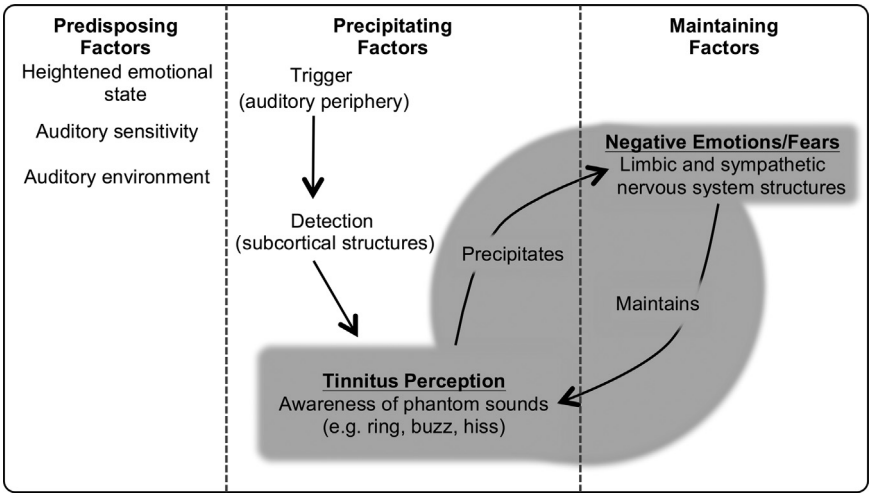

Fig. 1. Psychological framework of the neurophysiological model of tinnitus and the 'Vicious Cycle' (shaded) (Jastreboff et al., 1996). Note that the vicious cycle contains a precipitating pathway, where the onset of chronic tinnitus leads to negative emotions such as anxiety, which in turn reinforce tinnitus perceptions via the maintaining pathway.

to a 'vicious cycle' for maintaining tinnitus awareness through a feedback loop. The Neurophysiological Model of Tinnitus (Jastreboff et al., 1996) was particularly foundational in integrating auditory neurophysiology with psychological principles, such as negative reinforcement, which maintain the vicious cycle.

Arguably, the Neurophysiological Model of Tinnitus can be placed within a broader psychological framework that incorporates predisposing, precipitating and maintaining factors (Fig. 1). Precipitating factors principally relate to the perception of the tinnitus sound, with a lack of habituation of the random spontaneous activity of the peripheral auditory system serving as the 'trigger' that leads to the perception of a 'phantom auditory sound' (tinnitus). If this occurs within the context of predisposing factors, such as emotional arousal (e.g. anxiety), heightened sound sensitivity (e.g. hyperacusis), or a sudden change in the auditory environment, negative emotions can become associated with, and conditioned to, the phantom sound, leading to the onset of chronic tinnitus (the precipitating pathway). This is thought to be negatively reinforced by continued activation of limbic and sympathetic nervous system structures, which serves to maintain awareness and perception of the sound (the maintenance pathway), which in turn, strengthens the association between the sound and negative emotions via the precipitating pathway, creating a vicious cycle of hypervigilance (Fig. 1). As such, the association between negative emotions and the perception or awareness of the tinnitus sound drives the vicious cycle, rather than the psychoacoustic properties of the sound (e.g. pitch, volume) (Jastreboff et al., 1996). This model has formed the rationale for much of the current research on tinnitus in human and animal studies and thus, there is an emerging understanding of how emotion regulation, particularly anxiety, may be contributing to chronic tinnitus by maintaining awareness.

As a result of this work, anxiety has become a focal point for researchers. A recent systematic review found a significant increase in the lifetime and current prevalence of anxiety in people with tinnitus, in addition to evidence suggesting that common neural networks are involved in both conditions (Pattyn et al., 2016). Investigations of the relationship between tinnitus and anxiety have shown a moderate association, with above average state and trait anxiety ratings for almost 60% of participants (Ooms et al., 2012). A study of 75 audiology outpatients with tinnitus found 29% met DSM-IV diagnostic criteria for anxiety, 27% met criteria for an affective disorder, and 19% for a somatoform disorder (Marciano et al., 2003). Contrasting with these high prevalence rates of psychopathology, experimental studies often report scores in the subclinical or normal range for anxiety and mood (Simoens and Hébert, 2012), however this likely reflects varied sources of recruitment from community or clinical populations.

