Canadian Academy of Audiology
Academie Canadienne d'audiologie

Auditory Scene Analysis:
understanding the fundamental mechanisms of auditory perception and perspective for audiological rehabilitatio

Speaker: Andréanne Sharp, M.P.A., Ph.D.,
Professeure, Faculté de Médecine
Université Laval

Host: Mathieu Hotton

2022-06-08

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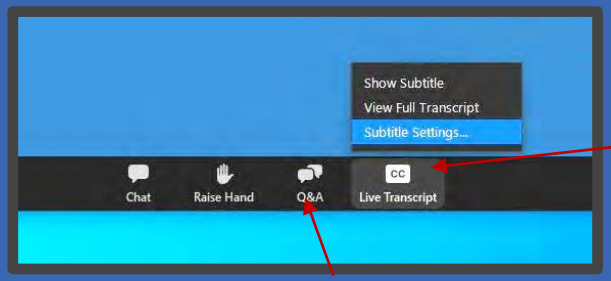

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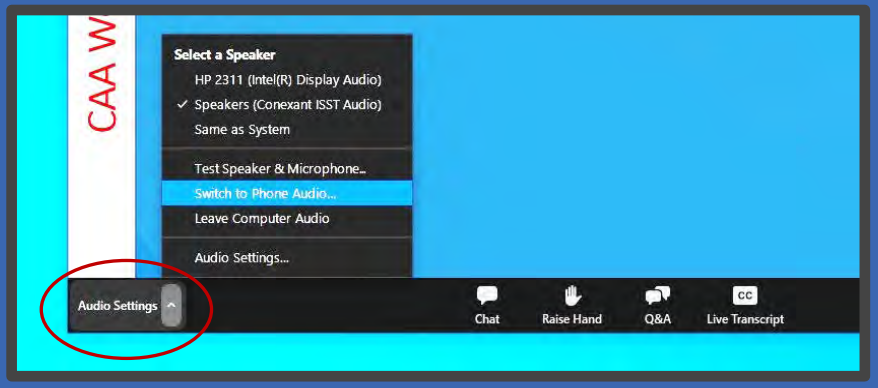

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Canadian Academy of Audiology is a professional association dedicated to enhancing the role of audiologists as primary hearing health care providers through advocacy, education and research.

Moderator – Mathieu Hotton, Ph.D.

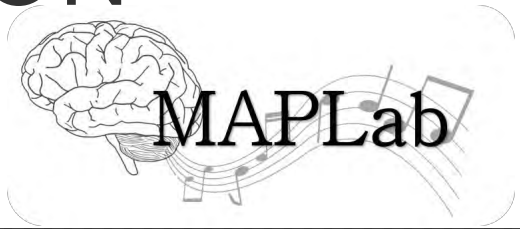
Mathieu Hotton is an audiologist and assistant professor at Laval University. He holds a master's degree in speech-language pathology and audiology from the University of Montreal,and a Ph.D. in experimental medicine from Laval University. He also pursued a postdoctoral fellowship with Jean-Pierre Gagné in 2018-2019, at the University of Montreal.

During his doctoral work, he studied the effectiveness of frequency-lowering hearing aids and EAS implants. The research he started as a postdoctoral fellow focus on the audiological needs assessment in adults and seniors living with hearing loss.

Speaker: Andréanne Sharp, M.P.A., Ph.D., Professeure, Faculté de Médecine Université Laval

Andréanne is an assistant professor at Laval and a certified clinical audiologist. She obtained her Ph.D. in the Auditory Neuroscience Research Laboratory of Professor François Champoux at the University of Montreal. It is her musical background that gave her the innovative idea of developing research projects linking audiology and music. She started to develop vibrotactile technological tools allowing her to study musical perception in individuals with profound deafness. Within her laboratory, Andréanne hopes to continue the development of knowledge in the field of adult rehabilitation by studying the limitations caused by deafness in terms of communication and recreation.

AUDITORY SCENE ANALYSIS : UNDERSTANDING THE FUNDAMENTAL MECHANISMS OF AUDITORY PERCEPTION AND PERSPECTIVE FOR AUDIOLOGICAL REHABILITATION



UNIVERSITÉ LAVAL

Andréanne Sharp, MPA, PhD
Audiologist, Assistant Professor & Researcher - CERVO Brain Research Centre
Laval University, Faculty of Medicine, Department of Rehabilitation
Audiology Program

CENTRE DE RECHERCHE CERVO BRAIN RESEARCH CENTRE

TO INTRODUCE MYSELF...

