

Meet Jolene: An inexpensive device for doing public health research and education on personal stereo systems

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INTRODUCTION

Hearing loss is prevalent among young people to a degree well beyond what one would expect from the normal aging and disease processes (14.9 % of 6 to 19 year olds. Niskar et al. 1998). A substantial portion of youth hearing loss has been attributed to exposure to loud sound (12.5 % of 6 – 19 year olds. Niskar et al. 2001). Children and adolescents are exposed to a wide range of potentially harmful sound sources but lack access to information and strategies that can help them protect themselves from acquiring hearing loss (Folmer 2003, 2008). Extensive noise exposure during development may have far-reaching consequences on hearing abilities later in life (Kujawa & Liberman 2006).

Personal stereo systems are capable of generating sound levels that can readily cause noise-induced hearing loss and tinnitus (Portnuff & Fligor 2006). Surveys of actual listening practices indicate that 12-25 % of personal stereo system users are listening at levels that exceed international safety recommendations on a daily basis (Williams 2005; Martin et al. 2008). The unprecedented availability of up to 40 continuous listening hours and 40,000 songs to choose from (the iPod Classic, 2008) at levels exceeding 100 dBA (Portnuff & Fligor 2006) has also resulted in an unprecedented opportunity for new extremes in personal sound exposure. Apple alone has sold over 120 million iPods as of October 2007 (Associated Press). Volume limiting software is available and vague warnings are posted in packaging materials, but there is little information available to the public on what are safe listening parameters. Williams (2005) reported that approximately 25 % of personal stereo system users studied listened at sound pressure levels and reported durations that exceed NIOSH recommended exposure levels. Young people appear to especially be at risk for excessive sound exposure through devices. Vogel et al. (2008) reported that most adolescents, especially male students from vocational schools, often listened to personal stereo systems at maximum volume, despite awareness that loud sound could cause hearing loss. There are no longitudinal studies of the effects of personal stereo system use and acquired hearing loss, but it is reasonable to expect that continual exposure to music at high levels through these systems will eventually cause permanent NIHL. In light of the probable risk, it is prudent to find creative ways of reaching young people with information that could positively influence their listening behaviors.

Dangerous Decibels[®] is a program intended to decrease the incidence of NIHL and related tinnitus (Griest et al. 2007; Martin et al. 2006b; Martin 2008). Jolene is one of the research and educational components of Dangerous Decibels.

“Jolene” was the brainchild of an undergraduate student during her summer fellowship in the Center for Research on Environmental and Occupational Toxicology at the Oregon Health & Science University (Figure 1). The intention was to create an in-

triguing and inviting device that would attract young people and engage them in discussions and evaluations of their beliefs and practices regarding use of personal stereo systems. A used (and partially broken) mannequin served as the host for a sound level meter that was modified and wired to a silicon, life-like ear on the mannequin's head. Jolene was fashionably attired with clothes and accessories. The sound level meter was calibrated and transfer functions for the outer ear for a music signal were established so results could be compared to established recommended exposure levels (e.g. NIOSH, World Health Organization, Environmental Protection Agency, OSHA). Jolene has made guest appearances at schools, conferences and in public venues and used to educate the public about risks related to personal stereo systems and for research on such exposures.

Jolene was developed as an instrument for hearing loss prevention and education. She has appeared in numerous classrooms, at health fairs and public events, and at several educational conferences. Her popularity has fostered such interest that schools, clinics, Universities and other organizations have requested instruction on how to build a Jolene. In response to those requests, the National Hearing Conservation Association (www.hearingconservation.org) funded the production of the *Jolene Cookbook* (Martin & Martin 2007, 2008) (Figure 2). The Cookbook includes a list of tools and supplies necessary to construct a Jolene and a list of relevant scientific references. The Cookbook can be downloaded for free from the Dangerous Decibels website (www.dangerousdecibels.org).

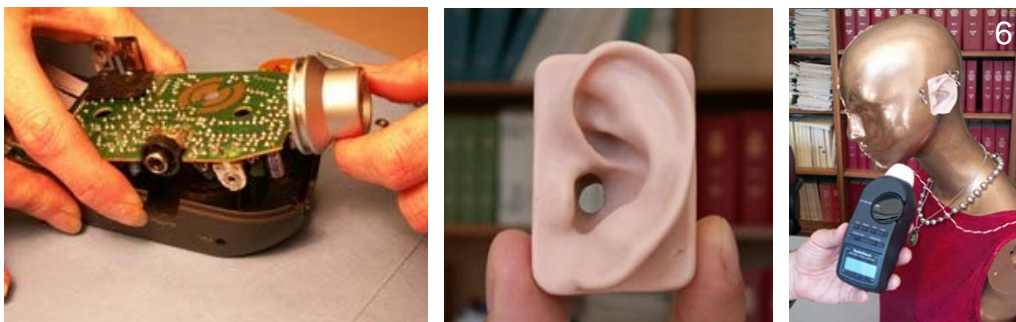


Figures 1 and 2: Jolene (left) and the cover of the *Jolene Cookbook* (right)

METHODS

The production of the first Jolene was exploratory, experimental and full of pitfalls. Most of the steps were documented in photographs. The Cookbook combined those initial images with a second set, shot with the specific intention of being used in a manual.

