Edith Cowan University
Faculty of Computing, Health and Science

The Sonic Silence Exhibit: Demonstrating the Consequences of Noise-Induced Hearing Loss and Tinnitus

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Title

The Sonic Silence Exhibit:
Demonstrating the Consequences of
Noise-Induced Hearing Loss and Tinnitus

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Disclaimer

The Sonic Silence exhibit was funded by the Hearing Loss Prevention Programme for the Department of Health and Ageing and this report is released to the Office of Hearing Services. The views expressed and the recommendations contained herein are those of the author and do not necessarily reflect Department of Health and Ageing policy. Judicious discretion should be applied when using, quoting, or applying any of the information contained in the report.

Attibution

Any attribution to this work should be made to the original author and include the following statement: Support for the original work was provided by the Commonwealth of Australia Department of Health and Ageing under the Hearing Loss Prevention Programme.

ABOVE FROM LEFT: David Fobrogo, Andrew Hannah, Phillip Verschuer, Paul Chang, Walter Maciejak, Hew Tromans, and Denham Dunstall.

Project Team

Project Team Members

Paul Chang, *School of Psychology and Social Science, Edith Cowan University*
Sandra Green, *School of Psychology and Social Science, Edith Cowan University*
Andrew Hannah, *Director of Science Programs, Scitech*
Denham Dunstall, *Director of Exhibition Design & Development, Scitech*
David Fobrogo, *Interactive Media Designer, Scitech*
Hew Tromans, *Computer Software Programmer, Scitech*
Rachael Hughes, *Science Communicator, Scitech*
Walter Maciejak, *Industrial Designer, Scitech*
Leon Cox, *Workshop Technician, Scitech*
Phillip Verschuer, *Science Presenter, Scitech*

Executive Summary

Many young people do not pay enough attention to the fact that listening to music or sounds at high volumes may damage their hearing. The Sonic Silence exhibit was designed to inspire a person to take up safe hearing habits. The exhibit resembles a giant pair of headphones in which two people can sit in each of the headphone 'pods.' The game-play in the exhibit may include one or two players communicating with a computer programme or with each other. The exhibit appeals to everyone, but is especially aimed at the generations who are growing up listening to music on earphones via the ubiquitous smartphone and MP3 player. Exposure to loud sounds during leisure activities is a concern to young people and their parents, yet there are few ways to get the message across that overexposure to loud sounds may lead to hearing loss and tinnitus. The Sonic Silence exhibit is a fun, novel, and interactive way to raise visitor awareness about safe hearing habits.

Key Outcome

The key outcome and deliverable of this project was the hands-on, interactive Sonic Silence exhibit. During game-play, the exhibit conveys an educational message about hearing loss and tinnitus designed for people of all ages, but especially aimed at young people and their parents. The exhibit is located in Perth at Scitech, the Western Australian science museum. From its launch on 14 June 2012, it is estimated that each day, an average of 185 people – of all ages – climb into the headphone-shaped exhibit to listen to auditory simulations of hearing loss and tinnitus conveyed in a hearing protection message.

> "It's an education-based strategy – we know that this is one of the most significant preventable causes of hearing loss we have in the community, and we know that if we get to children in their primary school years we can build some safe hearing habits."
>
> *The Honourable Mark Butler, MP, Federal Minister for Mental Health and Ageing; 14 June 2012.*




ABOVE: The Honourable Mark Butler, MP, Federal Minister for Mental Health and Ageing, with Year 7 students from Dalyellup College on the day of the official launch of the Sonic Silence exhibit. **FROM LEFT:** Darcy-Rose Taylor, Emily Jarman, Joshua Young, Dylan Taylor, Bevan Eales, and the Hon Mark Butler MP.

Scope of the Report

This is the final report for the project titled *The Cone of Deafness: An Interactive Demonstration of the Difficulties in Communication Between People When They Have Simulated Hearing Loss and Tinnitus.* The project was implemented by The Hearing Loss Prevention Programme for the Department of Health and Ageing. The aim of the project was to develop a hands-on, interactive exhibit incorporating auditory simulations of hearing loss and tinnitus to demonstrate the consequences of overexposure to loud sounds.

This report provides information about the design and implementation of the exhibit. The report begins with an overview of the impact of noise-induced hearing loss (NIHL), a brief literature review outlining the rationale for the exhibit, and the reasons for incorporating auditory simulations of hearing loss and tinnitus. Then, the outcomes and achievements of the project are described against each of the stated objectives set out in the funding agreement for the period 30 June 2009 to 12 December 2012. The report also includes an evaluation of the exhibit carried out by Scitech.

Table of Contents

Notes:

1 Introduction

1.1 Specific Aim of the Project

The specific aim of this project was to design and implement a hands-on science museum exhibit that conveyed the message of hearing protection. In creating the exhibit, several resources were developed including an interactive (and modifiable) computer game and the headphone-shaped infrastructure. In developing the interactive resource, care was taken in the design to inspire a person to heed a warning message about the dangers of loud noise. The developed exhibit targets young people because they are notoriously resistant to the hearing conservation message and because, at present, there exists few opportunities to convey the message of hearing protection to the target population in either school curricula or in the community at large.

1.2 Project Goals and their Relation to Previous Research

The goal of the project was to embed a hearing protection message in a science exhibit. The message included simulations of hearing loss and tinnitus. There is evidence that these types of auditory simulations help augment a hearing loss prevention message (see Chang, 2010 "Using Auditory Simulations to Enable Prevention of Noise Exposure in School-Age Children and Young Adults"). Indeed, the present exhibit acknowledges and successfully fulfils the following key recommendations from Chang's (2010) report on the effectiveness of auditory simulations:

- **Early Intervention and Prevention.**

  It is imperative for young adults and school-age children to be specifically targeted at school and in their leisure time with the aim of developing lifelong changes in their attitudes and behaviours towards hearing conservation.

- **Ongoing Communication Strategies.**

  Consistent and ongoing communication strategies are necessary to ensure the dissemination of information about the risks of noise-induced hearing loss and tinnitus. These strategies need to be innovative (e.g., through the use of auditory simulations and other educational messages) and relevant (e.g., focussing on the fidelity of music) to capture the attention of young people.

- **Use of Auditory Simulations of Hearing Loss and Tinnitus in Conjunction with Education.**

  The importance of the inclusion of auditory simulations used in conjunction with noise-induced hearing loss education has been shown to be effective with teenagers, probably because it is a novelty.

- **Involving Parents in Hearing Loss and Tinnitus Education.**

  Involving parents in the education of the risk factors leading to noise-induced hearing loss and tinnitus at schools enables them to reinforce any new positive behaviours at home.

1.3 Project Objectives

The specific objectives of this project (and a summary of how the objectives were met) are described below.

> ***Objective 1:*** *Develop an interactive, communication-based game that will demonstrate to users the difficulty of communicating with a hearing loss and tinnitus. Success in the game will depend on the participants being able to communicate with each other and, therefore, is compromised when people cannot hear each other properly. Embedding the auditory simulations within the context of a communication computer game will effectively demonstrate the difficulties and frustrations when trying to communicate with hearing loss.*

This objective has been met through the development of the interactive exhibit and its location in Scitech, the Western Australian science museum. The game-play in Sonic Silence involves a real-life activity (meeting at a park and communicating with members of a party). When the message to be communicated has been compromised (via auditory simulations of hearing loss and tinnitus), the result is that the message is not heard well. This experience is then followed by a message concerning hearing conservation that explicitly describes the consequences of overexposure to loud noise. Thus, embedding auditory simulations in the context of trying to communicate at a park conveys the message of hearing conservation while a visitor sits in the exhibit.

> ***Objective 2:*** *Design a comprehensive hearing conservation message using advertising aimed at young people who use personal music players.*

This objective has been achieved through the interactive game-play of the exhibit. Scitech visitors are children of varying ages, teenagers, young adults, parents, and grandparents. The Sonic Silence exhibit is positioned close to the entry of the main hall, and is usually one of the first exhibits that people interact with. In addition to the hearing conservation message delivered in the exhibit, there is also information printed on the barrel of the headphone pods about the structure of the ear, hearing loss and social isolation, the loudness of common sounds, and the dangers of exposure to loud noise.