World Congress of Audiology Vancouver 2016

PhD

Université de Montréal

Post-Doc

McGill

Clinical Private Practice

Start of the brand-new audiology program at Laval University September 2020

UNIVERSITÉ LAVAL

MAPLab

RESEARCH AXES

Axis 1

- Investigation of fundamental mecanisms of auditory perception in complex auditory environments
  - Auditory scene analysis in humans (normal hearing, non-musicians)
  - Impact of musical training on auditory perception

Axis 2

- Impact of hearing loss on fundamental mecanisms of auditory perception in complex auditory environments
  - Evaluation of performances
  - Improvement of auditory skills - Rehabilitation

3 KEY LEARNING POINTS

1. To understand better what is auditory scene analysis and why is it so important in everyday life.

2. How auditory illusions can help us to investigate auditory scene analysis?

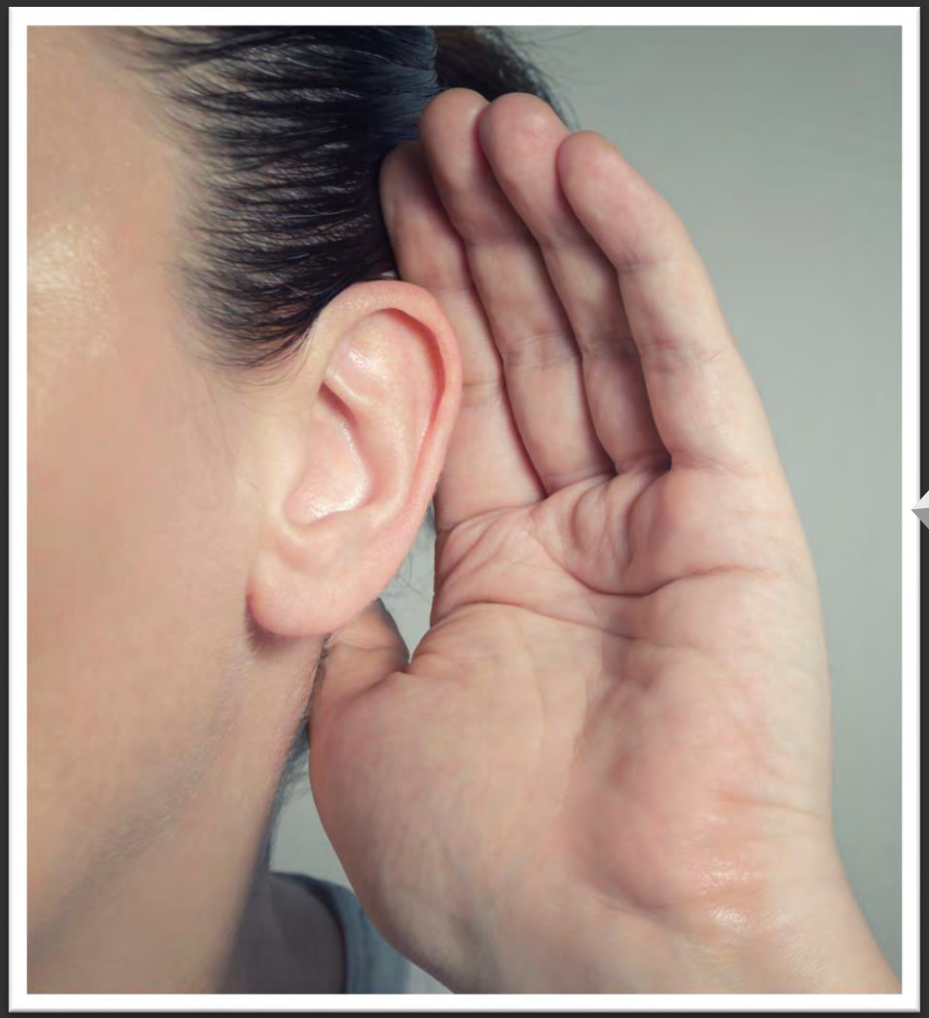
3. How can we help our patient to improve auditory scene analysis by widening horizons to new forms of audiological therapy.

