DEVELOPMENT OF HEALTH COMMUNICATIONS FOR PROMOTION OF SAFE LISTENING: A REVIEW

D.K. Meinke and W.H. Martin

Make Listening Safe WHO

The review was carried out by Dr Deanna K. Meinke and Dr William Hal Martin for WHO. It provides an insight into the relevance of a comprehensive communication strategy and reviews current practices.

February 2017

World Health Organization

Review of Background Materials for Development of Health Communications for Promotion of Safe Listening

Authored by:

Dr Deanna K. Meinke,
Professor
University of Northern Colorado
United States

Dr William Hal Martin
Professor
National University of Singapore
Singapore

Reviewed by

Ms Elena Altieri
Communications Officer
Department for Management of NCDs, Disability, Violence and Injury Prevention
World Health Organization, Geneva, Switzerland

Dr Shelly Chadha
Technical Officer, Prevention of deafness and hearing loss
Department for Management of NCDs, Disability, Violence and Injury Prevention
World Health Organization Geneva, Switzerland

Contents

EXECUTIVE SUMMARY

The following report summarizes the results of a desk-based literature review to gain background information which will support the development of effective health communications to promote safe listening practices among users of personal audio systems. The literature review was focused on four general areas: (1) principles of health communication that have been utilized in hearing health promotion/interventions designed for the prevention of noise-induced hearing loss and tinnitus; (2) principles of health communication that have been applied to music-player (personal audio system) research; (3) application of health message framing, and (4) the use of technology for health promotion.

Health behavior theories were reviewed in the context of three categorical levels; intrapersonal-level theories, interpersonal-level theories and community-level theories. Each of these theoretical levels and their related constructs may be applicable to hearing health promotion, however only some have appeared in the research literature. Intrapersonal-level theories attempt to predict how knowledge, attitudes, beliefs, and other traits within the individual will affect health behaviors. These theories include the "Transtheoretical Model" or "Stages of Change", the "Theory of Reasoned Action", the "Theory of Planned Behavior", the "Health Belief Model" and the "Protection Motivation Theory". Interpersonal-level theory that describe and predict how a person's relationships with others affect our social identity and normative expectations will affect health behaviors has been applied in the context of the "Social Cognitive Theory". Community-level theory using the "Ecological Model" has been utilized to predict how organizations, regulations and policies can affect health behavior. Each of these theoretical models and their related constructs previously reported in hearing health intervention research are reviewed and discussed in the context of how they might be applied to safe-listening behavior change. There are other models and theories of behavior change that have been developed and applied in public health, but not necessarily in the context of hearing health promotion.

An important realization when pursing hearing health promotion, is to recognize that there are also *unintended* outcomes from the efforts. These unintended outcomes may be desirable, e.g. influencing the health of others that were not part of the target audience, and some that may be undesirable, e.g. the influence works in the opposite than intended manner and may reinforce poor health behaviors. Using the approach provided by Cho and Salmon (2007), the types of unintended effects that might be the result of a safe-listening health campaign or promotion are discussed in the context of obfuscation, dissonance, boomerang, epidemic of apprehension, desensitization, culpability, opportunity cost, social reproduction, social norming, enabling, and system activation. Each of these unintended risks has the potential to undermine the effectiveness of a safe-listening health campaign without a priori consideration.

Four studies are reviewed in detail that have either applied actual health communication theory to listening habits and behaviors or the outcomes are relevant to health communication theory constructs. All of the studies were conducted in developed countries and primarily applied either the Health Belief Model or the Protection Motivation Theory in the research design. The relevant constructs from the Health Belief Model appear to be susceptibility to noise-induced hearing loss related to listening to music, severity of noise-induced hearing loss, benefits of preventing noise-induced hearing loss, and barriers to preventing noise-induced hearing loss. Although it appears that young adults obtain

their health information from the media, they do recognize the role of hearing health care professionals and parents in their health education. Additionally, hearing health promotion content should identify and address social misperceptions and communicate social norms. The generalization of these outcomes across diverse target populations, and in developing or underdeveloped countries may be limited. Additional research incorporating health behavior science into research design is needed for all target populations, especially with regard to community-based or ecological model theoretical frameworks. Other considerations when developing or evaluating hearing health promotion materials and programs are offered in the research and reviewed in the report.

Health promotion messages can be presented or framed in formats that convey the same information in ways that portray either the benefits of engaging in a particular behavior or the consequences of not to engage in a particular behavior. Gain-framed or loss-framed approaches to message-framing are reviewed and the influences and outcomes may differ between adults and adolescents.

The use of technology in the context of health promotion is a new area of public health research and studies emerging in this area may be relevant to future work related to hearing health promotion. The theoretical basis for individual behavior change may be different in this new context. There are no studies to date employing technology for the purposes of safe-listening behavior change. The application of text messaging and mobile health are reviewed and discussed. Although the use of technology is appealing and may show promise, it is important to consider that as of 2013 there were at least 40,000 mHealth apps available (IMS Institute for Healthcare Informatics, 2013) and there is little evidence that the vast majority of these apps (1) have a theoretical basis in Health Communication Science, (2) were designed specifically for the conditions they propose to address or the populations that are targeted and (3) have been evaluated for effectiveness at improving health behaviors. Therefore, there is a need to not only bridge health communication science to technologically based interventions, but to determine whether the same theoretical constructs are applicable and relevant to these newer approaches.

Perhaps most relevant to the future design, development and research of safe-listening health promotion is a report by op den Akker and colleagues (2015) that presents a detailed model and practical framework for theory-based, automated, real-time delivery of health behavior motivational messages in the context of physical activity coaching. Their “Model of Motivational Messages” was developed based on a combination of health communication theories (listed above), social marketing, evidence-based best practices and their years of personal experience with these activities. Their premise is that the likelihood of improving and maintaining healthy behaviors is enhanced through tailoring of the timing, content, intent and representation of supportive messages as specifically as possible to targeted individuals. Readily available personal technology (smartphones and other networked systems) provide a widely-distributed, readily-accessible and familiar venue for message delivery. The Model of Motivational Messages appears to be the most comprehensive framework for tailored health messaging currently available. The authors (op den Akker et al 2015) acknowledge that extensive research will be required to refine the sub-components of the model and determine how it may be applied to health behaviors beyond physical activity coaching.

Lessons learned from other health campaigns, mass media communications and health promotion initiatives are important to be cognizant of when developing safe-listening health promotion materials and programs. A report of “Health Campaigns and Their Impact on Behavior” by Leslie B.

Snyder (2007) completed a meta-analysis and systematic review of the published peer-reviewed evidence for the effectiveness of health communication campaigns (youth smoking/tobacco use, physical activity, dietary change, substance abuse, alcohol abuse, sexually transmitted diseases etc.) to inform future nutrition campaigns. In general, the average health campaign affects the intervention community by about 5 percentage points (5%). The authors concluded that health campaign developers should pay attention to lessons that relate to three critical elements of campaign planning: *goals, strategy and research*. Wakefield, et al. (2010) published an extensive review of the literature regarding the use of mass media (television, radio and newspapers) campaigns to change health behavior. The authors conclude that mass media campaigns can directly and indirectly produce positive changes in health-related behaviors across large populations. Specific recommendations for a successful campaign are offered and should be considered in the context of safe-listening hearing health promotion.

Currently, messaging to consumers regarding hazardous volume (listening) levels are contained within the device user manual and within pop-up messages when the volume is raised above a particular unspecified trigger point set by the manufacturers. There are no published studies focused solely on the effectiveness of pop-up warning messages specifically related to hazardous volume settings. The literature regarding the effectiveness of pop-up messaging in general appears to be published in the area of gambling and emergency weather-related events. Relevant outcomes from these studies are reviewed.

In summary, well established principles of health communication theory have yet to be systematically applied to promoting safe listening practices when using personal audio systems to a degree that would instill confidence in proposing regulatory standards or guidelines for messaging at this time. There is a large and growing body of literature that indicates that health messaging does facilitate positive health behavior changes and knowledge from these studies is ready to be evaluated in the context of personal audio system safety. Current audio device safety messaging appears to be provided because of regulatory obligation or to avoid possible litigation (liability) rather than being theory-based, best-practices for promoting safe listening. There are no published indications that existing messages are effective, but there is substantial evidence that warnings annoy users. Both short-term and long-term recommendations are offered for advancing the science needed to support successful and effective safe-listening hearing health promotion efforts.

<u>Short-term Recommendations</u>:

- Research be conducted to determine best-practices for implementing tailored messaging that will, in conjunction with technological safeguards, effectively promote healthy listening practices in users of personal audio systems. The most evidence-based short-term strategy would be to adapt and evaluate a model like the op den Akker Model of Motivational Messages and/or Bull's Integrated Theory of mHealth for safe listening hearing health promotion.

- Of immediate concern is the rapid and unchecked propagation of *mis*information about safe vs. unsafe listening practices in the media and through social network communications. In response to this need, we propose that the World Health Organization (WHO) establish an expert group to reach consensus on evidence-based and appropriate risk criteria for use of personal audio systems. In addition, we recommend that WHO establish an expert team that will be available to news sources, agencies and organizations to review the technical accuracy and consistency of statements related to sound exposures and risks as a public health resource.

Long-term Research Recommendations:

- Determine the effectiveness of various media used for implementing health behavior change messaging related to safe listening.

- Formative and Summative evaluation of interventions designed to change knowledge, attitudes, beliefs and behaviors related to safe-listening hearing health promotion.

- Further investigation of the health communication theories and constructs that address the motivation and barriers to safe-listening behavior change.

- Application and evaluation of the ecological model in terms of multi-level interventions designed to promote safe-listening.

- Quantify the intended and unintended outcomes of hearing health awareness campaigns and the degree to which various populations comply with the recommendations using attitudinal and behavioral measures.

- Future research should rely less on convenience samples and utilize stratified, randomized, controlled study designs targeting specific populations.

- Longitudinal studies are needed to demonstrate intervention effectiveness.

- Research may need to come from multiple sources; e.g. manufacturers, public health organization, music sites, traditional research collaborations.

Outcomes in these areas are necessary and will better inform safe-listening hearing health promotion initiatives in the future.

OBJECTIVES

The aim of this Agreement for Performance of Work (APW) for the World Health Organization (WHO) is to carry out a desk-based literature review to gain background information which will support the development of effective health communications to promote safe listening practices among users of personal audio systems.

SPECIFIC AIMS

Complete a desk-based literature review of the following topics;

1. Principles of health communication, which may be applicable to communication for safe listening.
2. Current practices in consumer messaging targeting users of personal audio systems.
3. Recommendations for regulations on messaging for behaviour modification to influence health.

METHODS

The literature review was conducted by implementing a conventional literature search using electronic library/reference services, librarian assistance and personal communication with a researcher utilizing technology for health promotion in an unrelated field. Only research, governmental or manufacturer information published in English was referenced.

The topic area of "principles of health communication" is extremely broad and diverse across health issues. Therefore, the literature review was focused on four general areas: (1) principles of health communication that have been utilized in hearing health promotion/interventions designed for the prevention of noise-induced hearing loss and tinnitus; (2) principles of health communication that have been applied to music-player (personal audio system) research; (3) application of health message framing, and (4) the use of technology for health promotion.

PRINCIPLES OF HEALTH COMMUNICATION APPLICABLE TO SAFE LISTENING

The following principles of health communication science have been applied to the prevention of noise-induced hearing loss and tinnitus in general. There is very little research specifically designed to investigate the health communication science and theory directly related to personal audio systems and safe-listening hearing health promotion. Additionally, research in other topic areas of health promotion suggest that the principles and theoretical basis of the health communication science may be different when technology is utilized for health promotion (Bull and Ezeanochie, 2015).

Health behavior theories can be categorized into three levels: (1) intrapersonal-level theories predict how knowledge, attitudes, beliefs, and other traits within the individual will affect health behaviors, (2) interpersonal-level theories describe and predict how a person's relationships with others affect our social identity and normative expectations will affect health behaviors, and (3) community-level theories predict how organizations, regulations and policies can affect health behavior (NCI, 2005; Sobel and Meikle, 2008). Each of these theoretical levels and their related constructs may be applicable to hearing health promotion, however only some have appeared in the research literature.

The following summarizes the theoretical basis and related constructs previously reported in hearing health intervention research and how they might be applied to safe-listening behavior change.

INTRAPERSONAL-LEVEL THEORIES:

The Transtheoretical Model (Stages of Change)

The SOC model focuses on the individual's readiness to make a behavior change and progress towards the healthy behavior is made in stages (Prochaska et al., 1994; Prochaska, 1996). The steps include (1) Precontemplation Stage: the individual is unaware of the unhealthy behavior and need for behavior change; (2) Contemplation Stage: the individual is aware of the unhealthy behavior and the inherent risk of negative consequences and is considering a behavior change in the near future; (3) Preparation Stage: the individual actively prepares to implement a behavior change such as enrolling in an exercise class for weight loss; (4) Action Stage: the individual initiates the healthy behavior such as starts attending an exercise class for weight loss; (5) Maintenance Stage: the individual strives to maintain the healthy behavior over time; and (6) Termination Stage: the individual practices the healthy behavior consistently and does not revert to unhealthy behaviors. Prochaska and colleagues note that not all individuals proceed through the stages sequentially, and that there may be relapses or a return to earlier stages during the process of behavior change.

In the context of safe-listening the stages of behavior change may be conceptualized as;

(1) Precontemplation Stage: the individual does not realize that listening at high volumes for extended periods of time may contribute to hearing loss and tinnitus. They have not seen media reports, read user manuals or spoken with others about the risk of hearing loss from listening at high volume levels over extended periods of time.

(2) Contemplation Stage: the individual is aware of that the volume level and amount of time they listen to their personal audio system may harm their hearing and they need to listen at lower volumes or shorten their listening time to ensure healthy hearing. They have seen media reports, read their user manual or spoken with others about the risk. They may have received a warning message on their personal audio device when the volume level is increased to potentially hazardous levels.

(3) Preparation Stage: the individual actively prepares to implement safe-listening behaviors. This may include implementing a maximum volume lock on the audio device; downloading an app that warns of unsafe-listening levels or having the output levels of their audio device measured so that they can

identify the volume setting that may be potentially hazardous to hearing (e.g. a "Jolene" interaction, or a clinical measure of sound levels in the ear canal).

(4) Action Stage: the individual initiates the safe-listening behavior by, lowering the volume when warning messages appear from an app or device, or complying with the volume limit advised from the sound level measurements.

(5) Maintenance Stage: the individual strives to maintain the safe-listening behavior over time, but may revert to unhealthy listening levels on occasion.

(6) Termination Stage: the individual practices the safe-listening behavior consistently and does not revert to unhealthy listening behaviors.

The individual may revert to earlier stages when new technology or devices are purchased, software is updated or when other influences contribute to relapses (e.g. peers).

The Theory of Reasoned Action

This theory is based on the recognition that behavioral *intentions* are highly predictive of future behavior (Fishbein and Azjen, 1975). The theory has three constructs that lead to behavior change; (1) the individual's attitude toward the behavior, (2) the individual's perceived control over the hazard, and (3) subjective norms or how the individual's perception regarding how others (peers) view the healthy behavior. This theory includes an interpersonal-level element as it relates to the influences of peers and parents.

In the context of safe-listening the stages of behavior change may be conceptualized as being influenced by (1) the individual's attitude toward safe-listening and whether they perceive a significant risk from listening at unsafe levels and durations, (2) the individual's perception that they can control the sound level of the personal audio system or listening time, for instance they would be able to implement safe-listening strategies themselves and would not have to rely on others, and (3) the influence of peers may be positive (reinforcing) or negative (teasing) when they practice listening safely, and parents will be influential in terms of promoting safe-listening behaviors in children.