Objective 3: *Measure the effectiveness of the message according to attitude to the recommended behaviours, behavioural intention to adopt and self-reported behaviour change.*

Two primary measures are used by Scitech in evaluating their exhibits. The first is a visitor intercept survey that indicates a high degree of satisfaction with the exhibit. For example, 66% of visitors who used the exhibit were likely to recommend the experience to a friend. Furthermore, 71% of visitors surveyed indicated that the exhibit was useful in conveying the dangers of loud sounds. The other measure is the exhibit dwell-time (that is, the time spent interacting with the exhibit). The average dwell-time (adjusted for outliers) for the exhibit was 2 minutes 24 seconds, which is a significantly longer dwell time than for most other science exhibits (the worldwide industry standard is 77 seconds; Serrell, 1998).

Objective 4: *Define behavioural characteristics of people who are resistant to the hearing conservation message.*

At the beginning of the project, several interviews were conducted with participants during the design phase of the Sonic Silence exhibit. A semi-structured interview schedule was created. The interview schedule included a series of questions that asked why young people were generally ignorant of the hearing conservation message. Most importantly, the interview included questions about the type of exhibit that they would respond to. The primary themes that emerged from these interviews that directed the design of the Sonic Silence included:

- A strategy that needed to be 'fun' and interactive, like a computer game;
- A strategy that needed to be personally relevant in terms of their own personal experiences; and
- A strategy that was to be brief, no more than 3-4 minutes in duration, otherwise the message was seen as being too didactic.




In addition, to Objectives 1 to 4 outlined above, two specific outcomes of the project are described below.

> ***Specific Outcome 1:*** *Uptake of the Sonic Silence (nee Cone of Deafness) exhibit by museums, and promotion of the Project's hearing conservation message, nationally.*

At this time, Scitech's intention is to keep the exhibit on its floor for five years, which is the lifespan of most of its exhibits. This is an excellent outcome because it means that the exhibit is seen as a fixture, attracting both new visitors and people who have already been exposed to the message before. At this time, however, it is uncertain whether or not Sonic Silence will be exhibited in other science museums. If the exhibit attracts interest from other science museums, then Scitech has a formal policy regarding the leasing of its exhibits allowing it to be installed elsewhere.

> ***Specific Outcome 2:*** *Reduction in the incidence of hearing loss in young Australians who use personal music players.*

This objective is a long-standing goal and a longitudinal study of visitor behaviour is beyond the scope of the project. It should be kept in mind that this is an extremely ambitious outcome, but it is clear that for visitors who interact with Sonic Silence, the exhibit is a very popular addition to Scitech.

"At this time, Scitech's intention is to keep the exhibit on its floor for five years, which is the lifespan of most of its exhibits."




2 Background to the Project

2.1 What is Noise-Induced Hearing Loss?

Noise-induced hearing loss (NIHL) is a condition resulting from exposure to sounds of sufficient intensity and duration that permanently damages hearing. The physiological basis for NIHL is a sensorineural hearing loss usually resulting from irreversible damage to (and death of) cochlear hair cells. Typically, a person with NIHL reports a decreased sensitivity for high-pitched sounds and difficulties understanding speech, especially in background noise (LePage, 1998). The decrease in hearing sensitivity is often accompanied by tinnitus, a term that describes internally generated noises which a person may hear as “buzzes” or “whistles.” Excessive noise exposure, especially when one is young, may not only affect speech perception, it may also increase the risk of social isolation, depression, and accidents (Noble, 2009). There is no surgical or medical intervention that can reverse the effects of NIHL.

2.2 Effects of Noise-Induced Hearing Loss on Hearing and Well-Being

Past research and the experience of practising audiologists at Australian Hearing and at the National Acoustic Laboratories is that the vast majority of people simply do not heed early warning signals of overexposure to loud sounds or dismiss the idea that hearing loss may be cumulative. After all, even if your hearing goes for a short time, it always comes back, doesn’t it? And even if you hear some ringing or buzzing sounds, it’s always temporary, right? By the time most people are even aware of having a hearing loss, it is too late: The loss is irreversible (e.g., Crandell, Mills, & Gauthier, 2004).

A large part of the reason for the poor awareness of the cumulative effects of noise exposure is the lack of a coordinated educational hearing conservation programme undertaken by health promotion agencies. Furthermore, researchers and public policy planners have also stated that it is imperative for young adults and school-age children to be specifically targeted at school and in their leisure time with the aim of developing lifelong changes in their attitudes towards hearing conservation (e.g., Australian Government Hearing Services Research Program: Research Framework, 2007; Chung, Des Roches, Meunier, & Eavey, 2005). Incorporation of educational programmes about hearing processes and NIHL into school curricula is probably the ‘holy grail’ when it comes to educating young people about hearing loss prevention, but to date, this remains an elusive goal (e.g., Community Affairs Reference Committee: Senate Report, 2010).

Aside from the obvious financial cost to society, the cost of NIHL to one’s personal life is inestimable: Poor hearing leads to frustration, miscommunication, withdrawal from society, and a quantifiable loss of quality of life (Mathers, Vos, & Stevenson, 1999). In non-occupational settings, engaging in recreational activities (e.g., riding motorcycles, shooting), hobbies (e.g., using power tools, leaf blowers, lawn mowers), and listening to music (attending rock and symphony concerts, using personal and car stereos) also has the potential to cause NIHL. To our knowledge, there are no studies documenting how often hearing protection is used in many non-occupational settings, but the number of people who use earplugs at concerts is small (Royster & Royster, 1990).

2.3 Why the Younger Population is at Increased Risk of Noise-Induced Hearing Loss

The present project focused on young people, especially those who use headphones and personal stereo systems (e.g., smartphones, iPods, and other MP3 players). Personal stereos are especially popular with school-age children and young people as well as commuters and factory workers who wish to mask out background noise.

Surveys estimate that almost one in five teenagers have a slight hearing loss, meaning that they often cannot distinguish between subtle differences between consonants that sound alike (e.g., Ss versus Fs, Ts versus Ks), or hearing speech in low-level background noise (Shargorodsky, Curhan, Curhan, & Eavey, 2010). Moreover, earphone and headphone users who listen to MP3 music players at high volumes for over one hour per day are at an increased risk of permanent hearing loss after five years (SCENIHR, 2008). Between 37% (in England) to 80% (in the USA and Hong Kong) of school children aged between 11 to 18 years own and use personal stereos (Clark, 1992). Comparable usage rates for Australia are not known, but 52% of LePage and Murray's (1998) subjects aged between 10-19 years were classified as moderate or heavy users of personal stereos. The preferred volume level for personal stereos is typically high, with estimates ranging from 90 to 104 dB (Lee, Senders, Gantz, & Otto, 1985; Rice, Breslin, & Roper, 1987). In a recent survey, 22% of teenagers regularly listen to their MP3 players between 75% to 100% of the maximum volume (Chang, 2010). Rice, Rossi, and Olina (1987) have concluded that children are especially at risk from personal stereos after finding that approximately 20% of a sample group of school children reported sensations of fullness or ringing after their listening sessions.

2.4 Effectiveness of Hearing Conservation Programs

The goals of hearing conservation are straightforward and strategies to prevent NIHL can be easily implemented. The difficulty, however, is that the development of a hearing loss is insidious: A permanent impairment may not manifest itself for years, even though the listener has experienced early warning signs, such as tinnitus and/or temporary threshold shift (TTS) (Haller & Montgomery, 2004; Niskar et al., 2001). By the time a person seeks help with NIHL, thresholds at 4 and 6 kHz are typically around 25 dB, which, though roughly classified as only a 5% hearing loss (Macrae, 1998), is a level that is certainly noticeable. Moreover, given the fact that hearing loss prevention is not taught as part of any school curricula, it is not surprising to note that there is a general lack of awareness of the dangers of hearing music at high volumes amongst young people.

