Hearing Loss and Emotions

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Disclosures

- **Lori Rakita, Au.D.**

  Lori Rakita is a research audiologist at Phonak. Lori has managed a significant program of research including extensive technical assessments to participant testing to improve the application, evidence basis and clinical support of Phonak products. Lori received her Bachelor of Science in Psychology from the University of Wisconsin-Madison and Doctorate of Audiology from Washington University, St. Louis.

  - Financial-Phonak employee who receives a salary for employment
  - Nonfinancial-No relevant nonfinancial relationships exists

Presented in partnership with
Learner Objectives

- Participants will understand currently existing data on the topic of emotions and hearing loss
- Participants will be able to better counsel patients and their families on the impact of hearing loss and emotions
- Participants will learn research tests used to assess emotional constructs
Who Cares?
Emotional Intelligence is Important for Well-Being

Cognition

Happiness

Relationships

Health

Hearing Loss

Isolation increases risk of depression and cardiovascular disease
How Hearing Loss and Age Affect Emotional Responses to Nonspeech Sounds

International Affective Digitized Sounds (IADS)


Research Purpose

Arousal  Valence  Dominance

What are the effects of acquired hearing loss and age on emotional ratings?
Methods

Effect of Age
Younger, Normal Hearing
Older Normal Hearing
Older Hearing Loss
Effect of HL

Outcome Measure:

IADS
Presented at a soft/loud level
Group A: 35 and 65 dB SPL
Group B: 50 and 80 dB SPL

Results

Findings:
- Older listeners with hearing loss, lower ratings than peers with normal hearing
- Listeners with HL exhibited a reduced range of valence in responses
The relationship between emotional responses to sound and social function

Erin Picou, Gabrielle Buono 2017. Vanderbilt University Medical Center.

Research Questions

If listeners do not perceive pleasant sounds as pleasant, are they less likely to engage socially?

Is there a relationship between lab measures of emotional responses to sound and social connectedness?

International Affective Digitized Sounds (IADS)
Perceived Disconnectedness and Social Isolation Scales
Hospital Anxiety and Depression Scale
Results

Figure 4. Significant relationships between disconnectedness or isolation and average rating of valence for pleasant stimuli ($p < 0.01; n = 83$).

Reduced “Valence” Range

[Graph showing valence ratings against PTA (dB) with different conditions plotted.]
What Does This Mean?

People with more hearing loss experienced a reduced “dynamic range of emotions”

This occurs particularly at higher sound input levels

Correlates with social isolation

Role of Hearing Aids?
Perception of Emotional Speech by Listeners with Hearing Aids


Toronto Emotions Speech Set (TESS)

7 emotions (x 7 times x 3 conditions) = 147 trials
+ 49 practice trials

Happy, Pleasant Surprise, Neutral, Sad, Disgust, Angry, Fear
Confusions made by HL listeners, when unaided…

<table>
<thead>
<tr>
<th>HA, unaided</th>
<th>RESPONSE</th>
<th>angry</th>
<th>disgust</th>
<th>fear</th>
<th>happy</th>
<th>neutral</th>
<th>ps</th>
<th>sad</th>
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<tbody>
<tr>
<td>TRUE</td>
<td>angry</td>
<td>28</td>
<td>11</td>
<td>4</td>
<td>6</td>
<td>40</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>disgust</td>
<td>5</td>
<td>25</td>
<td>5</td>
<td>10</td>
<td>41</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>fear</td>
<td>3</td>
<td>28</td>
<td>28</td>
<td>10</td>
<td>30</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>happy</td>
<td>2</td>
<td>7</td>
<td>6</td>
<td>30</td>
<td>32</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>neutral</td>
<td>8</td>
<td>14</td>
<td>16</td>
<td>1</td>
<td>37</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>ps</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>44</td>
<td>5</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>sad</td>
<td>0</td>
<td>10</td>
<td>15</td>
<td>0</td>
<td>19</td>
<td>1</td>
<td>55</td>
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<td></td>
<td>total</td>
<td>47</td>
<td>73</td>
<td>75</td>
<td>117</td>
<td>184</td>
<td>120</td>
<td>84</td>
</tr>
</tbody>
</table>

Perception of Emotional Speech by Listeners with Hearing Aids

Questions asked by Goy et. al (2016):
1. How well do older adults with hearing loss recognize emotional affect?
2. Are hearing aids beneficial?

Task:
Toronto Emotional Speech Set (TESS)
“Say the word learn”

Research question

Comparing within original recordings:
What acoustic properties are different between emotions?
What acoustic properties are listeners using to identify emotion in speech?
Comparing emotions (original recordings)

Combination of acoustic properties

Linear discriminant analysis:
Three measures of F0 mean, F0 SD and Spectral centre-of-gravity can correctly classify 96% of 1176 emotional speech tokens.
Hearing aid processing

- Less intensity variation with NAL fast amplitude compression

Hearing aid processing

- More high frequency energy with NAL fitting
Remaining Questions

Understanding the role of hearing aids in emotion recognition

» Question of audibility → Personal hearing aids
» Emotion recognition as a cognitive vs. peripheral issue
» Mixed effect of hearing aids?
Research Question

Do we get a different result than Goy et. al (2016) with hearing aid fittings that are verified?

