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Informació

LAB03: Loudness

In the following exercises you will be given some contextual information related to the contents that have been presented in recent classes, and then asked to perform a listening task and answering some questions on what you have been listening to. Questions will be marked with bold font types. You can download the pack of listening stimuli from here, if it is more convenient for you than using the directly linked audio files.

If you have questions or something requires further clarifications, please send me a message. Maybe for some exercises you will have to listen more than one time the example to completely grasp what is going on. Take your time. My advice is to split the exercises into 2 or 3 sessions (40 minutes each at most).

Many examples come from the ASA CD "Auditory Demonstrations". For more information about the CD click here.

Pregunta **1**

Correcte

Puntuació 1,00 sobre 1,00

Decibels

Please, refresh your knowledge about decibels and **select the right answers below**

Trieu-ne una o més:

- a. A decibel is a relative measurement that always works by comparison to a reference measure ✔
- b. A decibel scale is only useful to measure loudness or sound intensity
- c. dBSPL values can be negative when the sound pressure level is below the hearing theshold ✔
- d. The dBSPL is a measure of sound pressure level ✔
- e. All dB scales use the formula 10log(x), where x is the ratio between the measured magnitude and the reference level
- f. The dBSPL is a measure of subjective loudness
- g. dB scales are useful when measured values span across a wide range: the log helps to make the values to be more constrained ✔

Les respostes correctes són: A decibel is a relative measurement that always works by comparison to a reference measure, The dBSPL is a measure of sound pressure level, dBSPL values can be negative when the sound pressure level is below the hearing theshold, dB scales are useful when measured values span across a wide range: the log helps to make the values to be more constrained

Pregunta **2**

Correcte

Puntuació 1,00 sobre 1,00

Decibels

In this demonstration, we hear broadband noise reduced in steps of 6, 3, and 1 dB in order to obtain a feeling for the decibel scale.

When loudness decreases in jumps of 6 dB_{SPL}, which is the subjective sensation of decrease that you get? Would you say that it is half loud or that the loudness decreases a bit more or less than a half? How prominent is the 1dB decrease?

Now you can listen to this example (02-01.wav)

and **select the correct options from the list below**.

Trieu-ne una o més:

- a. When intensity decreases by 6dBSPL, loudness decreases much more than a half
- b. When intensity decreases by 6dBSPL, loudness decreases a bit more than a half
- c. When intensity decreases by 6dBSPL, loudness decreases much less than a half
- d. A 1dB decrease can be barely perceivable when loudspeakers are used ✔
- e. When intensity decreases by 6dBSPL, loudness decreases a bit less than a half ✔
- f. In order to get a clear "half loudness" sensation, 10dBSPL jumps should have been used ✔
- g. When intensity decreases by 6dBSPL, loudness is halved
- h. A 1dB decrease is close to the JND for loudness for mid and high-frequency tones or broadband noises ✔

Les respostes correctes són: When intensity decreases by 6dBSPL, loudness decreases a bit less than a half, In order to get a clear "half loudness" sensation, 10dBSPL jumps should have been used, A 1dB decrease can be barely perceivable when loudspeakers are used, A 1dB decrease is close to the JND for loudness for mid and high-frequency tones or broadband noises

Pregunta **3**

Correcte

Puntuació 1,00 sobre 1,00

Decibels

Listen to this sound example containing 2 pairs of tones (TL.wav)

and **decide which loudness difference and dB difference could be in the first and in the second pair**. Tones 1 and 3 have the same intensity. Tones 2 and 4 vary with respect to 1-3.

Trieu-ne una o més:

- [ ] a. 10dBSPL in both cases. The same loudness change happened
- [ ] b. 3dBSPL for the first pair, 6dBSPL for the second. The fourth tone sounds as being twice louder than the third tone
- [ ] c. -6dBHL and -10dBHL respectively. Loudness doubled in the second pair only
- [ ] d. 10dBSPL for the first pair and 20dBSPL for the second. Loudness doubled for the first pair
- [x] e. 6dBSPL for the first pair, 10dBSPL for the second. The fourth tone sounds as being twice louder than the third tone ✔
- [ ] f. 6dbSPL and 12dBSPL respectively. Loudness increased more than twice in the second pair

La resposta correcta és: 6dBSPL for the first pair, 10dBSPL for the second. The fourth tone sounds as being twice louder than the third tone

Pregunta **4**

Correcte

Puntuació 1,00 sobre 1,00

Intensity, loudness and distance

In this example, a voice is heard at distances of 25, 50, 100, and 200 cm from an omni-directional microphone in an anechoic chamber. Under these conditions, the sound pressure level decreases about 6 dB each time the distance is doubled. [In a normal room this will not be the case, because of reflections from walls, ceiling, floor, and objects in the room.]