2.5 Contemporary Society: Why Young People are at Risk for NIHL

The risk of getting a hearing loss if you are a young person is becoming a key issue for our society. If you are a teenager, chances are you already have an iPod (or smartphone) or you desperately want to have one. The project exhibit was aimed directly at people who use an iPod or any other personal music player. (For that matter, the project was aimed at anyone in the community who is exposed to loud noise in their leisure activities.). Since 2004, Apple's iPod has popularised the use of personal music players. The iPod has approximately 90% of the market for players that use a hard drive. In the latter part of the 2000s, more than 250 million personal music players have been sold in Europe alone. Between 2004 and 2008, over 4.4 million iPods were sold in Australia. Over the past few decades, but especially since 2000, around 300 scientific papers have looked at the risks that personal music players pose to users. The consensus is that over 10% of people who use personal music players are risking permanent hearing loss and tinnitus by simply playing their personal music player at an unacceptably high level. Just one hour a day, one day a week usage at high volumes for a period of five years is likely to cause damage: an irreversible hearing loss and tinnitus are the consequences of not turning the volume down (Chung et al., 2005; Haller & Montgomery, 2004; LePage, 1998; Rabinowitz, 2000).

2.6 Are Policy-Driven Solutions Likely to be of Benefit?

The issue of NIHL is a particularly difficult health promotion topic. There is, as yet, little public awareness of the severe effect of hearing loss on an individual's life, although people who suffer from a hearing loss certainly do know of its effects. People more frequently deplore the possibility of going blind even though those who are both deaf and blind state that being deaf is far worse, as it cuts them off from ordinary human interaction (Ackerman, 1990). Age-related hearing loss and tinnitus cannot be eliminated by following the recommendations of hearing conservation programs, but premature NIHL caused by exposure to loud sounds can be averted.

Given the popularity of the personal music player, can we find a common, policy-driven solution to the problem? Probably not, because personal music players are not inherently unsafe. At this time, consumers actually benefit from the highest possible safety standards regarding the use of personal music players. Apple, for example, has a volume limiter in its iPod range, though anecdotally, one of the first things that people do when they get their iPod is to disengage the volume limiter. Getting people to use such features, however, is the problem that health promotion professionals face. In this regard, if we want to get people to 'turn down' the volume of their music player (or protect their hearing in other potentially harmful situations), then having sufficient knowledge and being motivated enough to do so is the key to changing behaviour. Without an understanding of the way in which communication and the way that listening to music can be compromised by a hearing loss and tinnitus, it is unlikely that anyone will be motivated to change their behaviour to conserve their hearing.

2.7 The Cost of Hearing Loss and Tinnitus to Young People's Personal Lives

Aside from the obvious financial cost to society, the cost of hearing loss and tinnitus to one's personal life is inestimable: Poor hearing leads to frustration, miscommunication, withdrawal from society, and a quantifiable loss of quality of life (Mathers et al., 1999). In Australia, 70% of people aged between 18-34 experience tinnitus. In non-occupational settings, binge listening to music (attending pubs, night clubs, and rock concerts on weekends), using personal and car stereos, engaging in recreational activities (e.g., riding motorcycles, shooting), and hobbies (e.g., using power tools, leaf blowers, lawn mowers), also has the potential to cause irreversible hearing loss and tinnitus (Australian Hearing, 2010).

When there is damage to hearing, all physiological functions of the ear are affected: blood supply, sensory cells, and neural cells (Catalano & Levin, 1985; Mostafapour, Lahargoue, & Gates, 1998; Niskar et al., 2001). Humans cannot detect the risk sufficiently well before the irreversible damage is done. Indeed, there are no physiological warnings when a hearing loss occurs (as there are when you, say, damage a tendon in the elbow). Instead, damage to hearing occurs during leisure activity (e.g., listening to music) and there is no reliable appreciation of any physical risk levels – you simply do not know how loud something is to cause damage. Hence, the effects of the excessive noise almost always start as slight and temporary. Insidiously over time, they can become permanent. Of course, there are individual variations in the susceptibility to damage from noise: Illness and fatigue may play a role, as could a genetic susceptibility, though this notion is contentious when it comes to human beings. There is no cure for hearing loss, and having a strong awareness of the risks is the only way to potentially prevent hearing loss and tinnitus.

2.8 Audio Simulations as a Strategy to Enhance Hearing Conservation

In health promotion, an emotion-based motivational appeal increases positive attitudes to the message (Geller, 2003). For high involvement issues such as those that encourage behavioural change by an individual, a stronger emotional arousal or arousal on progressively deeper levels may be necessary (Donovan, 1995). In other words, it makes sense to make the health risk personally relevant to the individual, or else there is no chance whatsoever that the message will be heeded. The use of personal music players is clearly a high involvement issue for many people, and the playing of music at loud levels has been described as an addiction for some (Florentine, Hunter, Robinson, Ballou, & Buss, 1998). On buses, trains, and on the street, one can hear evidence of how loud people turn up their music from the sounds blaring out of their earphones. This simply confirms research showing that, on average, most people exceed the maximum recommended listening volumes and times when they use their iPods (Portnuff & Fligor, 2006).

2.9 Genesis of the Idea to Incorporate Auditory Simulations of Hearing Loss and Tinnitus in a Science Museum Exhibit

The issue of noise exposure is a particularly difficult health promotion topic to address because the long-term effects are difficult to imagine. In conceptualising the exhibit, we thought that it would be effective to link auditory simulations of hearing loss and tinnitus with the fear of premature aging, as aging is a fear that is commonly recognised as severe. To this end, a hands-on exhibit was conceptualised as a fun, novel, and innovative way to augment the hearing conservation message. At this time, there is no comparable hands-on exhibit of its kind anywhere in the world and so the Scitech exhibit fills a gap with respect to targeting this message at young people (and their parents) who are notoriously difficult to convince. The exhibit achieves this goal by demonstrating the difficulties and frustrations of having a hearing loss and tinnitus when collaborating in playing a computer game that relies on effective communication and good hearing.

The exhibit was designed to convey something of the experience of a noise-induced hearing loss. High frequency components that are electronically filtered from speech almost always impair speech comprehension and detract from the fidelity of music. The experience of practising audiologists at Australian Hearing and at the National Acoustic Laboratories is that filtered speech is as close an approximation to how a hearing impaired person hears as possible. We hypothesised that people listening to the auditory simulations will be able to appreciate more fully the frustration and annoyance of suffering NIHL and tinnitus, as well as obtain some understanding of the associated isolation from normal everyday human communication compared to a generic health promotion message. It is predicted that this will deepen the experiential level of fear arousal and thus increase the effectiveness of the message. Thus, the inclusion of auditory simulations of NIHL and tinnitus in the exhibit would represent a powerful and, most importantly, a personalised demonstration of the consequences of ignoring the risks of loud noise.

2.10 Genesis of the Exhibit Name

The original name of the exhibit was the ‘Cone of Deafness.’ This name was chosen because it was deemed gimmicky enough to attract potential listeners to interact with the exhibit. The name paid homage to the ‘Cone of Silence’ prop used in the TV show ‘Get Smart,’ popular in the late 1960s and early 1970s in Australia. On later reflection, the name was changed to its present moniker “Sonic Silence” because of potential breach-of-copyright reasons, and because the actual shape of the exhibit reflects a gigantic set of headphones rather than a cone as was initially envisaged.

2.11 Contemporary Messages and the Necessity for the Sonic Silence Exhibit

This project planned to implement an interactive exhibit under the auspices of the Office of Hearing Services' priority areas, namely, Targeting School-Age Children and Young People With Preventative Education. The project focused on young people (from primary school age and over) who would not regularly receive a hearing protection message in school or social environments. Moreover, it was important to focus on getting a message through to young people because they are notoriously resistant to the hearing conservation message (Florentine et al., 1998; Lewis, 1989; Roeser, 1980) and because of the growing influence of portable devices that can deliver music at loud volumes.

