ABSOLUTE JUDGEMENT

For this part of the case study, you are free to explore the performance of human operators (HO) in absolute judgment tasks. You may either modify the MATLAB software I provide (so that you may explore the maximum H_T of loudness and frequency, or the combination of them) or use whatever software/tools (e.g., PowerPoint) to explore other modalities.

Planning and Conducting Your Experiment

In theory, you should know what you are looking for, such that your challenge is *to design an experiment that, if successful, will demonstrate the human operator's limit in this absolute judgment task.* You should explore at least one hypothesis. Here are some hypotheses you may consider (but of course, you can explore others):

- Whether the *limit of performance* is the same for different modalities (that is to say, you should explore at least two modalities and compare HO's performance)?
- Whether having an Orthogonal or Correlated information dimension will increase/decrease the performance when the physical dimension is Separable or Integral?
- Whether the limit is the same for different frequency ranges (when you are interested in the pitch of the sound)?

Here are some hints:

- For each set of stimulus conditions, you should carry out a number of practice trials, to get a sense of whether your choice of parameters is likely to give you what you're looking for. In other words:
  - You want to have a range of stimuli that will allow you to estimate a function (expressed either as some mathematical function or with a simple sketch) that will adequately describe human performance in this task, most importantly in terms of estimating what is the *limit of performance*.
  - You don't want to do more work than you have to, by presenting *too many* conditions.
  - You don't want to present *too few* conditions (and thus not be able to estimate the desired function).
  - You don't want to do more work than necessary, by presenting more stimuli than you need to for each condition.
  - You don't want to present too few stimuli for each condition, which might prevent you from deriving reliable estimates of the parameters needed.
- Don't forget that every time you change the size of the stimulus set (N), you can no longer use the same 'code' for identifying the stimuli that you used the previous time (for a different N). That means that your participant(s) will have to go through the learning phase each time.
- Some other important decisions:
  - Ideally, each set of experimental conditions should be presented in *random* order. The responsibility for figuring out how to do this systematically is left up to *you*.
  - You should decide whether you wish to go with the option of an equal number of occurrences for each stimulus, or whether these should be presented 'randomly'. Either way, make sure to have a reason for your decision.

Make sure to take the time to do your exploratory work (i.e., pilot tests), so that you can carry out your experiment(s) *efficiently* as opposed to discovering *afterward* that you should have defined things differently at the beginning.

Analysis

1. From the results of each run, form a stimulus-response matrix, and use it to compute the **information in the source (H_S),** as well as the **information transmitted (H_T)** from the input (stimulus tones presented) to the output (your numerical responses). This computation should be included in your report.
2. Plot your results in terms of $\mathbf{H_T}$ vs $\mathbf{H_S}$, in a manner that will allow you to estimate the expected *trend* that indicates a *limitation* in performing this absolute judgment task.

Suggestions for Preparing Your Report

- Make sure to present the results from *both* partners and discuss *both* sets of results. One interesting decision you will have to make is how to combine the results from the two partners (who have presumably undergone the same experimental conditions). That is, should you aggregate the results to find the combined event frequencies, and then use these to estimate the associated probabilities? Or should you compute each set of probabilities and then use those separately? (In other words, *think* about what you're doing.)
- Make sure to present the details of the method you used to obtain your results, and the steps that you took to arrive at your experimental design decisions.

- Did the results of your experiments confirm your hypothesized relationship between $\mathbf{H_T}$ and $\mathbf{H_S}$?
- As with most experiments in this course, there are always limitations. Discuss the limitations that you discovered with your experiment(s). Don't be afraid to reveal any errors or bad decisions that you made; that's how one learns!

SIGNAL DETECTION THEORY

Objectives and Method

The overall objective of this study is to explore the properties of the two SDT model parameters: **d'** and **(effective) beta**. To this end, you are being provided MATLAB software that simulates the fuzzy state of whether a 'signal' exists or not. You will use the software provided along with this instruction; or any software/tools that feel OK to implement the experiment. You are of course encouraged to modify the software that I provide when necessary.

If you plan to use the provided MATLAB software, it is the same one that was used for threshold discriminant. However, you may regard the "two signals are different" as a signal while the two signals are exactly the same as the signal absent.

As with earlier experiments in the course, your challenge is *to design your own experiment*, *with the goal of testing a particular set of hypotheses.* In particular, your job is to explore how each of the two SDT model parameters (the *dependent* variables) are expected to vary as a result of manipulating the following two *independent* variables:

A. the effect of varying signal strength (i.e., the differences of the two signals in the threshold discriminant software);
B. the effect of varying the probability of signals appearing.

Some Tips for Designing Your SDT Experiment

- Make sure that you *understand* the behaviours that you wish to investigate. In other words, you should take care to have reasonably well-formed hypotheses.
- Make sure to invest sufficient time in *pilot testing* your experimental variables. In other words, it makes sense first to try a few experimental *practice runs*, each with a small number of stimulus presentations, in order to get a good sense of whether you have chosen parameters that are suitable for your actual data-gathering runs.
- If you decide to investigate the effect of varying signal strength, make sure to test *at least two* different signal strengths – i.e. an easier one and a harder one. Make sure as well that the signal strengths you choose are sufficiently different, to increase the chances of observing actual performance differences.
- Further to the preceding point, you don't want to make your signals too difficult to detect, or too easy. In the former case, you may end up with chance performance (i.e., d'=0); in the latter case with an infinite value for d'.
- It also goes without saying that, once you have designed a particular signal, make sure to use that *same* signal for *all* conditions for which you want the signal strength not to vary (i.e. to stay constant).
- If you decide to investigate the effect of varying signal probability, make sure (for similar reasons) to test *at least* two different levels of probability. Furthermore, in light of the fact that humans are not very good at comprehending probability, make sure not to test probability values that are too close to each other.
- Keep in mind that at the end of your experimental runs, you are going to have to estimate the probabilities of Hits, False Alarms, etc. that characterize your signal detection system. In other words, as discussed in class, make sure to carry out a *sufficiently large number of trials* to give you reasonable estimates of those probabilities. (For example, if you have a signal probability of, for example, 10%, and if you decide to run only 10 trials, you should realize that there is a good chance that *no signals* will appear!)
- Both you and your reporting partner should make sure to carry out the experiment as participants. It is up to you to decide whether you wish to design your experiments together, or separately.

Some Considerations for Writing Up Your Report

- It is advisable to *start* your report with a discussion of what it is that you were looking for, culminating in a set of reasonably articulated hypotheses. This will make it easier after you present your results to discuss to what extent those results supported your hypotheses.
- It is not hard to find software that will compute all of the SDT model parameters for you. You will surely agree, however, that if you choose *only* to use such software, you are unlikely to learn about what is really going on. Please make sure, therefore, to include in your report extensive explanations for at least some of your computations.
- Although it is always nice to obtain well-behaved results that confirm your hypotheses, it is not the end of the world if you do *not* obtain such results. The important thing is that you be able to discuss *why* you believe that you did manage or did not manage to obtain such nice results. (This is a very effective way for you to demonstrate that you

understand the material being studied.)

- Related to the point above, make sure to discuss the *limitations* of your experiment.

This case study is due in two weeks, i.e., 23:59 pm of Nov. 5, 2022.