INTRODUCTION

In everyday life, **it is rare to find an environment where there is only one sound at a time.**

The daily auditory scene of humans is made of a **wide variety of sounds** with **various spectral** and **temporal components.**

AUDITORY SCENE ANALYSIS



Auditory Stream Integration

Auditory Stream Segregation

AUDITORY SCENE ANALYSIS

- This ability is called auditory scene analysis (Bregman, 1994).
- During the past half-century, researchers tried to resolve the “cocktail party” problem → ability to understand speech in a crowded and noisy environment as well as the difficulties encountered to do so (Cherry, 1953)

Auditory illusions are precious tools to help understand perception as they allow us to investigate the limits of auditory perception.

AUDITORY ILLUSIONS

- Auditory illusion → when a sound stimulation does not match the reported perception

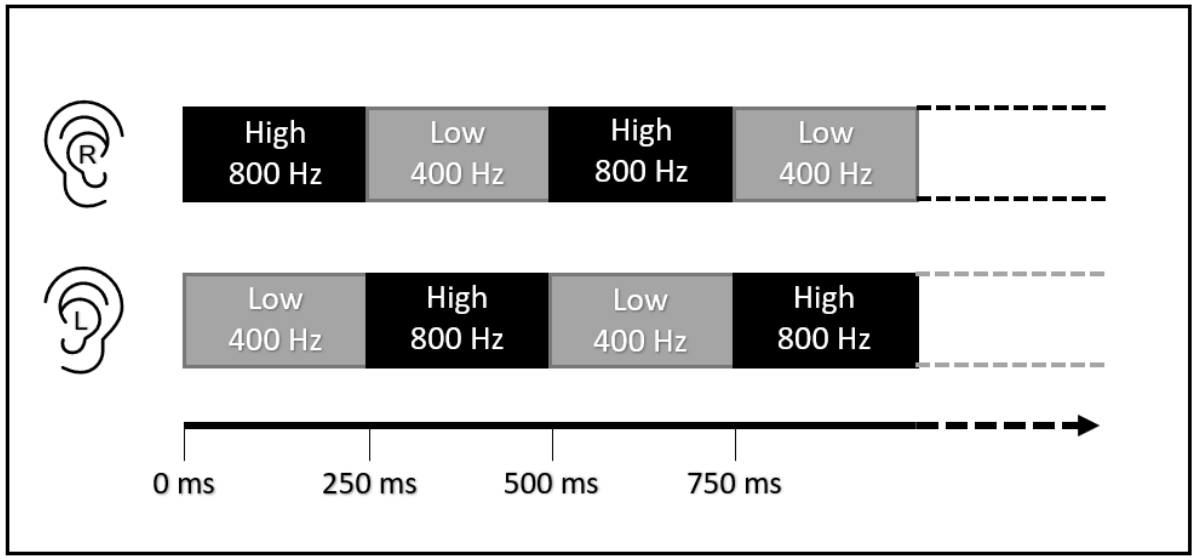
These illusions show that the auditory system not only faithfully transmits sound information as it enters our ears, but also alters and rearranges this information in various ways.

OCTAVE ILLUSION : FREQUENCY COMPONENTS OF STIMULATION CAN MODULATE PERCEPTION

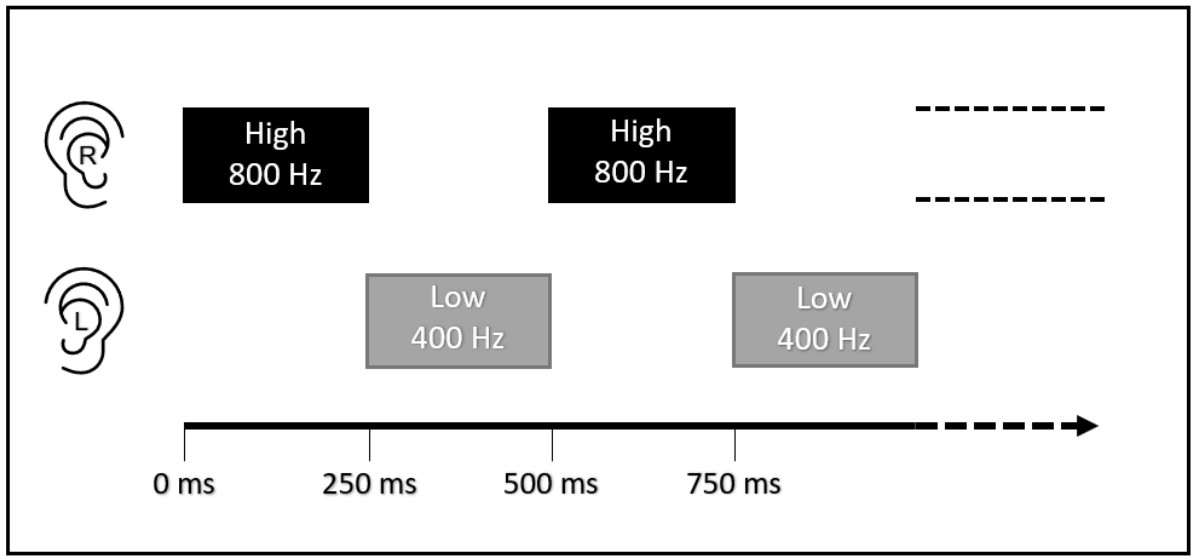
Whittom, A., Couture, F, Chauvette, L. et Sharp A. (Submitted)

