Institution: Leeds Trinity University		
Unit of Assessment: Psychology, Psychiatry and Neuroscience		
Title of case study: International impact of research identifying novel and objective measurement of tinnitus distress: collaborations and education.		
Period when the underpinning research was undertaken: Jan 2013 – Jan 2019		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): Dr James Jackson	**Role(s) (e.g. job title):** Reader in Psychology	**Period(s) employed by submitting HEI:** 2008 onwards
Period when the claimed impact occurred: Jan 2014 – Dec 2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact [98 words]

This ICS details research on objective measurement of tinnitus distress, and how this research has been used to **educate** 100s of healthcare practitioners (audiologists in the UK and beyond) to better explain tinnitus to their patients and to stress how important it is for patients to acquire a **sense of control** over their tinnitus, enabling engagement with effective interventions. Further, 1000s of individuals with tinnitus (in the UK and beyond) have attended sessions/read articles which have enabled them to better **understand** their condition (e.g. links between tinnitus, clinical depression and concentration difficulties) and be **empowered** to take action.

2. Underpinning research [500 words]

Background

Tinnitus is a chronic medical condition characterised by perception of noise in the absence of corresponding external stimuli, often resulting in distress, concentration difficulties (**Jackson** et al., 2014), and/or clinical depression (**Jackson**, 2019). Approx. 10-12% of the general population have persistent tinnitus, with 1-2% (gen pop) suffering significant reduction in life quality. Unusually for such a widespread aliment, tinnitus has no cure and few clinically significant treatment options. The most significant obstacle is the lack of a recognised objective measure of the condition to enable effective investigation of treatment efficacy. Tinnitus distress is currently evaluated by healthcare professionals with self-report questionnaires (e.g. Tinnitus Functional Index) and since tinnitus has a strong comorbidity with depression, these subjective measures are open to considerable response bias.

Cognitive Inefficiency in Tinnitus Patients

Jackson et al. (2014) investigated impact of tinnitus distress on selected cognitive tasks, evidencing that tinnitus affected task performance though reduction in processing speed. The paper put forward **a novel theory of cognitive inefficiency**, suggesting that task-irrelevant anxieties (i.e. intrusive thoughts about tinnitus) were drawing on finite cognitive resources, denying use for task completion. It is part of a contemporary body of work considering whether such cognitive inefficiencies could be an objective marker of tinnitus distress. It has informed later studies as to the most appropriate cognitive tasks to use (i.e. tasks of selective attention).

The Cortisol Awakening Response in Tinnitus Patients

Cortisol is a stress hormone. Previous research investigating cortisol concentrations in tinnitus patients did not evidence findings of note. However, none considered the Cortisol Awakening Response (CAR). The CAR is a robust physiological phenomena that sees cortisol concentrations rise by 40-75% post-awakening, supporting the move from sleep to wakefulness. This robust response occurs naturally, and any deviation from normal functioning can be considered an objective biomarker of distress.

Funded by the British Tinnitus Association (£5,000), **Jackson** (2019) was the first researcher to consider CAR methodology in tinnitus research. This novel paper compared controls with tinnitus patients. Habituated individuals with tinnitus were indistinguishable from controls, but those reporting significant tinnitus distress had a 'flat diurnal rhythm' indicative of **vulnerability to clinical depression** and **inability to cope** with significant personal challenges. Previously, the literature has been conflicted on whether tinnitus cause clinical depression or whether clinical depression increase likelihood of persistent tinnitus.

These are significant findings. The literature is divided on what constitutes severe tinnitus distress, and what constitutes a 'clinically significant' intervention. For example, the Tinnitus Functional Index has a range of 0-100. Some researchers believe a reduction of '13' is clinically significant, others believe a reduction of '22.4' is needed. **Jackson** (2019) suggests a dichotomous approach based on physiology – either patients have a robust CAR (indicating habituation to the condition) – or they do not. Specifically, tinnitus interventions should only be considered successful if the CAR has returned to normal functioning. Furthermore, dysfunctional CAR values were most associated with poor 'sense of control' (SoC) over tinnitus, suggesting that tinnitus-specific interventions focusing on improving self-efficacy and **'empowerment'** may be most effective.