Now you are going to listen to an example of the loudness changes when the sound source is moved away. First it will be at 0.25 metres, then at 0.50 metres, then at 1 metre, and finally at 2 metres.

Play the sound example (02-02.wav)

and try to subjectively quantify how much loudness decreases as we double the distance from the sound source.

Trieu-ne una:

- (•) a. Everytime we double the distance it decreases about less than a half ✔
- ( ) b. When we move from 50 to 100 it decreases much more than from 25 to 50 as the distance is longer
- ( ) c. Everytime we double the distance it decreases just a bit
- ( ) d. Everytime we double the distance it decreases a half, as it is reduced 6dBSPL
- ( ) e. Everytime we double the distance it decreases 10dB SPL, to say the least

La resposta correcta és: Everytime we double the distance it decreases about less than a half

Pregunta **5**

Completa

Puntuació 1,00 sobre 1,00

Loudness scaling

Establishing a scale of subjective loudness requires careful psychoacoustical experimentation involving large numbers of subjects. A scale of sones has been used widely to describe subjective loudness. On this scale, the loudness in sones S is proportional to sound pressure p raised to the 0.6 power: S = Cp^0.6, where C depends on the frequency. In other words, the loudness doubles for about a 10 dB increase in sound pressure level. Some investigators have found that the exponent varies with tone frequency, increasing at low frequency and low level to approach a value of 1.0. [An exponent of 1.0 would mean that loudness doubled for a 6 dB increase in sound pressure level instead of the usual 10 dB].

In this demonstration, a reference sound of broadband noise alternates with similar noises having levels of 0, +/-5, +/10, +/15, +/20 dB with respect to the reference tone. The tones are 1 second long, separated by 250 ms of quiet, and the trials are separated by 2.25 s of quiet (RefTone - 250ms - ToneToRate - 2250ms). Think of the reference tone as having a loudness of "100". Then a test tone you hear as twice as loud as the reference tone would be designated as "200", and a test tone half as loud as the reference would be "50", etc. For each of the 20 pairs, write down a number reflecting the loudness of the second (test) tone relative to the reference. To help to establish a sense of scale in this example (NIVELLS.SND) the reference tone is first presented along with the strongest and weakest sound that will be heard.

Then you can start listening to the pairs (EXEMPLE2.WAV)

and assigning them a value according to the proposed numerical convention. When you have finished, please use this list of values (corresponding to the real levels used in the series you have just listened to) to relate the physical levels with your subjective values. You can paste below a data table linked here (i.e., showing that when it was +10 you wrote, maybe "200", and that when it was -20 you maybe wrote "25"). In addition, paste a plot that uses the data (maybe after some re-arranging) to show the relationship between the physical changes of intensity and the subjective judgements. You can indeed use a file in the cloud if it is more convenient to you.

Item #	dBSPL difference	your rating
1	15	100
2	-5	80
3	-20	30
4	0	100
5	-10	70
6	20	200
7	5	110
8	10	150
9	-15	50
10	0	100
11	-10	75
12	15	200
13	20	250
14	-5	90
15	10	110
16	-15	90
17	-5	100
18	-20	50
19	5	100
20	15	110

Graph: https://drive.google.com/file/d/16BJ7WUef1goFwBCrvOQ_pZPOd1XQB_YE/view?usp=share_link

Pregunta **6**

Completa

Puntuació 1,00 sobre 1,00

Equal loudness curves (Frequency response of the ear)

Although sounds with greater sound pressure level usually sound louder, this is not always the case. The sensitivity of the ear varies with the frequency and the quality of the sound. In their famous experiments of 1933, Fletcher and Munson determined curves of equal loudness for pure tones, demonstrating the relative insensitivity of the ear to sounds of low frequency at moderate to low intensity levels. Hearing sensitivity reaches a maximum around 4000 Hz, which is near the first resonance frequency of the outer ear canal, and again peaks around 12 kHz, the frequency of the second resonance.