Further support for a role of psychological factors in tinnitus comes from the success of psychological therapies targeting anxiety and fears about tinnitus to break the vicious cycle, thereby reducing negative reinforcement of the tinnitus sound. In particular, cognitive behaviour therapies have been reported as effective in reducing the awareness and impact of tinnitus on people's lives (Cima et al., 2012). Also consistent with predictions of the vicious cycle, a range of neuroimaging techniques have shown increased activation of the anterior cingulate cortex, insula, parahippocampal gyrus and prefrontal cortex in people with tinnitus compared to those without (Husain, 2016). These regions form part of the affective and salience networks, as well as being implicated in both anxiety (Martin et al., 2009) and depression (Sheline et al., 2010).

Despite growing support for the relationship between tinnitus and anxiety, recent work has also established that a range of other psychological factors, such as depression, obsessive compulsive tendencies, and illness attitudes including somatisation tendencies, are involved in the experience of chronic tinnitus (Genç et al., 2013). These findings highlight the importance of considering potential mediators of the vicious cycle that maintains awareness of the tinnitus sound, as they suggest greater complexity in the psychological drivers of chronic tinnitus (Andersson and Westin, 2008). In other words, we need to identify factors that may contribute to the relationship between anxiety and tinnitus, such as latent traits or states that may help explain this relationship. It is also important to consider an individual's response to the daily experience of tinnitus since coping strategies, such as acceptance, have been found to be more adaptive for people living with chronic tinnitus (Hesser et al., 2015). Such strategies can be targeted in psychological treatments, facilitating the translation of experimental research to community and clinical treatment settings.

Thus, the aim of the present study was to identify the psychological mediators of the vicious cycle proposed to maintain the perception of chronic tinnitus. We first aimed to replicate evidence of the vicious cycle by demonstrating a relationship between tinnitus and anxiety. We hypothesised that this relationship would be mediated by psychological factors, such as depressed mood,

obsessive-compulsive tendencies, and illness attitudes. Second, we aimed to examine whether coping strategies were related to any identified mediators to identify potential behavioural targets for treatment.

2. Methods

2.1. Participants

We aimed to recruit a heterogeneous sample of 70 participants to best represent the full range of the tinnitus experience. This sample size was based on power calculations (G*Power v3.1.9.2) to detect a moderate correlation ($r=.30$) or moderate effect size in a linear multiple regression ($f^2=0.15$) with power of 0.80 and $\alpha=.05$ (Faul et al., 2009). We recruited a community-based sample of 82 volunteers via online advertisements posted on university and community noticeboards, as well as newsletters and flyers distributed in local audiology clinics. We continued to include respondents to the advertisements after reaching our target to allow all responders the opportunity to participate in the study. All participants were required to meet the following criteria for chronic tinnitus: (1) experiencing tinnitus for >3 months, and (2) experiencing tinnitus as always present. One participant failed to meet the second criterion and was excluded from further analysis. This resulted in a final sample of 81 participants with chronic self-identified tinnitus.

The participants ranged in age from 18 to 82 years ($M=44.6$ years, $SD=16.2$) and 57% were female. The tinnitus characteristics of the sample are summarised in Table 1. We used the World Health Organisation's Hearing Impairment Scale to calculate hearing impairment for all participants for whom an audiogram was available ($n=71$) (Concha-Barrientos et al., 2004). Of these participants, 59 (83%) were classified as having normal hearing; eight (11%) were classified with a slight impairment, and four (6%) with a moderate impairment. Independent samples t-tests revealed no differences between participant's with normal hearing ($n=59$) and those with hearing loss ($n=12$) on demographic, psychological or tinnitus measures ($p<0.10$ for all comparisons). The study was approved by the Human Research Ethics Committee at The University of Melbourne and carried out in accordance with the Declaration of Helsinki. All participants gave written informed consent prior to their participation.

