Automatic Hearing Aid Classification Systems

Lori Rakita, Au.D.

Phonak Audiology Research Center

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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*

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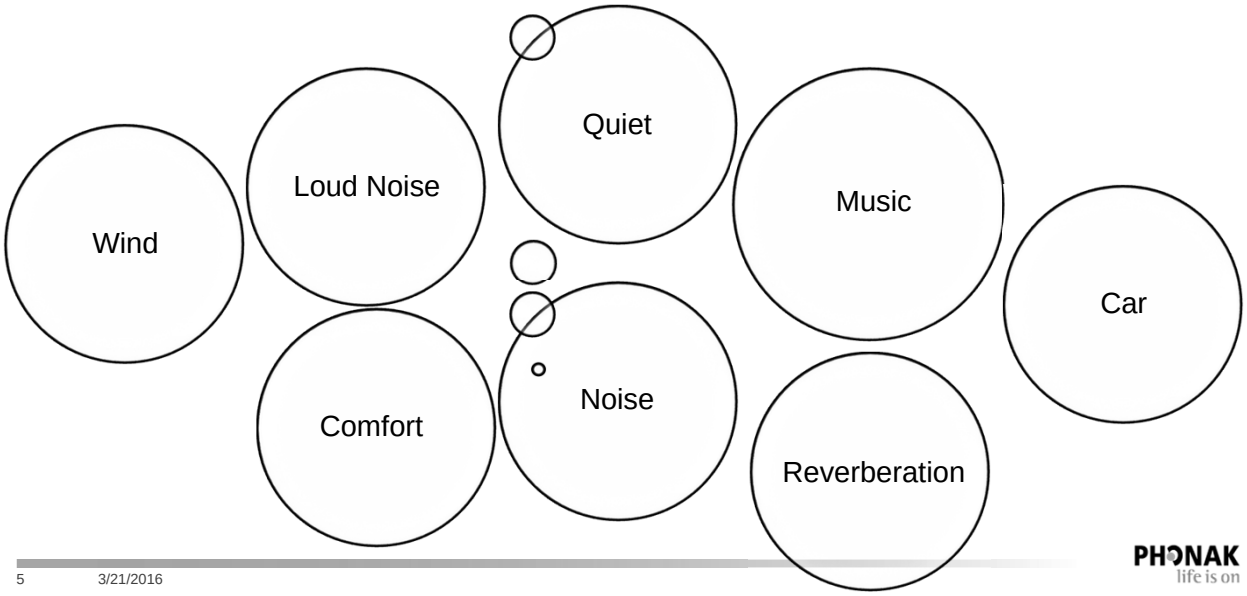
Learner Objectives

- Participants will be able to discuss the impact of manual vs automatic program changes on patient outcomes
- Participants will gain an understanding of automatic hearing aid technology capabilities and classification
- Participants will be able to discuss and apply the results of the discussed studies in their clinical practice

Increased Hearing Aid Complexity



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A Need for An Automatic Program:
A "Noise" program is not going to cut it!

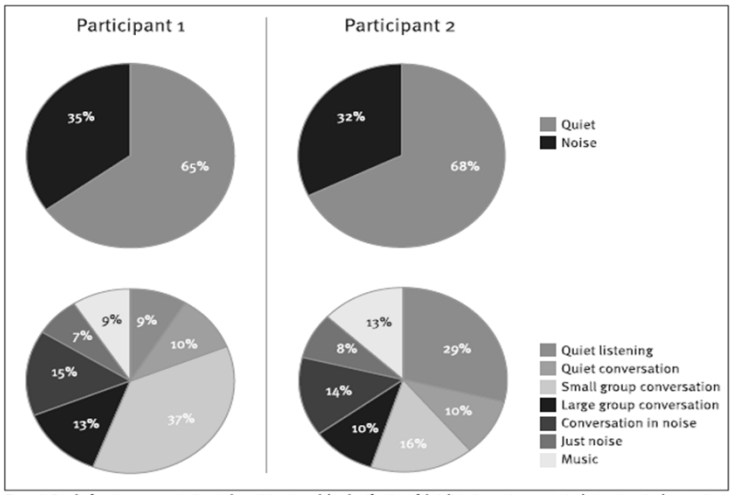

Figure 1. Results from two representative study participants and the classification of their listening environments. In the top two pie charts, using a 2-destination (quiet or noise) paradigm to classify their listening environments, one could be led to believe that they encounter very similar listening environments and have very similar listening needs. However, a more granular 7-item categorization of the listening environments (bottom two pie charts) reveals important differences for these two individuals.