3. References to the research [351 words]

Both referenced outputs were published in international journals, having undergone rigorous peer-review by way of initial screening (desk editor), anonymised double-blind review by two or more reviewers, and at least one round of author revision.

Jackson, J. G., Coyne, I. J., & Clough, P. J. (2014). A preliminary investigation of potential cognitive performance decrements in non-help-seeking tinnitus sufferers. *International Journal of Audiology*, *53*(2), 88-93. https://doi.org/10.3109/14992027.2013.846481

As of Feb 2021, SCOPUS reports 19 citations for this paper (90th percentile), including the Journal of Psychosomatic Research, Frontiers in Psychology, and Trends in Hearing. This includes systematic reviews and meta-analyses.

Key Findings: Presence of tinnitus results in reduced performance across two cognitive tasks, and greater tinnitus distress results in poorer performance. Cognitive Tasks (Executive Function) are candidates for objective measures of tinnitus distress.

Jackson, J. G. (2019). The cortisol awakening response: A feasibility study investigating the use of the area under the curve with respect to increase as an effective objective measure of tinnitus distress. *American Journal of Audiology*, 28(3), 583–596. https://doi.org/10.1044/2019_AJA-18-0174

As of Feb 2021, SCOPUS reports 2 citations for this paper (73rd percentile) - in Annals of Otology, Rhinology and Laryngology and the International Journal of Audiology. Further metrics (https://asha.altmetric.com/details/63757721#score; retrieved 05/03/21) has this paper in the 89th percentile of papers tracked by Altmetrics, and is ranked 1st of 29 American Journal of Audiology outputs of similar age. Findings have been presented to multiple academic conferences, resulting in further invitations (e.g. University of Edgehill).

Key Findings: Severe tinnitus distress results in a blunted Cortisol Awakening Response (CAR), particularly 'sense of control' (SoC) over tinnitus. As such, it is a candidate objective biomarker of tinnitus distress. The CAR can predict ability to cope (or fail to cope) with tinnitus later the same day. Severe tinnitus increases vulnerability to clinical depression.

Supporting Grant: This study was charitably funded by the British Tinnitus Association Small Grant Scheme following rigorous review by lay patients with tinnitus, the BTA Professional Adviser's Committee (https://www.tinnitus.org.uk/pages/faqs/category/pac), and charitable trustees. Start Date 1st April 2017. End date 1st July 2018 (15 months). Value: £5,000.

4. Details of the impact [909 words]

This ICS focuses on the usefulness of research into underlying mechanisms and consequences of tinnitus distress, how it can better **educate** healthcare professionals in their interactions with

tinnitus patients, help tinnitus patients better **understand** their condition - and how a proactive mindset (i.e. improved sense of control) can **empower** patients to engage with viable interventions.

(i) Business/Corporate

Impact at corporate events is evidenced by way of a global hearing aid manufacturer **(S1)**. In this typical event, research findings were presented to 40+ private audiologists, ENT surgeons and industry professionals from the UK, Ireland, France, and Switzerland – so as to increase their **understanding** of tinnitus. Phonak produces Lyric™, a 24/7 hearing aid that can be worn while sleeping, or in the shower. Lyric™ provides a constant soundscape to distract from the tinnitus sensation – it represents **empowerment** (as 80% of tinnitus patients have hearing loss). **(S1)** reflects this: "*hearing aid professionals need to understand tinnitus and its mechanisms… …to best serve their customers"; "people will be less likely to focus on their tinnitus";* and "*his research supports our confidence in our product."*

Jackson also presented to the Specsavers **(S2)** Audiology Professional Advancement Conference (PAC2020), where *"over 400 audiology professionals… …from Australia, New Zealand, Denmark, Ireland, Spain and the UK"* **(S2)** attended. Feedback was very positive, with comments including: *"patients feel empowered"* **(S2)**, *"I now feel more confident in talking to patients about their tinnitus"* **(S2)**, and *"I have personally used some of the exercises… … and have found them to be incredibly effective in… …calming my tinnitus*." **(S2)**.

With these examples **(S1 + S2)**, 100s of private audiologists are now better placed to encourage their patients to **make changes** and habituate to tinnitus.