Theory of Planned Behavior

This theory is an extension of the Theory of Reasoned Action by Bandura (1977) and adds constructs related to the influence of the perceived behavioral control in terms of the individual's belief in their own ability to perform the behavior (self-efficacy) and their ability to control the desired behavior. The differences are subtle, however self-efficacy specifically relates to the individual's own ability to control the sound level of the personal audio system or listening time, for instance are they capable of lowering the volume setting, or setting their own volume lock themselves. In the case of young children this may not be possible, or for those unfamiliar with the technology operation and control.

Self-efficacy is strengthened by effective peer-to-peer communication that explains the reason for the safe-listening behavior and promotes a healthy hearing social norm. Communication with peers can be facilitated by behavior modeling and role playing, developing responses to social pressures, developing refusal skills, public contract-making, and assertiveness training.

In the context of safe-listening hearing health promotion; self-efficacy would involve both a technological skill basis as well as the development of tools and interactive training resources that would promote effective peer-to-peer communication. For instance; tutorials on how to adjust the volume or set a volume limits or download a safe-listening app might be useful for the diverse array of technology available today. Opportunities to develop peer-to-peer communication would need to be developed and evaluated that would teach and allow practice. For instance, a virtual world in which the person learns to respond to different peer-pressures might be developed, or an interactive social media environment might exist where the individual can observe and interact with others implementing safe-listening behaviors, or receive coaching regarding responses to negative peer influences. Groups (e.g. organizations, manufacturers, schools etc.) might be able to implement public contracting to promote safe-listening.

Health Belief Model

Rosenstock, (1960) first developed the Health Belief Model. Janz and Becker (1984) further identified the factors that influence a person's decision to practice a health behavior. The constructs are (1) Perceived Susceptibility to the health consequences, (2) Perceived Severity of the health risk, (3) Perceived Barriers to implementing the health behavior, (4) Perceived Benefits to implement the health behavior, (5) Self-efficacy to perform the healthy behavior and (6) Cues to Action that identify when the healthy behavior should occur.

Application of the HBM factors to safe-listening behavior might imply the following;

1) Perceived Susceptibility: Individuals would need to recognize that they increase their change of getting a hearing impairment or tinnitus when listening to music or other audio sources at hazardous sound levels and that even young ears are at risk of hearing loss and tinnitus. The perception of "tough ears", or other reasons for individual's feeling invincible would need to be identified. There may be a need for humanitarian stories and testimonials that individuals from different age groups and backgrounds can relate to. In addition, the susceptibility to risk may be complex to describe, especially when one considers individuals who may be noise-exposed during other work/activities, or taking medications or drugs that may increase their relative risk.

2) Perceived Severity: Individuals would need to recognize and acknowledge the consequences of unsafe listening behaviors in their daily life. In this case, the individual would have to recognize the long-term implications of noise-induced hearing loss and tinnitus which may not be readily evident in the short-term. Effective message framing will be an important adjunct to this construct.

3) Perceived Barriers: Identification of the barriers that prevent safe-listening behavior. These barriers may be physical or psychological. For instance, not knowing how to turn the volume lower or how the sound level and duration of exposure interact to create a hearing hazard.

4) Perceived Benefits: The benefits of safe-listening strategies must out-weight the costs. For instance if costly apps or expensive technology is needed, the opportunities for safe-listening behavior will be less. If the benefit of "good hearing" is not sufficiently valued, then the sacrifice

of lowering volume level and perhaps having less enjoyment of the sound source will be too costly to the listener and safe-listening behavior will not be implemented.

5) Self-Efficacy: As described in the Theory of Planned Behavior; self-efficacy specifically relates to the individual's own ability to control the sound level of the personal audio system or listening time, for instance are they capable of lowering the volume setting, or setting their own volume lock themselves.

6) Cues to Action: Audio listeners will need cues to know when to lower the volume or when their "dose" of sound has reached the limit advised. This requires an integration of sound level and duration of listening data which is not currently readily available to listeners. It also requires consideration of listening across multiple devices and exposure sources. The cues can also be presented in several formats; for instance would cues be better displayed visually on the media device or delivered via an audio message through the devices earphones/headsets, or both? Are there cues to action that can be delivered to others concerned about the individuals hearing health, for instance parents or teachers/healthcare professionals? Sophisticated tracking may be feasible within devices to track the behavioral responses to cues to action.

Protection Motivation Theory

The Protection Motivation Theory (Rogers, 1975) evolved from the HBM. This theory predicts health behavior on the basis of two appraisal processes. A process of threat appraisal (fear) and a process of coping appraisal, in which the options for diminishing the threat are considered. There are four constructs; two in the context of threat appraisal; severity of the illness and vulnerability of contracting the illness (or worsening of the illness) and two in the context of coping appraisal; self-efficacy and response effectiveness (knowing what to change). The protective behavior is the desired behavioral response to the health risk.

In the context of safe-listening the individual would have a fear of hearing loss and tinnitus and feels personally vulnerable to the consequences of unsafe listening. The individual would also need to gain an understanding of what behavior changes are effective at minimizing the threat to their hearing (e.g. reducing the volume and/or listening time) and have the ability to successfully implement the needed behavior.

INTERPERSONAL-LEVEL THEORIES:

Social Cognitive Theory

This influential theory was developed by Bandura (1986) and predicts the health behavior on the basis of the individual's behavior within a social environment. Health behavior is learned and practiced through interactions with others and the social environment promotes an understanding of the outcomes of the desired behavior. Individuals learn the healthy behavior by observing others, anticipating behavioral outcomes and practicing the skills and gaining confidence in the health behavior. This theory recognizes that both the positive and negative outcomes of the health behavior will influence an individual's actual behavior. Individuals learn to judge their own behavior against the social norm of their peers and/or modify their own behavior to fit in and match that which is perceived to be

"normal", “desirable” or “cool”. Individuals may not be able to observe peer behaviors directly, but will still develop their own perceptions that may or may not match reality.

In the context of safe-listening, this theory would support the need to practice safe-listening behavior in social groups. Individuals would practice and implement the safe-listening behaviors with others and learn to respond to efforts designed to dissuade the safe-listening behavior. Efforts to make safe-listening behavior acceptable and even admirable may be applicable. Peer-educators may be an important component to safe-listening health promotion. Social reinforcements for safe-listening behaviors would be created.

COMMUNITY-LEVEL THEORIES:

Ecological Models

Health education is focused on both the individual and the social environmental factors that influence the health behaviors. Changes to the social and physical environment can serve to encourage change or reinforce unhealthy behaviors. In this case, human behavior is influenced by multiple factors; intrapersonal, interpersonal, organizational, community and public policy. Attention is focused on environmental interventions for health promotion and not solely on the individual level.

In the context of safe-listening health promotion; the ecological model would implement strategies to promote safe-listening behavior beyond the individual and involve families, schools, workplaces, community organizations and governmental and policy-setting entities. The messages and hearing health promotion should be related and congruent.

OTHER THEORIES:

There are other models and theories of behavior change that have been developed and applied in public health, but not necessarily in the context of hearing health promotion. Examples of these theories are (1) the Health Promotion Model (Shin et al, 2005), (2) Social Ecology Models (Booth, 2001), (3) Precede-Proceed Model (Green, 1999), (4) RE-AIM (Klesges, 2005), (5) Consumer Information Processing Model (Bettman, 1970), (6) Social Networks (Israel, 1982), (7) Community Organization (Rothman, 2001), (8) Diffusion of Innovations Theory (Rogers and Shoemaker, 1971), and (9) Organizational Change Theories (Lebanon and Stone, 2008). There may applications to safe-listening health promotion that can be drawn from these theories that are not reviewed here.

UNINTENDED OUTCOMES:

The majority of research based upon health communication theory are designed to examine the *intended* outcomes from the health promotion effort. Since health promotions and campaigns are social activities, there are also *unintended* outcomes from the efforts. Some of which are desirable, e.g. influencing the health of others that were not part of the target audience, and some of which are undesirable (e.g. the influence works in an opposite than intended manner and may reinforce poor health behaviors). The unintended effects occur on both the individual level and at the societal level. Cho and Salmon (2007), proposed a context to consider the types of unintended effects that might be the result of a health campaign or promotion, including obfuscation, dissonance, boomerang, epidemic of apprehension, desensitization, culpability, opportunity cost, social reproduction, social norming, enabling, and system activation. Without elaborating too extensively, some of these unintended effects can be understood in the context of safe-listening health promotion:

1. Obfuscation is misunderstanding and confusion regarding the health risk and risk prevention methods. This can be related to safe-listening in the context of which damage risk criteria for measuring noise dose is most appropriate and can the public understand the rationale for different noise dose calculations, especially in the context of differences between types of technology and transducers (earphones/headphones)?

2. Dissonance is the psychological discomfort or distress that might occur when the individual desires to make the health behavior changes but perceive that they lack the abilities or environmental supports to make the change. In the case of personal audio systems the individual's ability to control their behavior is direct, however they lack the feedback system to notify them when behavior change is warranted (e.g. how loud is too loud?).

3. Boomerang effect is when the reaction from the audience is opposite of that intended. This has occurred in both smoking cessation and drinking reduction campaigns when fear appeals were used. In this case, the efforts to promote safe listening would actually result in more unsafe listening; individuals would listen louder and for longer periods of time.

4. Desensitization occurs when repeated exposure to messages about a particular health risk may over the longer term render the public apathetic. Instances of this are already evident in the case of safe listening strategies, especially when one considers the widespread media interest in the topic that has lasted for more than 10 years now.

5. System Activation occurs when the health promotion influences various unintended sectors of society, and their actions mediate or moderate the effect on the intended audience. Safe listening campaigns that are focused on a universal volume limit inadvertently provide a disadvantage for individuals with hearing impairment. How this influences success of the campaign is unknown.

APPLICATION OF HEALTH BEHAVIOR SCIENCE TO SAFE-LISTENING

In terms of listening behavior, the majority of studies have focused on the measured or reported volume level setting and duration of listening to compute an exposure metric in terms of dose. Few studies (Table 1) have applied actual health communication theory to listening habits and behaviors. These studies have been conducted in developed countries and applied the Health Belief Model or the Protection Motivation Theory in the research design. Therefore, the generalization of these outcomes across diverse target populations, and in developing or underdeveloped countries may be limited. Additional research incorporating health behavior science into research design is needed for all target populations, especially with regard to community-based or ecological model theoretical frameworks.

The 26-item **Listening Habits Questionnaire (LHQ)** was developed by **Portnuff, Fligor and Arehart (2011)** using the constructs of the Health Belief Model to assess listening behaviors, attitudes and beliefs about listening levels in adolescents aged 13-17 years. The constructs included: susceptibility to noise-induced hearing loss related to listening to music, severity of noise-induced hearing loss, benefits of

preventing noise-induced hearing loss, barriers to preventing noise-induced hearing loss and self-efficacy for taking preventative action. The questionnaire was developed as part of a larger study of output levels of personal music devices and is included as Appendix A. These researchers conducted two experiments to assess listeners' self-reported and laboratory-measured chosen listening levels (CLL): (1) a series of acoustic measurements of personal audio systems (PAS) output levels were taken on an acoustic test fixture, and (2) CLL's were measured using a microphone-in-real-ear (MIRE) technique in the presence of 3 different types of background noise, using 3 different styles of earphones. Additionally, the LHQ was developed to allow adolescents to report their typical volume control levels, and earphone style. This 2-stage research design provided a conversion factor for estimating the output level of a PAS from the volume control level given in listener self-reports. The study outcomes indicated that PASs are capable of reaching levels that could increase the risk for NIHL, and 14% of the teenagers in the study reported behavior that puts them at increased risk for hearing loss. The laboratory CLLs did not correlate well with self-reported typical listening levels. The authors speculate that this may be due to two factors: (1) one-time laboratory measurements may not accurately reflect the "average" reported volume setting used over time by the listener and/or (2) listeners may not be able to provide accurate reports of their chosen volume settings. The researchers conclude that more research is needed in this area to assess the reliability of reported volume settings.

With regard to the LHQ, the authors conclude that Health Belief Model constructs were useful in determining what factors influence an adolescents *reported* (i.e. perceived) chosen listening level (CLL) and were poor predictors of the actual CLLs in a laboratory setting measured in dBA, regardless of noise condition. All Health Belief Model constructs, with the exception of self-efficacy, were significant predictors of the reported CLL and the researchers concluded that the study validated the use of the Health Belief Model as an effective method for modeling self-reported listening behavior. It was hypothesized by the authors that CLLs are representative of *perceived* listening levels, and this may relate to the fact that all of the Health Belief Model constructs are dependent on the listener's self-perceptions (i.e., perceived susceptibility to NIHL). The authors went on to suggest that these outcomes may reflect the possibility that perceived beliefs might be more strongly related to perceived behaviors, rather than actually measured behaviors. In conclusion, the authors suggest that successful educational intervention might focus on promoting the benefits of safe-listening and reducing the barriers to prevention, such as teaching what volume levels are considered safe and the benefits of sound-isolating earphones when listening in the presence of background noise. This study had 29 subjects and generalization of the findings may be limited by the small sample size.

Gilliver et al, (2012) surveyed 484 adolescent and young adults in Australia. The study aimed to gain an understanding of the **social-based factors** that may influence an individual's motivation to engage in positive hearing health behaviors. The larger questionnaire was designed to explore knowledge and attitudes regarding hearing and noise and this reference reported on a subset of five questions relating to perceptions of their own and their peers' listening behaviors. Participants were generally aware of their own risk of listening to personal music players, and the volume levels that were potentially hazardous. The participants estimated the listening levels for their peers significantly higher than their own self-reported listening levels. The authors concluded that "misperceptions of social norms relating to listening behavior may decrease the individuals' perceptions of susceptibility to hearing damage". These outcomes suggest that hearing health promotion content should identify and address the social misperceptions and communicate social norms.

Quintanilla-Dieck et al (2009) expanded on a MTV survey conducted in 2002 regarding awareness and behavioral trends regarding intentional exposure to loud music. Although, not framed within health behavior science, the study does explore isolated constructs that can be related to health behavior theories. Only 32% of the respondents felt that hearing loss was a problem, and nearly half of the respondents reported experiencing tinnitus or hearing loss after loud music exposure. The respondents could not recall educational content specific to hearing loss prevention and reported that the media was the most informative source and not healthcare professionals, even though they reported a willingness to implement safe-listening behaviors when informed by healthcare professionals. The authors recommended that future efforts to promote safe-listening incorporate media attention (e.g. public service announcements), expanded educational promotion by professional and governmental organizations, manufacturer resources/information and tools for safe-listening and informative website. The authors emphasized that widespread education from the health care community is needed. The authors noted that other countries have pursued legislative controls (limits) on music player outputs (e.g. France), however they specifically stated they are not advocating for this type of control.

Vogel (2008) applied the **Protection Motivation Theory (PMT)** to analyze responses recorded during focus group interviews of adolescents 12-18 years. Outcomes indicated that the adolescents recognized the threat of hearing loss, but underestimated their personal vulnerability to the threat. Participants who experienced tinnitus did not perceive it as a warning that they were personally susceptible to hearing loss. The respondents were also unable to determine when listening becomes hazardous in terms of sound level. The following recommendations for educational content were made in order to promote a sense of personal "vulnerability";

1. Specific information on dangerous decibel levels should be provided
2. The decibel levels should be related to exposure times
3. MP3 players should be equipped with an indicator of current volume output level (expressed in decibels) and a signal (such as a flashing light) to warn of hazardous exposures.
4. Testimonials from real people who lost hearing from listening to loud music should be utilized.