Hearing aids can have up to 8 different hearing aid program types

The Hearing Review: Does Current Hearing Aid Technology Meet the Needs of Healthy Aging? February 2015

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A Need for An Automatic Program: People don't WANT to switch their hearing aid program/volume

Reason #10 individuals are not wearing hearing aids: Volume control adjustments

MarketTrak V February 2000. Vol 53. No. 2

Rank	Stated reason for not wearing hearing aids	Number of mentions	Percent of respondents	Estimated number of hearing aid owners
1	Poor benefit from hearing aids	103	29.6%	268,510
2	Background noise/noisy situations	88	25.3%	229,407
3	Fit & comfort	65	18.7%	169,448
4	Negative side effects of H.A.	38	10.9%	99,062
5	Price & cost of repairs	36	10.3%	93,848
6	Don't need help	28	8.0%	72,993
7	Hearing aid is broken	27	7.8%	70,386
8	Sound quality is poor	22	6.3%	57,352
9	Unspecified - do not wear	21	6.0%	54,745
10	Volume control adjustment	17	4.9%	44,317
11	Whistling and feedback	15	4.3%	39,103
12	Nuisance/hassle/annoying	14	4.0%	36,497
13	Poor service from dispenser	11	3.2%	28,676
14	High-frequency loss not helped	10	2.9%	26,069
15	Stigma of wearing hearing aids	10	2.9%	26,069

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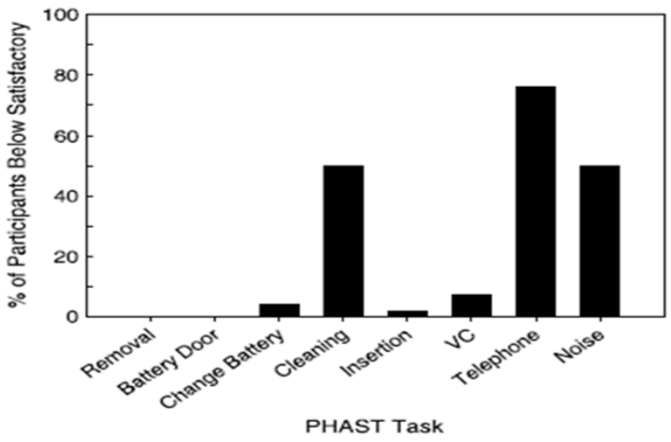
A need for an Automatic Program: Hearing aid Users describe use of a noise program as a "complex task"

Figure 3. The percentage of participants scoring below satisfactory for each PHAST skill task. VC = volume control.



Even experienced hearing aid users have difficulty demonstrating the use of a manual noise program

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Desjardins JL, and Doherty KA. (2009) Do Experienced Hearing Aid Users Know How to Use Their Hearing Aids Correctly? *American Journal of Audiology*. 18 (June):69-76.

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hearing aid users should not have to **think** about **switching** their hearing aid program

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Feature Detection Model

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Auditory and acoustic scene analysis

Brain

INPUT SOUND

FEATURE EXTRACTION

SEGMENTATION

GROUPING

EVALUATION

AutoSense OS

INPUT SOUND

FEATURE CALCULATION

MULTIDIMENSIONAL CLASSIFIER

PROPORTIONAL MANIPULATION

FEATURE ACTIVITY CALCULATION

Auditory scene analysis computational models: Image adapted from the International Encyclopedia of the Social & Behavioral Sciences 1992

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Acoustic Scene Analysis

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Challenges for Automatic Classification Systems

- Power
- Fast-acting
- Correct identification of the sound class
- Correct activation of features
- No audible transitions

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Accuracy and precision are both important

Accuracy:

- How many sound environments can the hearing aid correctly identify?

Example:

"Am I in noise" or " Am I in quiet"?	→ EASY
"Am I in a noisy car" or "Am I in a noisy café"?	→ HARDER

Why is accuracy important?

- The hearing aids will accurately recognize the sound environment

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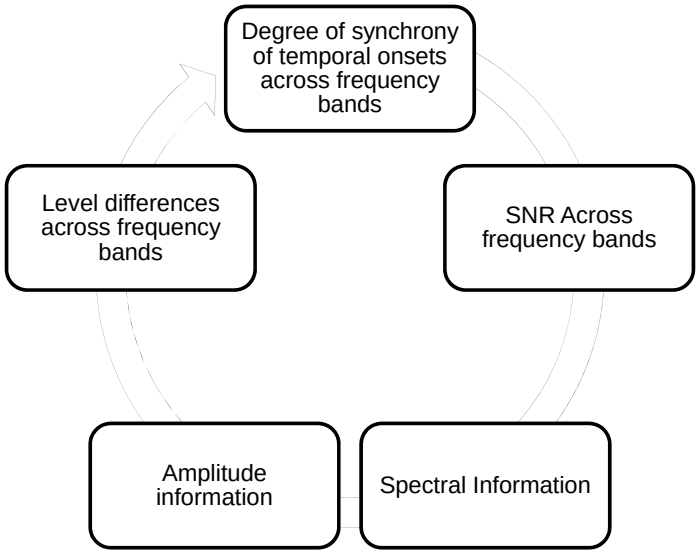
How to Automatic Classification Systems Work Today?



