

# ANL: A Tool for Predicting Hearing Aid Success

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## Introduction

- ▶ Poor understanding of why individuals utilize hearing aids differently
- ▶ Lack of reliable, objective predictors of hearing aid use
- ▶ Background noise complicates hearing aid use
- ▶ The willingness to listen in noise may be more indicative of hearing aid use than speech understanding

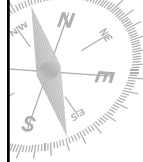
## Introduction

- ▶ Nabelek, Tucker, and Letowski (1991) developed a procedure to quantify the amount of background noise a listener is willing to accept while listening to speech.



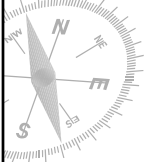
## Measurement of ANL

- ▶ Sound-treated room
- ▶ Loudspeaker
- ▶ Instructions
- ▶ Stimuli



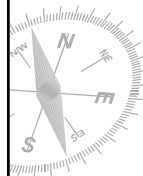
## Stimuli

- ▶ Primary discourse – Arizona Travelogue (Cosmos, Inc.)
- ▶ Noise – 12-talker babble (R-SPIN)



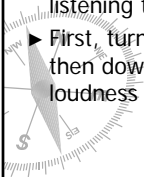
## Quantifying ANL

- ▶ Most Comfortable Level (MCL)
- ▶ Background Noise Level (BNL)



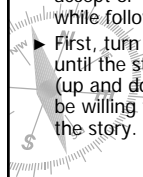
## Instructions for MCL

- ▶ You will listen to a story through a loudspeaker. After a few moments, select the loudness of the story that is most comfortable for you, as if listening to a radio.
- ▶ First, turn the loudness up until it is too loud and then down until it is too soft. Finally, select the loudness level that is most comfortable for you.



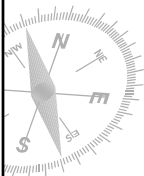
## Instructions for BNL

- ▶ You will listen to the same story with background noise of several people talking at the same time. After you have listened to this for a few moments select the level of background noise that is the MOST you would be willing to accept or "put-up-with" without becoming tense and tired while following the story.
- ▶ First, turn the noise up until it is too loud and then down until the story becomes very clear. Finally, adjust the noise (up and down) to the MAXIMUM noise level that you would be willing to "put-up-with" for a long time while following the story.



## ANL Demo

- ▶ MCL
- ▶ BNL



## Calculation of ANL

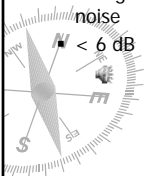
- ▶ ANL is then calculated by subtracting BNL from MCL.
- ▶  $ANL = MCL - BNL$



Listener 1	Listener 2
MCL 60	MCL 60
<u>BNL -50</u>	<u>BNL -58</u>
ANL 10	ANL 2

## Comparison of ANLs

- ▶ Low ANL
  - greater acceptance of background noise
- ▶ Medium ANL
  - Nabelek et al. (2006)
  - 10 dB
- ▶ High ANL
  - less acceptance of background noise
  - > 14 dB

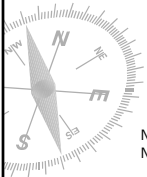


## ANL – Research Overview



## ANL and Hearing Sensitivity

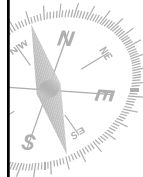
- ▶ There appears to be no relationship between ANL and hearing sensitivity



Nabelek et al., 1991  
Nabelek, Freyaldenhoven, Tampas, Burchfield, & Muenchen, 2006

## ANL and Speech Recognition in Noise Scores

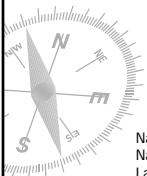
- ▶ ANL does not appear to be related to R-SPIN scores



Nabelek et al., 2004  
Nabelek et al., 2006

## ANL and Age

- ▶ Age does not appear to be a factor for ANL



Nabelek et al., 1991  
Nabelek et al., 2006  
Lambeth, Moore, & Gordon-Hickey, in preparation

## ANL and Gender

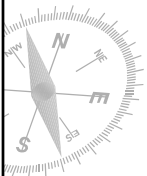
- ▶ There appears to be no ANL differences between females and males
  - Females: MCL = 36.2; BNL = 24.8; ANL = 11.4
  - Males: MCL = 42.1; BNL = 31.7; ANL = 10.4