"The project focused on young people (from primary school age and over) who would not regularly receive a hearing protection message in school or social environments."




3 Achievements Against Each Stage of the Project

3.1 Stage One: Project Set-Up and Consultation

The main activities undertaken during Stage One were creating the appropriate committees of consultation and obtaining ethics clearance for the project.

3.1.1 Establishment of the Project Executive and Recruitment of the Project Manager

The project executive consisted of Associate Professor Paul Chang (Team Leader) and Ms Sandra Green (Project Manager) from the School of Psychology and Social Science at Edith Cowan University (ECU). The role of the Project Manager, employed in July 2009, was to organise the various aspects of the project, including the application of ethics approval and development of the project plan.

3.1.2 Refinement of the Consultative Process

A consultative committee was formed whose primary role was to provide ad hoc feedback on various stages of the design and implementation of the exhibit.

The committee comprised of:

- **Professor Donna Cross**

  Professor Cross is the Director of the ECU Child Health Promotion Research Centre and has extensive experience in the development of health promotion programs aimed at school-aged children and young adults.

- **Professor Harvey Dillon**

  Professor Dillon is the Research Director of the National Acoustic Laboratories. He advised primarily on the procedures for devising the interactive computer game-play.

- **Dr Nicky Chong-White**

  Dr Chong-White is a research engineer at the National Acoustic Laboratories. She advised primarily on the development of the auditory simulation resources and specifically on the programming of auditory simulations of hearing loss and tinnitus (see Appendix 1).

- **Mr Graeme Quelch**

  Mr Quelch is Manager of the Curriculum Council WA dealing with course accreditation and review. He has links with the Primary Principals Association of WA and advised on the nature of the hearing loss message and on the portability of the hearing loss exhibit to schools in urban and rural areas.

3.1.3 Involvement of Key Stakeholder Groups

Two key stakeholder groups – Scitech and the National Acoustic Laboratories – were initially approached to participate in the project and both groups contributed to the initial stages including the development of computer software to produce real-time simulations of hearing loss and tinnitus and the interactive computer game. Scitech was responsible for all aspects of the final design, storyboarding, prototyping, and implementation of the exhibit.

Scitech is a not-for-profit science museum based in Perth, Western Australia. It was founded in 1988 and has become WA's leading science and communication provider. Scitech emphasises the development of interesting new ways to actively engage people so that they learn about topics in science and technology. (A comparable science museum in the eastern states is Questacon in Canberra.). Scitech was the first Australian science centre to produce their own large-scale exhibitions and they continue to design and build most of their exhibits. At present, there are over 20 interactive hands-on exhibits at Scitech. Scitech was inducted into the Western Australian Tourism Awards Hall of Fame recognising the fact that it is one of the state's a major tourist attractions. In 2012, 304,978 people visited Scitech and their travelling science teams deliver a wide variety of hands-on science workshops, lessons and activities to over 100,000 people in regional and remote W.A.

The National Acoustic Laboratories (NAL) undertakes scientific investigations into hearing, hearing habilitation and rehabilitation, and the prevention of hearing loss. NAL is the research division of Australian Hearing, and much of their research is performed as a Community Service Obligation funded by the Commonwealth Department of Health and Ageing.

3.1.4 Ethics Approval

Ethics approval was granted by the ECU Human Research Ethics Committee for the period 1 September 2009 to 30 April 2011, which covered the conduction of surveys and preliminary interviews.

3.1.5 Short Qualitative Study: Preliminary Interviews with Potential Users of the Exhibit

During the design phase, several interviews were conducted with potential users of the exhibit. A semi-structured interview schedule was created. The interview schedule included questions that interrogated why young people were generally ignorant of the hearing conservation message. Most importantly, the interview schedule included questions about the type of exhibit that they would respond to. The primary themes that emerged and eventually informed the design and development of the Sonic Silence exhibit included:

- A strategy that needed to be 'fun' and interactive, like a computer game;
- A strategy that needed to be personally relevant in terms of their own personal experiences; and
- A strategy that needed to be brief, no more than 3-4 minutes in duration, otherwise the message was seen as being too didactic.

ABOVE: Project Team Members with Dangerous Decibels workshop educators, February 2011. **FROM LEFT:** David Fobrogo, Andrew Hannah, Dr Deanna Meinke (seated, University of Northern Colorado), Denham Dunstall, Hew Tromans, Professor William Martin (seated in front of the laptop, Oregon Health & Science University), Dr Judy Sobel (Portland State University), and Susan Griest (M.P.H., Oregon Health & Science University).

> "I love the look of the exhibit component. We had wanted to do something like that for the ListenUp! I think it looks like something I would really want to climb into and check out! I'm very excited about this addition to your museum and will post the link on Jolene's Facebook page (Jolene OHSU)."
>
> William Martin, *MD, Professor of Otolaryngology/Head and Neck Surgery and Professor of Public Health & Preventive Medicine at the Oregon Health & Science University*

3.1.6 Participation in the Dangerous Decibels Workshop (February 2011) and Discussions with the Designers of the Workshop

In February 2011, team members Dunstall, Hannah, Tromans, Fobrogo, and Chang attended the Dangerous Decibels workshop in Auckland, New Zealand. It cannot be emphasised too strongly how important attending this workshop was to the inspiration behind the eventual design and implementation of the exhibit. Dangerous Decibels is a world-renowned educational programme designed to increase participants' knowledge of hearing loss prevention programmes as well as inspire the development of innovative and novel educational materials to convey the message of hearing loss prevention (Greist, Folmer, & Martin, 2007). Team members had, over the course of the two-day workshop, the opportunity to meet with all the workshop presenters from the Oregon Health and Science University. In particular, several formal meetings with Professor William Martin and other members of the Dangerous Decibels team were held. These discussions were invaluable and they helped to guide the direction of the exhibit.

3.2 Stage Two: Design of the Exhibit

Several prototypes of the exhibit were considered, but eventually the design that was adopted resembled a giant pair of headphones with two pods that participants could climb into. The game-play for the exhibit allows one or two players to communicate with a computer programme or with each other. Several storyboards were considered (for example, see Appendix 2) but eventually the game-play revolved around a group of patrons at a park (funfair) who were trying to communicate with each other about where to go next. The hearing conservation message was tailored so that the length of time that a person interacts with the exhibit was about two and a half minutes long. The goal of the exhibit was to give the listener an idea of what a hearing loss sounds like (through auditory simulations) to get across the point that listening to loud sounds may damage your hearing rendering poorer, more effortful communication. The experience of sitting in one of the pods is immersive in that a computer screen directs the viewer's attention to an interactive game that ultimately provides a hearing conservation message.

4 Launch of the Sonic Silence Exhibit

4.1 Official Launch

On Thursday, 14 June 2012, the Sonic Silence Exhibit was launched at Scitech with the Honourable Mark Butler, MP, Minister for Mental Health and Ageing cutting the official ribbon (see Appendix 3 for the Scitech media release). Aside from the Project Team, the list of dignitaries who attended were:

- The Hon. Mark Butler MP, *Federal Minister for Mental Health and Ageing*
- Professor Kerry Cox, *Vice Chancellor of Edith Cowan University*
- Professor Ken Greenwood, *Head of School of Psychology and Social Science, Edith Cowan University*
- Ms Erica Smyth, *Chairperson, Scitech*
- Mr Alan Brien, *CEO, Scitech*
- Dr Simon Carroll, *Director Science Partnerships, Scitech*
- Ms Kate Elder, *Director of Communications, Scitech*
- Associate Professor Rob Eikelbloom, *Ear Science Institute of Australia*
- Ms Gemma Upson, *Ear Science Institute of Australia*
- Ms Natalie Leishman, *Cheers for Ears Coordinator, Ear Science Institute of Australia*
- Dr Claire Pannell, *CSIRO Education (WA)*
- Selected Year 7 students from Dalyellup College
- Selected clients from Ear Institute of Australia

Overall, the launch was a great success and feedback from the Minister's office was extremely positive.

