AUDL 4007 / PLING 304
Auditory Perception

Laboratory exercise: Adaptive tracks and psychometric functions

The purpose of this assignment is familiarise you with the notion of psychometric functions and adaptive tracks from psychoacoustic testing, plus give you some experience in manipulating data in Excel and/or SPSS. You will be using a special purpose computer program (SHaPS), written specifically to run a wide variety of discrimination tests. Here, we use it to measure the minimal detectable gap in a white noise that you can hear.

Commands for using SHaPS

1. Start SHaPS
2. Right click mouse → Session
3. Enter a name and code. Ensure there are no spaces in the code
4. Pick a gap detection task by selecting 'Gaps.txt'
5. On the display of stimulus parameters: Options → Confirm
6. Run the test(s)
7. For the analyses: Right click mouse → RShell
8. Right click mouse → Choose a script
   navigate to the directory:
   C:\Users\B07_Lab\Documents\AUDL4007 gaps*.R
   and choose the file SHaPS3_gaps_11JAN2013.R
9. Right click mouse → Choose one or more data files
   navigate to the directory:
   C:\Users\B07_Lab\Documents\AUDL4007 gaps\Results\YourCode

Run yourself through the 3I-3AFC format using SHaPS for gap detection three times. There are 6 results files generated from these tests. The .csv files can be opened in Excel, and they contain the trial-by-trial results from the task, with the following information:

Trial: trial number
Track
Level
Continuum
Standard: stimulus number on the continuum for the fixed stimulus (no gap)
Comparison: stimulus number on the continuum for the comparison stimulus (with a gap)
Accuracy: 1 if correct and 0 if incorrect for that particular trial
Direction
LevittCount
Reversals: reversal number
StepSize: the amount by which the comparison stimulus will change, if required
RespTime
TrialType
Time
Answer: the position of the noise with the gap (Left, Middle or Right)
RespKey: the response given by the listener

Once you start manipulating these files, save them as Excel files (.xls or .xlsx) so you can preserve the work you do in them. Email them all to yourself to keep them safe.

The stimulus continuum is numbered from 1 to 40, with stimulus 1 having a gap of 0.5 ms (pretty much impossible), and stimulus 50 having a gap of 30 ms (really easy). The gap durations are spaced logarithmically in between. You can convert any particular stimulus number, call it *N*, to the gap it corresponds to using this equation (note that you must calculate the power before multiplying by the initial '0.5'):

$$0.5\left[\frac{30}{0.5}\right]^{\frac{N-1}{39}}$$

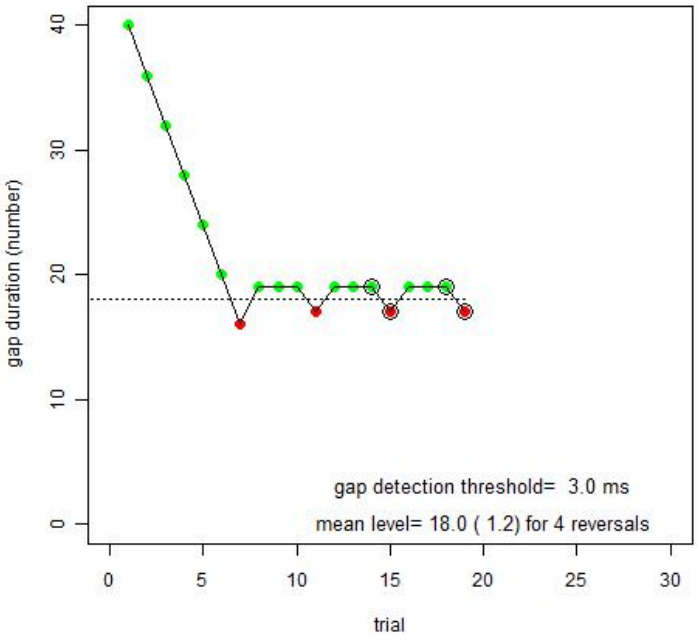
which can be written in Excel as :