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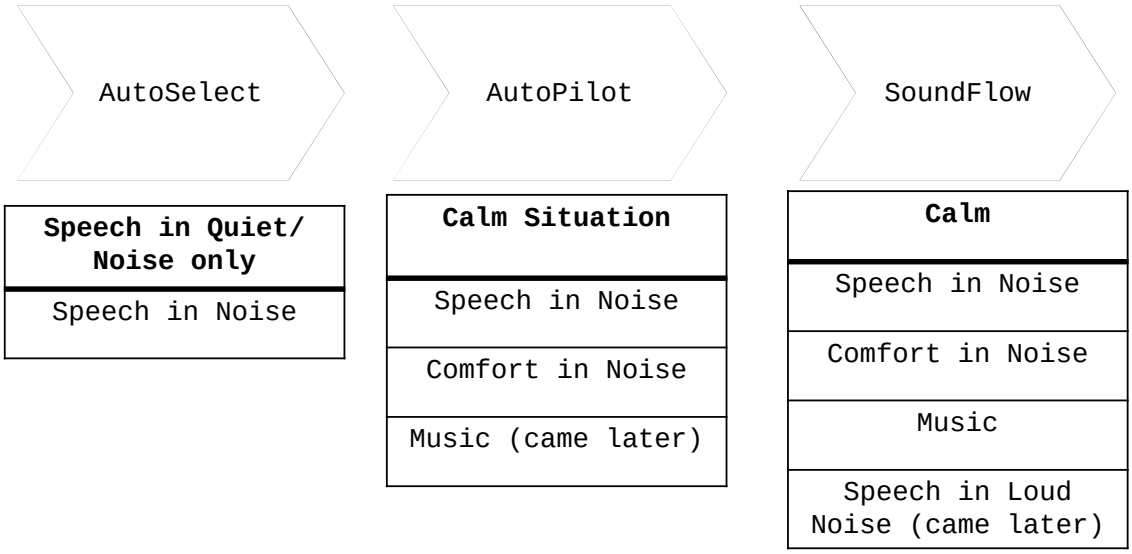
Evolution of Automatic Hearing Aid Technology - Phonak



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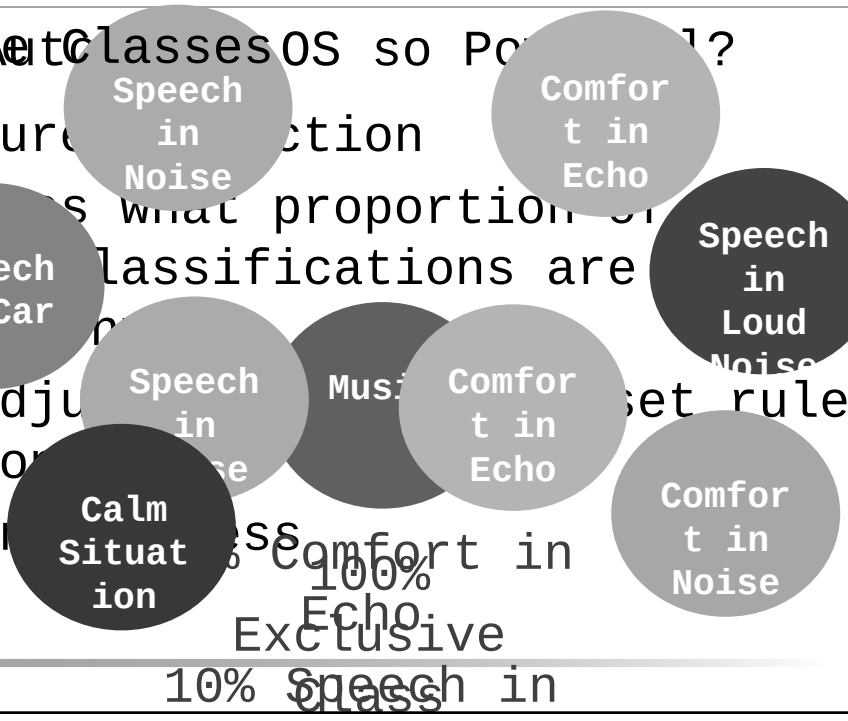
Why is AutoClassesOS so Powerful?

- 31-feature [illegible]ction
- Identifies what proportion of [illegible]rent acoustic classifications are [illegible] in the [illegible]
- Makes adju[illegible]set rules or condition[illegible]
- Smoothin[illegible]ss



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AutoSense OS

- Fourth iteration of Phonak automatic classification

Now on the Venture Chip….

- Faster processing
- More memory
- Less power consumption
- More accurate at classifying the acoustic environment
- Does this multiple times per second (3 times

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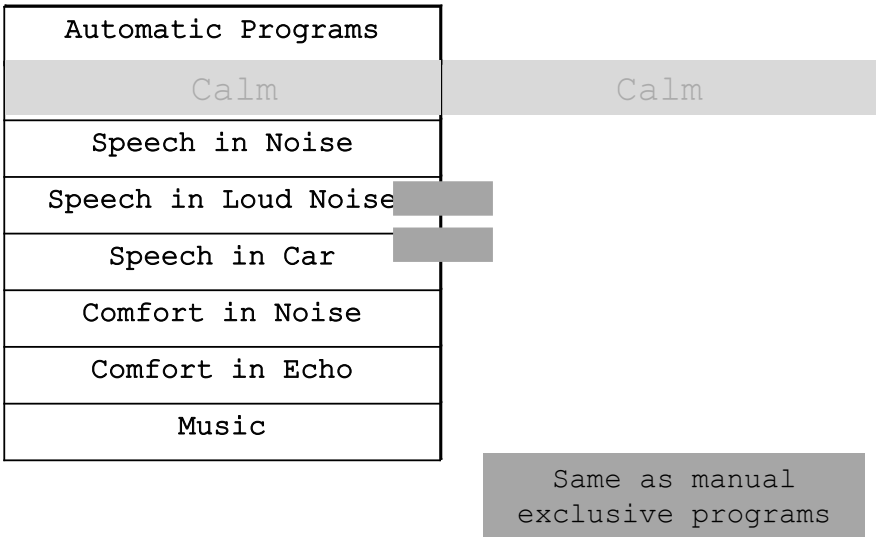
Automatic Programs – Phonak