4.2 News Coverage of the Official Launch

The exhibit was featured on the Channel 10 Perth news at 5 p.m. The news story may be viewed here: http://www.youtube.com/watch?v=zG7NWbF_-Bs&feature=plcp

The Channel 10 news story aired on 14 June 2012 is transcribed below.

Introduction

Narelda Jacobs, Ten News: *"Listening to MP3 players at full volume can lead to a lifetime of hearing problems. Scitech and ECU have come together for a new project to educate children on the dangers."*

Rebecca Munro, Ten News: *"In the past, the most common cause of hearing loss among Australians has been a noisy workplace. Today, the biggest threat comes from iPods and MP3 players. One in six of us experience hearing problems. Technology is expected to bump that number up to one in four over the next 40 years."*

Associate Professor Paul Chang: *"Every kid who doesn't have an iPod wants one. So, in that respect, they are going to become ubiquitous in years to come."*

Rebecca Munro, Ten News: *"Today, Scitech and ECU have launched a new weapon called Sonic Silence to educate children on the dangers of loud music. The interactive, headphone-shaped exhibit allows users to experience what having a hearing loss problem sounds or, doesn't sound like."*

Racheal Hughes, Scitech: *"It's like, wow, that was really frustrating, which for most of our exhibits, we don't want people to come out thinking that was a really frustrating experience. But, in this case, we actually do."*

Minister Mark Butler: *"It's an education-based strategy – we know that this is one of the most significant preventable causes of hearing loss we have in the community, and we know that if we get to children in their primary school years we can build some safe hearing habits."*

Rebecca Munro, Ten News: *"The response: shock."*

Young child 1: *"To know that technology can kill your hearing and make you deaf – yeah, it's really scary."*

Young child 2: *"Yeah, I never knew that putting an iPod on at maximum volume would hurt your ears."*

ABOVE FROM LEFT, STANDING: The Honourable Mark Butler, MP, Professor Kerry Cox, Vice Chancellor of ECU, Associate Professor Paul Chang, and Martha Chang. **ABOVE FROM LEFT, KNEELING:** Bevan Eales, Darcy-Rose Taylor, Emily Jarman, Joshua Young, and Dylan Taylor.

4.3 Media Monitoring of the Official Launch

Media Monitors© reported that 68,000 people viewed the Sonic Silence news story when it was aired (28,000 were males aged 16 and over and 38,000 were females aged 16 and over).

4.4 Photographs from the Official Launch
















5 Evaluation

In November 2012, Scitech conducted an evaluation of the Sonic Silence exhibit as part of their regular review of exhibits that are 'on the floor.'

5.1 Methodology

Both qualitative and quantitative performance evaluations were carried out. The qualitative evaluations involved a visitor intercept survey to gauge the effectiveness of the exhibit in meeting the educational aims. The quantitative evaluation involved an observational analysis based on a video log of visitors. Analysis of the video log provided information about the demographics of the visitor (gender, age, and group size) as well as the dwell time and behaviour of each visitor as they interacted with the exhibit.

5.2 Visitor Intercept Survey (Customer Satisfaction): Pertinent Results

A Visitor Intercept Survey was conducted by Scitech staff. The survey consisted of 13 semi-structured interview questions. Twenty four exhibit visitors were interviewed, along with 10 visitors who did not use the exhibit (non-users) who served as a 'control' group.

The pertinent results regarding the effectiveness of the exhibit are summarised here.

Overall, the survey showed a high level of satisfaction with the exhibit: 66% of visitors who engaged with the exhibit said that they would be likely to recommend the experience to a friend (75% of single users and 50% of multi-users).

Worryingly, 20% of people interviewed reported that they were hitherto unaware of the link between exposure to loud noise and permanent hearing loss.

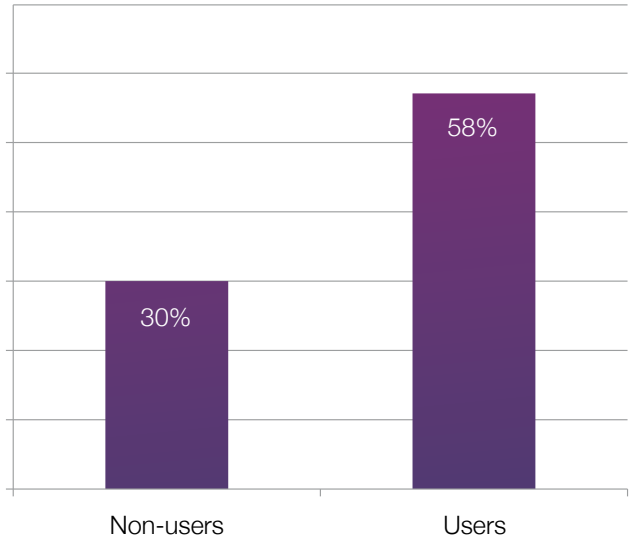
The survey was designed to assess the performance of the exhibit in meeting three stated educational aims. These aims were to:

- Raise awareness of the challenges faced by people who have partial deafness;
- Inform visitors of the environmental factors that can affect hearing; and
- Encourage people to take action to avoid situations that cause deafness.

5.2.1 Raise Awareness of the Challenges Faced by People who have Partial Deafness

The survey found that non-users of the exhibit underestimated the difficulty faced by people who had a hearing loss compared to those who used the exhibit: 30% of non-users compared with 58% of users rated a hearing loss as difficult or extremely difficult to deal with. This result suggests that the exhibit was successful in raising awareness of the challenges of hearing loss.

Percentage of People who Rated a Hearing Loss as Difficult or Extremely Difficult to Deal With



5.2.2 Inform Visitors of the Environmental Factors that can Affect Hearing

71% of users reported that they had learned something new about the dangers of loud sounds and felt that the exhibit was effective in warning about the dangers of noise exposure.

5.2.3 Encourage People to Take Action to Avoid Situations that Cause Deafness

40% of exhibit users indicated that they would change or modify their behaviour with regards to exposure to loud noise. This is an encouraging result, but is clearly only a 'snapshot' obtained after viewing the exhibit. At this time, long-term follow up of whether or not behaviour change actually takes place is beyond the scope of the project.

5.3 Exhibit Observational Study

A camera recording process developed for the project was used to capture observational data from visitors who attended the exhibit. The camera recorded the exhibit over 20 days, but data was only stored when visitors' movements triggered the recording. The video data was then analysed for:

- Time spent at the exhibit
- Gender of the visitor
- Age (coded as child, teen, or adult)
- Group profile (i.e., whether or not the visitor was a member of a group)
- Activity (either entering the headphone pod and/or reading the information panels)

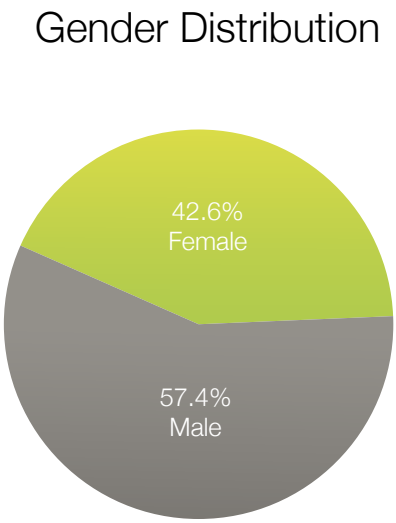
5.3.1 Time Spent at the Exhibit

The data from one (randomly selected) day's video was analysed. The analysis showed that users spent an average of 2 minutes 24 seconds (known as 'dwell time') interacting with the exhibit. This dwell time exceeds the industry average of 77 seconds per exhibit (Serrell, 1998). The longer dwell time for Sonic Silence is most likely due to the 'investment' that a visitor has to make: Climbing into the pod, putting the headphones on, and interacting with the computer programme.

