Is there a preference between Hearing Aids and Personal Sound Amplification Products (PSAPs)?

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Background

- 48 million Americans are estimated to have hearing loss
  - fewer than 20% seek treatment
- On average, people wait 10 years before pursuing hearing aids
- Cost is one of the main reasons why people do not pursue hearing aids
Purpose

- Laboratory comparison of amplification devices at 3 different levels of costs for those with mild to moderate hearing loss.
This study

• Compared the sound preference for different hearing aids and personal sound amplification products (PSAPs)
The FDA (2009) defines

• **Hearing aid**: “any wearable instrument or device designed for, offered for the purpose of, or represented as aiding persons with or compensating for, impaired hearing”

• **Personal Sound Amplification Products (PSAPS)**: “intended to amplify environmental sound for non-hearing impaired consumers. They are not intended to compensate for hearing impairment.”
What are PSAPs?

• Despite the definition from the FDA, they are advertised as…

**Personal Sound™** amplifies hard to hear sounds, reduces background noise and enhances hearing in difficult listening environments. A light 2TAP™ over the device switches to a clear sound.}

**RCA Symphonix™**

Clearly Better Hearing.

RCA Symphonix is designed to help you hear better in all kinds of situations: large groups, crowded streets, office settings, watching TV, or at a restaurant with friends. Symphonix helps you hear what's going on.

Beyond just making sounds louder, the Perfect Choice HD brings sounds in clearer and crisper, making voices easier to understand. Imagine the next time your favorite television show is on, that you’re able to clearly hear what’s being said without having to crank up the volume to unpleasant levels. It's great for restaurants, parties, lectures, sermons, meetings and more!
Choosing the PSAPs

- Cost is one of the biggest reasons why consumers do not purchase a hearing aid
- For the project, we needed PSAPs that were substantially less expensive than a basic hearing aid (at cost)
- PSAPs < $400.00
Hearing Instruments used

Premium A and Basic A

Premium B and Basic B

PSAP 1

PSAP 2
Cost (without services)

- Dentures (mid-range per plate)
- Higher cost PSAP
- Our PSAP
- Basic Hearing Aid
- Premium Hearing Aid

Dollars

0 500 1000 1500
How do we compare these instruments?

- Use pre-recorded stimuli to allow for easy comparison
- Record the output of the hearing instruments on Kemar
- Have the participant listen to the recordings through an ER-2 earphone
- Stimuli presented in one ear, while the other ear was plugged with an earplug
- Create and score via double round robin tournament
Why use pre-recordings?

- **Pros**
  - Participants blinded to products
  - Allows paired comparison method
  - Standardization

- **Cons**
  - No real-ear fitting
What stimuli should we present?

- Typical sounds that occur in daily life
  - Conversation in quiet 🎤
  - Everyday Noises 🎤
  - Music 🎵
Research Questions

1. Is there a preference for amplified sounds from different levels of hearing aid technology; premium hearing aids, basic hearing aids, or PSAPs?
2. Is the same trend clear for the three listening conditions; conversation, environmental sounds, and music?
Participants

- 20 participants ranging in age from 26-83
- “Mild to moderate” hearing loss
- Each participant awarded a $10 Kroger gift card

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<thead>
<tr>
<th>4 FAHL</th>
<th>Slope dB per octave</th>
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<td>0-40</td>
<td>6 dB or greater</td>
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<tr>
<td>40-60</td>
<td>6-10 dB</td>
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How were these audiograms chosen?

- HARL database- categorized audiograms for their 4FAHL and slope
- “PSAP candidates” we defined as those individuals who might be on the fence about whether or not they needed hearing aids, and might try a PSAP as a “starter” hearing aid.
- Averaged these thresholds and obtained:

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<th>Frequency (Hz)</th>
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Audiograms of the participants
The audiogram was entered into the Verifit’s Speechmapping program, with these settings:

- Instrument – BTE (used closed domes)
- Mode - On ear
- Adult
- Insert + Foam
- Targets - NAL-NL2
- Binaural - No
Fittings: Hearing Aid Programming

- The fitting audiogram was entered.

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- “Real-ear” measurements were performed on KEMAR’s left ear
- Programmed to best match targets for 70 and 55 dB SPL inputs, and to approach MPO targets without exceeding them.
Fittings: performed on KEMAR
**Advanced A**

**Advanced B**

**On KEMAR's Ear**
**On KEMAR’s Ear**
PSAP 1  
(volume in high)

PSAP 2  
(default setting)

**On KEMAR’s Ear**
Making the recordings

• Kemar wore a hearing instrument on his left ear
• Recorded speech and music were presented from a loud speaker at 0 degrees azimuth
• Everyday sounds were presented live by researcher at 0 degrees azimuth
• Recordings were performed in a sound treated booth
• Amplified sound at Kemar’s simulated eardrum was digitally recorded
Procedure (1) - Collecting the data