Table 1
Tinnitus characteristics ($n=81$).

	n (%)	Mean (95% CI)
Time with tinnitus (years)		14.68 (11.70, 17.66)
Tinnitus handicap score (0–100)		26.32 (21.79, 30.85)
Tinnitus handicap classification[a]		
Slight	30 (37%)	
Mild	33 (41%)	
Moderate	10 (12%)	
Severe	3 (4%)	
Catastrophic	5 (6%)	
Tinnitus awareness (0–100)		45.55 (38.38, 52.72)
Tinnitus annoyance (0–100)		19.86 (14.28, 25.45)
Tinnitus loudness (0–100)		48.38 (42.78, 53.99)
Laterality		
Left ear	10 (12%)	
Both ears, worse in left	11 (14%)	
Both ears/Inside the head	42 (52%)	
Both ears, worse in right	12 (15%)	
Right ear	6 (7%)	
Onset		
Sudden	24 (30%)	
Gradual	54 (67%)	
Unknown	3 (4%)	
Believed cause		
Known[b]	54 (67%)	
Unknown	27 (33%)	

[a] Grading based on McCombe et al (2001).
[b] Causes believed to be medical (25%), stress (18%), hearing changes (17%), loud sound blast (15%), music (13%), prolonged noise exposure (8%), head injury (3%).

2.2. Tinnitus measures

We used the Tinnitus Case Sample History Questionnaire (Langguth et al., 2007) to collect qualitative information about people's tinnitus, which included 0–100 ratings of tinnitus awareness, annoyance, and loudness (see Table 1). We validated our second inclusion criteria (tinnitus perceived as always present) with the awareness rating from this questionnaire, with all participants rating awareness levels above zero (range: 5–100). We used the 25-item Tinnitus Handicap Inventory (THI) to assess chronic perception of the tinnitus sound. This scale measures the impact of perceiving the sound on daily life, particularly in terms of symptoms of tinnitus awareness relating to its emotional effects (e.g. “do you complain a great deal about your tinnitus?”) and functional impact (e.g. “do you find it difficult to focus your attention away from your tinnitus and on other things?”) (Newman et al., 1996). The THI has an associated grading scale from slight (grade 1) to catastrophic (grade 5) (McCombe et al., 2001). Both are recommended as gold-standard measures by the Tinnitus Research Initiative for work in this field (Langguth et al., 2007).

2.3. Psychological measures

All scales were chosen for their well-documented and robust psychometric properties represented here by their internal consistency scores (α). We used the trait subscale of the State Trait Anxiety Inventory (STAI) (Spielberger et al., 1983) to assess anxiety symptoms ($\alpha=0.91$), and the Beck Depression Inventory (BDI-II) (Beck et al., 1996) to assess symptoms of depression ($\alpha=0.93$). The 29-item Illness Attitudes Scale (IAS) was used to assess health-related behaviours and anxiety ($\alpha=0.90$) (Hiller et al., 2002; Kellner et al., 1987), and the 44-item version of the Obsessive Beliefs Questionnaire (OBQ-44) was used to assess obsessive-compulsive symptoms ($\alpha=0.95$) (Obsessive Compulsive Cognitions Working Group, 2005). We used the 66-item Ways of Coping Questionnaire (WAYS), which has eight well-established coping style scales that measure coping strategies. Scales include confrontive coping ($\alpha=0.70$), distancing ($\alpha=0.61$), self-controlling ($\alpha=0.70$), seeking social support ($\alpha=0.76$), behavioural self-blame (also known as accepting responsibility $\alpha=0.66$), escape-avoidance ($\alpha=0.72$), planful problem solving ($\alpha=0.68$), and positive reappraisal ($\alpha=0.79$) (Folkman et al., 1986).