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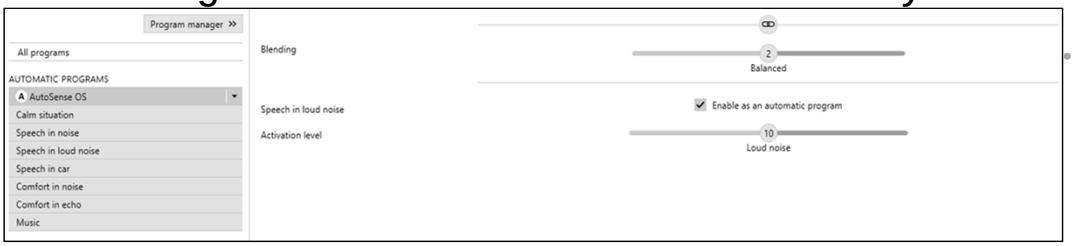
Audiologist Control and Flexibility



- Changes to AutoSense OS (globally)

- Changes to Programs within AutoSense OS

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Manual vs. Automatic?

Programs
1. 
5. Comfort in Noise
6. Comfort in Echo
7. Music

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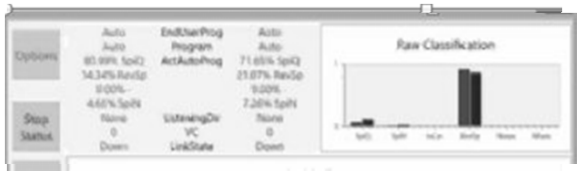
Listening Loft



Final classification:
Reverberant Speech Detected
Blend of echo and speech

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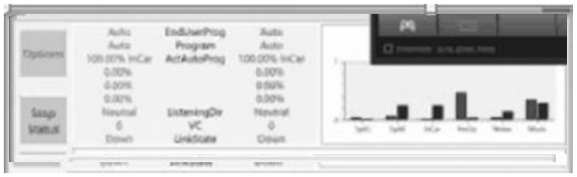
Car



Detection of Music
Detection of Noise
Detection of Speech in Car

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Street

Detection of Noise
(not a directional
microphone)

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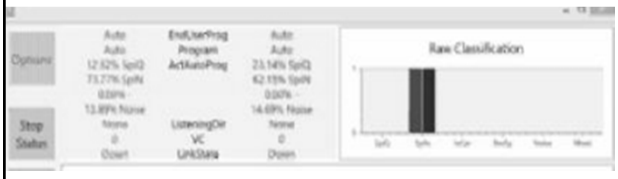
Coffee Shop



Speech in Loud Noise

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Sound Scene

- Difficult to manipulate between 7 programs (and remember what they are!)
- Sound scenes are not straight forward in our everyday lives
- We cannot blend between manual programs

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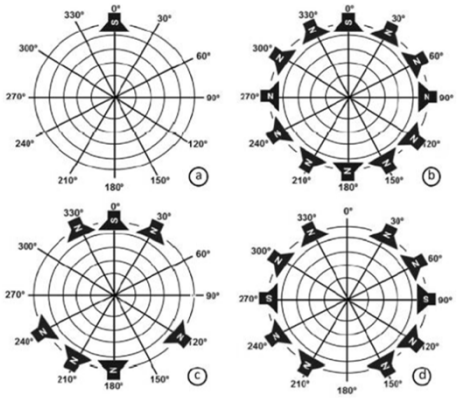
Four Scenes



	Manual Programs
A	Calm Situation
B	Speech in Noise
C	Speech in Loud Noise
D	Speech in Car

Question #1: Which manual program does the participant prefer in each of the four acoustic scenes?