Dissemination also led to an invitation to become the clinical and scientific advisor for Hearing Power (Australia) and their smartphone-based virtual coach 'Tinnibot' – which provides easily-accessible digital therapies for tinnitus patients. *"Dr Jackson was instrumental in…"* **(S3)** obtaining a $50,000 (AUS) Global Connections Bridging Grant from the Australian Academy of Technology & Engineering, encouraging international cooperation between a business (Australia) and a Higher Education establishment (elsewhere in the world). "*Tinnibot is now used by over 1000 people around the world"*, **(S3)** and preliminary findings (in prep) have 33% of users (over 300 people) – in the UK, Mexico, USA, Australia and New Zealand – reporting **clinically significant reductions** in their tinnitus distress, with content provided by **Jackson**. Tinnibot **educates** users so they better **understand** their condition and **empower** decisions "*to access digital therapy with the potential to improve… …quality of life."* **(S3)**. Collaboration with Hearing Power has led to further efforts *"with a truly international feel"* **(S3)**, alongside universities in Australia (n=3), New Zealand (n=2), Belgium and the Netherlands **(S3)**.

(ii) Healthcare Professionals

Jackson has presented to and supports the work of three NHS Trusts, this typical work represented by Rotherham NHS Foundation Trust **(S4)**. **Jackson** has supported the work of the Audiology department for seven years, with lectures to patients and audiologists described as *"a real asset"* **(S4)**, with feedback from these sessions *"very positive"* **(S4)** and *"of great value"* **(S4)** – with many patients commenting later as to how *"their viewpoint had changed"* **(S4)** through **education**, and that *"their tinnitus had changed for the better"* **(S4)**. The Trust has also organised multiple national NHS events. Over the years, **Jackson** has **educated** and **empowered** 100s of patients (and audiologists) on behalf of the Trust.

Research findings have been disseminated to professional societies – the British Academy of Audiologists (BAA) and the British Society of Hearing Aid Audiologists (BSHAA). Using BSHAA (**S5**) as a typical example, where an audience in the 100s *"including hearing aid professionals and researchers from all over the world"* **(S5) learned** more about the mechanisms of tinnitus and the importance of patients being able to gain a **sense of control** over their tinnitus, with *"very positive feedback"* **(S5)** from this professional audience.

(iii) Charities and the Public

One public speaking example (n=18 since 2014) was the Tinnitus and Hearing Information Show (THIS) in Glasgow, UK **(S5)**. **Jackson** has spoken at this event for the general public on three occasions, with *"audiences ranging from 100-250 people"* **(S5)** each time. THIS audiences were provided with methods to improve **sense of control** over tinnitus, many subsequently **seeking treatment**. *"He… …was able to… …explain to our audience the importance of empowerment"* **(S5)** and "*As a practitioner, I make frequent use of [his] research"* **(S5)**.

Jackson has also presented to ten UK self-help tinnitus groups, a typical example being the Cambridge Tinnitus Support Group **(S6)**, with an audience of 30+ members and a local NHS tinnitus lead. Self-help group members have benefitted from these talks, with feedback positive: *"Our members struggle with… …lack of control… [his] explanation… … really helped our members make sense of this."* **(S6)**.

Jackson has presented at three British Tinnitus Association (BTA) conferences "*with on average, over 200 delegates from around the world"* **(S7)**, **educating** healthcare professionals, researchers and patients on the importance of **empowerment.** In the same vain, he has written articles for the BTA quarterly magazine "Quiet" *"circulation circa. 4000"* UK patients **(S7)** and having funded the 2019 paper *"following rigorous review"* **(S7)**, the BTA state *"It is pleasing to see… …worldwide recognition for what is a novel and original piece of research".* **(S7)**.

In conclusion, evidence as to ongoing improvement in the quality of life of many 100s of tinnitus patients is emerging (in the UK and beyond), with the ICS continuing into the next REF.

5. Sources to corroborate the impact

Source 1: Global Clinical Development and Training Manager, Phonak AG, Switzerland

Source 2: Organiser: Specsavers Audiology PAC2020, UK

Source 3: Director, Hearing Power, Australia

Source 4: Senior Audiologist, Rotherham NHS Foundation Trust

Source 5: THIS Organiser, Council Member (BSHAA), UK

Source 6: Honorary Secretary, Cambridge Tinnitus Self-help Group (CTSG)

Source 7: CEO, British Tinnitus Association (BTA)