2.4. Statistical analyses

All analyses were done using IBM SPSS version 22 (IBM Corp, 2013), and mediation analyses were computed using the PROCESS macro for SPSS (Hayes, 2013). To establish the presence of a positive linear relationship between anxiety and tinnitus, we computed a 2-tailed correlation. To address our first hypothesis we conducted a series of simple mediation regression analyses examining the influence of psychological variables on the precipitating and maintaining pathways (Fig. 1) of the vicious cycle existing between anxiety and tinnitus. The confidence intervals for the indirect effects were calculated using bias corrected bootstrapped confidence intervals based on 1000 samples (BCa CI). Mediating factors included depressed mood, illness attitudes, and obsessive-compulsive symptoms. To address our second aim we performed a discriminant function analysis to determine whether

coping strategies (measured by the WAYS) could differentiate people who experienced any identified mediating factors from those who did not.

3. Results

Our final sample was predominantly recruited from community advertisements with only two participants from clinical settings. This was reflected in the subclinical psychological profiles of the participants, with most falling in the low-moderate range for symptoms of tinnitus handicap, anxiety, depression, illness attitudes and obsessive-compulsiveness (see Table 2).

3.1. The vicious cycle

Nonparametric Spearman correlation coefficients were calculated to assess the relationships between anxiety and tinnitus as anxiety scores showed significant negative skewness $D(81)=.11$, $p=.02$, as did tinnitus handicap $D(81)=0.15$, $p<0.001$. We observed a moderate to large effect size for a significant, positive association between anxiety and tinnitus handicap ($r_s(81)=0.43$, $p<0.001$, 95% CI (0.24, 0.59)) consistent with predictions of a vicious cycle.

3.2. Mediators of the vicious cycle

All psychological mediators assessed were found to have significant positive correlations with tinnitus handicap and anxiety, again assessed using Spearman correlation coefficients (Table 3).

The precipitating pathway of the vicious cycle, where tinnitus handicap predicts anxiety, was fully mediated by symptoms of depressed mood. As shown in Fig. 2, there was a significant indirect effect when mood was included in the model, representing a large mediating effect $\kappa^2=0.43$, 95% BCa CI (0.28, 0.55). The maintaining pathway of the vicious cycle, whereby anxiety predicts tinnitus handicap, was also fully mediated by symptoms of depressed mood, again representing a large effect, $\kappa^2=0.32$ (0.09, 0.51) (indirect effect, $b=0.79$, 95% BCa CI (0.19, 1.31)). This indicates that when symptoms of depression are included in the regression models, the vicious cycle is no longer present, meaning that depression fully explains the relationship between tinnitus and anxiety.

Table 2
Clinical characteristics of the participants ($n=81$).

	Descriptive Statistics		Grade	
	M (95% CI)	Range		
Anxiety (STAI)[a]	40.02 (37.56, 42.49)	21–68	Low	5%
			Moderate	72%
			High	23%
Depression (BDI-II)[b]	9.95 (7.62, 12.28)	0–50	Minimal	72%
			Mild	16%
			Moderate	6%
			Severe	6%
Illness attitudes (IAS)[c]	33.43 (30.55, 36.31)	11–72	Above clinical cut-off (≥ 47)	20%
Obsessive-compulsiveness (OBQ-44)[d]	113.89 (124.60, 143.18)	62–241	Above clinical cut-off (≥ 169)	17%

[a] Low ($\leq$ 15th percentile), moderate (16–84th percentile) and high ($\geq$ 85th percentile) categorisation based on Australian normative data Crawford et al. (2011).
[b] Grading based on Beck et al. (1996).
[c] Cut-off based on Hedman et al. (2015).
[d] Cut-off based on Anholt et al. (2010).

Table 3
Associations (r_s) between the 'vicious cycle' and proposed mediators ($n=81$).