Parental influence was also identified as an important factor that should be further investigated in terms of safe-listening behavior change and parental-training programs may be warranted. This study provided evidence that the PMT can be utilized to investigate safe-listening behavior.

Table 1. Comparative summary of research studies applying health communication science to personal audio device listening behavior.

Authorship	Experimental Design	Purpose	Population and/or Acoustic Test Fixture(s)	Outcomes/ Conclusion(s)
Gilliver, Carter, Macoun, Rosen & Williams (2012) Australia	Survey drawn from larger iHEAR study group.	To gain a better understanding of social-based factors that may influence an individual's motivation to engage in positive hearing health behaviors. [social norms]	n=486 adolescents and young adults grouped into age categories based on educational status; early high school (n=151, grades 7-9), senior high school (n=244, grades 10-12), young-adulthood (n=91, 18-24 years no longer in school).	1. 90% of respondents use a personal stereo player (PSP) and 97% believed the PSPs use may pose a potential risk to hearing (97%). 2. Mean volume control setting that participants believed to pose a risk to hearing was 79% of the volume range. 3. Perceived risk varied significantly across age groups. Early High School students reported higher perceived risk volumes than the Senior High School group, and both were higher than the Young Adulthood group. 4. ~1 out of 5 participants reported using listening volumes at levels perceived to be dangerous and is consistent with other study outcomes in the literature. 5. Participants showed less awareness of peers' behavior and consistently over-estimated the volumes at which they believed their friends listened. 6. Misperceptions of social norms relating to listening behavior may decrease individuals' perceptions of susceptibility to hearing damage.

Portnuff, Fligor & Arehart (2011) United States	Descriptive Laboratory and Self-Report	Exp. 1. Investigate the relationship between volume control setting and output levels of PASs, Exp. 2. Examine how adolescents' listening behavior changes as a function of background noise and noise isolation, Exp. 3. Investigate the relationship between self-reported listening levels and laboratory-measured listening levels, *Exp. 4. Evaluate the validity of the Listening Habits Questionnaire (LHQ) as a research tool for evaluating how attitudes and beliefs relate to PAS use.*	Exp. 1. KEMAR manikin output levels of 5 commercially available PASs. Exp. 2. n=29 normal-hearing teenagers (12 males, 17 females) that listened to PASs at least 2 hr./week. Age: 13-17 years; mean age 14.4 years. Probe microphone measurements of chosen listening level for 3 earphone types (earbud, isolator, supra-aural) in 7 background noise conditions. Exp. 3. n=29 normal-hearing teenagers (12 males, 17 females) that listened to PASs at least 2 hr./week. Age: 13-17 years; mean age 14.4 years. Self-report of number of hours per day that they usually listened to PAS and self-reported volume levels converted to estimated diffuse-field equivalent dBA using laboratory measured output level measurements. *Exp. 4. Mean and SDs of group responses and measure of internal consistency reliability for LHQ. Seven models based upon health belief model (HBM) constructs were evaluated for prediction of chosen listening level.*	Exp. 1. ~6 dBA increase in output level with 10% volume control increase. Maximum output 112-113 dBA for 1 kHz tone, and 99-104 dBA for Pink Noise. Exp. 2. CLL increases as background noise increases for all earphones, and CLL is higher for earbud and supra-aural earphones than isolator. Risk of hearing loss is higher for earbud/supra-aural earphone type when compared to isolator earphone. Exp. 3. 14% of the teenagers are at increased risk of hearing loss based upon self-reported listening behaviors. Output levels measured in the laboratory did not correlate well with self-reported typical listening levels. *Exp. 4. Cronbach's alphas ranged from 0.81 to 0.87 on all health belief model constructs suggesting good reliability.* *No HBM-based models were useful in predicting CLLs in the laboratory.* *Self-reported volume control-equivalent CLLs explained 67.9% of the variance and is the most useful predictor.*

Quintanilla-Dieck, Artunduaga, Eavy, 2009. United States	Online Survey	Purpose was to update MTV.com survey outcomes from 2007 after recent media attention on the risk of hearing loss from loud music exposure.	The 28 question 2002 survey was incorporated into a new 73-question 2007 instrument. The survey was presented to every 30th visitor on the MTV.com website to attract a comparable convenience sample demographic populations. Questions addressed hearing loss awareness and hearing behavior with earplug use and MP3 players. n=2500 (31% male and 69% female). Age: 9-31 years, mean= 21.7 years.	1. Hearing loss was considered problem by 32% of the respondents and less than concern with other health issues such as drug/alcohol use (62%). Only sport-related injuries were perceived as a problem of similar concern to hearing loss. 2. More than 2/3 had learned about the issue of music-induced hearing loss within the last year. (From TV-55% or Internet-33%. The remainder learned from individuals (parent 32%, teacher 27%, friend 26%, and health-care professional 21%. 3. Approximately half of the respondents admitted experiencing symptoms such as tinnitus (77%) or hearing loss (40%) or ear pain (34%) after loud music exposure. Sources of sounds causing the ear symptoms were concert, party, club, MP3 player and stereo (in descending rank order). 4. Most respondents were still not likely to wear earplugs to a concert or club, however the percentage stating that they are likely to wear earplugs increased significantly in 2007 (28%) when compared to 2002 survey (22%). Most respondents are willing to adopt ear protective behavior with education awareness. 5. 75% owned an MP3 player and 24% listened for more than 15 hours/week. Most used earbuds (75%). 45% of the listeners reported volume settings of 75-100% of capacity. 89% of listeners would increase the volume on subways, traffic noise)

Vogel, Brug, Hosli, van der Ploeg & Raat, 2007.	Qualitative analysis of focus-group discussions	To explore the behavioral determinants of hearing conservation in adolescents in the context of the Protection Motivation Theory (PMT).	n=73 adolescents (44 male and 29 female) recruited from secondary school communities (1 urban, 1 rural) divided into 8 groups based upon age (12-14 yrs. and 15-18 years), education (university prep males & females combined), vocational prep (males only), vocational prep (females only). Focus-group interviews Responses were interpreted in the context of 6 PMT constructs; threat severity, threat vulnerability, response efficacy, self-efficacy, maladaptive response rewards and perceived costs and barriers of adaptive response.	1. Preferred Listening Level: Motives for playing music at maximum volume: to reduce background noise, or to be able to hear it well (favorite song or singing along). The rationales for listening at lower volume levels included; batteries "flat", going to sleep, sound quality degrades, need to participate in social activities, need to concentrate or to hear traffic. 2. Consequences of Exposure to Loud Music: Hearing loss was recognized as a consequence, but only happens when the exposure was very frequent, very long, and very loud, which they said was the case with them. Some viewed it as a "fairy-tale, and expressed that you only live once, so enjoy it. They underestimated their own "vulnerability to loud music listening. They need guidance on what is "too loud" and "too long". 3. Tinnitus was experienced by most adolescents after listening to loud music. Most felt that tinnitus was "no problem" for them and did not recognize it as a warning that their hearing was "susceptible". 4. Hearing Conservation Actions: Most did not intend to change behavior and if they did they would have to sure that loud music was the cause of the hearing loss, They would not likely purchase output-limiting earphones. 5. Parental Influence: Some respondents would respond positively to parental warnings about loud music listening.

1. Expansion of the HBM constructs to include a standardized scale of adolescents' risk-taking behavior or sensation-seeking behavior as suggested by Bohlin and Erlandsson (2007).

2. Listening behaviors are not static, and may vary as a function of listening technology, listening environment, music preference, and activities performed while listening. Monaural and binaural listening habits will also impact risk (Snowden and Zapala, 2010). Therefore, a singular snapshot of listening level or duration may not reflect the actual long-term safe or dangerous behavior patterns for an individual listener or across all listeners.

3. Limited information exists relative to the independent variables such as age, gender, socio-economic status, ethnicity and race in terms of unsafe listening behavior. Large-scale studies are needed to further evaluate these variables which are important considerations when tailoring heath communication messages.

4. Tools such as the Youth Attitudes towards Noise Scale (YANS) developed by Widen & Erlandsson (2004) may be adaptable as a tool to implement with regard to risky listening behavior research, similar to studies of adolescents use of hearing protection devices. This tool has been translated for use in Brazil and China.

5. Health communication messages must be drafted around existing damage risk criteria for which there is no consensus for personal audio system sound exposures in general or for specific potentially vulnerable populations such as children. For instance, the Scientific Committee on Emerging and Newly Identified Health Risks assumed that listening for 1 hour a day to sound levels in excess of 89 dBA is potentially damaging (SCENIHR, 2008). Others reference adult occupational exposure damage risk criteria or a percentage of allowable occupational exposures (e.g. 50% dose). The continuity of health communication messages is disrupted by these varying definitions of hazardous music-player exposure criteria. It will be a critically important pre-requisite to come to a consensus regarding the applicable damage-risk criteria prior to designing any health communication messaging.

6. Trust influences an individual's response to public health messages. Honesty and consistency of information from public health officials are the components most frequently identified as determining trust or distrust (Meredith et al, 2007). People responded with alarm, loss of credibility in media source, and "confusion, hypervigilance, anxiety, stress, distrust of science and medicine" (p.392) when the media reported contradictory information, overwhelming amounts of information, oversimplifications about a disease and/or inaccuracies about a health issue (Covello and Peters, 2002). The public may also become skeptical and doubt the reality presented in the health message when their personal experiences differ from media portrayals (Cozzens & Contractor, 1987).

7. A source with high credibility will increase acceptance of the message, the health communication messages must be communicated by credible organizations and spokespeople that balance trustworthiness and expertise (Snyder, 2007). The World Health Organization is highly respected and it is critically important that the credibility be maintained through fact-

checking and peer-review of health communication messages related to the promotion of safe-listening.

8. Specific evidence-based and theoretically-based research on effective hearing health promotion and effective messaging in the context of personal audio device listening should be carefully designed and systematically implemented, longitudinally if possible. These studies would further inform the useful attributes of safe-listening health promotion and the role of parental monitoring and adolescent risk-taking influences (Vogel, 2008).

9. The unintended consequences should be considered along with intended effects when design safe-listening hearing health promotion interventions.

10. The issue of high-level music exposure from personal audio systems is not easily separated from other sources of high-level music exposure in adolescents and young adults since the cumulative exposure to music also includes time at clubs and concerts. The auditory damage-risk is actually cumulative across all music-listening activities, as well as non-music noise hazardous activities. There is the potential to have an individual utilize all of their "allowable" sound exposure for music listening from a personal audio system, and not recognize the additional risk when participating in other noise hazardous activities or jobs.

MESSAGE FRAMING

Health promotion messages can be presented or framed in formats that convey the same information in ways that portray either the benefits of engaging in a particular behavior or the consequences of not to engage in a particular behavior. A gain-framed message aimed at increasing tooth brushing behavior might be "Brushing your teeth will give you fresh breath and a beautiful smile." A loss-framed message might be "Not brushing your teeth will lead to tooth decay and bad breath". Research indicates that individuals respond differently to the same health information, depending on how it is presented (Rothman & Salovey, 1997). Prospect Theory (Tversky & Kahneman, 1981) predicts that individuals will make choices regarding relatively low and high risk options depending whether the options are gain or loss framed when presented.

The rationale as to why gain-framed messages should be more effective than loss-framed messages is related to the perceived risk involved. Gain-framed messaging presents a relatively low risk health behavior. Brushing teeth is a low risk activity that is likely to have positive results. It is hard to imagine a risk related to tooth brushing. Other health behaviors may have high perceived risk such as being tested for cancer. The risk is that the individual may get bad news from the exam and in fact have cancer. It is predicted that loss-framed messaging should be more effective at promoting a health behavior if there is a risk associated with the outcome. In general, behaviors related to prevention tend to present little or no risk to the individual and should respond to gain-framed messaging. Behaviors related to detection of a condition present some risk to the individual and are more effectively addressed by loss-framed messaging (Rothman & Salovey, 1997).

The effectiveness of message framing varies with several factors. If the desired outcome is *prevention behaviors* in adults, gain-framed messages are more likely that loss-framed messages to yield positive results (Gallagher & Updegraff, 2012). No framing effect was noted for changes in attitudes or intentions. The relationship between intentions and actual behavior varies considerably across studies. In general, the relationship between intended behavior and actual behavior across studies indicated that a medium-large change in intention resulted in a small to medium change in behavior. Intensions were less likely to result in behavior changes when participants lacked control over the behavior, when there was risk of social reaction and when the related activities were habit forming (Webb & Sheeran, 2006).

The vast majority of message framing studies have been conducted on adults. One study (de Bruijn et al 2016) evaluated messaging framing in adolescents, specifically related to intentions towards hearing loss prevention. Adolescent students were presented messages to encourage music listening at reduced volume. Gain-framed message emphasized the positive consequences of listening to music at reduced volume. Loss-framed messages emphasized the negative consequences of not listening to music at reduced volume. Consequences were also framed as being short-term or long-term creating four intervention formats (gain/short-short term, loss/short-term, gain/long-term, loss/long-term). Changes in intention to listen at lower volume was only found when messages were loss-framed with consequences in the short-term. The execution of the study faced several challenges (convenience sample enrolment, high dropout rate) and potential design flaws (non-validated questionnaires, non-linear scales across answer options) however it did illuminate a very important consideration.

Adolescents use very different risk-benefit evaluation processes than do adults Casey et al (2008). (Yurgelun-Todd, 2007) suggested a neurobiological basis for this reporting, “brain regions that underlie attention, reward evaluation, affective discrimination, response inhibition and goal-directed behavior undergo structural and functional re-organization throughout late childhood and early adulthood”. The authors (de Bruijn et al 2016) suggested that adolescents are also likely to process the temporal aspect of consequences differently than adults. Temporally distant, theoretical consequences may have little influence on a young person. In addition, their inexperience with the short-term consequences from an unhealthy behavior may limit their abilities to act prospectively. An example would be that a young adolescent may not have yet experienced tinnitus or ear pain after a loud music exposure. An experience like that can serve to enhance the importance of a preventive message and promote behavior change. Age and life-experience are factors that must be considered when developing message framing.

Levin et al (1998) astutely noted that research should be “very sensitive to the characteristics of language” in terms of message framing.

Punch et al. (2011) completed a comprehensive review of the literature that addressed the hearing risk attributed to patterns of use of personal audio systems and attitudes expressed by young people that they are invulnerable to a hearing loss from such use. The systematic review of the English-language scholarly literature was conducted by referencing peer-reviewed literature, books, book chapters, recent conference papers, online journals, technical reports, and standards. In addition, the authors searched for theoretical framework relevance to why some young people engage in risky behavior, as well as recommendations regarding specific messages that might be communicated to them to raise their awareness of the risks of hearing loss from PASs and to motivate them to reduce their risks. The authors note that the literature does not provide a consensus view regarding a causative relationship between PAS use and hearing loss, although multiple studies conclude the PASs when used by teenagers

and young adults present a substantial risk of hearing loss, and are a contributing factor to hearing loss developing over the lifespan. Table 1 of this publication provides an extensive summary of the experimental and survey studies reported in the peer-reviewed literature regarding the relationship between the use of PASs and hearing loss. The review article summarizes the outcomes in these topic areas; damage risk criteria (what levels and durations are unsafe), patterns of PAS use in young adults and adolescents, effects of earphone types, framework for health messages, conveying targeted hearing health messages, and future health risk communication research needs. Upon completion of the systematic review, Punch et al (2011) made the following recommendations for hearing health messages;

- All messages should be conveyed via age-appropriate media (public service announcements TV and radio/satellite radio, online newspapers and blogs, as well as advertisements or public service announcements in magazines and newsletters, and on Internet sites.