An outline of each step was prepared, based on the construction of the original Jolene and on the construction of a second version that was made exclusively for the purpose of documenting the process in great detail. Several shots were taken at each step in order to insure the clarity and quality required for someone trying to make one for the first time. The 130 images included were painstakingly cropped, edited resized and in many case retaken. Nearly 1,000 photos were taken in the process (Figures 3-5).



Figures 3-5: Images from the Jolene Cookbook. Dissassembly of a sound level meter (left). Silicon ear with hole to serve a coupler for headphone (center). Sound level meter connected to Jolene (right)

The outline served as the skeleton for both images and for detailed description of each step. The target audience was to be as young as junior high students, but some steps would require adult help. Once the detailed outline was completed, it was reviewed to make sure that the descriptions were adequate for someone trying this for the first time.

A list of every tool, part and supply was compiled with photos of most items. Locations on where to purchase them and approximate prices were also included. The items were assembled in the form of a checklist.

Once the first draft was completed, it was circulated to the Jolene Cookbook Advisory Group for review and suggestions. Following editing of wording and image placement and order, the draft Cookbook was sent to the University of Northern Colorado for a test run. University students in the Audiology doctoral program, having never constructed anything like this before, served as test pilots for the manual. As a group under the guidance of Dr. Deanna Meinke, they built two devices, Günter and Nick, following the Cookbook and documenting any points requiring clarification or modification. Comments and editorial recommendations were adopted into the current version. Günter (Figure 6) resides at the University of Northern Colorado in the Audiology & Speech-Language Sciences program and Nick lives at the National Institute for Occupational Safety and Health (Wakefield et al. 2008).



Figure 6: Jolene and her sibling, Günter, at the National Hearing Conservation Association meeting in Portland, February, 2008

The final addition included instruction on how to calculate a TFOE (transfer function of the outer ear) so that the sound levels measured may be applied to standardized recommendations from regulatory agencies (OSHA, NIOSH, I-INCE, World Health Organization).

RESULTS

Version 1.0 of the *Jolene Cookbook* went online on January 4, 2008. The current Version 1.1a is available online for free. The Cookbook has 39 pages including 130 color images, 10 detailed steps to production, a calibration section and a description of how to calculate a TFOE (transfer function for the outer ear). A table of National Institute for Occupational Safety and Health (NIOSH) recommended exposure limits and list of 35 relevant references on noise-induced hearing loss are included. The base cost to produce a Jolene is roughly \$100. The greatest variable in price relates to the access to a used mannequin and your choice of wardrobe and accessories. Jolene has been useful as an educational outreach and research tool (Martin et al. 2006a, 2008; Martin & Martin 2008). A study using Jolene indicated that 16 % of 14-18 year-olds were using their personal stereo systems at levels and durations that exceed NIOSH recommended exposure levels on a daily basis. However, using Jolene as an educational tool for those identified *at-risk* for NIHL in that study proved helpful. After only a brief encounter with Jolene and her student educator companion, 44 % of those who regularly exceed NIOSH safety levels said that they intended to lower listening volumes on their devices in the future. The Cookbook has been downloaded across the US and in Canada, Japan, Mexico, New Zealand, Portugal, and Saipan. As a result the number of Jolene's siblings is rapidly growing and her family album is on the Dangerous Decibels website.

CONCLUSION

The *Jolene Cookbook* is available for research and outreach education to a wide variety of groups, schools, professional organizations and individuals. This makes an excellent science project for health & science students. Once complete, Jolene can be used as part of a hearing health education program, promoting awareness of risks related to prolonged listening to personal stereo systems at high volumes. She can also be used to help individuals develop a “feel” for what appropriate listening levels should be (Figure 7). Jolene and her siblings each have a unique style created by their fabricators. This personality moves away from production line products and draws curious people wherever she goes. Health communication research indicates that peer or older-peer education is effective at hearing health promotion (Sobel & Meikle 2008). Developed by a young person for young people, she meets an important need in the health communication strategy to promote hearing health in a high-risk age group.



Figure 7: Jolene educating young personal stereo system users about safe listening levels

Jolene also serves as a useful research tool for those studying NIHL related to personal stereo systems. Once calibrated and modified to accommodate a TFOE, values recorded by Jolene are quite comparable to those acquired using much more expensive instrumentation.

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