	Depression symptoms	Illness attitudes	Obsessive-compulsive tendencies
Tinnitus handicap	0.51***	0.32**	0.32**
Anxiety symptoms	0.69***	0.32**	0.34**
Depression symptoms		0.38***	0.45***
Illness attitudes			0.36***

** $p<0.01$.
*** $p<0.001$.

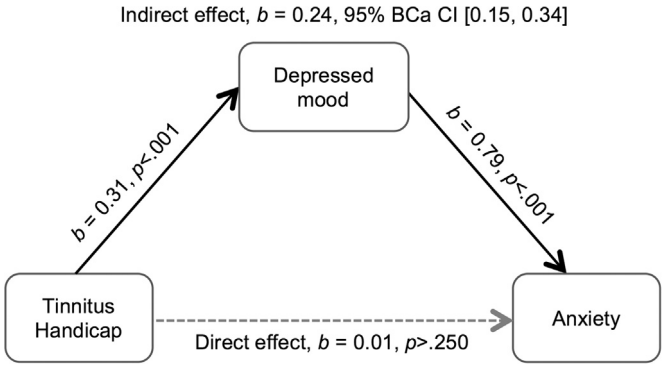

Fig. 2. Model of tinnitus as a predictor of anxiety (precipitating pathway), mediated by depressed mood as measured using the total score of the BDI-II. The confidence interval for the indirect effect is a bias corrected bootstrapped confidence interval (BCa CI) based on 1000 samples.

To confirm that the above mediation models for depressed mood were robust and not just reflective of the subgroup of more depressed individuals in the full sample, we ran the same models with participants who scored in the 'minimal' range for depressed mood ($n=58$; Table 2). We found the same full mediation effect in this subgroup for both the precipitating pathway (indirect effect, $b=0.08$, 95% BCa CI (0.02, 0.15)) and the maintaining pathway (indirect effect, $b=0.37$, 95% BCa CI (0.10, 0.92)). We also assessed whether the mediation effects were largely driven by cognitive or somatic depressive symptoms by including the relevant subscale of the BDI-II in the mediation model, rather than total BDI-II scores (Beck et al., 1996). This showed that neither subset of symptoms could fully explain the vicious cycle between tinnitus and anxiety, with both the cognitive ($b=0.07$, 95% BCa CI (0.01, 0.19)) and somatic ($b=0.06$, 95% BCa CI (0.04, 0.16)) models showing small but significant partial mediation effects for the precipitating pathway, and no significant effects for the maintaining pathway. It should be noted, however, that the subscales had a reduced range of scores potentially restricting the size of the effects.

As the THI assesses both emotional and functional symptoms of chronic tinnitus perception, we investigated the possibility that emotional reactions to the tinnitus sound assessed by the THI could influence the results. To do this we restricted the analysis to only include the functional subscale of the THI, which assesses the intrusion of tinnitus perception on mental, social and physical functioning. We found the same full mediation effect in this analysis for both the precipitating pathway (indirect effect, $b=0.41$, 95% BCa CI (0.22, 0.63)) and the maintaining pathway (indirect effect, $b=0.35$, 95% BCa CI (0.07, 0.66)).

Two partial mediators were also found for tinnitus handicap predicting anxiety (precipitating pathway). Obsessive-compulsiveness showed a small but significant effect, $\kappa^2=0.13$, 95% BCa CI

(0.03, 0.26) (indirect effect, $b=.07$, 95% BCa CI (0.01, 0.15)), as did illness attitudes, $\kappa^2=0.09$, 95% BCa CI (0.02, 0.21) (indirect effect, $b=0.05$, 95% BCa CI (0.01, 0.12)). When symptoms of depressed mood were entered as a covariate in the mediation models, however, both obsessive-compulsiveness and illness attitudes were no longer significant mediators, suggesting that depressive symptoms account for these effects (see Table 3).