Anecdotally, it was frequently observed that when young children were in the exhibit, parents or grandparents who accompanied them would stand and read the information panels.

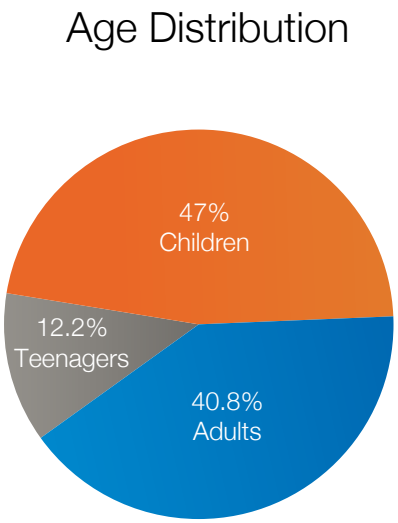
5.3.2 Gender of the Visitor

More males visited the exhibit on average than females.



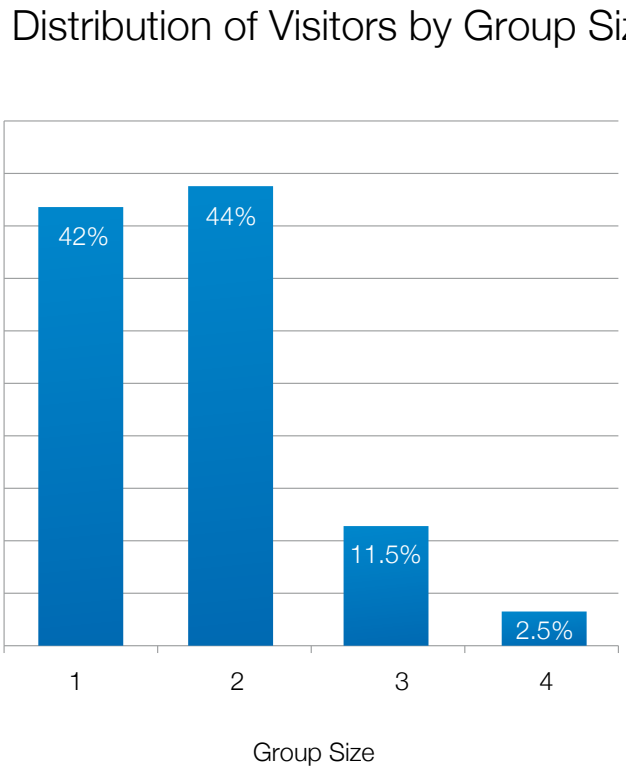
5.3.3 Age Distribution

The exhibit was visited primarily by children and adults (including parents and grandparents).



5.3.4 Group Profile

The exhibit was used primarily by individuals and pairs.



6 Dissemination and Promotion of the Exhibit

Sonic Silence is being promoted in a range of different ways. For example, the exhibit, NIHL, and hearing prevention was featured in the *Journal of the Science Teachers' Association of Western Australia* (Appendix 4) which invited WA science teachers to include Scitech in their excursion planning. The exhibit has also been promoted to Scitech members via the *Scitalk* newsletter (Appendix 5) and on the internet (Appendix 6). Plans for future dissemination and promotion of the exhibit include presentations at health promotion and psychology conferences, as well as conferences pertaining to the network of science and technology museums. In addition, presentations about Sonic Silence will be made to a range of international (e.g., the Singapore Science Centre) and national (e.g., Questacon) science museums to promote the exhibit.

7 Conclusions

Past research suggests that young people are putting themselves at risk of noise-induced hearing loss by listening to music for long periods of time, often at high volumes. Without concerted efforts to educate people about the long-term effects of loud sounds during leisure activities, young people will continue to engage in behaviours that are likely to be detrimental to their hearing. This project successfully designed and implemented a hands-on exhibit aimed at educating young people about the potential effects of exposure to loud noise using auditory simulations of hearing loss and tinnitus, housed within a fun, novel, and interactive exhibit that promotes safe hearing practices.

> “Without concerted efforts to educate people about the long-term effects of loud sounds during leisure activities, young people will continue to engage in behaviours that are likely to be detrimental to their hearing.”

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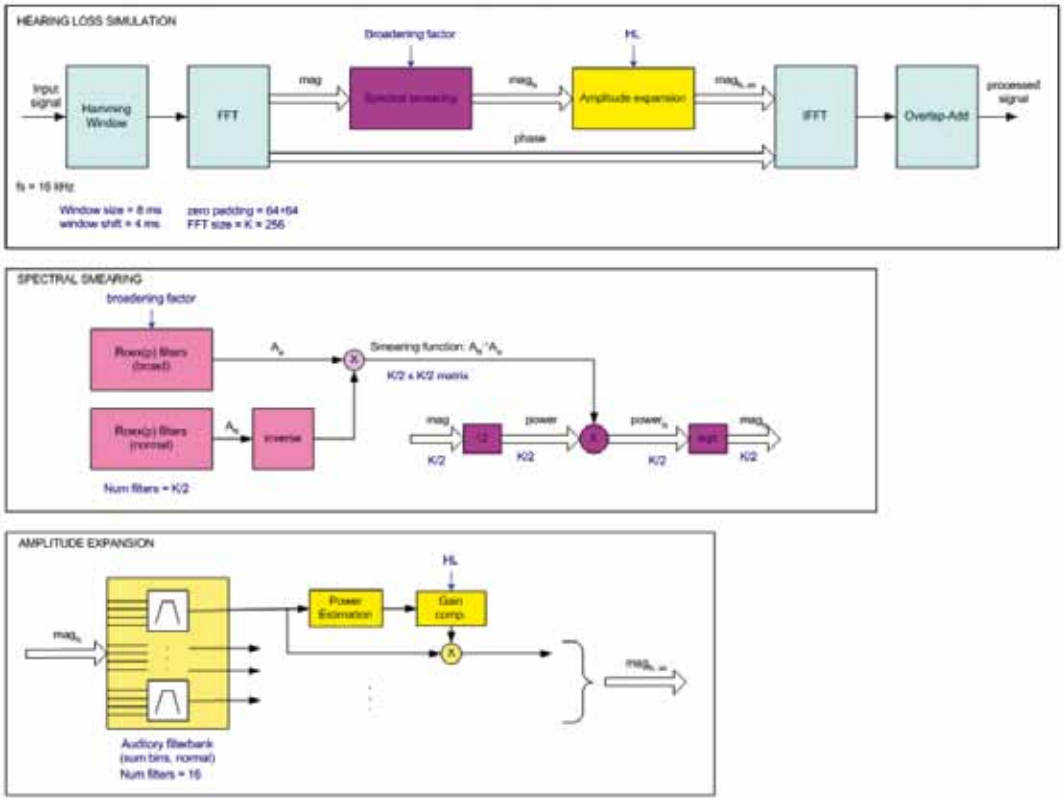
9 Appendices

1. National Acoustic Laboratories – preliminary design for hearing loss simulator



2. Scitech – sample storyboard

scitech

Production	Scene	Sheet No#
Cone of Deafness - Quick-timed Response Activity	Scenario Example: 1. Night at the Big Gig	
	Sequence	