In this demonstration, we compare the thresholds of audibility (in a room) for tones having frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 Hz. The tones are 100 ms in length and decrease in 10 steps of -5 dB each. Each sequence will be repeated twice. *Count the number of steps you hear at each frequency.*

But before starting, please calibrate the volume of your headphones with the following test-tone (CALIBRA.SND) in order that it is just audible (nearly inaudible).

Once you have done the calibration, proceed with the tones (EXEMPLE3.SND). Count and note down how many tones you can hear for each frequency and paste the results here.

125: 10 tones

250: 10 tones

500: 10 tones

1000: 10 tones

2000: 10 tones

4000: 10 tones

8000: 10 tones

Pregunta **7**

Correcte

Puntuació 1,00 sobre 1,00

Equal loudness curves (Frequency response of the ear)

When you have pasted your results please **select the answers below that are correct**.

Trieu-ne una o més:

- [x] a. I heard more tones for the central frequencies than for the high and low extremes ✔
- [x] b. Overall, the pattern resembles what the equal-loudness curves illustrate ✔
- [ ] c. High frequencies tend to be perceived with more difficulties than lower ones
- [ ] d. All the frequencies can be perceived with roughly the same difficulty

Les respostes correctes són: Overall, the pattern resembles what the equal-loudness curves illustrate, I heard more tones for the central frequencies than for the high and low extremes

Informació

In order to answer to the next questions, please use this up-to-date equal-loudness curve graph, which corresponds to the ISO 226:2003

Pregunta **8**

Correcte

Puntuació 1,00 sobre 1,00

Which is the loudness level of a pure tone of 200 Hz. at 33 dBSPL?

Trieu-ne una:

- a. Exactly the same than a 100Hz tone at 33dB SPL
- b. 20dB SPL
- c. 20 phon approximately ✔
- d. We do not have enough data to compute that

La resposta correcta és: 20 phon approximately

Pregunta **9**

Correcte

Puntuació 1,00 sobre 1,00

Which is the dB level of a pure tone of 4000 Hz that is isophonic with another of 8000 Hz at 53 dB?

Trieu-ne una o més:

- a. Even without a table or graph we could be sure that it will be more than 53 dBSPL
- b. We need more data to calculate it
- c. 53dB SPL approximately
- d. 36dB SPL approximately ✔
- e. Even without a table or graph we could be sure that it will be less than 53 dBSPL ✔

Les respostes correctes són: 36dB SPL approximately, Even without a table or graph we could be sure that it will be less than 53 dBSPL

Pregunta **10**

Correcte

Puntuació 1,00 sobre 1,00

Which should be the dB values to be set on an equalizer in order that the frequencies (in Hz) 125, 250, 500, 1000, 2000, 4000, and 8000 would have the same loudness level, if we would be listening at 80 dB_{SPL}? (and using a reference for those values 0 dB at 1000Hz –i.e., at 1000Hz the EQ would be set "flat", not amplifying, not attenuating-)?

Trieu-ne una o més:

- a. +80dB SPL in all cases
- b. +0dB in all cases
- c. +10, +3, 0, 0, 0, -1, +12 respectively and approximately ✔
- d. +20, +6, -1, 0, 0, -2, +24 respectively and approximately
- e. -10, -3, 0, 0, 0, +1, -12 respectively and approximately

La resposta correcta és: +10, +3, 0, 0, 0, -1, +12 respectively and approximately

Pregunta **11**

Correcte

Puntuació 1,00 sobre 1,00

With the help of the isophones, calculate the level (in dB_{SPL}) resulting after simultaneously playing 3 pure tones of 100, 1000 and 10000 Hz, in case each one would generate a loudness sensation of 20 phone (we will suppose coherent sources, i.e., all the tones reach our ears in phase).