3.3. Depressive symptoms and coping strategies

To identify potential coping strategies that may be addressed in treatment, we first investigated the relationship between the coping strategies employed by individuals with tinnitus and depressive symptoms. We found significant positive Spearman correlations between depressive symptoms and the escape-avoidance scale of the WAYS ($r_s=.47$, $p<0.001$), and depressive symptoms and the self-blame scale ($r_s=.30$, $p=.01$). We then used a discriminant function analysis to determine the extent to which these coping strategies differentiated between individuals with symptoms of depression (mild to severe, $n=23$) from those with minimal symptoms ($n=58$; Table 2). Together, the discriminating power of these two types of coping strategies was significant, Wilk's $\lambda=0.74$, χ^2 (2)=23.03, $p<0.001$, and correctly classified 78% of cases. The analysis showed high specificity for participants with minimal depressive symptoms (90%), indicating that maladaptive coping strategies were predominantly used by the more depressed group. In contrast, there was lower sensitivity (48%) for the more depressed group, likely reflecting their large range of depressive symptoms (from mild to severe).

4. Discussion

Our study provides new and important insights into the relationship between anxiety and tinnitus, suggesting that depressed mood is key to maintaining awareness of tinnitus. Consistent with predictions based on existing models of tinnitus maintenance, we observed a relationship between anxiety and tinnitus handicap, however, this was fully explained by the presence of depressive symptoms in a mediation analysis. These findings help unpack the complex relationships between psychological factors and the experience of chronic tinnitus, and suggest that the presence of the vicious cycle is conditional on mood.

4.1. The role of depression in tinnitus maintenance

Our findings indicate that depressive symptoms mediate the 'vicious cycle' of tinnitus maintenance in people currently experiencing chronic tinnitus for both the precipitating and maintaining pathways. This suggests that depressive symptoms play a key role in facilitating the chronic nature of tinnitus and may underpin the onset and continued reinforcement of the two pathways of the 'vicious cycle' (Fig. 3). In support of the present results, depression commonly co-occurs with both anxiety and tinnitus, and has substantial overlap with symptoms of tinnitus, such as insomnia, concentration difficulties, and social withdrawal. Moreover, depressive thoughts may lead the sound to take on negative meanings, causing fear and anxiety in people with chronic tinnitus (Langguth et al., 2011).

Recent advances in our knowledge of depression provide a novel context for understanding how depressive symptoms might be maintaining tinnitus and its associated psychosocial impact. New neurocognitive accounts conceptualise unipolar depression as the functional disruption of particular brain networks, including the Cognitive Control Network (CCN), the Salience Network (SN) and the Affective Network (AN) (Rayner et al., 2016). In particular, decreased activation of the CCN is thought to reduce top-down regulation of the SN, AN and HPA-axis leading to increased AN activity, which may present as anxiety and promote increased monitoring of emotional information in people with depression. In other words, the anxiety and limbic system activation proposed in the vicious cycle may reflect reduced activation of the CCN, with impaired down regulation of the AN and SN associated with being depressed.

In support of this interpretation cognitive symptoms of depression that reflect CCN disruption, such as impaired working memory and attention, have been reported in people with chronic tinnitus (McKenna et al., 2014). There is also neurobiological evidence of altered functioning of hubs in the CCN, SN, AN (Husain, 2016) and the HPA-axis (Simoens and Hébert, 2012) in people with chronic tinnitus. In particular, reduced functional connectivity at rest between the AN and auditory regions has been found which may reflect reduced regulation of the AN by the CCN which could facilitate an ongoing association between negative emotions and the tinnitus sound (Husain, 2016). In addition, treatments known to be effective in restoring normal functioning in these networks, such as anti-depressant therapy, transcranial magnetic stimulation and cognitive behavioural therapy, have shown positive effects for