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Program selected as “favorite”

Program selected by individual subject	Program selected by AutoSense OS			
	Calm	**SiN**	**SiLN**	**CAR**
Calm	SiLN	SiN	SiLN	
SiN	SiLN	SiN	SiLN	
Calm	SiLN	SiLN	SiN	
CAR	ComIN	ComIN	SiN	
Calm	ComIN	ComIN	Calm	
CAR	ComIN	ComIN	Calm	
SiN	SiLN	ComIN	ComIN	
SiN	SiN	ComIN	ComIN	
SiN	ComIN	ComIN	SiN	
SiN	SiLN	SiN	ComIN	
SiLN	SiN	SiLN	CAR	
SiLN	ComIN	SiN	SiN	
Calm	SiN	SiLN	CAR	
CAR	SiN	ComIN	ComIN	

automatic selection # manual selection
automatic selection = manual selection

No more than 4 participants chose the same program as AutoSense OS in any scene

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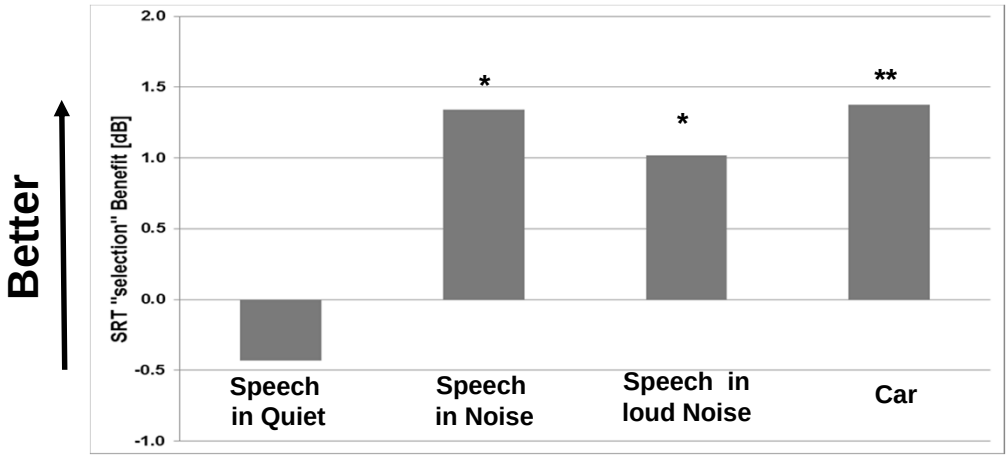
Objective benefit of AutoSense OS

Goettinger sentence test



** ⇔ 0.01
* ⇔ 0.05

The program selected by AutoSense OS provides better speech intelligibility in each noisy situation.

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A Need for A Study Done Outside of PARC’s walls…

How do we know what is happening in the REAL WORLD?

Scene Creation

Challenges:
- Speech from behind
- Reverberation
- Noise

Challenges:
- Road Noise
- Speech from side

Challenges:
- LOTS of noise
- Reverberation

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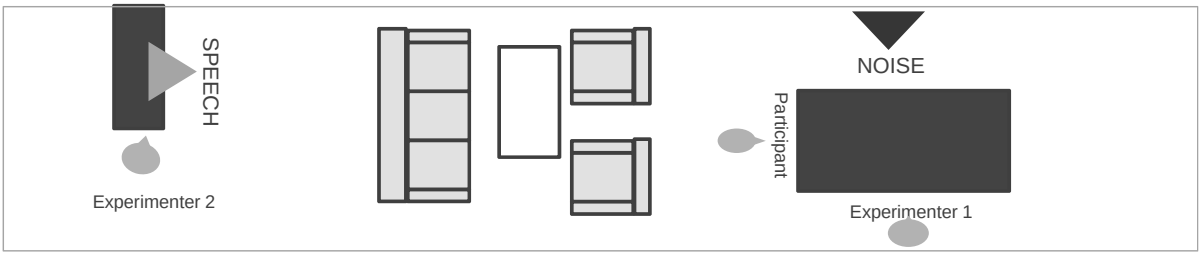
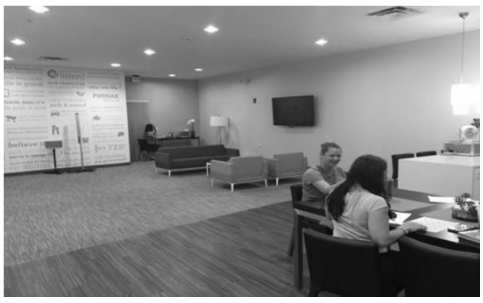
Scene #1: Listening Loft





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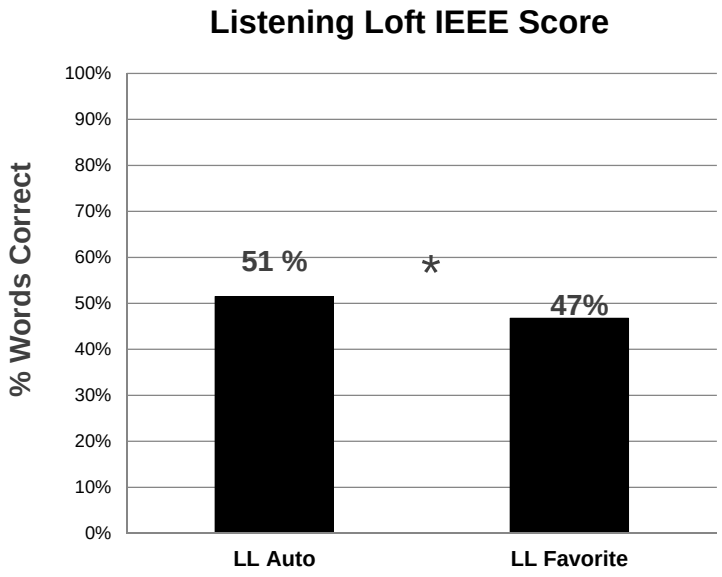
Objective score