Rogers, Harkrider, Burchfield, & Nabelek, 2003

## ANL and Type of Background Noise

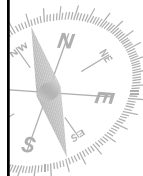
- ▶ ANLs are similar regardless of the background noise used (well not exactly)



Nabelek et al., 1991  
Gordon-Hickey & Moore, 2007  
Gordon-Hickey, 2007

## ANL and Middle Ear and MOCB Function

- ▶ ANL appears to be unrelated to both



Harkrider & Smith, 2005

## ANL and Evoked Potentials

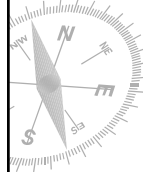
- ▶ ANLs appeared to be related to evoked potentials measured from more central regions of the central auditory system



Tampas & Harkrider, 2006

## ANL and Stimulant Medication

- ▶ Stimulant medication appears to improve ANLs in individuals with ADHD/ADD



Freyaldenhoven, Thelin, Plyler, Nabelek, & Burchfield, 2005

## Reliability of ANL Measures

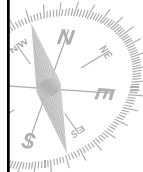
- ▶ ANL appears to be reliable over a 3 week period for individuals with normal hearing and over a 3 month period for individuals with hearing loss



Freyaldenhoven, Smiley, Muenchen, & Konrad, 2006  
Nabelek et al., 2006

## ANL and Primary Discourse Presentation Level

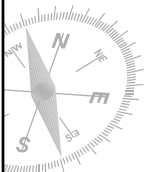
- ▶ ANL appears to be related to the presentation level of the primary signal



Franklin, Thelin, Nabelek, & Burchfield, 2006  
Freyaldenhoven, Plyler, Thelin, & Hedrick, 2007

## ANL and Intelligibility of Primary Discourse

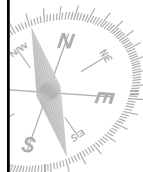
- ▶ ANL may be related to the intelligibility of the primary discourse



Gordon-Hickey & Moore, in review

## ANL and Hearing Aids

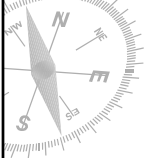
- ▶ ANL may be useful for measuring benefit of directional microphones and digital technology



Freyaldenhoven, Nabelek, Burchfield, & Thelin, 2005  
Mueller, Weber, & Hornsby, 2006

## Relationship Between ANL and Hearing Aid Use

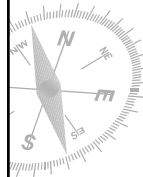
- ▶ Full-time users – mean ANL = 7.5 dB
- ▶ Part-time users – mean ANL = 14.0 dB
- ▶ Nonusers – mean ANL = 14.5 dB



Nabelek et al., 1991

## Relationship Between ANL and Hearing Aid Use

- ▶ The relationship between ANL and several other subjective variables



Crowley, 1994

## Relationship Between ANL and Hearing Aid Use

- ▶ First evidence that ANLs might be able to predict hearing aid outcome



Crowley & Nabelek, 1996

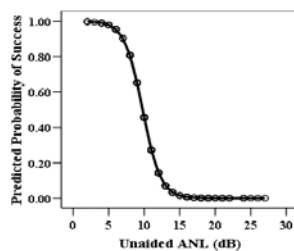
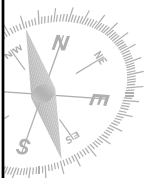
## Relationship Between ANL and Hearing Aid Use

- ▶ Effort to predict hearing aid use using ANL alone

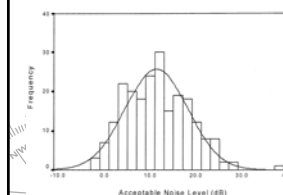


Nabelek et al., 2004  
Nabelek et al., 2006

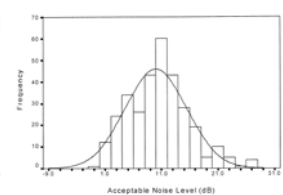
## ANL Regression Model



## ANL Distribution



221 listeners with normal hearing



315 listeners with impaired hearing

## Future Directions of ANL

- ▶ Audiological Rehabilitation
- ▶ Pharmacological intervention
- ▶ Longitudinal studies