- Messages should educate and inform adolescents and young adults about the potential consequences of unsafe listening on hearing using written articles, postings and links on websites such as YouTube.

- Messages should be delivered by spokespersons from the health professions and have some level of involvement from related peer groups.

- For adolescents, attitude shifts toward hearing-healthy behaviors are likely to require multimodality interventions (Griest, Folmer & Martin, 2007).

- Messages should be directed toward parents to equip them with accurate and relevant information to convey to their children and students about the potential risks of unsafe music listening.

- Messages should communicate the gradual, incipient, invisible and permanent nature of noise-induced hearing loss. The impact of hearing loss on safety, communication and personal relationships should be discussed.

- The relationship between intensity and duration of listening should be part of the message.

- Adolescents should be advised that tinnitus may be a warning sign to turn down the volume or take a listening break.

- The advantages and disadvantages of various earphone styles and types should be included in terms of music exposure and environmental awareness for personal safety purposes.

- Manufacturers should include warning messages on personal audio devices or packaging.

- Healthcare professionals should routinely convey health communication messages regarding the importance of safe-listening behavior.

- Messaging should alert listeners that other sources of hazardous sound levels can contribute to the risk of NIHL and should describe the behaviors that can reduce these risks such as wearing earplugs or earmuffs. Specific mention of musicians' earplugs for concerts is advocated.

- The higher risk associated with monaural listening should be addressed with adolescents.

- Youth should be advised that warnings by parents or others may not be sufficient for identifying hazardous listening levels.

THE USE OF TECHNOLOGY IN HEALTH PROMOTION:

The use of technology in the context of health promotion is a new area of public health research and studies emerging in this area may be relevant to future work related to hearing health promotion. The theoretical basis for individual behavior change may be different in this new context. There are no studies to date employing technology for the purposes of safe-listening behavior change. Certainly, the widespread use of mobile technology drives researchers to leverage these new forms of communication. Mobile health "mHealth" is defined as health promotion and disease management programs delivered via text message, social media, and applications (apps) downloaded to phones and tables.

Text Messaging:

Text messaging is popular world-wide and permits the exchange of short messages, typically 160 characters which can be sent from mobile phones and Internet sites. The technology is widely available globally and does not rely on smart-phone capabilities. Meta-analysis of cellphone and Internet text messaging health programs indicate that the approach is effective in facilitating improvements in knowledge and behavior change (Head et al., 2013). Text message usage differs across population segments. Lenhart (2010) notes that minority groups are more likely to send/receive text messages than Whites in the U.S., and teens in the U.S. exchange more texts than adults (5:1). Texting is especially popular in developing countries such as Indonesia, Kenya, and Lebanon. The advantages of text messaging for health promotion include; widespread/global availability, relatively low cost, and the omnipresence of the technology that is an integral part of everyday lives of each user as opposed to having to drive a person to a particular media source for information. Critics note the disadvantages including; increased meatal health morbidity, lack of privacy and data confidentiality, and social stigma, if the message is read by someone other than the intended recipient and omission and questions regarding the literacy required for use of the technology (Bull and Ezeanochie, 2015).

In terms of health promotion, Fjeldsoe et al., 2012 has identified 4 purposes for the use of text messaging; 1) enhancing health service provision, 2) distributing mass health education messages, 3) encouraging better disease self-management practices and 4) delivering personalized health promotion interventions. Researchers not applied existing health communication theory, nor have they developed new or adapted theories sensitive to this new technology use. Fjeldsoe et al, also note that randomized control trials have been implemented in more recent studies, but more sophisticated research designs and analysis are needed.

mHEALTH:

The following studies provide examples and insight into the use of technology for health promotion.

1. **Head et al. (2013)** conducted a meta-analysis of 19 randomized controlled trials conducted in 13 countries meeting inclusion criteria and were coded on a variety of participant, intervention and methodological moderators. Interventions were designed to promote behavior change related to smoking cessation, physical activity, weight loss, medication for prevention, primary care appointment attendance, healthy pregnancy outcome, safer sex/condom use and sexually transmitted infection testing and contraceptive use. Factors were associated with greater intervention efficacy were; 1) messages that were both mass targeted and tailored to the individual, 2) intervention messages that were tailored on demographics and psychosocial variables and 3) messages that were texted on variable schedules either set up by the participant or decreasing in frequency over time as opposed to fixed-frequency messaging. Text-only messages were just as effective as those that included websites, print materials and human counselors. Interestingly, interventions that used health communication theory were not significantly more efficacious than those that did not, but the authors noted that the studies may have employed theoretical constructs but not specifically aligned with a single theoretical approach.

2. **Devine et al. (2015)** evaluated the use of an automated short message service text messaging (SMS) program designed to supplement a 25-session youth development program with demonstrated efficacy for reductions in teen pregnancy in 221 adolescents 14-18 years. The study was designed to explore the level of engagement with the texting program. Youth received 40, 006 messages and 16,501 were bi-directional in which the teen was asked to text a response (82% complied at least once). Response frequency varied by gender, age, and ethnicity. Youth were more likely to respond to messages that included questions and quizzes.The authors did not evaluate the independent efficacy of text messaging intervention for pregnancy prevention, but are working towards the development of hybrid health education programs which would link face-to-face program delivery with technology-based follow-up interactions.

3. **Bull and Ezeanochie, (2015)** provide 1) a review of research synthesis and meta-analysis to document the use of theory in mHealth and to identify any empirical evidence demonstrating improved efforts when theory is employed and 2) a proposal for an integrated theoretical framework to explain motivations and opportunities for people to engage with, benefit from and share mHealth to maximize public health. Table 1 of this study provides an excellent summary of the theoretical basis of the studies included in their analysis. The authors concluded that there is very limited use of social science theory in mHealth despite demonstrated benefits in doing so. An Integrated Theory of mHealth is proposed and the steps are summarized in Table 2 and applications of the Integrated Theory in mHealth programs. These steps and applications may be especially useful when considering the potential development of safe-listening mHealth interventions. This work implies that conventional theories of health promotion have to be utilized, adapted and built upon for use in mHealth.

4. **Block G. et al (2015)** utilized a fully automated behavioral intervention by email, web and mobile phone in a randomized controlled trial among persons with prediabetes. This automated

program provided tailored behavioral support in the areas of physical activity, eating habits, and addressed weight loss, sleep and stress. Weekly emails were linked to an individual Web page with tools for tracking and coaching, social support through virtual teams, competition, and health information. A mobile phone app and automated phone calls were also utilized to provide additional support. The outcomes indicated the mHealth program improved glycemic control, body weight, BMI, waist circumference, TF/HDL ratio, and diabetes risk in 339 persons assigned to the intervention group as compared to 176 in a control group. This study is useful for considering how to integrate mHealth interventions across multiple technology formats.

As of 2013 there were at least 40,000 mHealth apps available (IMS Institute for Healthcare Informatics, 2013). Unfortunately, there is little evidence that the vast majority of apps (1) have a theoretical basis in Health Communication Science, (2) were designed specifically for the conditions they propose to address or the populations that are targeted and (3 have been evaluated for effectiveness at improving health behaviors.

"Contagious: Why Things Catch On"

Jonah Berger's book "Contagious" (2013) is being used as a text book in public health classes at the University of Colorado taught by Sheana Bull, PhD. She recommended this book as a resource related to using technology for health promotion and message framing. Jonah Berger is a marketing researcher at the Wharton School at the University of Pennsylvania who has spent over 15 years studying how social influence works and how it drives products and ideas to catch on. Ideas in our context, would relate to positive health behaviors or messages that promote health. "Contagious" means likely to spread and diffuse by word-of-mouth and social influence. The book expands on six key "STEPPS" that cause things to be talked about, shared and imitated supported by examples and research. The six principles are:

1. Social Currency: How does the message make a person look to talk about it with others? People would rather look smart, rich, cool etc. Messages should be crafted to help people achieve their desired social impression on others. This indirectly gives them group status.

2. Triggers: People need to be reminded to talk about the talk. Everyday encounters, environments and associations may trigger the person to think of the message and spontaneously share it with others. "Top of mind, leads to tip of tongue".

3. Emotion: People share topics they personally care about. Messages and ideas need to make people feel something. Avoid "function" and focus on "feeling". "Kindle an emotional fire".

4. Public: Can others see when others are using the product or engaging in the desired behavior. It is hard to imitate things that are not observable, or talk about things that are invisible to others. There is a need to create "behavioral residue" that sticks around for others to see and engage in the same way with.

5. Practical Value: The message or content needs to be useful. People like to help others, so ideas that save time, improve health, or save money will be spread by word-of-mouth. These messages need to be highlighted and stand out from the massive amounts of information available on a daily basis.

6. Stories: People share stories, not just information. Embed the messages in stories that will be shared.

Each of these principles is explored in detail, and in the context of research evidence that supports the attribute, as well as the factors that might influence each principle. This book may be useful when developing and crafting the safe-listening health promotion messages. It provides an extension of message-framing in terms of creating the opportunity for the messages to be shared and discussed.

Automated, tailored messaging

A report by op den Akker and colleagues (2015) presents a detailed model and practical framework for theory-based, automated, real-time delivery of health behavior motivational messages. The specific target behavior was physical activity coaching but the model was described in a way that could be applied to other health behavior issues. The model was developed based on a combination of health communication theories (listed above), social marketing, evidence-based best practices and their years of personal experience with these activities. The **Model of Motivational Messages** encompassed all of the critical concepts related to motivational message generation.

Their premise is that the likelihood of improving and maintaining healthy behaviors is enhanced through tailoring of the timing, content, intent and representation of supportive messages as specifically as possible to targeted individuals. Readily available personal technology (smartphones and other networked systems) provide a widely-distributed, readily-accessible and familiar venue for message delivery. Tailoring garners attention and makes messages relevant, motivating and effective at modifying behaviors of individuals. Message framing can also add (or detract) from the persuasiveness of the message. Investigators agree that message composition increases in effectiveness when it is based on behavior change theories (Michie et al, 2009). In order to tailor or frame personalized messages, information about the target individual must be known or acquired. Information needed may include demographics, condition needing to be addressed, readiness to change health behavior, personal preferences and the starting point for practices of the target health behavior. Ongoing information about activities (in the case of using personal audio systems this could be listening practices including sound levels, durations, days of the week and times during the day) can be used to develop message delivery strategies.

Message timing

Most health messaging is delivered through offline vehicles including regular mail, telephone, or websites. The available of app technology allows for the implementation of real-time and adaptive timing of message delivery. The timing of the message can be initiated by the user (user-initiated) or can be generated by the device (system initiated) based on an algorithm tailored to the profile, state in process and needs of the user. Timing should be based on when the user is able and willing to take action. In the case of “listening level and duration” behavior, messages could be generated at several points in time: when the device is turned on, when listening is initiated, at some preset sound exposure dosage has been reached or when a maximum dosage has been exceeded. The most effective timing for hearing health promotion messaging has yet to be determined.

Message intention

Motivational messages have been described as having primary and secondary intentions (Akker et al 2015). In their model, the primary intention of a message relates to motivation for specific behaviors. Their example uses motivation to increase physical activity for those in need of exercise. The message can also be to reduce activity if the user is too active as in someone with chronic fatigue syndrome. If the activity level happens to be appropriate, a neutral intention message can be delivered. Each of these primary intention messages can be expressed through secondary intention messages.

Four types of secondary messages address sub-components of the primary message. *Feedback* secondary messages inform the user about how he/she is currently performing in terms of safe behaviors. An *argument* secondary message educates the user about the benefits (gain-framed) or consequences (loss-framed) consequences of their current behavior. A *suggestion* secondary message suggests practical ways by which the user may achieve the desired goal or practice. *Reinforcement* secondary messages encourage the user to continue current practices is applicable only when the user is performing well.

This model may be applied to promoting safe listening behaviors using personal audio systems. The primary intention of motivational messages can be to *discourage* unhealthy listening activity (turn down volume or limit duration) or to *encourage* current listening practice (indicating that volume levels at this time are safe). A target level or goal is necessary to define the primary intentions as being to discourage or encourage. An example of a target level would be to keep the cumulative sound exposure dosage (based on 85 dBA/8 hours; 3 dB exchange rate) below 50% in any 24 hour period. *Feedback* intention messaging could periodically update listeners regarding the relative safety of their recent listening practice. An *argument* intention message could either indicate that they can enjoy hours of listening enjoyment at the current sound levels or remind them of the risk for an adverse effect of their current listening level (e.g. getting tinnitus) if the levels are dangerously high. A *suggestion* might be to turn the volume down to safe level or take a listening break. *Reinforcement* messaging would let them know that their listening levels have been safe through simple indicators such as an occasional flashing green light, stars or symbols that are displayed and collected on a screen when a certain duration of safe listening has occurred or some form of credit towards a more substantial reward for safe listening.

Message content

Message content is the most complex component of messaging. Studies indicate that the first component of the message is *feedback* about the user's current status of activity (e.g. listening level). The next component of the message is the *follow-up* and is determined by the intention of the message. If the user is performing well, a reinforcement message is delivered. If there current activity is to be discouraged, a practical *suggestion* of action is included. An *argument* presenting the benefits of implementing the *suggestion* can be added. A pool of message components can be generated, categorized, stored, accessed and delivered automatically using an algorithm tailored to the target individual.

Message representation

The outer representation or format of the message can also be tailored to the individual. Representation can be done is different ways. Visual modalities include text, images, cartoons and animations. The

majority of messaging in place uses natural language text, but there is an indication that alternative may be more engaging and potentially more effective that text alone. Audio messaging can be musical, alarms or wording. Haptic signals can be combined with the above to alert the user to an incoming message or serve as warnings.

Considerations

Several factors must be considered when implementing the four components of this Model. Messages are sent *to* someone, *from* someone. The sender or source of the message will have a relationship with the receiver that will influence the timing, intention, content and representation of the message as well as the credibility and authority of the message. Credibility can be based on professional status, credentials or affiliation with a specific healthcare institute. Non-traditional sources can also be considered credible. A panel of five high school students discussing the role of social media in health decisions at a conference (Sobel & Hanson, 2013) acknowledged that if they read something on the internet or if the source was a celebrity, they tended to consider the information credible. All admitted that they did not pursue fact checking in information from these sources. Message timing, intention, content and representation are likely to require accommodation for user age. The effectiveness of gain or loss message framing is likely to be age dependent (de Bruijn et al 2016) as may be the impact of message representation formats. Literacy (or limits thereof) for the target population may dictate message content and representation.

The Model of Motivational Messages appears to be the most comprehensive framework for tailored health messaging. The authors (op den Akker et al 2015) acknowledge that extensive research will be required to refine the sub-components of the model and determine how it may be applied to health behaviors beyond physical activity coaching.

LESSONS LEARNED FROM OTHER HEALTH COMMUNICATION CAMPAIGNS

A report of "Health Campaigns and Their Impact on Behavior" by Leslie B. Snyder (2007) reviewed the published peer-reviewed evidence for the effectiveness of health communication campaigns (youth smoking/tobacco use, physical activity, dietary change, substance abuse, alcohol abuse, sexually transmitted diseases etc.) to inform future nutrition campaigns. The review of meta-analyses and systematic reviews based upon 441 peer-reviewed studies, concluded that new efforts to develop and promote healthy nutrition campaigns should pay attention to lessons that relate to three critical elements of campaign planning: *goals, strategy and research*.

Communication campaigns are defined as an "organized communication activity, directed at a particular population for a particular period of time, to achieve a particular goal". Campaigns vary widely in terms of communication activities and include posters, handouts, public service announcements, discussion groups, workplace or clinic-based counseling, and in-school presentation. *Mediated campaigns* use some form of media in their communication efforts.