* = p < 0.05

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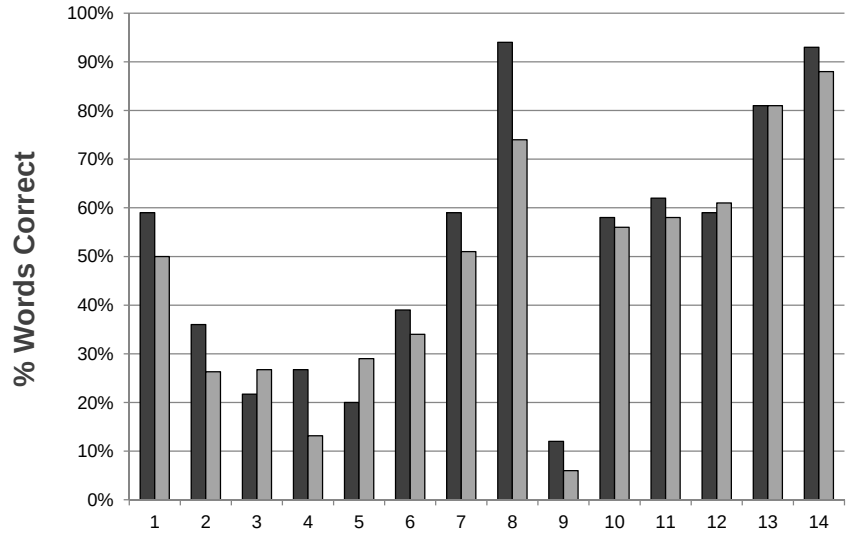
Listening loft speech performance



12/14 participants performed the same or better in Auto than Favorite

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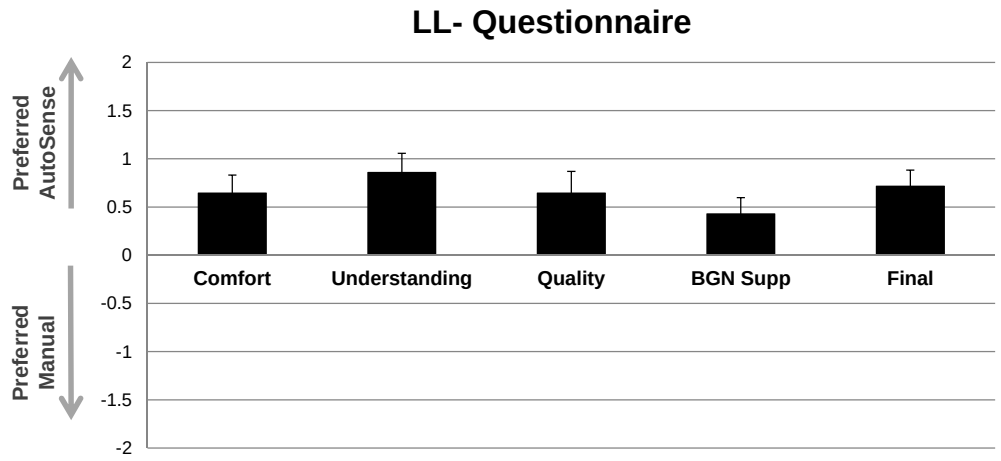
Do participants prefer AutoSense or “Favorite” Manual Program?



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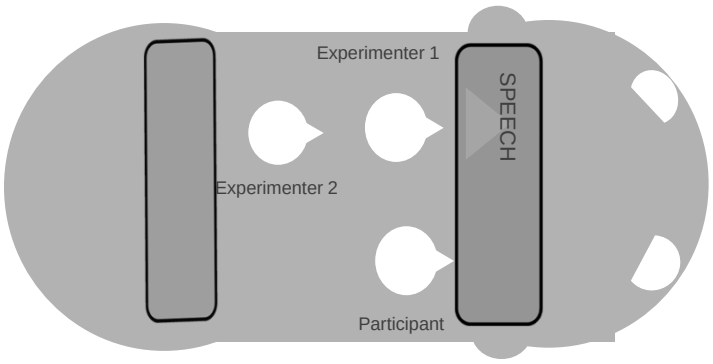
Scene #2: Car



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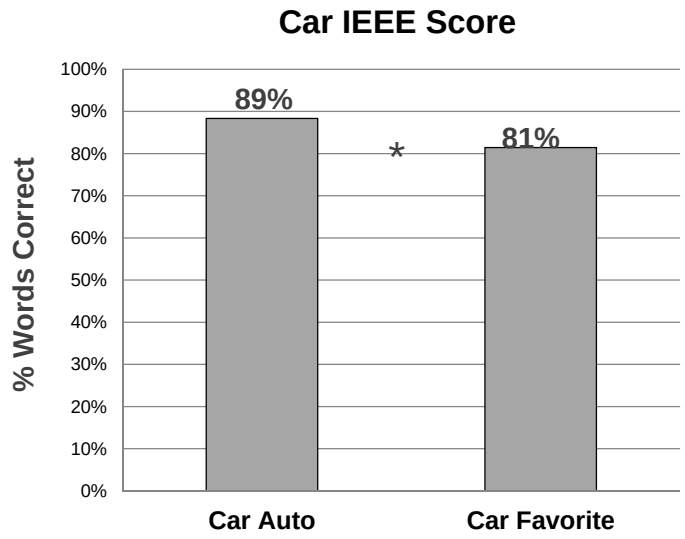
Objective Score



