Lab Exercises

Equipment needed to conduct these exercises:

- A computer with any software that can play sound files.
- Supra-aural headphones or speakers. The quality of the headphones is not important, but some of these exercises use earplugs and so students should use supra-aural earphones or speakers for those exercises. Students should be able to purchase an inexpensive set of headphones for under $15.

Instructors may choose to have students write up a lab report for these exercises. Examples of possible data analysis and discussion questions are provided here.

Lab Exercise 1. Yes-No vs. 2I-2AFC

Introduction

This lab exercise will allow you to compare and contrast the yes-no procedure with the 2I-2AFC procedure. Your job will be to detect a pulsed pure tone of about 1000 Hz embedded in a broadband noise (white noise low-pass filtered at 4000 Hz) for both of these procedures. Follow the steps to complete this lab exercise.

Read all of the instructions before you complete the exercise.

Calibration

Using headphones of your choice, listen to the calibration sound track [**ex1-calibration.wav**] and set the volume on your computer so that you can comfortably hear a beeping sound within a background noise. Be sure that you can hear the beeping sound – this will be the sound you will be listening for during the experiment. Once you have the volume set to a comfortable level, you are ready to begin the experiment.

Lab Steps

This is the yes-no portion of the experiment.

1. Open the data collection sheet in Excel [**ex1-methoddatasheet.xls**].
2. Select one of the yes-no experimental files. You might want to start with the files that use the SNR of -12 dB or -15 dB [e.g., **ex1.yesno.snr-12.wav** or **ex1.yesno.snr-15.wav**]. Your goal is to find the sound file for which you will not be 100% correct, but you should be better than 50% correct.
3. Start the yes-no sound track and complete this part of the experiment. You may find that the first few trials are very easy. If this is the case, stop the track and select one of the files with a lower SNR. You may find that you need a file with a much lower SNR, so do not hesitate to try those files if you need them.
4. When you listen to the yes-no sound track, you will indicate whether you heard the beeping sound in each of the trials: In the Excel file, you should put a 1 for a yes or a 0 for a no next to the trial number. In one of the columns of the Excel file, you will be told whether you were correct or incorrect.
5. Note that there will be 30 trials in this experiment. Some of these are "Yes" trials and some are "No" trials. The answers are in the Excel file, but don't look at them until you complete the experiment.

Scoring for Yes-No

The Excel sheet will automatically score percent correct, hits, misses, false alarms, and correct rejections. If you were at 100% correct, then this SNR was at a level for which your criterion cannot be calculated. If you were at 50% correct, then this SNR was too difficult for you. Try one of the files with a better or worse SNR to find a level at which you make some but not a lot of mistakes.

Lab Step 2

This is the 2I-2AFC portion of the experiment.

1. Use the same SNR that you used for the yes-no experiment, but play the 2AFC file.
2. When you listen to the 2I-2AFC portion of the sound track, you will hear two observation intervals for each trial. Indicate whether you heard the signal in the first or second observation interval by typing a 1 or a 2 into the Excel spreadsheet. Note that a signal is always present in one of these intervals, so if you did not hear it, you should make your best guess. In one of the columns of the Excel file, you will be told whether you were correct or incorrect.

Scoring for 2I-2AFC

Excel will again calculate your percent correct for the 2I-2AFC experiment. Note that there is no way to score hits, misses, or false answers with this methodology.

Analysis and Discussion

1. For the yes-no experiment, examine the false positive and miss rate. Are these values the same? If so, what do you think the implications are? If not, consider whether your bias was liberal or conservative. Discuss.
2. How could knowing someone's bias be helpful in psychoacoustic testing?
3. Next, consider the 2I-2AFC experiment and discuss how this procedure might eliminate a response bias that is present. Do you think this procedure might be more applicable for a liberal bias (lots of false positives) or a conservative bias (lots of false negatives, such as someone faking their hearing loss)? Would there be times that this procedure may not be useful to someone testing hearing?
4. This experiment used defined observation intervals, as you were told when to listen. How do you think undefined observation intervals (like used in clinical testing) might alter the threshold that you estimated? Would this experiment be easier? Or more difficult? Discuss.

Lab Exercise 2. The Psychometric Function

Introduction

This lab exercise will allow you to evaluate the psychometric function. You will measure your psychometric function for detecting a tone added to noise with and without ear plugs. You will assess whether this conductive hearing loss makes it more difficult to hear a tone added to noise. To address this question, you will implement a 2I-2AFC procedure to measure the psychometric function, and you will compare the two psychometric functions while wearing earplugs and while not. You will detect a pulsed 1000-Hz pure tone added to a white noise low-pass filtered at 4000 Hz. The SNR will be varied between -9 and -30 dB.

Calibration

Using headphones of your choice, listen to the calibration sound track [**ex2-calibration.wav**] and set the volume on your computer so that you can comfortably hear a beeping sound within a background noise. Be sure that you can hear the beeping sound – this will be the sound you will be listening for during the experiment. Once you have the volume set to a comfortable level, you are ready to begin the experiment.