=0.5(30/0.5)^((N-1)/39)*

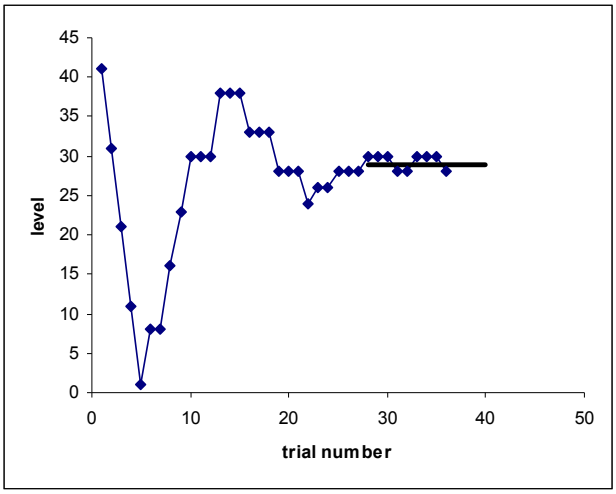
So, for example, N=18 means a gap duration of 3.0 ms.

Looking at individual adaptive tracks

Here's an example adaptive track which plots the stimulus level as a function of trial number.



Look at your adaptive tracks through RShell and work out the rules followed by the tracking algorithm. You will find it useful to read Levitt (1971) as SHaPS uses a modification of the 3-down 1-up rule (a link for this paper can be found on the course web site). How do step-sizes change throughout the track?



Using Excel, plot the comparison level as a function of trial number. Draw in the threshold calculated from the final 4 track reversals and comment on how well the calculated threshold seems to relate to the track. Compare your track to the one generated in RShell. At left is an example of a track as plotted in Excel (from a different task).

Creating a psychometric function

A psychometric function (PF) is a plot of the performance of listener (usually in proportion correct) as a function of the acoustic feature being manipulated. For this gap detection task, that means performance plotted as a function of gap duration. When the gap is really small, you expect performance to be poor. When it is large, you expect performance to be at or near perfect.

comp	r	n
1	0	1
8	1	2
11	1	1
16	0	1
21	1	3
23	0	1
24	0	1
26	2	7
28	19	29
30	20	21
31	9	9
33	3	3
36	6	6
38	3	3
41	3	3

The first step in plotting a psychometric function is to calculate, for each gap duration, the number of trials that were presented, and how many times the listener made the correct response. At left is an example of the basic data you need to construct a PF.

Here **comp** is the level of the comparison stimulus, **r** is the total number correct, and **n** is the total number of trials.

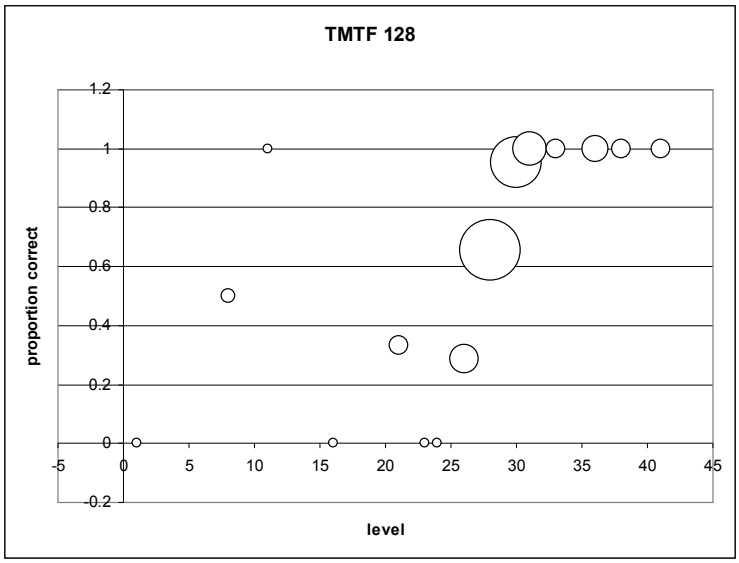
To construct a PF from your own data, first collect together all the trials from the three tracks on a single worksheet, labelling each column appropriately. There are two ways to do the next part of the analysis. SPSS is a little more fool proof but trickier if you are not used to using it. If you prefer, you can do these calculations in Excel. In either case, you are trying to generate a table like the one above.