OCTAVE ILLUSION

Auditory stimulus

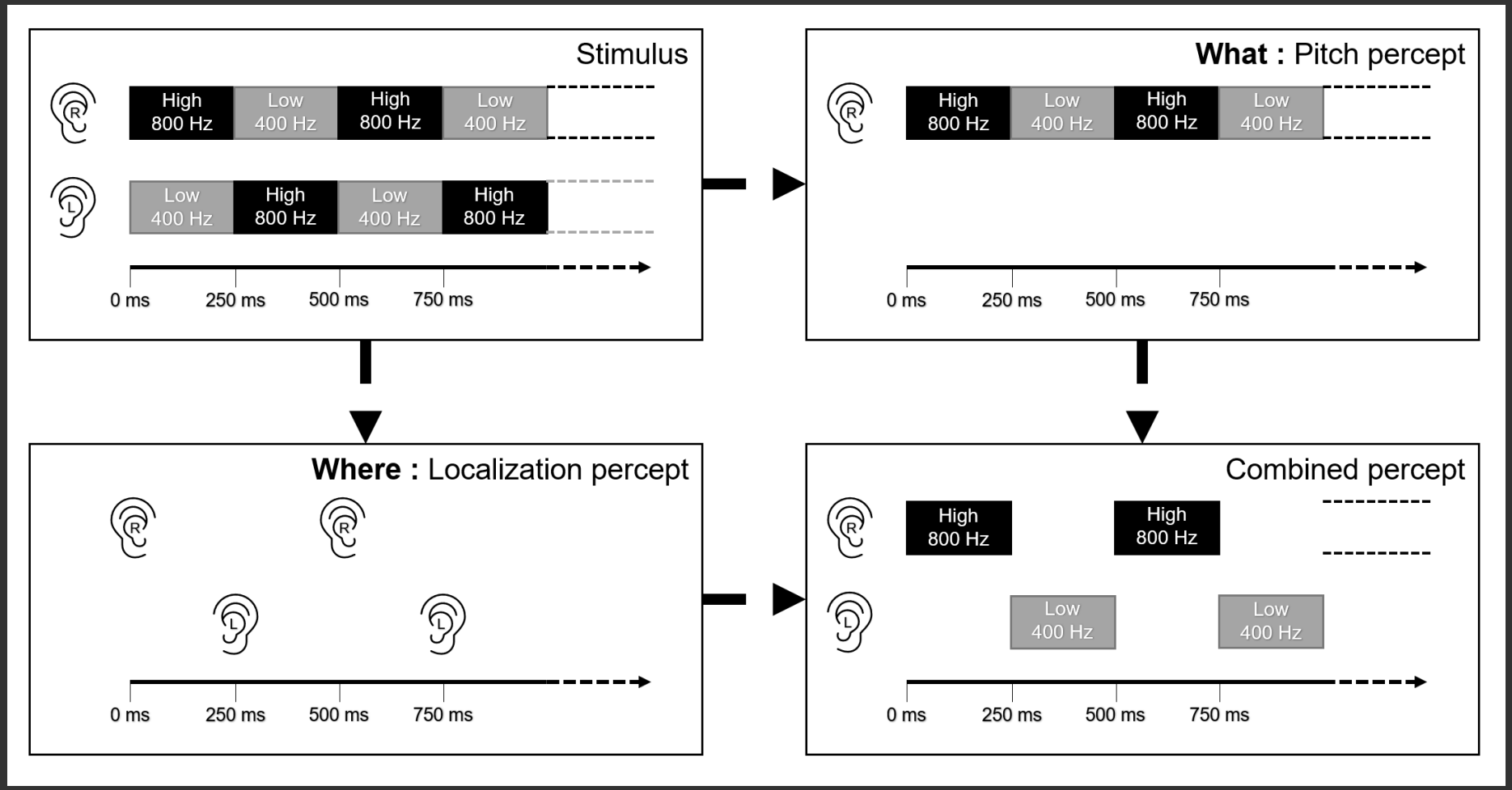


Percept



(Whittom et al., 2022 - Submitted)