Lab Steps

Complete this section of the experiment first without wearing the earplugs.

1. Open the data collection sheet in Excel [**ex2-psychometricdatasheet.xls**]. You will write your answers in the answer column (first in the column labeled without earplugs and second in the column labeled with earplugs). Note that there are 56 trials at 7 different SNRs (-9, -15, -18, -21, -24, -27, and -30 dB). Each trial contains two observations intervals. One of those intervals has the signal and one has noise by itself.
2. Select the experimental file **ex2.run1.wav** to start the experiment. Note: These files are relatively long (over 11 minutes), so if you want the ability to stop and start them, open them in QuickTime or Windows Media Player so that you can stop them when needed.
3. When you listen to the experimental file, you will hear a series of trials and will indicate the interval in which you heard the beeping sound. In the Excel file, you should put a 1 for a yes or a 0 for a no next to the trial number.
4. Note that there will be 56 trials in this experiment. It is random whether the signal beep is in interval 1 or interval 2. If you are unsure which interval has the signal, guess either 1 or 2. The answers are in the Excel file, but don't look at them until you complete the experiment.
5. When you are finished with this section without the earplugs in, put them in and repeat the experiment using **ex2.run2.wave**. Do not change the level of the stimuli in order to hear the sounds better.

Analysis and Discussion

The Excel file will automatically generate the psychometric function for you.

1. Generate a figure with the psychometric functions for the two conditions: with and without earplugs. Plot both psychometric functions on the same figure to see the differences.
2. Note the lowest percent correct and the highest percent correct of the psychometric functions – are these values what you expected? Why or why not?
3. Compare your two psychometric functions obtained with and without earplugs. Are they the same or different? Does this result surprise you? Discuss.
4. Finally, estimate a threshold from these psychometric functions. Using this threshold estimate for both of the conditions, would you come to the same conclusion regarding detecting signals in noise with and without earplugs? Discuss.

Lab Exercise 3. Effects of Conductive Hearing Loss on Temporal Processing

Introduction

This lab exercise will allow you to evaluate how a conductive hearing loss influences temporal processing measures. The focus of this experiment is gap detection, which is a common component of testing auditory processing disorder. The goal is to make you aware of how a simple factor, like reduced audibility, can make accessing temporal information in sound more difficult. In order to estimate the gap detection threshold, you will measure a psychometric function for gap detection with and without ear plugs. You will implement a 2I-2AFC procedure to measure the psychometric function. You then will calculate the threshold. Note that you will run the procedure two times: once while wearing headphones alone and a second time wearing earplugs. Be sure to run both of these conditions with the same calibration. The gap durations tested are .25, .5, 1, 2, 4, 8, and 16 ms, and the stimulus is a noise low-pass filtered at 4000 Hz. There are 8 trials at each gap duration.

Calibration

Using headphones of your choice, listen to the calibration sound track called **ex3-calibration.wav** and set the volume on your computer so that you can comfortably hear a pulsing noise. Once you have the volume on the computer to a comfortable level, you are ready to begin the experiment.

Lab Steps

1. Open the score sheet given in Excel (**ex3-gapdatasheet.xls**) to prepare yourself for the experiment.
2. First, conduct the experiment without earplugs and listen to the gap detection sound track (**ex3.run1.wav**). In this sound track, you will hear two observation intervals for each of the trials. One of the observation intervals contains an interrupted sound (e.g., a gap) and the other does not. In the first column of the score sheet, indicate whether you heard the gap in the first or second observation interval. Note that a gap is always present in one of these intervals, so if you did not hear it, you should make your best guess.
3. Once you have completed this experiment, run the second gap detection file (**ex3.run2.wav**) but while wearing earplugs. This experiment is the same as for step 1 only the sounds are randomized differently. Do not turn up the volume. Type your answers into the score sheet.

Scoring

Excel will calculate the numbers for the psychometric function and whether you were correct or incorrect. Using this information, plot the psychometric function using Excel or a piece of paper. Do this for both experiments (with and without earplugs) and plot the psychometric functions on the same figure.

Analysis and Discussion

1. Consider the psychometric functions you just collected. Estimate the threshold (e.g., the JND for duration) for each.
2. Are the psychometric functions and associated thresholds similar when you were wearing earplugs compared to when you were not? What are the factors that could contribute to the similarity or differences in these measurements? Discuss.
3. Consider the implications of hearing loss on the gap detection measures – given your results do you think that it is straightforward to compare gap detection measures for listeners with good and impaired hearing? What modifications could you make to the experiment to ensure that you are measuring true temporal processing deficits and not factors related to being able to hear the signal?
4. Do your results speak to whether amplification would help someone get better access temporal information in sound?

Lab Exercise 4. Loudness Ratings

Introduction

This lab exercise will allow you to examine the methodology used to measure loudness growth functions. In this experiment, you will hear sets of a 500-Hz pulsed tone presented at various intensities. You will rate the loudness of each of these tones using conduct categorical loudness scaling.