* = p < 0.05

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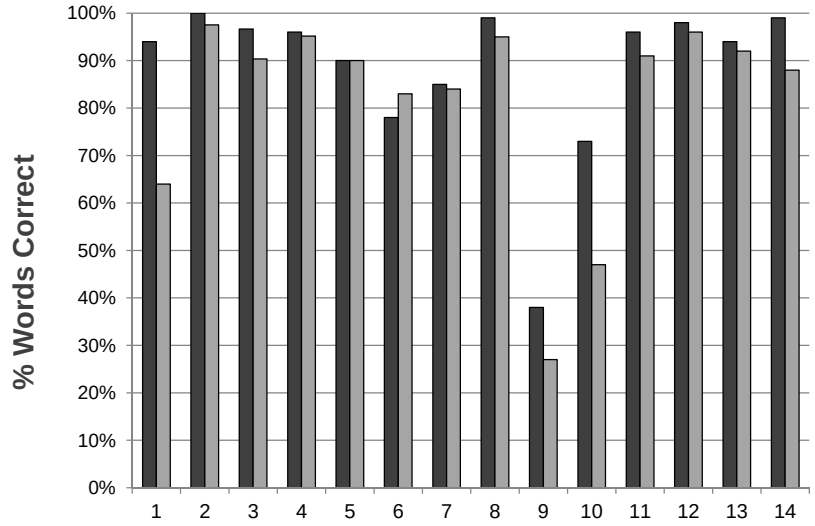
Car speech performance



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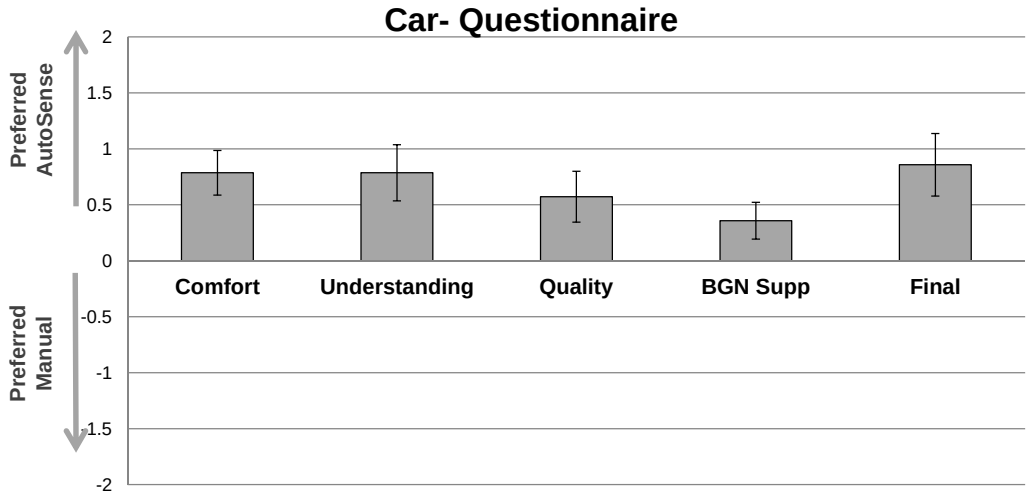

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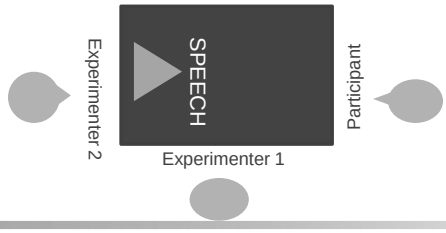
Starbucks



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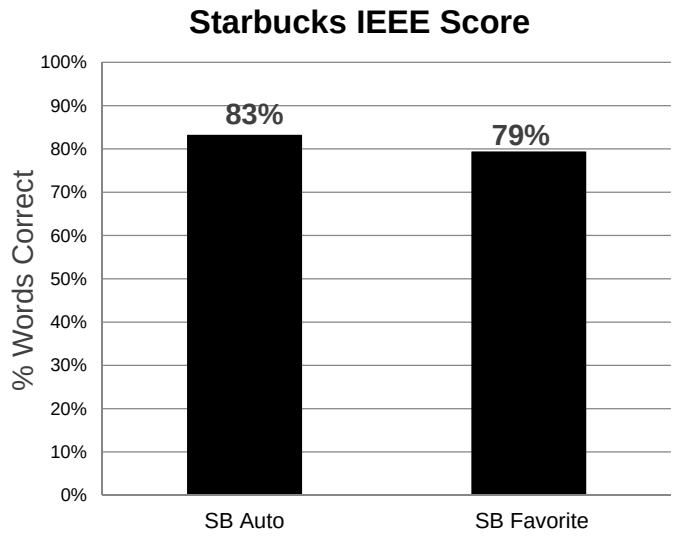
Objective Score