SUPPRESSION MODEL



(Whittom et al., 2022 - Submitted)

PAST STUDIES

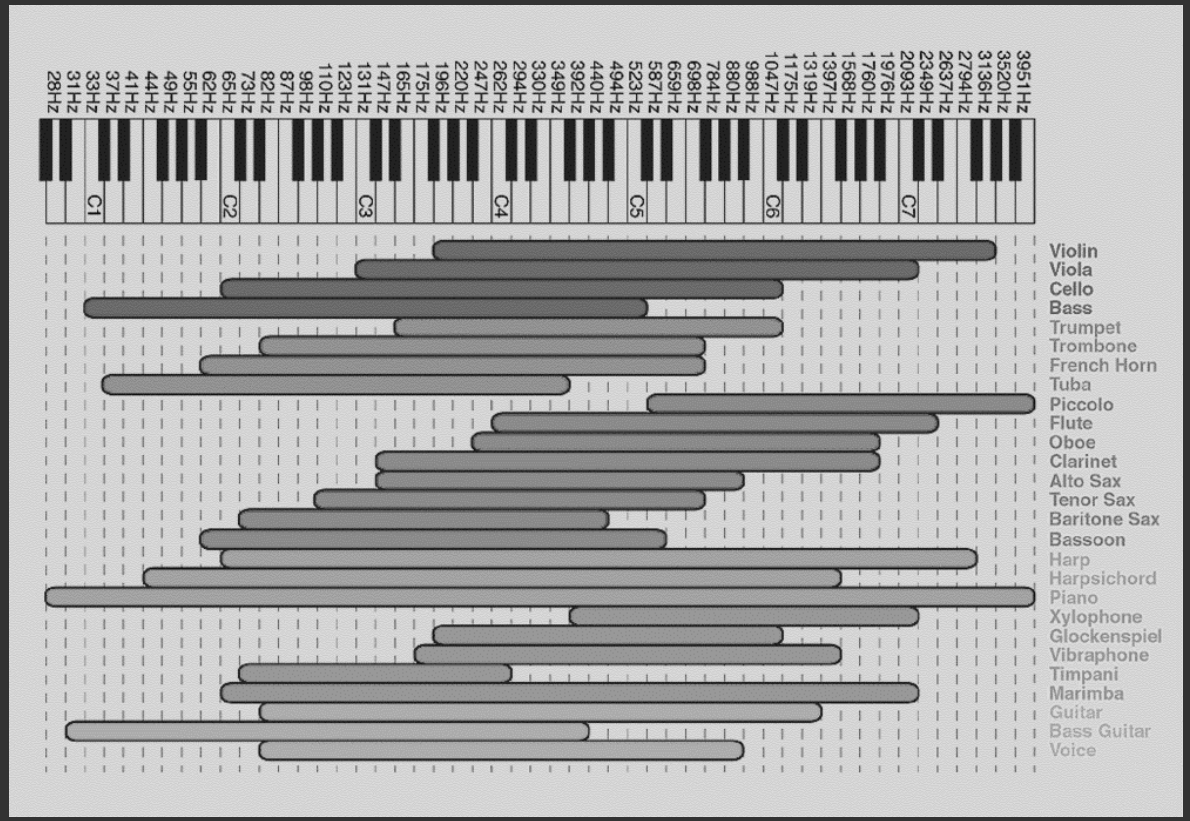
Since the original study in 1974, many acoustic features have been investigated to assess their impact on the percept :

- Harmonic complex and timbre (McClurkin & Hall, 1981)
- Tone pairs (Deutsch 1974; 1988)
  - 200-400Hz, 400-800Hz, 600-1200Hz, 800-1600Hz
- Intensity (Deutsch, 1988)
- Frequency ratios and duration (Brancucci et al., 2009)
- Narrow-spectrum noises (Brännström & Nilsson, 2011)

AN IMPORTANT ASPECT HAS NOT BEEN INVESTIGATED TO DATE !