Trieu-ne una:

- a. The sounds will have, respectively 46, 20 and 35 dBSPL, and then the combination will yield 48.5 dBSPL approximately ✔
- b. The sounds will have, respectively 50, 20 and 50 dBSPL, and then the combination will yield 56.1 dBSPL approximately
- c. The sounds will have, respectively 46, 20 and 35 dBSPL, and then the combination will yield 46.3 dBSPL approximately
- d. The sounds will have, respectively 46, 20 and 35 dBSPL, and then the combination will yield 101 dBSPL approximately
- e. The sounds will have 20 dB SPL each, so they will generate 60 dBSPL

La resposta correcta és: The sounds will have, respectively 46, 20 and 35 dBSPL, and then the combination will yield 48.5 dBSPL approximately

Pregunta **12**

Correcte

Puntuació 1,00 sobre 1,00

We have seen that in order to get a sensation of doubling or halving loudness we need a sound pressure level change of 10 dBSPL. By inspecting the curves, **do you think this value holds for any frequency?**

Trieu-ne una:

- a. We cannot tell. We would need to look at Sones curves
- b. This only holds for low listening levels (e.g. < 60 phon)
- c. Yes. This is a perceptual constant
- d. No. For low frequencies the curves are closer than for 1kHz. This means that you achieve double or half loudness sensations when you apply higher-than-10dBSPL changes
- e. No. For low frequencies the curves are closer than for 1kHz. This means that you achieve double or half loudness sensations with less that 10dB changes ✔

La resposta correcta és: No. For low frequencies the curves are closer than for 1kHz. This means that you achieve double or half loudness sensations with less that 10dB changes

Pregunta **13**

Correcte

Puntuació 1,00 sobre 1,00

Temporal Integration

How does the loudness of an impulsive sound compare with the loudness of a steady sound at the same sound level? Numerous experiments have pretty well established that the "ear" averages sound energy over about 0.2 s (200 ms), so loudness grows with duration up to this value, loudness level increasing by 10 dB when the duration is increased by a factor of 10. The loudness level of broadband noise seems to depend somewhat more strongly on stimulus duration than the loudness level of pure tones.

In this demonstration (EXEMPLE9.SND), bursts of broadband noise having durations of 1000, 300, 100, 30, 10, 3, and 1 ms are presented at 8 decreasing levels (0 –or reference level for listening-, -16, -20, -24, -28, -32, -36, and -40 dB) in the presence of a broadband masking noise. *Count the number of steps you are able to hear in each case and prepare a table or plot to be pasted in another question.* ***Now select the option(s) that best represent what you have perceived.***

Trieu-ne una o més:

- [ ] a. Loudness does not change as the duration is shortened
- [x] b. Loudness of sounds shorter than 150ms is reduced because the brain needs more time to integrate the energy ✔
- [ ] c. Loudness decreases for sounds shorter than 500ms.
- [ ] d. Loudness decreases as the length of the sound decreases
- [ ] e. Loudness is increased only for very long sounds
- [ ] f. Loudness increases as duration decreases
- [x] g. Loudness progressively decreases only for very short durations ✔

Les respostes correctes són: Loudness progressively decreases only for very short durations, Loudness of sounds shorter than 150ms is reduced because the brain needs more time to integrate the energy

Pregunta **14**

Completa

Puntuació 1,00 sobre 1,00

Temporal integration

Now paste below your table or plot and interpret your data

Once the duration of of the noise gets shorter, its harder to listen to the steps that are under -30dB

Graph: https://drive.google.com/file/d/1-2CuoDTHFOY45d0kv-ngXBSgoTlsc2_U/view?usp=share_link

Pregunta **15**

Correcte

Puntuació 1,00 sobre 1,00

Complex loudness

In this last example (ComplexLoudness.wav)

you will be presented 3 different tones.

Select the sentences that are correct, according to your sensation and what we know about loudness. You can save the file and look at the spectra of the 3 tones in order to better understand what is involved in the experience.

Trieu-ne una o més:

- [x] a. The magnitudes of the partials in the second and third sound are the same, but their frequency separation is not; some components of the second sound could be sharing the same CB and hence they will not independently contribute (sum up) to the loudness sensation ✔
- [ ] b. The second tone and the third tone are isophonic whereas the first one, as it only contains a single harmonic, sounds softer
- [x] c. The loudness of the third tone could be the biggest one because its partials were more separated than those of the second tone ✔
- [ ] d. The 3 tones are isophonic
- [ ] e. The three tones of the example are complex tones

Les respostes correctes són: The loudness of the third tone could be the biggest one because its partials were more separated than those of the second tone, The magnitudes of the partials in the second and third sound are the same, but their frequency separation is not; some components of the second sound could be sharing the same CB and hence they will not independently contribute (sum up) to the loudness sensation

◄ Lab 2 - Masking Lab

Salta a...

Lab 4: Pitch Lab ►