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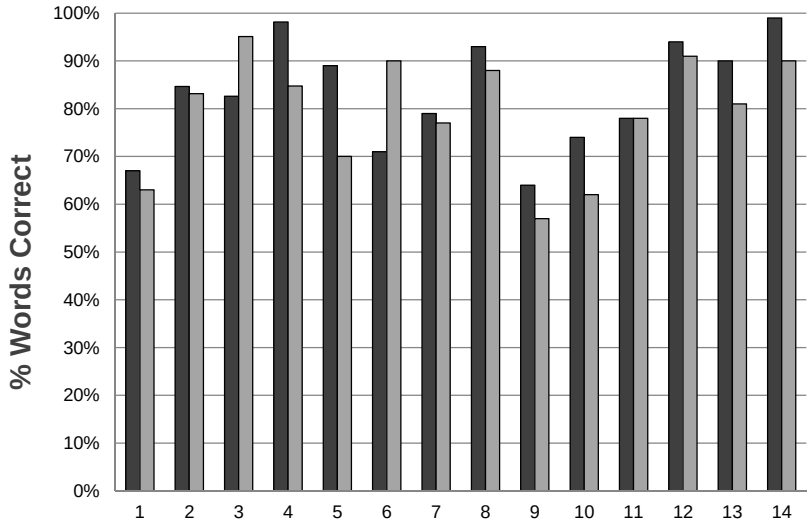
Starbucks Speech Performance



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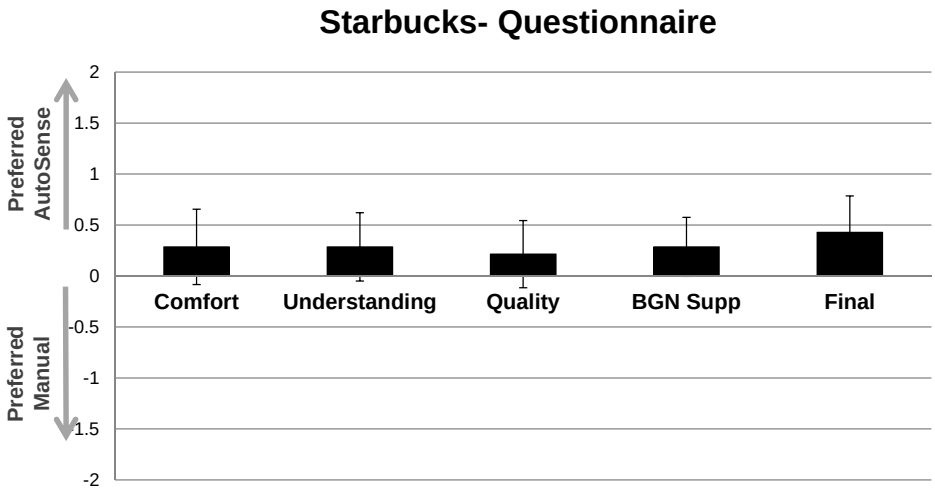

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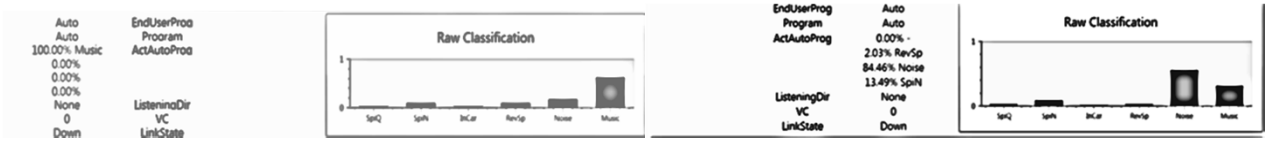
Automatic Systems for Little Ears

- AutoSense OS Sky
  - Children are NOT in the same listening environments as adults!
  - Detecting group work as “Speech in Noise” happens much more consistently and accurately
  - Classification of kids yelling to a “Comfort in Noise” program instead of “Music”



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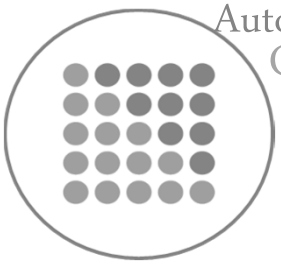
AutoSense OS Conclusions



- AutoSense OS is an incredibly powerful and **accurate** scene classification system
- Participants **performed better** in AutoSense OS than their preferred manual program
- Participants **performed better** in AutoSense OS than the “acoustically appropriate” target program
- Participants **preferred AutoSense OS** in all three listening scenes

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Take Aways

- Automatic classification systems should be a priority for any hearing aid manufacturer, since this ultimately affects how hearing aid users interact with his/her hearing aid

- With new advancements hearing aids have become increasingly more complex in their ability to adapt to a number of environments, and automatic classification systems allow hearing aid users to take

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Questions?

Thank you!