- **Frequency range !**

Our sense of musical pitch and our ability to make octave correspondences largely disappear above 5000 Hz
(Moore,1977)



(Image : https://www.soundonsound.com)

NEW PARADIGM

The stimuli were generated with the open source software Audacity 3.0.0

Pure tones (generated sine waves) all had a duration of 250ms

The amplitude was controlled so as not to perceive any variation throughout the stimulation

The stimulation had a total duration of 30s

7 frequency pairs investigated :

40-80Hz, 100-200Hz, 200-400Hz,

400-800Hz, 800-1600Hz, 1600-3200Hz, 2000-4000Hz

PARTICIPANTS

- N = 30 (14H /16F)
- Normal hearing
- Average: 26 ± 3 years old
- Had less than 5 years of musical experience on average
- All self-reported right-handed

QUESTIONNAIRE

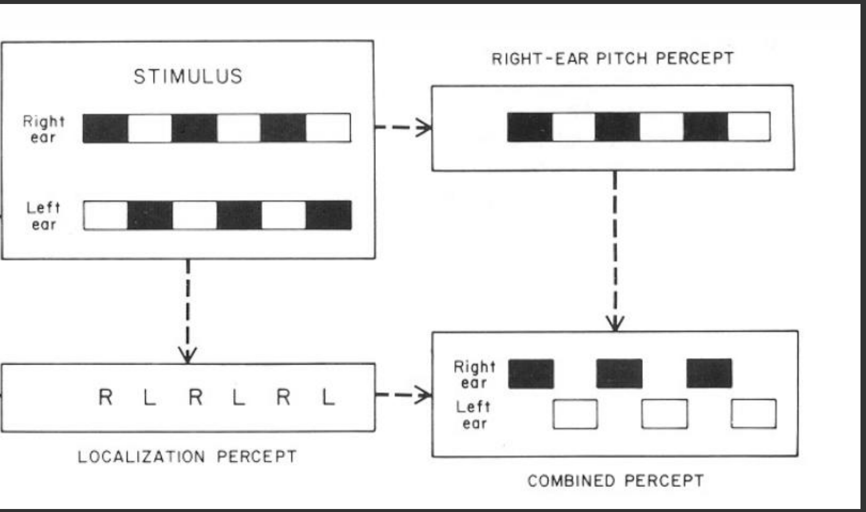
1) A high-pitched sound on the right alternating with a low-pitched sound on the left

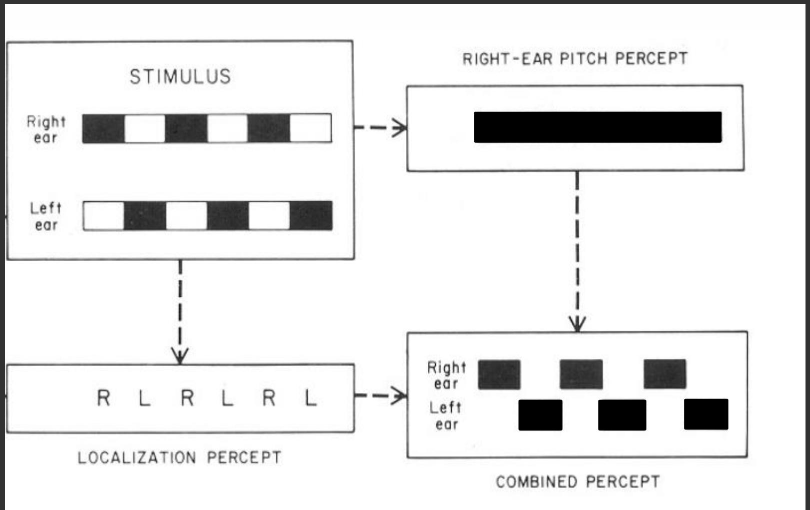
2) A high-pitched sound on the left alternating with a low-pitched sound on the right