Can we do anything to the hearing aid processing to make emotion recognition better?

Normal Hearing Group

Performance by Emotion

<table>
<thead>
<tr>
<th>Emotion</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happy</td>
<td>96%</td>
</tr>
<tr>
<td>Surprise</td>
<td>83%</td>
</tr>
<tr>
<td>Neutral</td>
<td>88%</td>
</tr>
<tr>
<td>Sad</td>
<td>99%</td>
</tr>
<tr>
<td>Disgust</td>
<td>78%</td>
</tr>
<tr>
<td>Anger</td>
<td>96%</td>
</tr>
<tr>
<td>Fear</td>
<td>92%</td>
</tr>
</tbody>
</table>

Average = 90%

» Best performance: Sad
» Worst performance: Disgust

Presented in partnership with
Experimental Group

Moderate Hearing Loss

- N = 17
- Average Age = 67
Performance x Emotion

Unaided Comparisons (Moderate/Normal averaged across all conditions)

Averages
Normal: 86%
Moderate: 67%

** = p < 0.01
## What Mistakes do Normal Hearing Listeners Make?

### Presented Emotion

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Happy</td>
<td>78%</td>
<td>6%</td>
<td>0%</td>
<td>0%</td>
<td>10%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>6. Surprise</td>
<td>14%</td>
<td>76%</td>
<td>0%</td>
<td>0%</td>
<td>10%</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>5. Neutral</td>
<td>8%</td>
<td>10%</td>
<td>71%</td>
<td>0%</td>
<td>26%</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>4. Sad</td>
<td>0%</td>
<td>0%</td>
<td>20%</td>
<td>98%</td>
<td>1%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>3. Disgust</td>
<td>0%</td>
<td>8%</td>
<td>8%</td>
<td>2%</td>
<td>50%</td>
<td>12%</td>
<td>0%</td>
</tr>
<tr>
<td>2. Anger</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>3%</td>
<td>80%</td>
<td>0%</td>
</tr>
<tr>
<td>1. Fear</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>93%</td>
</tr>
</tbody>
</table>

## What Mistakes do Moderate Hearing Loss Listeners Make?

### Correct Answer

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>7. Happy</td>
<td>59%</td>
<td>13%</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td>6. Surprise</td>
<td>13%</td>
<td>63%</td>
<td>0%</td>
<td>0%</td>
<td>4%</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td>5. Neutral</td>
<td>13%</td>
<td>8%</td>
<td>59%</td>
<td>5%</td>
<td>30%</td>
<td>10%</td>
<td>6%</td>
</tr>
<tr>
<td>4. Sad</td>
<td>6%</td>
<td>7%</td>
<td>30%</td>
<td>91%</td>
<td>4%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>3. Disgust</td>
<td>4%</td>
<td>8%</td>
<td>7%</td>
<td>3%</td>
<td>57%</td>
<td>14%</td>
<td>1%</td>
</tr>
<tr>
<td>2. Anger</td>
<td>4%</td>
<td>0%</td>
<td>1%</td>
<td>0%</td>
<td>2%</td>
<td>75%</td>
<td>9%</td>
</tr>
<tr>
<td>1. Fear</td>
<td>0%</td>
<td>1%</td>
<td>3%</td>
<td>1%</td>
<td>1%</td>
<td>0%</td>
<td>67%</td>
</tr>
</tbody>
</table>
Combination of acoustic properties

Linear discriminant analysis:
Three measures of F0 mean, F0 SD and Spectral centre-of-gravity can correctly classify 96% of 1176 emotional speech tokens.

Listening Conditions

**“Processed Condition”**
- All currently available sound cleaning on
- Frequency Lowering “on”
- Prescribed compression (WDRC)

**“Unprocessed Condition”**
- All adaptive sound cleaning features off
- Frequency-lowering “off”
- Linear amplification
Average Performance – Normal Hearing

N.S.

![Average Performance – Normal Hearing Graph](image)

- Avg = 82%
- Pilot Avg → 90%

Average Performance – Moderate Hearing Loss

No S.D.

![Average Performance – Moderate Hearing Loss Graph](image)
Age Effect

Scatterplot of Avg Score against Age

Spreadsheet31 in Workbook5 10y 17c

Age: Avg Score: $r = -0.6686$, $p = 0.0172$, $R^2 = 0.3233$

Avg Score = 1.3687 - 0.0104*x

Can we make hearing aids better?