- 3 double round robin tournaments per participant: music, conversation, and everyday noises
- Each ‘tournament’ was randomized using a double round robin tournament generator software.
- Each ‘tournament’ was counterbalanced in regard to order
- Printouts of tournament order were used as scoring sheets
What the participant saw

Confidence Scale
1. Very sure
2. Slightly sure
3. Slightly unsure
4. Very unsure
Procedure (2)

- The participant was seated in a sound treated booth facing the monitor, keyboard, and confidence scale.
- An earphone was placed in one ear, while the other ear was plugged with an ear plug.
- Participant verbally responded with their answer, I recorded answer on printout score sheet.
Interface

Push red key to stop when you have decided
Points verbally covered and explained

- Two recordings to listen to, recording A and recording B.
- Decide which recording you would prefer for long term listening in daily life.
- You have the ability to flip between each recording.
- Use the confidence scale in front of you. For example, if you preferred A over B and you were reasonably certain, you would say A2. If you were very unsure you would say A4.
- You may take as little or as much time needed to make your decision.
Instructions

• **Music/Conversation:**
  ▫ First I am going to play A all the way through so you know what to expect to hear for the music/conversation recording. After it is over, you may begin the comparison.
  ▫ Remember you can switch back and forth as many times as you like, it is recommended to wait about 5 seconds before switching back and forth.

• **Everyday noises:**
  ▫ You are going to hear some everyday noises
  ▫ This time I will have you listen to each recording until the end before switching to the next recording.
  ▫ It will be your job to tell me which one you would prefer for long term listening.
Double Round Robin Tournament

[Diagram showing a sequence of matches between players A and B, with P1 and P2.]
Scoring

- 3 points for a win
- 1 point each for a tie (rating of 4)
Statistics

1. A general linear model ANOVA was run for each stimulus to compare the 6 mean scores

2. A priori planned contrasts
   - Hearing aids vs PSAPs
   - Advanced hearing aids vs Basic hearing aids
   - Basic hearing aid vs PSAP
Results: Conversation in Quiet

Average overall point score

Listening Condition

- Adv. A
- Adv. B
- Basic A
- Basic B
- PSAP 1
- PSAP 2
Results Conversation in Quiet

- Main effect of instruments was significant (p=.012)
  - Hearing aids vs PSAPs (p=.014)
  - Advanced hearing aids vs Basic hearing aids (p=.219)
  - Basic hearing aid vs PSAP (p=.007)
Results: Everyday noises

![Bar graph showing average overall point score by listening condition]

- **Adv. A**
- **Adv. B**
- **Basic A**
- **Basic B**
- **PSAP 1**
- **PSAP 2**
Results: Everyday noises

- Main effect of instruments was significant ($p=0.015$)
  - Hearing aids vs PSAPs ($p=0.747$)
  - Advanced hearing aids vs Basic hearing aids ($p=0.782$)
  - Basic hearing aid vs PSAP ($p=0.706$)
Results: Music

Average overall point score

Listening Condition

- Adv. A
- Adv. B
- Basic A
- Basic B
- PSAP 1
- PSAP 2
Results: Music

- There was no significant difference across the 6 instruments. ($p=.195$)
  - Hearing aids vs PSAPs ($p=.95$)
  - Advanced hearing aids vs Basic hearing aids ($p=.714$)
  - Basic hearing aid vs PSAP ($p=.966$)
Summary

• **Conversation:** Hearing aids received a significantly better rating than PSAPs. Basic hearing aids received a significantly better rating then PSAPs. No significant difference was observed between premium and basic hearing aids.

• **Everyday noises:** No significant difference between hearing aids versus PSAPs, premium versus basic hearing aids, or basic hearing aids versus PSAPs in spite of the significant main effect.

• **Music:** There was no significant differences among the instruments.
Points to consider:

- PSAPs performed as well as hearing ads in the music and everyday noises tournaments.
- Hearing aids performed better than PSAPs in the conversation tournament.
- PSAPs are becoming more widely known:
  - Estimated 1.2 million PSAP users and 300,000 direct-mail users in the US (Strom 2010)
- Higher cost PSAPs advertised as having more advanced technology.
Research Questions

1. Is there a preference for amplified sounds from different levels of hearing aid technology; premium hearing aids, basic hearing aids, or PSAPs?
   - Speech: Yes
   - Everyday Noises: No
   - Music: No

2. Is the same trend clear for the three listening conditions; conversation, environmental sounds, and music?
   - No
Limitations of the Study:

- The devices were fit to an average hearing loss, some under-amplifying and over-amplifying may have occurred.
- Only 2 hearing aid and 2 PSAP manufacturers were used.
- Performed in the lab – no evaluation of performance in the real world.
- Only 20 subjects were used.
- Directional microphone technology was not measured due to lack of ambient noise from behind.
- Feedback/occlusion might be a problem in real ear fitting when devices are fitted without a fully closed ear mold.
Acknowledgements

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