For doing the analysis in SPSS: SPSS is very fussy about the length of the labels used, so use labels like: session,trial,std,comp,correct,dir,L,rev,step,latency,test,time,order,resp

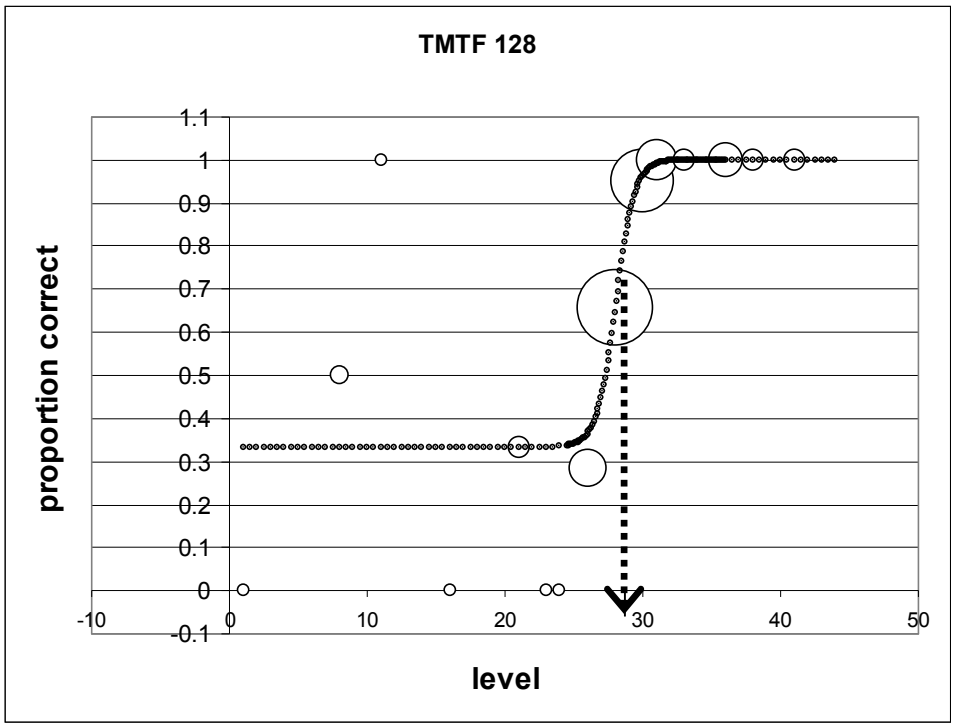
Open your Excel file in SPSS, telling it to read the variable names from the top row. Save away this SPSS file with an appropriate name. You can then get SPSS to tally up your psychometric function using Analyze → Tables → Basic Tables and calculating the sum and count of the appropriate variable (*Accuracy*). Then copy this table into your Excel file on another worksheet.

If you want to use Excel only, it is probably easiest just to sort your table by 'Comparison' and count up the number correct and the total number of trials by hand, in order to construct a table like the one above.

However you do it, you can then calculate the probability of being correct at each comparison level (**p**), and plot your psychometric function using a bubble plot so the size of the points you plot is related to the number of trials at that particular level.



In this particular instance, you would see a plot something like this at left:



Sketch a sigmoid (S-shaped) curve by eye to the data points, weighting larger symbols more. Towards the left-hand side, your function should flatten out at chance level (⅓) because you used Triples 3AFC format. Here's an example at left, with a threshold of about 28:

From your fitted psychometric function, determine the stimulus level that leads to 79% correct (the level tracked by the 3-down 1-up rule. How does this compare to the median threshold of your 3 tracks?

Up until now, you can express all your results in terms of stimulus number on the continuum. Now take your best estimate of the threshold (perhaps an average of the median of the 3 tracks and your estimate from the psychometric function). Convert those to genuine physical values (here the gap duration in ms) by using the equation above, and compare the value with others near you. It should be about 2-3 ms.

Summary of what you should produce

- A short (one-paragraph) summary of the stimuli in the particular test you used, and a description of what physical variable that is being manipulated.
- A description of the adaptive psychophysical procedure
- A plot of one adaptive track with the calculated threshold drawn in, and a sentence or two about the correspondence
- Your psychometric function in a table
- Your psychometric function as a bubble chart with an appropriate sigmoid function drawn in (by hand is fine), and a threshold indicated.
- A few sentences about the threshold derived from the adaptive tracks, and from the psychometric function
- A calculation of what the threshold represent in physical terms, and a comparison of this value to one obtained in a previous study

You need not hand in this work but you must do it. Brevity is all!

Levitt, H. (1971). Transformed up-down methods in psychoacoustics. *Journal of the Acoustical Society of America, 49,* 467-477.