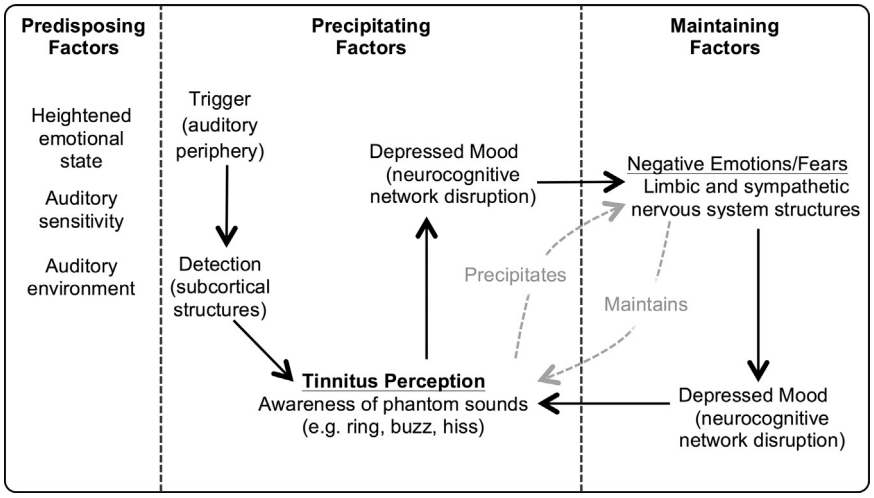

Fig. 3. The mediating role of depression in the 'Vicious Cycle'. The 'Vicious Cycle' is represented by faded dashed lines. Note that depressive symptoms explain both the precipitating pathway, where the onset of chronic tinnitus leads to negative emotions such as anxiety, and the maintaining pathway, where anxiety reinforces tinnitus perceptions.

altering or relieving tinnitus symptoms (Cima et al., 2012; Meeus et al., 2011; Vanneste and de Ridder, 2012). Thus, one interpretation of the current findings is that network disruption is responsible for tinnitus maintenance.

We identified two maladaptive coping strategies that were characteristic of people with chronic tinnitus and depressive symptoms. Avoidance behaviours (e.g. "I hoped for a miracle") and self-blame (e.g. "I criticized or lectured myself") clearly discriminated individuals with minimal depressive symptoms from those with mild to severe symptoms. Reducing reliance on these coping strategies may complement traditional psychological treatments such as cognitive behaviour therapy by improving mood and providing relief from the experience of living with chronic tinnitus.

4.2. Theory and future directions

The current study extends our understanding of chronic tinnitus by elucidating the complexity of psychological factors at play in the vicious cycle of anxiety and tinnitus handicap. The growing research on tinnitus, including neuroimaging work, has highlighted a range of additional processes involved in the experience of tinnitus, with our data pointing to a significant role of depressive symptoms. In particular, our results are drawn from a comprehensive assessment of a community sample and suggest that the vicious cycle is conditional on the presence of low mood. A limitation of the current work is the need to replicate this finding in a clinical cohort of people with tinnitus, who typically have greater psychological co-morbidity and psychosocial impact of tinnitus. Our study specifically addresses the role of psychological factors in maintaining hypervigilance to the tinnitus sound in people currently experiencing chronic tinnitus. The role of these factors in the onset of tinnitus perception, and the progression from initial onset to chronic tinnitus awareness will be important to establish in future research. Longitudinal studies are warranted to determine the contribution of psychological factors to the progression from acute onset to chronic perception, particularly with regard to the critical role of depressive symptoms in predicting both tinnitus handicap and anxiety in this study. Future neuroimaging studies are also warranted to interrogate the networks of people with chronic tinnitus to determine the relevance of recent neurocognitive accounts of unipolar depression. This account proposes that chronic tinnitus is associated with impaired cognitive control and down regulation of negative ruminations and emotions associated with tinnitus. This likely produces the complaints commonly reported by people with tinnitus, such as hypervigilance to the tinnitus sound, emotional difficulties including suicidal thoughts and anxiety, poor sleep, social withdrawal and interference with day-to-day functioning. Finally, our data highlight the need to further investigate coping strategies in people with tinnitus; as such strategies can be highly responsive to psychological treatment.

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