Calibration

Using headphones of your choice, listen to the calibration sound track called **ex4-calibration.wav** and set the volume on your computer so that this pulsed tone is perceived as "uncomfortably loud." This will be the loudest sound that you will hear in this experiment, and it should be set to a level that you find uncomfortable but not so loud that it is damaging your hearing. Once you have the volume on the computer to an uncomfortable level, you are ready to begin the experiment. You can use speakers or headphones for this experiment, but laptops may not generate enough sound level to get a high-intensity calibration signal and they may also distort the high-level sounds. If you use a laptop, it is recommended to listen through a headset if possible. If you turn the volume up all the way and still do not hear an uncomfortably loud sound, run the experiment with the volume up as high as possible.

Lab Steps

1. Open the word file **ex4-louddatasheet.docx** to start the experiment. The score sheet contains a diagram of the categories and a table in which you can code your responses to the lab. Using the score sheet given, prepare yourself for the experiment. Remember that once you start the sound track, your job will provide a categorical rating of the sound that you hear.
2. Open the experimental file **ex4.loudness.wav** in an audio player and start the sound file. Write or type your ratings into the table provided in **ex4-louddatasheet.docx** to. Note that the experimental file can pass you by quickly, so feel free to back up the file and play each trial as many times as needed.
3. Note that there are 11 different sound levels being tested, and each sound is presented 3 times. You may not be able to hear all of the sounds. If this is the case, write "can't hear" in the data table.

Analysis and Discussion

Although, we don’t know the level of the signal in dB SPL, we do know the decibel relationship between the sounds, which is 10 dB. In this experiment, the full range of sounds presented was 100 dB. As a result, you can calculate your loudness growth from the data you collected.

1. Collate the data you collected using the key to the sounds presented during the experiment [**ex4-dBlevels.docx**]. To do this, for each sound level that was tested, determine the average sound level associated with each category. Make a plot of the sound level (in terms of dB re: uncomfortable) versus the sound category.
2. As you collate the data, determine whether you provided the same category for each time that sound was presented. Using your analysis, discuss whether you provided reliable and repeatable data for each sound presentation. If you did not, are there any possible explanations that you can think of?
3. Calculate your dynamic range. Because your uncomfortably loud sound was assigned 0 dB, you can estimate your dynamic range by determining the lowest sound level that was assigned “very soft.” The difference between the two is your dynamic range. Discuss whether this is a value that you would have expected based on your readings and understanding of the growth of loudness.
4. Finally, now that you have conducted an experiment in which categorical loudness scaling was used, consider the strengths and weaknesses of this approach to measure the growth of loudness. Would you recommend this procedure to an experimenter or a clinician?

Lab Exercise 5. Pitch Ratings

Introduction

This lab exercise will allow you to examine how sounds with different acoustic characteristics yield different pitch strengths. In this experiment, you will hear different sounds ranging from pure tones to complex tones to noises. All sounds are designed to have a pitch matched to 250 Hz, but the sounds will vary. You will rate the pitch strengths each of these sounds and then relate your results to the acoustic characteristics of the sounds.

Calibration

Using headphones of your choice, listen to the calibration sound track called **ex5-calibration.wav** and set the volume on your computer so that this pulsed tone is perceived at a comfortable level. This calibration tone is also assigned a pitch strength rating of 100. This will be the clearest pitch that you will hear in the experiment. Feel free during the experimental lab steps to listen to it again if you need a reminder of the reference. Once you have the volume on the computer to an uncomfortable level, you are ready to begin the experiment.

Lab Steps

1. Open the word file **ex5-pitchdatasheet.docx** to start the experiment. The score sheet contains a table in which you assign ratings to the different sounds. Feel free to type your numbers into the table or print off the data collection sheet and fill in by hand. Using the score sheet given, prepare yourself for the experiment. Remember that once you start the sound track, your job will provide a categorical rating of the sound that you hear.
2. Open the experimental file **ex5-pitch.wav** in an audio player and start the sound file. Write or type your ratings into the table provided in **ex5-pitchdatasheet.docx**. Note that the experimental file can go by quickly, so feel free to back up the file and play each trial as many times as needed.
3. Note that there are 6 different sounds being tested, and each sound is presented 3 times. If you do not believe the sound has a pitch, assign it a pitch rating of 0.

Analysis and Discussion

1. Collate the data you collected using the key to the sounds presented in the experiment [**ex5-soundlist.docx**]. To do this, for each sound that was tested, determine the average pitch strength rating. Make a bar chat plotting the pitch strength of each sound with the sound labels on the x axis.
2. As you collate the data, determine whether you provided the same pitch strength rating for each time that sound was presented. Did you always select a rating that was similar to the other ratings? Or did your ratings vary greatly? Discuss your findings.
3. Consider the acoustics of the different sounds. Can the acoustics explain why some sounds have a strong pitch and others do not? Discuss. Things to consider might be: which sounds were associated with a strong pitch and which were associated with a weak pitch? Discuss acoustic aspects that might explain this result.