Hearing Research 332 (2016) 199–209

Contents lists available at ScienceDirect

Hearing Research

journal homepage: www.elsevier.com/locate/heares

Review

The consequences of tinnitus and tinnitus severity on cognition: A review of the behavioural evidence

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ARTICLE INFO

Article history:
Received 13 July 2015
Received in revised form
4 October 2015
Accepted 5 October 2015
Available online 31 October 2015

Keywords:
Cognitive performance
Chronic tinnitus
Hypothesised model

ABSTRACT

People with tinnitus report anecdotal difficulties in mental concentration and psychological treatments for tinnitus advise on concentration difficulties and how to manage them. Yet the literature lacks any coherent discussion about what precise theoretical cognitive constructs might be mediating reported concentration problems. This review addresses this gap by describing and critically appraising the behavioural evidence for the effects of tinnitus on cognitive performance (namely working memory and attention). Empirical evidence is somewhat limited, but there is some support that tinnitus interferes with executive attention, and mixed support that it impairs working memory and selective attention. We highlight a number of methodological considerations to help drive the field forward and we propose a putative model of the complex inter-relationships between tinnitus, cognition and confounding factors. This model provides a basis for hypothesis testing.

Contents

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1. Introduction

There is a body of clinical evidence that people with tinnitus report anecdotal difficulties in mental concentration (Tyler and

http://dx.doi.org/10.1016/j.heares.2015.10.001

Baker, 1983; Sanchez and Stephens, 1997; Andersson et al., 1999). In terms of clinical management for tinnitus, psychological approaches advise on concentration difficulties and how to manage them (Abbott et al., 2009; Andersson, 2001; Andersson and Kaldo, 2004; Andersson et al., 2002; Kaldo et al., 2007; Kaldo-Sandström et al., 2004). Many tinnitus questionnaires ask about ability to concentrate, to think clearly or to focus on other things apart from tinnitus (e.g. Meikle et al., 2012). A dedicated tinnitus questionnaire has recently been developed to specify the degree of cognitive 'failures and mishaps' that are relevant to performing adequately in daily life (Bankstahl and Görtelmeyer, 2013). This instrument has not yet gained widespread use. An earlier tool (the Cognitive Failures Questionnaire, Broadbent et al., 1982) has been used in tinnitus research (e.g. McKenna et al., 1995; McKenna and Hallam, 1999), but this tool has been criticized for its limited use as a standard measure in clinical practice (Wagle et al., 1999). In particular, psychologists have noted that the accuracy of an individual's self-assessment of his/her own abilities alters radically with age-related changes in self-regard and in life-style (Rabbit and Abson, 1991), and this might also be relevant for self-assessment of mental concentration in older adults with tinnitus. Whether or not self-reported everyday cognitive slips and errors are more common in people with tinnitus, and not simply a general reflection of ageing, is contradictory (Bankstahl and Görtelmeyer, 2013; McKenna et al., 1995; McKenna and Hallam, 1999; Rossiter et al., 2006). Moreover, audiologists have noted that people with tinnitus often attribute hearing problems to the tinnitus itself (Henry et al., 2015). In other words, complaints about concentration *may* be caused by difficulties in listening and communicating, not due to tinnitus per se (see McKenna and Hallam, 1999).

While a concept such as 'concentration' is a lay person's label for his/her personal experience, scientific studies of exactly how cognition is affected by tinnitus are needed to explain clinical findings and to better understand the impact of tinnitus severity on cognitive impairment. This review focuses on working memory and attention because these are the most relevant theoretical constructs for cognition. Cognitive psychologists have examined theories/models of working memory and attention largely based on experiments under controlled, scientific conditions that reduce cognition to its basic constituents (Eysenck and Keane, 2015). While these experiments may lack ecological validity, their advantage lies in identifying what specific elements of cognition might mediate the self-reported lapses in concentration.

A review of contemporary behavioural evidence is warranted. To our knowledge, the only dedicated review of this topic was published almost 10 years ago (Andersson and McKenna, 2006) and the authors concluded: "In sum, the published evidence so far concerning the disruption of information processing is relatively weak" (pp 40). Our review brings several unique features. Not only does it consider behavioural evidence in the context of well-established psychological models of cognition, it also examines the evidence for linking it back to anecdotal clinical observation. The primary aim of our review is to summarise and critically appraise behavioural research that addresses the impact of tinnitus and tinnitus severity on various aspects of working memory and attention. We do not review studies using challenging tasks in which it is not possible to separate out the contributions of many different components of cognitive processing (e.g. Acrani and Pereira, 2010; Pierce et al., 2012; the Vienna Determination Task in Jackson et al., 2014). On occasion we may use different terminology from the authors to describe what cognitive constituent each task addresses because we present the body of knowledge according to well-established models (see Sections 4 and 5, respectively). A secondary objective is to examine whether studies have considered how impaired cognitive performance relates to those people with tinnitus who actually report concentration difficulties or cognitive failures and mishaps. Third, we appraise the included studies for important aspects of risk of bias in order to make general recommendations for future research. We end by proposing a testable cognitive model that is a synthesis of the research literature considered within this article.

2. Identification and selection of publications

The peer-reviewed literature was searched using the PubMed electronic database which includes Medline. To identify articles examining the effect of tinnitus and tinnitus severity on specific components of working memory and attention, the search was: ((((tinnitus[Title]) AND cogniti*[Title])) OR ((tinnitus[Title]) AND attention[Title])) OR ((tinnitus[Title]) AND memory[Title]), with records filtered for a publication date on or after 1990, English language and restricted to humans. The date of 1990 was chosen as it corresponded to the landmark publication by Posner and Petersen (1990) presenting a psychological model of attention. This search returned 65 records in total, with 3 further records identified after a hand search of the two reviews (Andersson and McKenna, 2006; Roberts et al., 2013) within the original list of 65. This gave 68 potentially eligible records. Fifty-nine records were excluded because they were out of scope (see Fig. 1), leaving 9 records for review.

For each of the included records, Sections 3 and 4 presents a narrative synthesis describing the participant groups, cognitive tests administered and the findings as they relate to our primary objective. Section 5 gathers the evidence for the link between

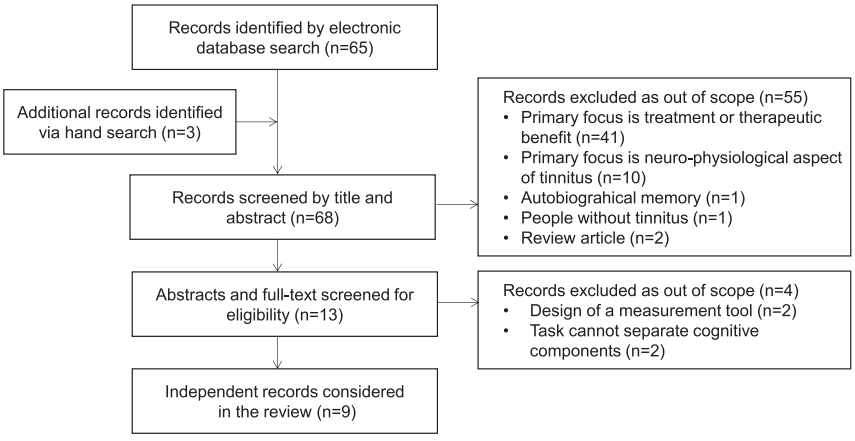

Fig. 1. Flow diagram of study selection.