Effectiveness of Campaigns: In general the average health campaign affects the intervention community by about 5 percentage points (5%). This outcome only applies to campaigns that do not use coercion

(e.g. legal or regulatory enforcement of the behavior). Campaigns that promote the adoption of a behavior that is new to the individual or replacement of an old behavior with a new one have a greater success rate than campaigns aiming to cease an unhealthy behavior or prevent commencement of a risky behavior (Snyder et al., 2004).Outcomes are typically assessed in terms of behavior change, however intermediate outcomes in terms of changes in knowledge, beliefs, and interpersonal communication are helpful in attaining the ultimate behavior change goal.

3 Lessons learned from previous campaigns:

1. *Campaign Goals* specify what the campaign is designed to accomplish within a period of time. Goals state desired outcomes, target population, and should specify measureable objectives to evaluate success. Intermediate goals such as increasing knowledge or awareness of a problem should also be determined in advance. Outcomes need to explicitly state the behavior change goal in order to guide development of the appropriate messages and campaign strategies.

2. *Communication Strategies* try to change the behavior of the target populations, including strategies that attempt to change the political and economic context in which people make decisions, and those that influence individual behavior decisions. Communication strategies include communicating directly with the target population, indirect communication with influential people (e.g. parents), and address environmental barriers by advocating for policy or access changes. Communication may take place across a wide variety of activities and channels and are more successful if they reach the target population multiple times across multiple channels. As previously mentioned, message presentation, content and framing are important considerations. Campaigns should emphasize information that is new to the target group and essential for behavior change.

3. *Research and Evaluation* is important at each stage of the development and dissemination of the health communication campaign. Ongoing monitoring is also important to the campaign in order to assure the proper implementation and timely response to unforeseen outcomes.

Job and Hatfield (2000) describe effective communication of health messages regarding noise-induced hearing loss in general and present the short-comings of campaigns designed to promote the adoption of various self-protective behaviors by individuals. These short-comings include the following;

- “Campaigns rarely go beyond making the point that noise is somehow harmful”. Simple information alone has been shown to be ineffective in relation to other public health & safety issues (road safety and smoking).

- Campaigns limit the consequences to hearing loss and neglects the harmful non-auditory effects of noise.

The following suggestions are provided to improve the efficacy of campaigns designed to promote positive hearing health behaviors in the context of noise exposure;

- Avoid naivety and research the causes of the undesirable behavior in order to avoid worsening the situation by making wrong assumptions at the outset.

- Identify the motivation needed to engage in healthy hearing behavior. People often have the knowledge of the risk of noise-induced hearing loss but are not properly motivated to engage in protective behaviors. Additionally, individuals may not recognize their personal vulnerability and this inhibits behavior change. Campaign messages should be salient and personally relevant to the targeted individuals.

- Barriers to desirable behaviors need to be removed or minimized. These barriers may include doubting the effectiveness of the protective behavior (e.g. earplugs do not work), cost of the behavior in terms of money, time or social acceptability and convenience.

- The use of fear in health promotion must be considered carefully as positive reinforcement approaches tend to be more effective and less likely to backfire than fear campaigns. Campaigns should be imbued with positive values of adopting the health behavior.

These researchers note that ineffective campaigns waste time, money and effort and reduce the likely efficacy of subsequent campaigns by immunizing their audience against safety messages.

Wakefield, et al. (2010) published an extensive literature review of the literature regarding the use of mass media (television, radio and newspapers) campaigns to change health behavior. The review encompassed passive exposure to mass media messaging and excluded active exposures where the target population can choose to seek information using newer technologies such as smartphones and the internet. The appeal of mass media is the ability to disseminate focused messages to large audiences repeatedly over time. However, the reality is that campaign messages can fall short and even be counterproductive in some instances. The authors noted, "…exposure of audiences to the message might not meet expectations, hindered by inadequate funding, increasingly fractured and cluttered media environment, use of inappropriate or poorly research format (e.g. boring factual messages or age-inappropriate content), or a combination of these features; homogeneous messages might not be persuasive to heterogeneous audiences; and campaigns might address behaviors that audiences lack the resources to change." The literature search strategy was expansive across health topics, but did not include hearing loss. The authors provided an in-depth review of evidence for behavior change related to tobacco, alcohol, and illicit drugs, nutrition activity and prevention of heart disease, birth-rate reduction and prevention of HIV infection, cancer screening and prevention, child survival and other health behaviors such as road safety, helmet use for bicyclists, motorcyclists and skateboarders. Readers are encouraged to consult the original publication for detail that exceeds the scope of this report. The following recommendations were made with regard to using mass media to promote healthy behaviors in general:

- "Mass media campaigns should be included as key components of comprehensive approaches to improving population health behaviors."

- "Sufficient funding must be secured to enable frequent and widespread exposure to campaign messages continuously over time, especially for ongoing behaviors."

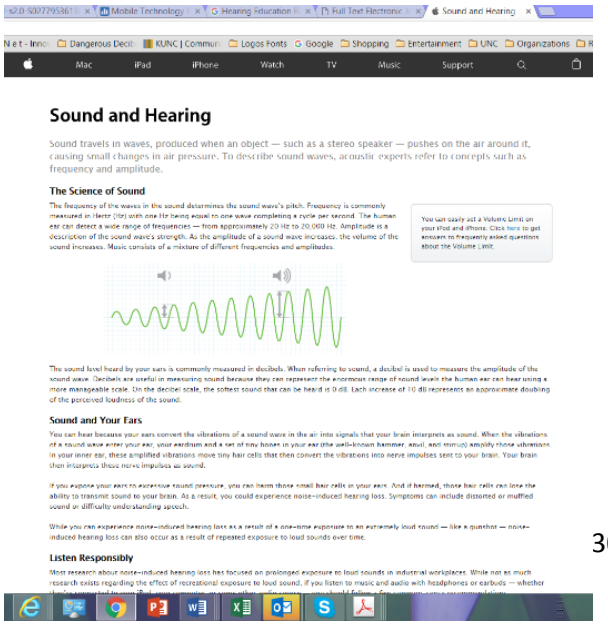
- "Adequate access to promoted services and products must be ensured."

- “Changes in health behavior might be maximized by complementary policy decisions that support opportunities to change, provide disincentives for not changing, and challenge or restrict competing marketing.”
- “Campaign messages should be based on sound research of the target group and should be tested during campaign development.”
- “Outcomes should undergo rigorous independent assessment and peer-reviewed publication should be sought.”

Wakefield et al. (2010) concluded that mass media campaigns can directly and indirectly produce positive changes in health-related behaviors across large populations. The likelihood of success is increased by the following; (1) application of multiple interventions when the target behavior is episodic in nature, rather than habitual, (2) concurrent availability of and access to key services and products are crucial to persuade individuals motivated by mass media messages, (3) creation of policies that support opportunities to change provides additional motivation for change, whereas policy enforcement can discourage unhealthy or unsafe behaviors, (4) public relations or media advocacy campaigns that address the issue by news and entertainment media are complimentary to conventional media campaigns. In addition, the likelihood of success or lack of sustained success is hindered by (1) pervasive marketing for competing products or opposing messages, (2) the power of social norms, (3) drive of addiction, and (4) fractured and cluttered media environment that limits the exposure to the message. The authors emphasized the crucial importance of careful planning and testing of campaign content and format with target audiences before widespread implementation.

CURRENT PRACTICES IN CONSUMER MESSAGING TARGETING USERS OF PERSONAL AUDIO SYSTEMS

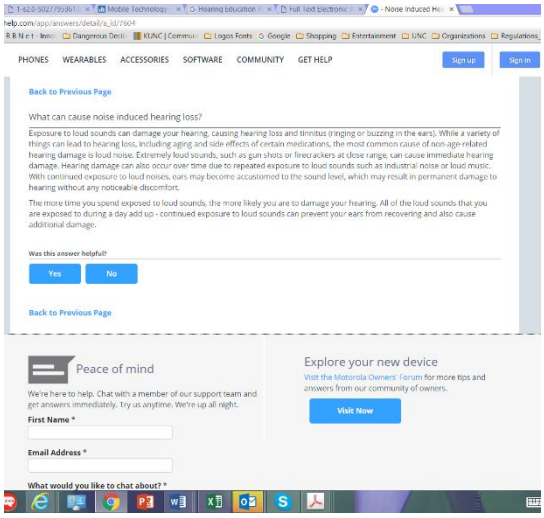
Messaging to consumers regarding hazardous volume (listening) levels are contained within the device user manual and within pop-up messages when the volume is raised above a particular unspecified trigger point set by the manufacturers. Consumers receive a wide variety of messaging content on their mobile devices regarding volume levels. These messages are not standardized between manufacturers. Most are informational in nature with a simple message that high volume may damage hearing. Most manufacturers avoid specific reference to hearing loss but refer to “hearing damage”. We did not identify any messages related to high volume contributing to



tinnitus. Some warnings also relate to the transducers paired with the device and warn against other audio earphones/headphones being used. In the U.S., these warnings are likely approved by legal counsel and some of the brevity may relate to minimizing any risk of liability. Other apps specifically ask the listener to release them from liability when the volume is raised. There is no evidence of systematic evidence of health promotion messaging being based upon theoretical constructs of behavior change or object parameters based on the end-user listening habits. Most of the images we found of screen messages were collected from websites/blogs/forums where the end-users were seeking information to disable the pop-up warning messages. They found them to be a nuisance, repetitive and users wanted to bypass or circumvent them permanently. Two cellphone manufacturers actually provide basic educational material on their websites.

Apple at http://www.apple.com/sound/

and Motorola Frequently Asked Question (FAQ):
http://direct.motorola.com/hellomoto/nss/AcousticSafety.asp



EFFECTIVENESS OF POP-UP MESSAGING/FEEDBACK:

There are no published studies focused solely on the effectiveness of pop-up warning messages specifically related to hazardous volume settings. Focus group interviews did briefly explore the topic of warning messages on MP3 players in the Vogel el al. (2007) study. All participants said that a warning on the MP3 would be acceptable, although few expected it to influence their behavior. Comments included; “I never look at my MP3”, “It’s like with smoking: it says ‘Smoking Kills’ on a packet of cigarettes, but look how many people still smoke”. One experimental sub-group (pre-university group) indicated that they would think more consciously about their volume setting and take the warning into account when setting their volume. It appears that the effectiveness of pop-up warning messages related to volume levels may vary across target populations. Preliminary responses from 1903 adult respondents to an unpublished multi-country user survey (Meinke, 2015) indicated that 64% think there should be a warning on devices and 33% have received a warning message on their personal device. For the group that received a warning message; 34% ignored it, 6% disabled it and 8% turned it to a higher volume setting. This is in contrast to the 79% who reported that they would turn the music to a lower volume if they knew they were listening at an unsafe level (attitude). Sixteen percent stated they enjoy listening to loud music even if it is unsafe for their hearing and would be categorized as “risk takers”. It is possible that some listeners may view a volume warning as a challenge to exceed a safe limit.

The literature regarding the effectiveness of pop-up messaging in general appears to be published in the area of gambling and emergency weather-related events. Game operators have incorporated on-screen pop-up messages that appear to gamblers while they play on slot machines and/or online gambling games to promote responsible gambling. Outcomes from these laboratory studies suggest the following impacts (as cited in Auer & Griffiths, 2015);

- Messages that encourage player self-appraisal (e.g. Do you know how long you have been playing? Do you need to think about a break?) resulted in a significantly greater effect on self-reported thoughts during playing sessions and subsequent playing behavior when compared to purely informational messages.

- Exposure to a warning banner informing players of the randomness of outcomes of video lottery games decreased faulty gambling belief in both problem and non-problem video lottery gamblers.

- Pop-up messaging has been successful in helping gamblers set monetary limits while gambling.

- The most effective time-frame for a pop-up message to occur within a gambling session was after 60 minutes of gambling (compared to 14, 30 and 45 min) and resulted in an overall decrease in the length of time spent gambling among players.

- Previous exposure to a pop-up message during gambling did not influence either the likelihood of reading the message or choosing to stop play instead of selecting "yes" to continue.

Auer & Griffiths (2015) emphasize the importance of conducting real-world studies regarding the effectiveness of pop-up messaging to promote responsible gambling on gamblers. A study by Auer et al (2014) compared the behavioral tracking data of two random samples of 400,000 gambling sessions before and after a pop-up message was introduced by an online gaming operator. The study comprised approximately 200,000 gamblers, and a few thousand subjects played 1000 consecutive gambles on an online slot machine. These players received the pop-up message "You have now played 1000 slot games. Do want to continue? [Yes/No]". Nine times as many gamblers ceased their gambling at exactly 1000 games than did those gamblers who had not viewed the message after playing exactly 1000 games (n=45 versus 5). The authors concluded that pop-up messages influenced a very small number of gamblers to cease their playing session in the real world.

Another potential way to modify behavior is to use "normative feedback", where the recipient receives feedback relative to his/her peer group's engagement in the desired behavior. Normative beliefs have significantly influenced the behavioral outcome in studies encouraging smoking cessation, condom use, reduction of marijuana use and college student gambling that personalized normative feedback. Auer & Griffiths (2015) extended their application of health communication science to their responsible gambling research by adding normative feedback to their pop-up messaging. These researchers developed more sophisticated pop-up messages than those employed in the Auer et al, (2014) study. The new messages consisted of the following (page 3);

- "*We would like to inform you, that you have just played 1000 slot games"* objectively informs the player about their behavior.

- *"Only a few people play more than 1000 slot games"*: This part of the message provides normative feedback that very few other gamblers play 1000 consecutive slots games.

- *"The chance of winning does not increase with the duration of the session":* This part of the message addresses a common misbelief among gamblers.

- *"Taking a break often helps, and you can choose the duration of the break":* This part of the message provides advice (to aid self-efficacy) and leaves the decision up to the player and is in line with the techniques of motivational interviewing.

Gamer response buttons required a "close game" to exit the playing session, and if the player presses the "ok" button, the pop-u disappears and the playing session continues. The authors had 11,232 sessions that lasted at least 1000 consecutive slot games and received the original simple informational pop-up message, 75 sessions immediately terminated after the pop-up message was shown (0.67%). There were 11,787 sessions that lasted at least 1000 consecutive slot games and received the enhanced pop-up message, 169 sessions terminated immediately (1.39%). The authors concluded that pop-up messages influenced only a small number of gamblers to cease long playing sessions and that enhanced normative feedback messages were slightly more effective in helping gambler limit play time. The authors also noted that they were unaware of any other empirical studies that compared textual content in pop-up messages. Of interest, is that mandatory pop-up messages are being required by gambling accreditation organizations.

Casteel & Downing (2013) investigated the effectiveness of National Weather Service (NWS) warning messages regarding tornadoes (F4 or F5 severity) or flash floods sent either in plain text or a text that includes a radar image of the storm to smartphones. All NWS warning messages include information concerning: the severity of the risk, certainty of the event, urgency of the warning, specific advice about effective protective actions and location of the event. These messages were also incorporated into both the plain text or text+radar graphic conditions. The laboratory-based study participants were undergraduates at a Pennsylvania university with normal visual acuity. Participants were asked if their "town" was in the warning area, and response times for answering this question were measured. In addition, participants were asked to provide their agreement level (Likert scale 1-5) for whether the presence or absence of the radar image influenced the perceived magnitude of the weather event and the participants' likelihood to take appropriate action. Results indicated that decision response times did not differ between the graphic and non-graphic conditions. There were also no statistically comparable differences in the interpretation of the warning components; severity, damage, specific damage, certainty, personalization of risk and protective action. Additional research was advised before concluding that text messaging alone is sufficient and whether enhancement of the Wireless Emergency Alert (WEA) system in the U.S. is warranted. The authors also point out that perhaps other graphic messaging besides a radar image may communicate more effectively.