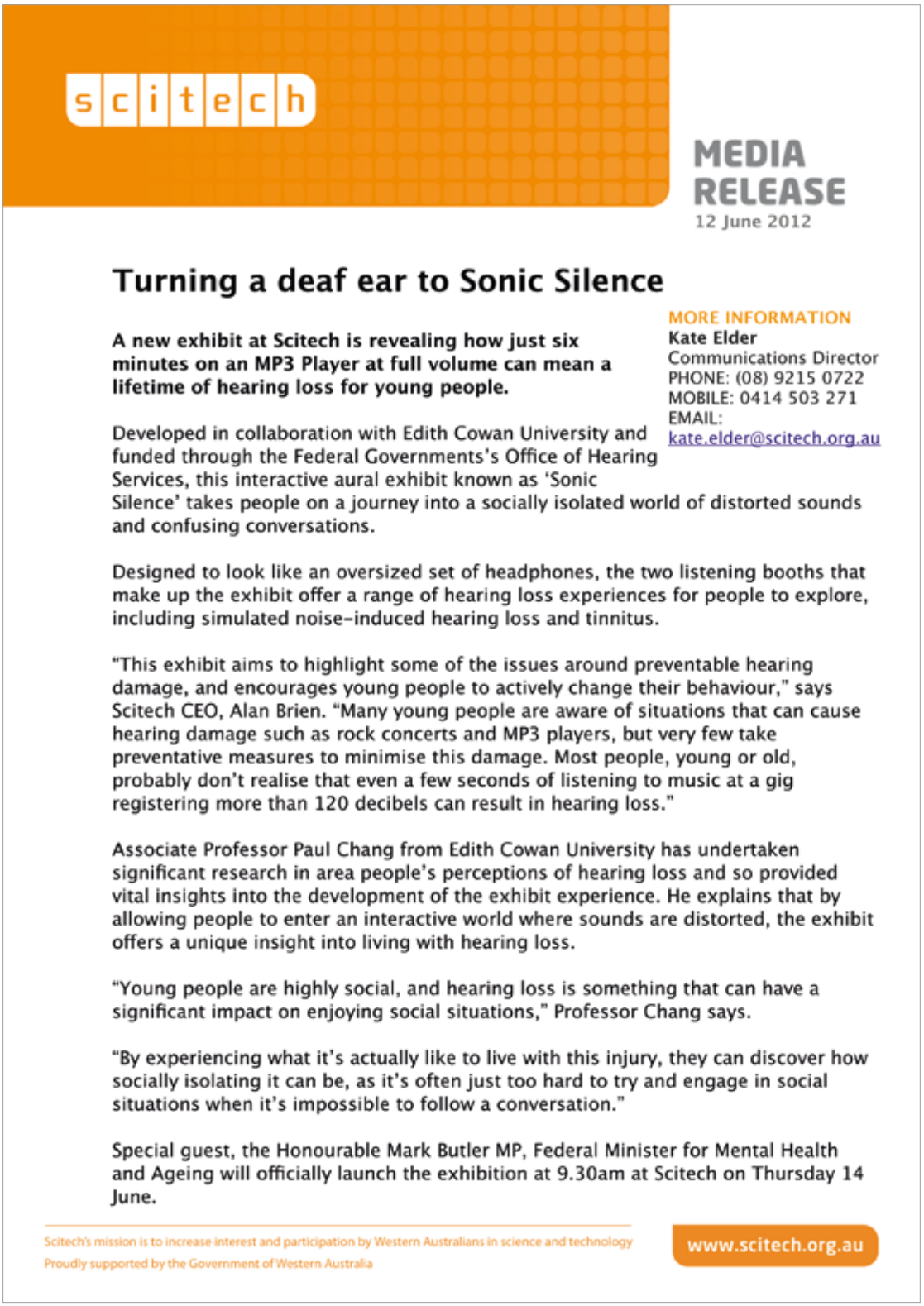
Scene	Time	Reference	B/G	Field	

Scene	Time	Reference	B/G	Field	

Scene	Time	Reference	B/G	Field	

Video	Video	Video
A screen which provides a lead in to the chosen scenario. *Text description superimposed as scenario fades into view behind. The silhouette of an animated character fades in concurrently.*	*When scene is at full opacity the animated character speaks to the visitor.* *Fairly immediately following each spoken question, a series of responses then overlays the scene. The visitor is required to answer the question as promptly as possible...*	*...The conversation plays out relatively in real time. Consequently, late, incorrect or a non-response will provide different feedback in the form of the character, or alternatively, the scene itself reacting to the player's response.* *The visitor is provided a visual and audio cue as feedback according to the type of response given.*
Audio	**Audio**	**Audio**
Audio swells in concurrently with visuals. *Atmos still audible.*	*Character then speaks to visitor playing the interactive. Questions asked by the character are randomised and the voice is distorted by a filter (The same filter is applied over a 2nd player if they decide to take over the character)* *Atmos still audible.*	*Character may speak response to the player and via simple verbal gestures (i.e. Grunts, murmurs, harumphs etc.)* *Atmos still audible.*

3. Scitech – media release



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MEDIA RELEASE
12 June 2012

Turning a deaf ear to Sonic Silence

MORE INFORMATION
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A new exhibit at Scitech is revealing how just six minutes on an MP3 Player at full volume can mean a lifetime of hearing loss for young people.

Developed in collaboration with Edith Cowan University and funded through the Federal Governments's Office of Hearing Services, this interactive aural exhibit known as 'Sonic Silence' takes people on a journey into a socially isolated world of distorted sounds and confusing conversations.

Designed to look like an oversized set of headphones, the two listening booths that make up the exhibit offer a range of hearing loss experiences for people to explore, including simulated noise-induced hearing loss and tinnitus.

"This exhibit aims to highlight some of the issues around preventable hearing damage, and encourages young people to actively change their behaviour," says Scitech CEO, Alan Brien. "Many young people are aware of situations that can cause hearing damage such as rock concerts and MP3 players, but very few take preventative measures to minimise this damage. Most people, young or old, probably don't realise that even a few seconds of listening to music at a gig registering more than 120 decibels can result in hearing loss."

Associate Professor Paul Chang from Edith Cowan University has undertaken significant research in area people's perceptions of hearing loss and so provided vital insights into the development of the exhibit experience. He explains that by allowing people to enter an interactive world where sounds are distorted, the exhibit offers a unique insight into living with hearing loss.

"Young people are highly social, and hearing loss is something that can have a significant impact on enjoying social situations," Professor Chang says.

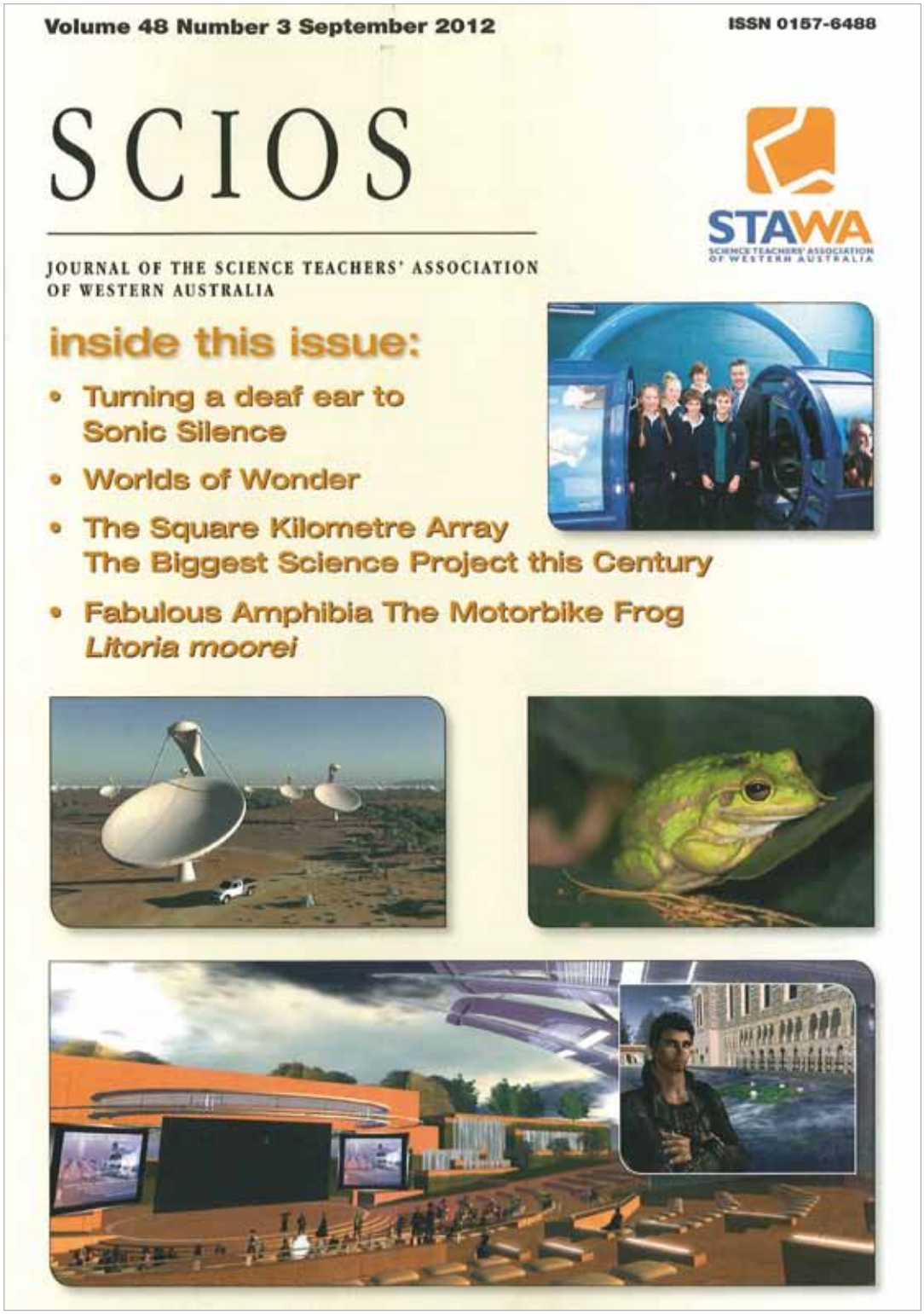
"By experiencing what it's actually like to live with this injury, they can discover how socially isolating it can be, as it's often just too hard to try and engage in social situations when it's impossible to follow a conversation."