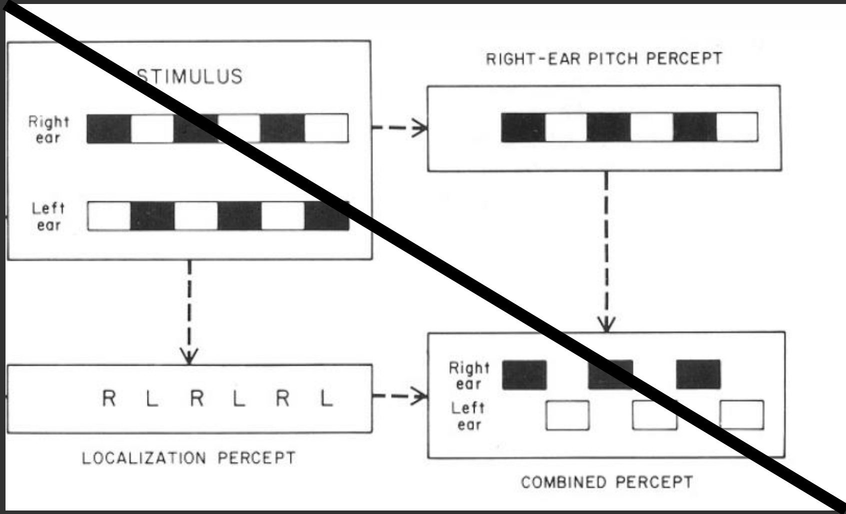
3) A sound that passes from one ear to the other without a change in pitch

4) None of these answers (The participant had to explain their perception if they gave this answer).

PERCEPTION







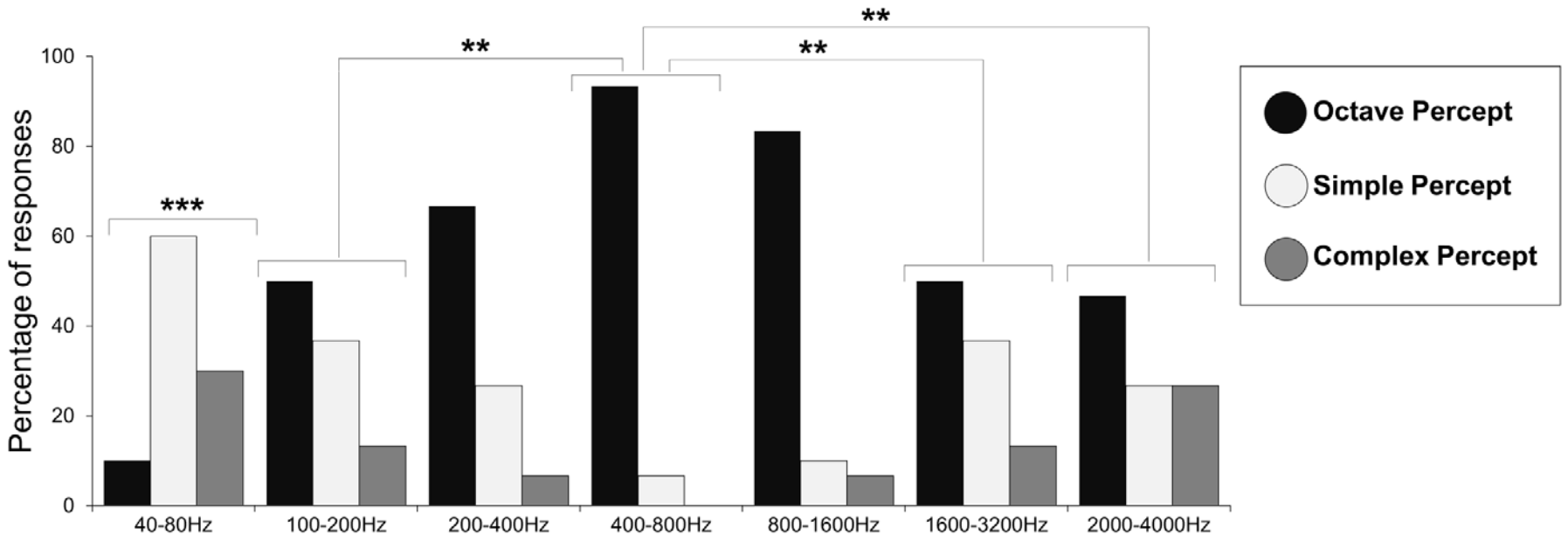
Octave → Simple → Complex

1) & 2)

3)

4)

RESULTS



** Statistically different distributions between two conditions, after bonferonni correction
*** Statistically different distribution from every other condition, after bonferonni correction

(Whittom et al., 2022 - Submitted)