RELEVANT HEARING LOSS PREVENTION EFFORTS RELATED TO SAFE-LISTENING:

A number of efforts have been undertaken over the years to promote hearing health and prevent noise-induced hearing loss and tinnitus in children (Folmer et al, 2002) and adults. Some of these efforts involve public awareness campaigns and activities, while others incorporate health communication science and evidence-based intervention within their programs. The ability to provide a comprehensive global listing and summary of these efforts is limited by access, language and scope of this report. Appendix C provides a listing of programs that were easily identifiable through cursory Internet search in English, specifically targeting those with content relevant to safe music listening with personal audio systems.

RECOMMENDATIONS

Well established principles of health communication theory have yet to be systematically applied to promoting safe listening practices when using personal audio systems to a degree that would instill confidence in proposing regulatory standards or guidelines for messaging at this time. There is a large and growing body of literature that indicates that health messaging does facilitate positive health behavior changes and knowledge from these studies is ready to evaluate in the context of personal audio system safety. Current audio device safety messaging appears to be provided because of regulatory obligation or to avoid possible litigation (liability) rather than being theory-based, best-practices for promoting safe listening. There are no published indications that existing messages are effective, but there is substantial evidence that warnings annoy users. A simple Google search of the terms “disable volume warning” results in over 32 million posts, the vast majority of which appear to be queries and discussions about how to disable the warnings. It is possible that current, non-strategic messaging could alienate users from messaging altogether and jeopardize future efforts to use messaging through devices appropriately and effectively.

We have approached our recommendations from two perspectives: Recommendations to be implemented in the short term and long-range research needs for the future.

Short-term recommendations:

We recommend that research be conducted to determine best-practices for implementing tailored messaging that will, in conjunction with technological safeguards, effectively promote healthy listening practices in users of personal audio systems. The most evidence-based short-term strategy would be to adapt and evaluate a model like the op den Akker Model of Motivational Messages and/or Bull’s Integrated Theory of mHealth for safe listening hearing health promotion. These studies are on the frontier of individualized behavior change using customized, tailored messaging that likely could be developed and implemented. Any application developed to apply to messaging for safe listening using personal audio systems will need to be (1) scientifically credible using high standards of research evaluation, (2) consistent across all forms of communication in all places, and (3) tailored to the personal audio system user’s own behavior. These considerations are critical for long-term success of any hearing health promotion intervention targeting listeners using personal audio systems.

Of immediate concern is the rapid and unchecked propagation of *mis*information about safe vs. unsafe listening practices in the media and through social network communications. Unsubstantiated statistics, exaggerated risk criteria and incorrect information about sound exposures appear regularly in news

articles, posts and on websites. This information is communicated by well-meaning individuals, students, professional organizations and health agencies. The resulting confusion undermines the credibility of all hearing health promotion efforts and decreases the likelihood of future messages being effective.

In response to this need, we propose that the World Health Organization (WHO) establish an expert group to reach consensus on evidence-based and appropriate risk criteria for use of personal audio systems. In addition, we recommend that WHO establish an expert team that will be available to news sources, agencies and organizations to review the technical accuracy of statements related to sound exposures and risks as a public health resource.

The following are offered as recommendations for future research needed to better inform efforts to successfully promote safe-listening behavior globally.

Long-term Research Recommendations:

1. Determine the effectiveness of various media used for implementing health behavior change messaging related to safe listening.

2. Formative and Summative evaluation of interventions designed to change knowledge, attitudes, beliefs and behaviors related to safe-listening hearing health promotion.

3. Further investigation of the health communication theories and constructs that address the motivation and barriers to safe-listening behavior change.

4. Application and evaluation of the ecological model in terms of multi-level interventions designed to promote safe-listening.

5. Quantify the intended and unintended outcomes of hearing health awareness campaigns and the degree to which various populations comply with the recommendations using attitudinal and behavioral measures.

6. Future research should rely less on convenience samples and utilize stratified, randomized, controlled study designs targeting specific populations.

7. Longitudinal studies are needed to demonstrate intervention effectiveness.

8. Research may need to come from multiple sources; e.g. manufacturers, public health organization, music sites, traditional research collaborations.

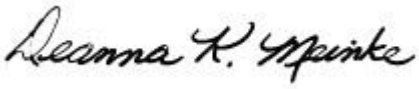
Outcomes in these areas are necessary before any policy-related recommendations can be offered with evidence-based support.

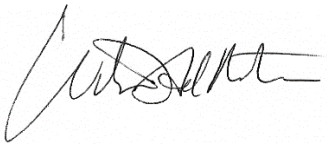
CONCLUSION

In summary, a critical component of safety standards for personal audio systems will be the requirement to include, theory-based, effective messaging that will enhance the behavioral component of listener

safety. Theoretical frameworks have been successfully applied to improve and sustain healthy behaviors, including those related to sound exposure. These frameworks need to be adapted for application to the use of personal audio systems. At the present time, there are no proven, effective, user tailored systems available to apply to personal audio technology. There are, however, models of health messaging that could be adapted to promote safe listening behaviors with limited modification. Extensive research is needed to expand our understanding of factors determining safe and risky listening behaviors and to effectively implement strategies and technologies to protect the hearing of listeners globally.

Respectively,





Deanna K. Meinke, Ph.D.
Professor of Audiology & Speech-Language Sciences
University of Northern Colorado
Deanna.Meinke@unco.edu

William Hal Martin, Ph.D.
Professor of Otolaryngology
National University of Singapore
Prof. of Public Health & Preventive Medicine
Oregon Health & Science University
entwhm@nus.edu.sg

REFERENCES

Auer, M.M. & Griffiths, M.D. (2015). Testing normative and self-appraisal feedback in an online slot-machine pop-up in a real-world setting. *Frontiers Psych,* 6, 339. doi.org/10.3389/fpsyg.2015.00339

Auer, M., Malischnig, D., and Griffiths, M. D. (2014). Is 'pop-up' messaging in online slot machine gambling effective as a responsible gambling strategy? An empirical re-search note. *J. Gambl. Issues* 29, 1–10. doi: 10.4309/jgi.2014.29.3

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavior change. *Psychological Review, 84*(2), 191-215. doi:10.1037/0033-295X.84.2.191

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

Berger, J. (2013). *Contagious: Why things catch on* (1st Simon & Schuster hardcover ed.). New York: Simon & Schuster.

Bettman, J. R. (1970). Information processing models of consumer behavior. *Journal of Marketing Research, 7*(3), 370-376. doi:10.2307/3150297

Block, G., Azar, K. M., Romanelli, R. J., Block, T. J., Hopkins, D., Carpenter, H. A., Dolginsky, M.S., Hudes, M.L., Palaniappan, L.P., Block, C. H. (2015). Diabetes Prevention and Weight Loss with a Fully Automated Behavioral Intervention by Email, Web, and Mobile Phone: A Randomized Controlled Trial Among Persons with Prediabetes. *Journal of Medical Internet Research*, *17*(10), e240. http://doi.org.libproxy1.nus.edu.sg/10.2196/jmir.4897

Bohlin, M.C. & Erlandsson, S.I. (2007). Risk behavior and noise exposure among adolescents. *Noise Health, 9*(36), 55-63. doi:10.4103/1463-1741.36981

Booth, S.L., Sallis, J.F., Ritenbaugh, C., Hill, J.O., Birch, L.L., Frank, L.D. … Hays, N.P. (2001). Environmental and societal factors affect food choice and physical activity: Rationale, influences, and leverage points. *Nutrition Reviews, 59*(3), S21-39. doi:10.1111/j.1753-4887.2001.tb06983.x

Bull, S. & Ezeanochie, N. (2015). From Foucault to Friere through Facebook: Toward an integrated theory of mHealth. *Health Education & Behavior.* doi:10.1177/1090198115605310

Casey, B. J., Jones, R. M., & Hare, T. A. (2008). The Adolescent Brain. *Annals of the New York Academy of Sciences*, *1124*, 111–126. doi: 10.1196/annals.1440.010

Casteel, M.A., & Downing, J.R. (2013). How individuals process NWS weather warning messages on their cell phones. *Weather, Climate & Society.* 5, 254-265. doi: 10.1175/WCAS-D-12-00031.1.

Cho, H. & Salmon, C.T. (2007). Unintended effects of health communication campaigns. *Journal of Communication,* 57(2), 293-317. doi: 10.1111/j.1460-2466.2007.00344

Covello, V.T. & Peters, R.G. (2002). Women's perceptions of the risks of age-related diseases, including breast cancer: Reports from a 3-year research study. *Health Commun*, 14, 377-395. doi: 10.1207/S15327027HC1403_5

Cozzens, M.D. & Contractor, N.S. (1987). The effect of conflicting information on media skepticism. *Commun Res* 14, 437-451.

de Bruijn, G.J., Spaans, P., Jansen, B., & van't Riet, J. (2016). Testing the effects of a message framing intervention on intentions towards hearing loss prevention in adolescents. *Health Education Research, 32*(2) 161-170. doi:10.1093/her/cyw006

Devine, S., Leeds, C., Shlay, J.C., Leytem, A., Beum, R., & Bull, S. (2015). Methods to asses youth engagement in a text messaging supplement to an effective teen pregnancy program. *Journal of Biomedical Informatics, 56,* 379-386. doi:10.1016/j.jbi.2015.07.003

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Folmer, R. L., Griest, S. E., & Martin, W. H. (2002). Hearing conservation education programs for children: a review. *Journal of School Health*, 72, 51-57.

Gallagher, K. M. & Updegraff, J. A. (2012). Health message framing on attitudes, intentions, and behavior: A meta-analytic review. *Annals of Behavioral Medicine, 43*(1), 101-116. doi:10.1007/s12160-011-9308-7

Gilliver, M., Carter, L., Macoun, D., Rosen, J., & Williams, W. (2012). Music to whose ears? The effect of social norms on young people's risk perceptions of hearing damage resulting from their music listening behavior. *Noise Health, 14*(57), 47-51. doi:10.4103/1463-1741.95131

Green, L.W. & Kreuter, M.W. (1999). *Health promotion planning: An educational and ecological approach.* Mountain View, CA: Mayfield.

Griest, S.E., Folmer, R. L., & Martin, W.H. (2007). Effectiveness of "Dangerous Decibels", a school-based hearing loss prevention program. *American Journal of Audiology, 16*, S165-S181. doi:10.1044/1059-0889(2007/021)

Head, K.J., Noar, S.M., Innarino, N.T., & Harrington, N. (2013). Efficacy of text messaging-based interventions: A meta-analysis. *Social Science & Medicine, 97,* 41-48. doi:10.1016/j.socscimed.2013.08.003

IMS Institute for Healthcare Informatics. (2013). Patient apps for improved healthcare: From novelty to mainstream. Retrieved from http://www.imshealth.com/deployedfiles/imshealth/Global/Content/Corporate/IMS%20Health%20Institute/Reports/Patient_Apps/IIHI_Patient_Apps_Report.pdf on February 15, 2016.

Israel, B.A. (1982). Social networks and health status: Linking theory, research, and practice. *Patient Counseling and Health Education, 4*(2), 65-79. doi:10.1016/S0190-2040(82)80002-5

Janz, N.K., & Becker, M.H. (1984). The health belief model: A decade later. *Health Education Quarterly, 11*(1), 1-47. doi: 10.1177/109019818401100101

Job, R.F.S. & Hatfield, J. (2000). Effective communication of health messages regarding noise-induced health effects. *Noise & Health*, 8, 33-38. PMID: 12689459.

Klesges, L.M., Estabrooks, P.A., Dzewaltowski, D.A., Bull, S.S., & Glasgow, R.E. (2005). Beginning with the application in mind: Designing and planning health behavior change interventions to enhance dissemination. *Annals of Behavioral Medicine, 29*(2), 66-75. doi: 10.1207/s15324796abm2902s_10

Lebanon, B. & Stone, R. (2008). *Managing Organizational Change.* Hoboken, NJ: John Wiley & Sons.

Lenhart, A. (2010). Cell phones and American adults. Pew internet & American life project. Retrieved from: http://www.pewinternet.org/2010/09/02/cell-phones-and-american-adults-2/ on February 11, 2016.

Levin, I. P., Schneider, S. L., & Gaeth, G. J. (1998). All frames are not created equal: A typology and critical analysis of framing effects. *Organizational Behavior and Human Decision Processes, 76*(2), 149-188. doi:10.1006/obhd.1998.2804

Meinke, D.K. (2015). User's perspectives: Results of multi-country user survey. Presentation at the *WHO-ITU Joint Stakeholders' Consultation on Safe Listening Devices*. October 1, Geneva, Switzerland.

Meredith, L.S., Eisenman, D.P., Rhodes, H., Ryan, G. & Long, A. (2007). Trust influences resposnse to publich health messages during a bioterrorist event. *J. Health Commun*, 12:3, 217-232, doi: 10.1080/10810730701265978.

Michie, S., Abraham, C., Whittington, J., McAteer, S., & Gupta, S. (2009). Effective techniques in healthy eating and physical activity interventions: a metaregression. *Health Psychology*. 28(6), 690-701. doi: 10.1037/a0016136

National Cancer Institute (NCI), U.S. Dept. of Health and Human Services. 2005. *Theory at a Glance: A Guide for Health Promotion Practice.* Bethesda, MD: National Institutes of Health; NIH Publication No. 05-3896. pp 1-49.

op den Akker, H., Cabrita, M., op den Akker, R., Jones, V.M., & Hermens, H.J. (2015) Tailored motivational message generation: A model and practical framework for real-tiem physical activity coaching. *Journal of Biomedical Informatics* 55:104-115. doi:10.1016/j.jbi.2015.03.005

Portnuff, C.D., Fligor, B.J., & Arehart, K.H. (2011). Teenage use of portable listening devices: A hazard to hearing? *Journal of the American Academy of Audiology, 22*(10), 663-677. doi: 10.3766/jaaa.22.10.5

Prochaska, J.O., Redding, C.A., Harlow, L.L., Rossi, J.S., & Velicer, W.F. (1994). The transtheoretical model of change and HIV prevention: A review. *Health Education Quarterly, 21*(4), 471-486. doi: 10.1177/109019819402100410

Prochaska J.O. (1996). A stage paradigm for integrating clinical and public health approaches to smoking cessation. *Addictive Behaviors, 21*(6), 721-732. doi: 10.1016/0306-4603(96)00031-7

Punch J.L., Elfenbein J.L., & James R.R. (2011). Targeting hearing health messages for users of personal listening devices. *American Journal of Audiology, 20*(1), 69-82. doi: 10.1044/1059-0889(2011/10-0039)

Quintanilla-Dieck M.L., Artunduaga M.A., & Eavey R.D. (2009). Intentional exposure to loud music: The second MTV.com survey reveals an opportunity to educate. *The Journal of Pediatrics, 155*(4), 550-5. doi: 10.1016/j.jpeds.2009.04.053

Rogers, E.M. & Shoemaker, F.F. (1971). *Communication of innovations: A cross-cultural approach.* New York, NY: The Free Press.

Rogers, R.W. (1975). A protection motivation theory of fear appeals and attitude change. *The Journal of Psychology: Interdisciplinary and Applied, 91*(1), 93-114. doi: 10.1080/00223980.1975.9915803

Rosenstock, I.M. (1960). What research in motivation suggests for public health. *American Journal of Public Health and the Nation's Health, 50*(3), 295–302. Retrieved from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1373163/ on February 11, 2016.