Presented in partnership with

continued
Interesting Cases

Are Participants Using Acoustic Cues (Pitch/Temporal)?

- Lifelong musician
- Conductor of a local orchestra
- Plays multiple instruments
Is Audibility a Factor?

- Normal Hearing (35 dB or better across all frequencies from 250 – 8000 Hz, AU)

![Bar chart showing percent correct for different groups.]

Does Duration of Hearing Loss Make a Difference? (Or HL since childhood)

- HL since 6-7 y.o.
- Inconsistent HA use
- HL for 25 years

![Bar chart showing percent correct for different groups.]
Summary and Remaining Questions

- Hearing loss and age impact emotion recognition ability
- Emotion recognition seems to reflect higher level cognitive abilities that remain unaffected by hearing aid processing
- Hearing aids neither help nor hinder emotion recognition ability
- Audibility does not appear to be a confounding factor

Remaining Questions:
- Validity of TESS for measuring emotion recognition ability?
- Can anything be done with hearing aids to improve this skill?

Next steps?
Research Questions

1. Is there a relationship between emotion “recognition” performance, and experienced emotional range?
2. How do hearing aids impact emotional range?
3. How closely do we approximate emotional range in the lab as compared to the real world?
Visit 1 Outcome Measures

LSNS (Lubben Social Network Scale)
- Developed by Lubben and Girona (2004) – Boston College
- Brief instrument to gauge social isolation in older adults
- Perceived social support received by family and friends
- 12 items, Max = 60

| FAMILY: Considering the people to whom you are related by birth, marriage, adoption, etc...
| 1. How many relatives do you see or hear from at least once a month?
| 0 = none | 1 = one | 2 = two | 3 = three or four | 4 = five to eight | 5 = nine or more
| 2. How many relatives do you feel at ease with that you can talk about private matters?
| 0 = none | 1 = one | 2 = two | 3 = three or four | 4 = five to eight | 5 = nine or more
| 3. How many relatives do you feel close to such that you could call on them for help?
| 0 = none | 1 = one | 2 = two | 3 = three or four | 4 = five to eight | 5 = nine or more

N = 3

Visit 1: Outcome Measures

TEIQue (Trait Emotional Intelligence Questionnaire)
- Developed at London Psychometric Laboratory
- Measure based on trait EI providing assessment of the emotional world of the individual
- 153 items, 15 facets- Score of 1 to 7 on each item

Adaptability
Assertiveness
Emotion perception (self and others)
Emotional expression
Emotion management (others)
Emotion regulation
Impulsiveness (me)
Relationships
Self-esteem
Self-efficacy
Social awareness
Stress management
Trait empathy
Trait happiness
Trait optimism

N = 3
Visit 2 – Lab Measures

Outcome Measures

- IADS (Emotional Range)
- TESS (Emotion Recognition)

- Impact of hearing aids on emotional range
- Relationship between these two measures
- Relationship between subjective measures of social interaction and these measures
Visit 3 – Ecological Momentary Assessment

Next Steps

- In-Situ questionnaire
- 8 “momentary” assessments (random)
- Retrospective (end of each day, end of week)

Rating of 1-9 of pleasantness

Analysis of NFE over home trial

- How do you rate the pleasantness of the soundscape? Unpleasant – Pleasant
- How do you rate the loudness of the soundscape? Very Loud – Not loud
- How do you rate the familiarity of the soundscape? Unfamiliar- familiar
- What is the predominant sound source in the soundscape? Free-format response
- How much attention did you pay to the soundscape before being prompted? Not at all- very much
- Please describe your mood! Bad- Good
- What are you doing at the moment? Free-format
- I am currently... At home/ at work/ on the way somewhere/ at other (inside) / at other (outside)
- I am... Alone/around others (not interacting)/ interacting with others

- What types of environments do people enter?
- Do the range of valence ratings reflect lab measurements?
- How does the timing of the measurement impact the outcome?
**Conclusions**

- Hearing loss seems to correspond with lower ratings of “pleasantness” than normal hearing individuals.
- Individuals with hearing loss seem to have a more limited “range” of emotions in regards to non-speech stimuli as compared to normal hearing individuals.
- This limited range seems to correlate with greater feelings of social isolation or disconnectedness.
- We are investigating if this result is consistent with hearing aids, or if hearing aids help/harm.
- Individuals with hearing loss seem to have more difficulty recognizing emotions, even with hearing aids.

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**Take-aways**

- As hearing healthcare providers…
  - We must be aware of these potential difficulties so we can better understand and serve our patient populations.
  - We must convey these difficulties to families, to facilitate a better understanding of a more “holistic” effect of hearing loss and better conversations.

- As hearing aid manufacturers…
  - We must take these findings into consideration with up and coming technologies.
  - Looking into what can be done with hearing aid processing to help in these domains.
Thank you