Special guest, the Honourable Mark Butler MP, Federal Minister for Mental Health and Ageing will officially launch the exhibition at 9.30am at Scitech on Thursday 14 June.

Scitech's mission is to increase interest and participation by Western Australians in science and technology
Proudly supported by the Government of Western Australia

www.scitech.org.au

4. Elder, K. (2012). Turning a deaf ear to Sonic Silence. *Journal of the Science Teachers' Association of Western Australia, 48,* 7.



Turning a deaf ear to Sonic Silence

Kate Elder

Director of Communications and Marketing, Scitech Discovery Centre

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"This exhibit aims to highlight some of the issues around preventable hearing damage, and encourages young people to actively change their behaviour," says Scitech CEO, Alan Brien. "Many young people are aware of situations that can cause hearing damage such as rock concerts and MP3 players, but very few take preventative measures to minimise this damage. Most people, young or old, probably don't realise that even a few minutes of listening to music at a gig registering more than 100 decibels can result in hearing loss and tinnitus. Many people leave a concert with ringing in the ears (tinnitus). This can be an early warning sign of potential hearing damage."

Associate Professor Paul Chang from Edith Cowan University has undertaken significant research in the area of people's perceptions of hearing loss and so provided vital insights into the development of the exhibit experience. He explains that by allowing people to enter an interactive world where sounds are distorted, the exhibit offers a unique insight into living with hearing loss.

"Young people are highly social and any hearing loss is something that can have a significant impact on enjoying social situations," explains Professor Chang. "By experiencing what it's actually like to live with this injury, they can discover how socially isolating it can be, as it's often just too hard to try and engage in social situations when it's impossible to follow a conversation."

Key findings from the research include: 50.6 per cent of 12-17 year-olds listen to music with personal, in ear headphones; 87.2 per cent of people aged 18-25 reported sometimes - always coming home from a concert with ringing ears; and, 68.3 per cent of teenagers reported that they do not wear any form of hearing protection.

Students from Dalyellup College were among the first to test out the exhibit when it was officially opened by the Federal Minister for Health and Ageing, the Hon. Mark Butler MP at Scitech in June. The exhibit is open every day at Scitech and is included as part of a Scitech exhibition excursion. For information about excursions to Scitech please visit www.scitech.org.au or call 9215 0740.

Edith Cowan University's Associate Professor Paul Chang with his daughter Martha using the new exhibit. Photo courtesy Scitech.

Year 7 students from Dalyellup College with the Honourable Mark Butler MP. Left to right: Darcy-Rose Taylor, Emily Jarman, Joshua Young, Dylan Turner, Bevan Eales and Honourable Mark Butler MP. Photo courtesy Scitech.

5. Scitech – *Scitalk* newsletter

scitech

NEWS

ALAN SAYS

Time to wrap up another financial year and what a fantastic 12 months it has been. I would like to make a special mention to our Outreach and Professional Learning teams, which continue to deliver outstanding science engagement programs in our community.

Sonic silence

Did you know that just six minutes of listening to an MP3 player at full volume could result in a lifetime of hearing loss?

Developed in collaboration with Associate Professor Paul Chang from Edith Cowan University and the Australian Government's Office of Hearing Services, *Sonic Silence* takes visitors on a journey into a socially isolated world of distorted sound and confusing conversations.

Designed to look like an oversized set of headphones, the two listening booths give people a chance to experience what it is like to have noise-induced hearing loss and learn about preventative measures.

Healthy bodies

Do you know how much sugar, salt and fat is in junk food, how sunscreen helps protect our skin, or how loud music affects our hearing?

With the support of BHP Billiton, *Healthy bodies* is a new CSIRO Lab workshop for middle school students that encourages a change in behaviour towards better health.

Students use glow-in-the-dark lotion to see how well they wash their hands, measure the fat content in some favourite foods, test the sodium levels in sports drinks and use a spirometer to measure their lung capacity.

bhpbilliton
resourcing the future

6. ECU – *3rd Degree*

3RD DEGREE
integrity…tenacity…intelligence

Volume 14 - Semester 02, 2012 » Edition 09 » B - Science, Tech & Medicine

Professor Chang showcases Sonic Silence

Image courtesy of Associate Professor Paul Chang

Send Feedback

Deafening silence at Scitech

By: Daniel BARTELS

Published: 26/10/2012

A new exhibit at Scitech gives visitors the chance to experience the frustrating and confusing effects of living with Noise-Induced Hearing Loss (NIHL).

The *Sonic Silence* exhibit was developed with the input of the Federal Government's Office of Hearing Services and Associate Professor Paul Chang from Edith Cowan University (ECU).

Prof Chang said:"It's an exhibit that is aimed at young children and teenagers that tries to get across the message that trying to protect your hearing is an important thing to do, especially in the age of constantly using iPods, MP3 players and smart phones.

"What we're trying to do is get across the message about hearing in a fun exhibit."

The *Sonic Silence* exhibit is designed to look like a pair of oversized headphones, and it uses two 'listening booths' to simulate the effects of NIHL on everyday activities like simply having a conversation.

The exhibit was designed with Prof Chang's input, using information gathered from a research report he wrote in 2010 on the effects of, and attitudes towards, NIHL in young people.

The study found nearly 45 per cent of young people surveyed spent a large amount of time involved in activities relating to loud music.

Of these, only slightly fewer than 30 per cent used any form of hearing protection.

Prof Chang said: "Even if people know about the idea of hearing loss, it's a difficult task to get them to pay attention.

"So not only do they not know about the consequences of hearing loss, but even if they do know the consequences, it's a hard sell for them."

However, the study also found young people who took part in a simulation and health education message showed a 30 per cent increase in motivation to protect themselves against NIHL.

Prof Chang said he hoped exhibits like *Sonic Silence* could be the first step in this regard.

"It's really clear, I think that what we need is to be able to get material about NIHL, hearing processes and ways to conserve your hearing in the school curriculum," he said.

"If this material is actually in the curricula, that is they have to learn it, then you've got a better shot at devising materials that will help them learn it, and convey the health promotion message at the same time.

"Trying to simply give them information out of context is probably not a good idea, and ineffective."

***Sonic Silence* is currently showing at Scitech. Tickets start from $9. For further information, please see the Scitech website.**

Like 0 Send Tweet 0

Notes:

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