Rothman, J., (2001). Approaches to community intervention. In J. Rothman, J. Erlich, & J. Tropman (Eds.), *Strategies of community intervention: Macro practice (6th Ed.)* (pp. 27-64). Itasca, IL: F. E. Peacock Publishers, Inc.

Rothman, A. J. & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: The role of message framing. *Psychological Bulletin, 121*(1), 3-19. doi:10.1037/0033-2909.121.1.3

Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), (2008). Potential health risks of exposure to noise from personal music players and mobile phones including a music playing function. Retrieved from: http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_017.pdf on March 1, 2016.

Shin, Y., Yun, S., Pender, N., & Jang, H. (2005). Test of the health promotion model as a causal model of commitment to plan for exercise among Korean adults with chronic disease. *Research in Nursing & Health, 28*(2), 117-125. doi: 10.1002/nur.20060

Snowden, C.K. & Zapala, D.A. (2010). Do middle school students set safe volume levels for routine iPod use? A comparison of monaural versus binaural listening trends. *Audiology Today*, *2010*(22), 53-59.

Snyder, L.B. (2007). Health communication campaigns and their impact on behavior. *J Nutr Educ Behav.* 39:S32-S40. doi:10.1016/j.jneb.2006.09.004

Snyder, L.B., Hamilton, M.A., Mitchell, E.W., Kiwanuka-Tondo, J., Fleming-Milici, F, & Proctor D. (2004). A meta-analysis of the effect of mediated health communication campaigns on behavior change in the United States. *J Health Commmun.* 9 (Supplement 1): 71-96. doi: 10.1080/10810730490271548.

Sobel, J. & Meikle, M. (2008). Applying health behavior theory to hearing conservation interventions. *Seminars in Hearing, 29*(1), 81-89. doi: 10.1055/s-2007-1021775

Sobel, J.L. & Hanson, A. (2013, October). *Leveraging social media for communicating with youth.* Panel presentation at the Conference on Innovations in Noise Induced Hearing Loss and Tinnitus Prevention in Kids, 3M Innovations Center, St. Paul, MN.

Tversky, A. & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science, 211*(448), 453–458. Retrieved from: http://www.jstor.org/stable/1685855 on February 4, 2016.

Vogel, I., Brug, J., Hosli, E.J., van der Ploeg, C.P., & Raat, H. (2008). MP3 players and hearing loss: Adolescents' perceptions of loud music and hearing conservation. *The Journal of Pediatrics, 152*(3), 400-404. doi: 10.1016/j.jpeds.2007.07.009

Wakefield, M. A., Loken, B., & Hornik, R. C. (2010). Use of mass media campaigns to change health behaviour. *The Lancet*, 376, doi: 1261-1271. doi:10.1016/S0140-6736(10)60809-4.

Webb, T. L. & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132*(2), 249-268. doi:10.1037/0033-2909.132.2.249

Widen, S.E.O & Erlandsson, S.I. (2004). The influence of socio-economic status on adolescent attitude to social noise and hearing protection. *Noise Health, 7*(25), 59-70. Retrieved from: http://www.noiseandhealth.org/article.asp?issn=1463-1741;year=2004;volume=7;issue=25;spage=59;epage=70;aulast=Olsen on February 11, 2016.

Yurgelun-Todd, D. (2007). Emotional and cognitive changes during adolescence. *Current Opinion in Neurobiology*, 17(2):251-257. PMID: 17383865.

APPENDIX A: Listening Habits Questionnaire from Portnuff et al., 2011

Appendix 1. Means and standard deviations of responses to Listening Habits Questionnaire questions organized by Health Belief Model construct. Indexes include Cronbach's alpha, a measure of internal consistency reliability for a scale variable. Responses ranged from 1 to 7, with greater numbers indicating agreement with the statement.

Question	Mean	SD	Alpha
Susceptibility to Music-Induced Hearing Loss (MIHL)			
1. How susceptible to hearing loss do you feel?	3.14	1.55	
2. What is the chance that you will experience hearing loss from listening to loud music?	3.62	1.86	
3. How likely do you think it is that you will experience hearing loss resulting from listening to loud music on an MP3 player?	3.83	1.91	
4. Would you say that you are the type of person who is likely to experience hearing loss?	3.00	1.79	
Susceptibility to MIHL Index	3.48	1.63	0.87
Severity of MIHL			
1. How disruptive would hearing loss be to your quality of life?	5.86	1.19	
2. How disruptive would the cost of treating hearing loss be?	5.21	1.57	
3. How disruptive would it be to have to wear a hearing aid?	5.34	1.70	
4. How disruptive would hearing loss be to your ability to communicate with your friends and loved ones?	6.24	1.38	
5. How disruptive would it be to sustain permanent hearing loss as a result of listening to loud music?	6.31	0.97	
6. Overall, how disruptive would hearing loss be in your life?	6.34	0.97	
Severity of MIHL Index	5.88	0.97	0.83
Benefits of Preventing MIHL			
1. Making sure I listen to music at safe levels would prevent me from experiencing hearing loss.	5.17	1.58	
2. Turning my music down to a safe level when I'm in a quiet environment would be a good thing for me to do.	6.14	1.19	
3. Turning my music down to a safe level when I'm in a loud environment would be a good thing for me to do.	4.86	1.75	
4. Making sure my music is at a safe level when I'm in a quiet environment would prevent hearing loss.	5.72	1.20	
5. Making sure my music is at a safe level when I'm in a loud environment would prevent hearing loss.	5.21	1.54	
6. Setting my volume limiter at a safe level would be a good thing for me to do.	4.34	1.84	
7. Using special earphones that block out background noise when I listen to music would be a good thing for me to do.	5.00	1.63	
Benefits of Preventing MIHL Index	5.21	1.05	0.81
Barriers to Preventing MIHL			
1. If I turned my music down to a safe level in a loud environment, I wouldn't be able to hear it.	5.24	1.77	
2. If I turned my music down to a safe level in a loud environment, I wouldn't enjoy my music as much.	5.31	1.91	
3. I don't know what level my music should be turned down to in a loud environment to protect my hearing.	4.38	1.61	
4. I don't know what level my music should be turned down to in a quiet environment to protect my hearing.	3.41	1.96	
Barriers to Preventing MIHL Index	4.59	1.47	0.83
Self-Efficacy for Taking Preventative Action			
1. I feel confident in my ability to monitor the volume at which I listen to my music.	5.55	1.40	
2. I feel confident in my ability to make sure I listen to music at a safe level when I'm in a quiet environment.	5.93	1.16	
3. I feel confident in my ability to make sure I listen to music at a safe level when I'm in a loud environment.	5.14	1.55	
4. I feel confident in my ability to set the volume limiter of my MP3 player to a safe level.	5.17	1.61	
5. If I knew I were listening at an unsafe level, I would be willing to turn down the volume.	5.41	1.66	
Self-Efficacy for Taking Preventative Action Index	5.44	1.24	0.89

APPENDIX B: Manufacturer Warnings and Messages

APPLE iPHONE 6: iOS 8.4 Software

Link to Manual:
https://manuals.info.apple.com/MANUALS/1000/MA1565/en_US/iphone_user_guide.pdf

---

Hearing loss: Listening to sound at high volumes may damage your hearing. Background noise, as well as continued exposure to high volume levels, can make sounds seem quieter than they actually are. Turn on audio playback and check the volume before inserting anything in your ear. For more information about hearing loss, see www.apple.com/sound/. For information about how to set a maximum volume limit on iPhone, see Music settings on page 76.

To avoid hearing damage, use only compatible receivers, earbuds, headphones, speakerphones, or earpieces with iPhone. The headsets sold with iPhone 4s or later in China (identifiable by dark insulating rings on the plug) are designed to comply with Chinese standards and are only compatible with iPhone 4s or later, iPad 2 or later, and iPod touch 5th generation.

WARNING: To prevent possible hearing damage, do not listen at high volume levels for long periods.

Safety Warning(s):

How to Set Volume Setting:

Hearing loss: To limit the maximum headset volume to this level, go to Settings > Music > Volume Limit, then turn on EU Volume Limit. To prevent changes to the volume limit, go to Settings > General > Restrictions.

http://40.media.tumblr.com/tumblr_md7mcxnOgt1qea4hso1_400.jpg

Additional Volume Information:

Note: In some European Union (EU) countries, iPhone may warn that you're setting the volume above the EU recommended level for hearing safety. To increase the volume beyond this level, you may need to briefly release the volume control. Note: To prevent changes to the volume limit, go to Settings > General > Restrictions > Volume Limit, then tap Don't Allow Changes.

SAMSUNG GALAXY NOTE 5 and s7: SM-G930F SM-G930FD

Link to Manual:

Note 5

http://downloadcenter.samsung.com/content/UM/201508/20150821044210180/VZW_SM-N920V_Galaxy-Note5_EN_UM_LL_5.1_OGE_FINAL.pdf

S7

http://downloadcenter.samsung.com/content/UM/201602/20160222104408745/SM-G930_UM_EU_Marshmallow_Eng_Rev.1.0_160219.pdf

---

No safety information is included in written manuals

Safety Warning(s):

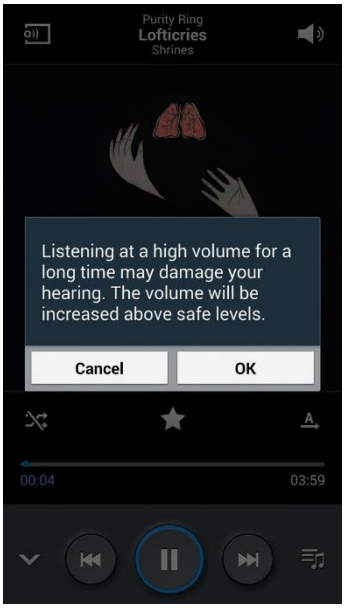
How to Set Volume Setting:

Volume: Adjust the volume level for call ringtones, music and videos, system sounds, and notifications.

Additional Volume Information:

None

Screen messages do appear when volume increase. Response required.



http://img.wonderhowto.com/img/10/73/63533423872161/0/disable-high-volume-warning-when-using-headphones-your-samsung-galaxy-s4.w654.jpg

LG 5:

Link to Manual:

https://support.t-mobile.com/docs/DOC-25561?sr=stream&ru=2028

Caution:
Avoid potential hearing loss.
Prolonged exposure to loud sounds (including music) is the most common cause of preventable hearing loss. Some scientific research suggests that using portable audio devices, such as portable music players and cellular telephones, at high volume settings for long durations may lead to permanent noise-induced hearing loss. This includes the use of headphones (including headsets, earbuds and Bluetooth or other wireless devices). Exposure to very loud sound has also been associated in some studies with tinnitus (a ringing in the ear), hypersensitivity to sound and distorted hearing. Individual susceptibility to noise-induced hearing loss and other potential hearing problems varies.

The amount of sound produced by a portable audio device varies depending on the nature of the sound, the device, the device settings and the headphones. You should follow some commonsense recommendations when using any portable audio device:
• Set the volume in a quiet environment and select the lowest volume at which you can hear adequately.
• When using headphones, turn the volume down if you cannot hear the people speaking near you or if the person sitting next to you can hear what you are listening to.
• Do not turn the volume up to block out noisy surroundings. If you choose to listen to your portable device in a noisy environment, use noise- canceling headphones to block out background environmental noise.
• Limit the amount of time you listen. As the volume increases, less time is required before your hearing could be affected.
• Avoid using headphones after exposure to extremely loud noises, such as rock concerts, that might cause temporary hearing loss. Temporary hearing loss might cause unsafe volumes to sound normal.
• Do not listen at any volume that causes you discomfort. If you experience ringing in your ears, hear muffled speech or experience any temporary hearing difficulty after listening to your portable audio device, discontinue use and consult your doctor.

Safety Warning(s):

How to Set Volume Setting:

NA
``

SAME Operating System Warning
as Galaxy Note and s7 (Android)

Additional Volume Information: NA

MOTOROLA: Droid Razr

Link to Manual:

https://www.motorola.com/moto_care/manuals/RAZR_M_UG_JB.pdf

Caution About High Volume Usage: Warning: Exposure to loud noise from any source for extended periods of time may affect your hearing. The louder the volume sound level, the less time is required before your hearing could be affected. To protect your hearing:

- *Limit the amount of time you use headsets or headphones at high volume.*
- *Avoid turning up the volume to block out noisy surroundings.*
- *Turn the volume down if you can't hear people speaking near you.*

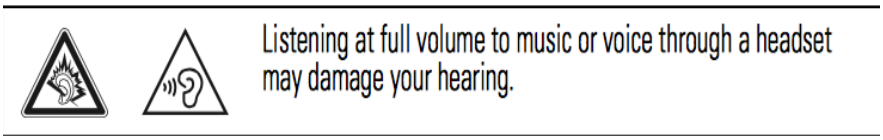
If you experience hearing discomfort, including the sensation of pressure or fullness in your ears, ringing in your ears, or muffled speech, you should stop listening to the device through your headset or headphones and have your hearing checked.
For more information about hearing, see our website at http://direct.motorola.com/hellomoto/nss/AcousticSafety.asp (in English only)

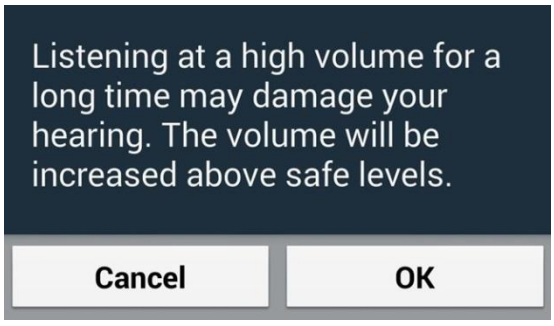
Safety Warning(s):

How to Set Volume Setting:

Additional Volume Information:

Device may use these symbols to warn about high volume limits





http://img.wonderhowto.com/img/10/25/63533437022064/0/disable-high-volume-warning-when-using-headphones-your-samsung-galaxy-s4.w654.jpg

NOKIA: Windows Lumia 830

Link to Manual:

https://images.wirelessdealer.ca/images/phones/userguide3903.pdf

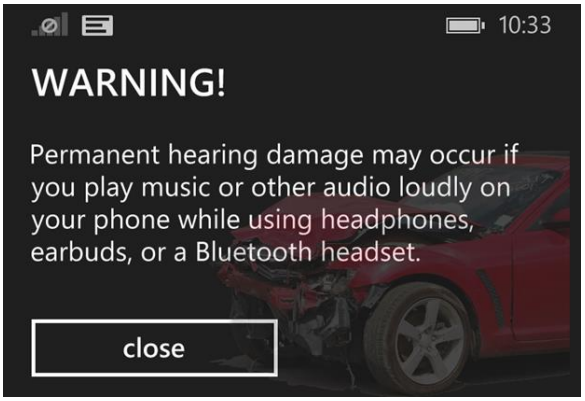
PROTECT YOUR HEARING

To prevent possible hearing damage, do not listen at high volume levels for long periods.

Exercise caution when holding your device near your ear while the speakerphone is in use.

Safety Warning(s):

How to Set Volume Setting:



Additional Volume Information:

Do not connect to products that create an output signal, as this may damage the device. Do not
connect any voltage source to the audio connector. If you connect an external device or headset,
other than those approved for use with this device, to the audio connector, pay special attention to volume levels

http://mspoweruser.com/microsoft-one-day-your-volume-warning-pop-up-will-kill-some-one/

KYOCERA MOBILE: Brigadier

Link to Manual:

https://www.kyoceramobile.com/brigadier/Brigadier-User-Guide_en.pdf

---

"Warning: Because of higher volume levels, do not place the phone near your ear during speakerphone use."

Safety Warning(s):

How to Set Volume Setting: NA

Additional Volume Information: NA

ZTE: Avid 4G

No warning images available specific to these devices. Likely uses Android message.

Link to Manual:

http://images.comparecellular.com/phones/1868/zte-avid-4g-manual.pdf

---

WARNING! *Because of higher volume levels, do not place the phone near your ear during speakerphone use.*
General Safety: Your phone can produce a loud sound.
Loud Noise:
This phone is capable of producing loud noises, which may damage your hearing. Turn down the volume before using headphones, Bluetooth stereo headsets or other audio devices.

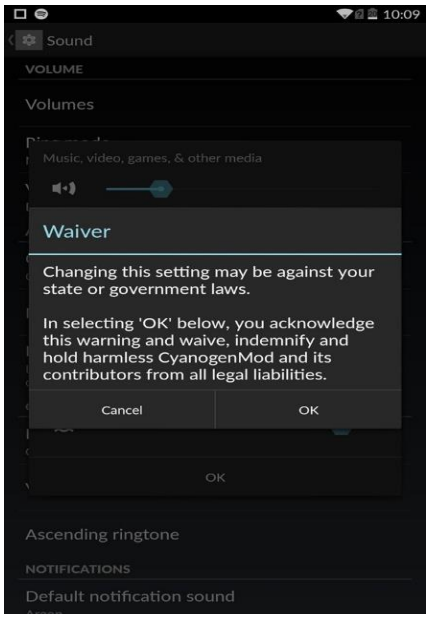
Safety Warning(s):

How to Set Volume Setting: NA

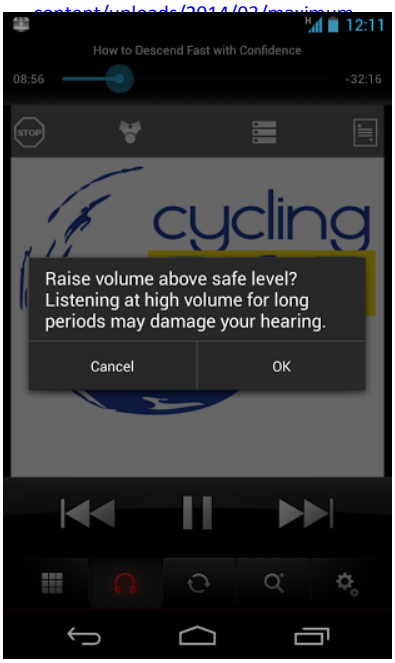
Additional Volume Information: NA

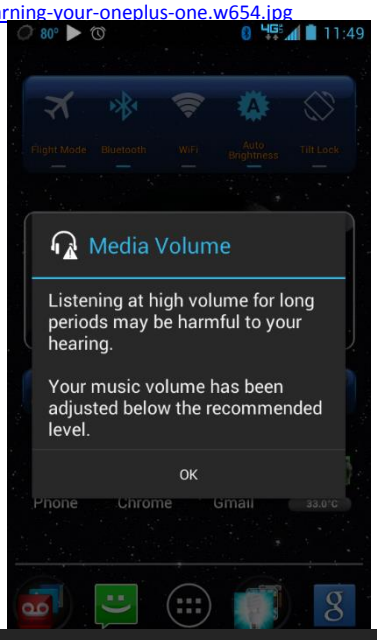
EXAMPLES OF OTHER WARNINGS MESSAGES: Phones and Apps

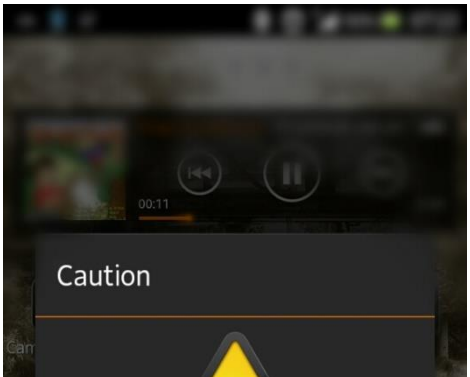
http://i2.wp.com/techverse.net/wp-

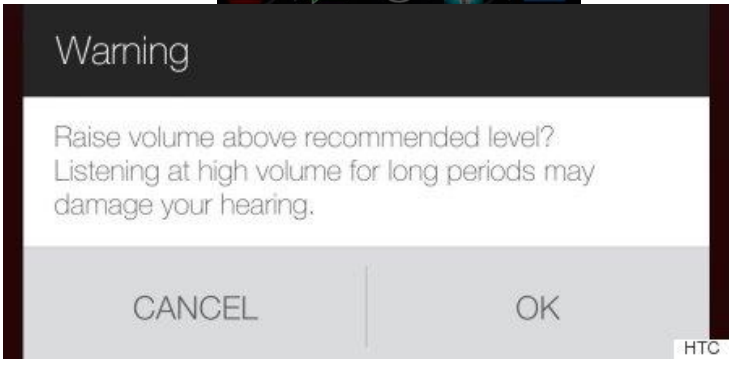


http://img.wonderhowto.com/img/77/28/63554476158553/0/disable-high-volume-warning-your-oneplus-one.w654.jpg









http://www.huffingtonpost.com/2015/03/06/music-

APPENDIX C: Hearing Loss Prevention Efforts Related to Safe-Listening

Note: this is a very cursory listing of general efforts to positively promote safe-listening habits. There is large variability in the extent of the efforts, with most being generally informative in nature and campaign oriented rather than intervention programs based on health communication science. There is an absence of evaluation or effectiveness information for most. When effectiveness has been researched and peer-reviewed, the publications/references are provided. In addition, there may be other resources that are not specifically identified here.

Apple: General information about safe-listening

1. Web link**:** http://www.apple.com/sound/

Beats by Dre: General information about safe-listening

2. Web link**:** https://www.beatsbydre.com/support/info/safe-listening.html

Cheers for Ears: currently inactive and status is under review in 2016

- Organization: Community education program by non-profit Ear Science Institute of Australia
- Web link**:** https://www.earscience.org.au/community/community-programs/cheers-for-ears
- Resources: Hearing conservation training for students 8-12 years, interactive computer game and apps.
- Language: English
- Country: Australia
- Peer-Reviewed Effectiveness Evidence-Base

  Taljaard, D. S., Leishman, N. F., & Eikelboom, R. H. (2013). Personal listening devices and the prevention of noise induced hearing loss in children: The Cheers for Ears Pilot Program. *Noise and Health*, *15*(65), 261.

- Other Publications: (partial)

  http://hearingservices.gov.au/wps/wcm/connect/0973edfb-50ff-4f32-b5bb-a8e23dc27951/cheers-for-ears.docx?MOD=AJPERES

Dangerous Decibels®:

- Organization: Academic partnership; Oregon Health & Science University (U.S.), National University of Singapore (Singapore), University of Northern Colorado (U.S.), University of Auckland (NZ).

- Web link: www.dangerousdecibels.org
- Resources: Online games and activities, 50-minute evidence-based classroom-program for children and small-group worksite program for adults, 2-day educator workshops to train individuals to deliver the 50-minute program, Jolene educational manikin that is used to measure music player output levels as part of community outreach activities (Jolene Cookbook, Jolene Travel Guide), Teacher Resource Guide (supplemental classroom activities), Community-based, multiple intervention program.
- Language: Online games available in French and English.
- Country: Materials in use in 40 countries.
- Peer-Reviewed Effectiveness Evidence-Base:

Martin, W. H., Sobel, J., Griest, S. E., Howarth, L., & Yongbing, S. H. I. (2006). Noise induced hearing loss in children: Preventing the silent epidemic. *Journal of Otology*, *1*(1), 11-21.

Griest, S. E., Folmer, R. L., & Martin, W. H. (2007). Effectiveness of "Dangerous Decibels," a school-based hearing loss prevention program. *American Journal of Audiology*, *16*(2), S165-S181.

Griest, S. (2008, February). Evaluation of a hearing-loss prevention program. In *Seminars in hearing* (Vol. 29, No. 01, pp. 122-136). © Thieme Medical Publishers.

Martin, W. H. (2008, February). Dangerous decibels: partnership for preventing noise-induced hearing loss and tinnitus in children. In *Seminars in Hearing* (Vol. 29, No. 01, pp. 102-110). © Thieme Medical Publishers.

Meinke, D. K., Martin, W. H., Griest, S. E., Howarth, L., Sobel, J. L., & Scarlotta, T. (2008, July). Dangerous Decibels® I: Noise induced hearing loss and tinnitus prevention in children. Noise exposures, epidemiology, detection, interventions and resources. In *Proceedings of the 9th Congress of the International Commission on Biological Effects of Noise-ICBEN* (pp. 62-70).

Martin, W. H., Meinke, D. K., Sobel, J. L., Griest, S. E., & Howarth, L. C. (2008). Dangerous Decibels® II: Critical components for an effective educational program and special considerations for hearing loss prevention devices for children. In *Proceedings of the 9th Congress of the International Commission on Biological Effects of Noise I CBEN* (pp. 91-97).

Martin, W. H., & Martin, G. Y. (2008). Meet Jolene: An inexpensive device for doing public health research and education on personal stereo systems. In *Hearing loss: 9th International Congress on Noise as a Public Health Problem (ICBEN), Foxwoods, CT*.

Howarth, L. C. (2008, February). Coordinating a hearing health education program: challenges and strategies. In *Seminars in Hearing* (Vol. 29, No. 01, pp. 111-121). © Thieme Medical Publishers.

Becker, T., Martin, W., Lambert, W., Griest, S., & Sobel, J. (2011). P1-393 Community based noise induced hearing loss prevention for tribal children. *Journal of Epidemiology and Community Health*, *65* (Suppl 1), A176-A176.

Dell, S. M., & Holmes, A. E. (2012). The effect of a hearing conservation program on adolescents' attitudes towards noise. *Noise and Health*, *14*(56), 39.

Martin, W. H., Griest, S. E., Sobel, J. L., & Howarth, L. C. (2013). Randomized trial of four noise-induced hearing loss and tinnitus prevention interventions for children. *International journal of audiology*, *52*(sup1), S41-S49.

Knobel, K. A. B., & Lima, M. C. P. M. (2014). Effectiveness of the Brazilian version of the Dangerous Decibels® educational program. *International journal of audiology*, *53*(sup2), S35-S42.

Welch, D., Reddy, R., Hand, J., & Devine, I. M. (2016). Educating teenagers about hearing health by training them to educate children. *International journal of audiology*, *55*(9), 499-506.

Reddy, Ravi, David Welch, Shanthi Ameratunga, and Peter Thorne. (2017) "An ecological approach to hearing-health promotion in workplaces." *International journal of audiology*, Published online http://www.tandfonline.com/doi/abs/10.1080/14992027.2016.1271467

- Other Publications: (partial)

Martin, W. H., Griest, S. E., & Howarth, L. C. (2004). Innovations in preventing noise-induced hearing loss and tinnitus. *SIG 6 Perspectives on Hearing and Hearing Disorders: Research and Diagnostics*, *8*(1), 12-15.

Cacace, A. T. (2006). Hearing loss and tinnitus prevention initiatives: Partnerships for success. *American journal of audiology*, *15*(2), 99-100.

Roberts, L. E., Martin, W. H., & Bosnyak, D. J. (2011). The prevention of tinnitus and noise-induced hearing loss. In *Textbook of Tinnitus* (pp. 527-534). Springer New York.

Levey, S., Fligor, B. J., Ginocchi, C., & Kagimbi, L. (2012). The effects of noise-induced hearing loss on children and young adults. *CICSD*, *39*(1), 76-83.

It's a Noisy Planet, Protect Their Hearing

- Organization: U.S. Department of Health and Human Services (DHHS), National Institutes of Health (NIH) National Institute on Deafness and Other Communication Disorders (NIDCD)

- Web link**:** https://www.noisyplanet.nidcd.nih.gov

- Resources: It's a Noisy Planet. Protect Their Hearing® is a national education campaign to raise awareness of the causes and prevention of noise-induced hearing loss, which is caused by damage to sensory structures in the inner ear from exposure to excessive or prolonged noise. The campaign targets children aged 8-12 years, their parents, teachers, health professionals, and other stakeholders. The efforts of this campaign works to address the Healthy People objective around noise-induced hearing loss. Pamphlets, posters, infographics, bookmarks and online resources are available. Messaging is adapted from Dangerous Decibels® program materials.

- Language: English, Spanish
- Country: USA
- Peer-Reviewed Effectiveness Evidence-Base:
- Other Publications:

  Noisy Planet Campaign Evaluation, 2008:

  https://www.noisyplanet.nidcd.nih.gov/about/noisy-planet-campaign-evaluation

Listen to Your Buds

- Organization: American Speech-Language Hearing Association (ASHA), Rockville, MD. U.S.
- Web link: http://www.asha.org/buds/
- Resources: Public service announcements, Information about hearing loss, videos, "Buds in the Schools" concert series,
- Language: English
- Peer-Reviewed Effectiveness Evidence-Base:
- Other Publications:
  - ASHA, 2012. "Listen to Your Buds" Poll Results Summary. http://www.asha.org/uploadedFiles/ASHA/Buds/2012-LTYB-Poll-Results-Summary.pdf
  - Cacace, A. (2006). Hearing loss and tinnitus prevention initiatives: partnerships for success. *American Journal of Audiology*. 15, 99-100. Editorial available at http://xt9lp6eh4r.scholar.serialssolutions.com/?sid=google&auinit=AT&aulast=Cacace&atitle=Hearing+loss+and+tinnitus+prevention+initiatives:+partnerships+for+success&id=doi:10.1044/1059-0889(2006/011)&title=American+journal+of+audiology&volume=15&issue=2&date=2006&spage=99&issn=1059-0889
  - Thomas, M. (2007). Popular technology and hearing loss campaign is a major success. *ASHA Perspectives Sig 8*, Hearing Conservation and Occupational Audiology. 3-4.

Make Listening Safe

- Organization: World Health Organization (WHO), Geneva, Switzerland
- Web link: http://www.who.int/pbd/deafness/activities/MLS/en/
- Resources: Brochures, posters, Tips for Safe Listening
- Language: English, Chinese, Arabic, French, Russian, & Spanish
- Country: International

- Peer-Reviewed Effectiveness Evidence-Base:

- Other Publications:

    - World Health Organization. (2015). Make listening safe. http://apps.who.int/iris/bitstream/10665/177884/1/WHO_NMH_NVI_15.2_eng.pdf?ua=1&ua=1

Samsung:

- Web link: http://www.samsung.com/us/Legal/Phone-HSGuide/

Skull Candy:

- Web link: http://www.skullcandy.com/customer-service/safety/safety.html

Sony:

- Web link: http://docs.esupport.sony.com/voicerecorder/ICDUX532_UX533_UX533F_UX534F_guide/en/contents/TP0000003616.html
-

Sound Sense

- Organization: Hearing Foundation of Canada

- Web link**:** http://soundsense.ca/

- Resources: *Sound Sense: Save Your Hearing for the Music! /Oui à l'ouie: ménagez vos oreilles pour la musique!* Classroom program for 4th – 6th grade. Posters, videos and general information on hearing loss prevention.

- Language: English, French

- Country: Canada

- Peer-Reviewed Effectiveness Evidence-Base:
  Neufeld, A., Westerberg, B. D., Nabi, S., Bryce, G., & Bureau, Y. (2011). Prospective, randomized controlled assessment of the short-and long-term efficacy of a hearing conservation education program in Canadian elementary school children. *The Laryngoscope*, *121*(1), 176-181.

- Other Publications: