frequency comparison

2024-08-23

results overview

these are the results for frenquencies [100, 330, 500, 800, 1000, 10000] * Hz, for two different HRTFs . all other parameters are kept the same. refractory period was kept as 1ms.

LSO

this HRTF's preference for the right LSO to the left is reflected accordingly in the ITD plot: the left era always receives a lower level stimulus for all angles attempted. this is strange, but it may be due to a mistake in creation of the HRTF.

```
SHOW_RATE_VS_ANGLE_LSO = True
SHOW_RATE_VS_ANGLE_MSO = True
SHOW_ITD_ILD = True
SHOW_ADDITIONAL_STATS = False
SHOW_PARAMS = False
```

```
%load_ext autoreload
%autoreload 2
import dill
import numpy as np
import matplotlib.pyplot as plt
import os
from pathlib import Path
from os import listdir
from os.path import isfile, join
from sorcery import dict_of
import pprint
import IPython
import consts as C
from utils.log import logger
from cochleas.RealisticCochlea import run_hrtf
from analyze import sound_analysis as SA
from utils.custom_sounds import Tone
import logging
```

```
2024-08-23 19:26:12,961 [INFO ]

>>>>> start execution
```

```
# scan results folder, default values for figures
# only show results from this "frozen" folder
results_dir    =    Path(IPython.extract_module_locals()[1]
["__vsc_ipynb_file__"]).parent
files = [
    f
    for f in listdir(results_dir)
    if isfile(join(results_dir, f)) and f.endswith(".pic")
]
files.sort()
selected_files = []

ax = None

plt.rcParams["axes.grid"] = True
plt.rcParams["figure.figsize"] = (6, 3)
```

```
def draw_rate_vs_angle(data, filename, show_lso=True, show_mso=True):
    angle_to_rate = data["angle_to_rate"]
    name = data["conf"]["model_desc"]["name"]
    sound_key = data["conf"]["sound_key"]
    # cochlea = data["conf"]["cochlea_type"]

    angles = list(angle_to_rate.keys())

    def average_firing_rate(x):
        active_neurons = set(x['senders'])
        return (
            (len(x["times"]) / len(active_neurons)) if len(active_neurons) >= 0
else 0
        )

    arr_n_spikes_r_lso = [
       average_firing_rate(x["R"]["LSO"]) for angle, x in angle_to_rate.items()
    ]
    arr_n_spikes_l_lso = [
       average_firing_rate(x["L"]["LSO"]) for angle, x in angle_to_rate.items()
    ]
    arr_n_spikes_r_mso = [
       average_firing_rate(x["R"]["MSO"]) for angle, x in angle_to_rate.items()
    ]
    arr_n_spikes_l_mso = [
       average_firing_rate(x["L"]["MSO"]) for angle, x in angle_to_rate.items()
    ]

    lso = {
        "spikes": [arr_n_spikes_r_lso, arr_n_spikes_l_lso],
```

```
        "show": show_lso,
        "label": "lso",
    }
    mso = {
        "spikes": [arr_n_spikes_r_mso, arr_n_spikes_l_mso],
        "show": show_mso,
        "label": "mso",
    }
    data = []
    for i in [lso, mso]:
        if i["show"]:
            data.append(i)
    num_subplots = len(data)
    fig, ax = plt.subplots(num_subplots, figsize=(8, 2 * num_subplots))
    if type(ax) is not np.ndarray:
        ax = [ax]
    for axis, d in zip(ax, data):
        axis.plot(angles, d["spikes"][0], ".-", label=f"right {d["label"]}")
        axis.plot(angles, d["spikes"][1], ".-", label=f"left {d["label"]}")
        axis.set_ylabel("avg spk/sec (Hz)")
        _ = axis.legend()
    # fig.suptitle(f"{name} with {sound_key}")
    plt.suptitle(filename)
    plt.setp([ax], xticks=angles)

    plt.tight_layout()
    plt.show()
    return fig


def draw_ITD_ILD(data, selected):
    previous_level = logger.level
    # itd and ild functions are VERY verbose
    logger.setLevel(logging.WARNING)
    tone: Tone = data["basesound"]
    angle_to_ild = {}
    angle_to_itd = {}
    angles = list(data["angle_to_rate"].keys())
    for angle in angles:
        binaural_sound = run_hrtf(
            tone,
            angle,
            data["conf"]["parameters"]["cochlea"]["realistic"]["subj_number"],
        )
        left = binaural_sound.left
        right = binaural_sound.right
        angle_to_itd[angle] = SA.itd(left, right)
        ild_res, all_freq_diff = SA.ild(left, right, tone.sound)
```

```
        angle_to_ild[angle] = ild_res
        # total_diff = np.sum(all_freq_diff)

    fig, ild = plt.subplots(1, sharex=True, figsize=(8, 1.8))
    fig.suptitle(
                        f"diff   =   max(|spectrum(left)|)-max(|spectrum(right)|),
freq={tone.frequency}"
    )

    ild.set_ylabel("Power (dB/Hz)", color="r")
    ild.plot(
        angles,
        [angle_to_ild[angle] for angle in angles],
        label="ILD",
        marker=".",
        color="r",
    )
    ild.tick_params(axis="y", labelcolor="r")
    itd = ild.twinx()
    itd.set_ylabel("seconds", color="b")
    itd.plot(
        angles,
        [angle_to_itd[angle] for angle in angles],
        label="ITD",
        marker=".",
        color="b",
    )
    itd.tick_params(axis="y", labelcolor="b")
    _ = fig.legend()

    fig.tight_layout()
    # plt.subplots_adjust(hspace=0.6, wspace=1)
    plt.setp([ild, itd], xticks=angles)
    plt.show()
    logger.setLevel(previous_level)
    return fig


def show_stats(data):
    total_spikes_R_LSO = sum(
                           [len(x["R"]["LSO"]["times"])   for   angle,   x   in
data["angle_to_rate"].items()]
    )
    total_spikes_L_LSO = sum(
                           [len(x["L"]["LSO"]["times"])   for   angle,   x   in
data["angle_to_rate"].items()]
    )
    total_spikes_R_MSO = sum(
```

```
                        [len(x["R"]["MSO"]["times"])   for   angle,   x   in
data["angle_to_rate"].items()]
    )
    total_spikes_L_MSO = sum(
                        [len(x["L"]["MSO"]["times"])   for   angle,   x   in
data["angle_to_rate"].items()]
    )
    print(
        dict_of(
            total_spikes_R_LSO,
            total_spikes_L_LSO,
            total_spikes_R_MSO,
            total_spikes_L_MSO,
        )
    )


def show_selected_info(selected):
    with open(join(results_dir, selected), "rb") as f:
        res = dill.load(f, ignore=True)
        print(
            f"""\
    name  : {res['conf']['model_desc']['name']}
    sndkey: {res['conf']['sound_key']}
    coctyp: {res['conf']['cochlea_type']}
              params:   {pprint.pformat(res['conf']['parameters'],   width=10,
sort_dicts=False)}"""
        )
```

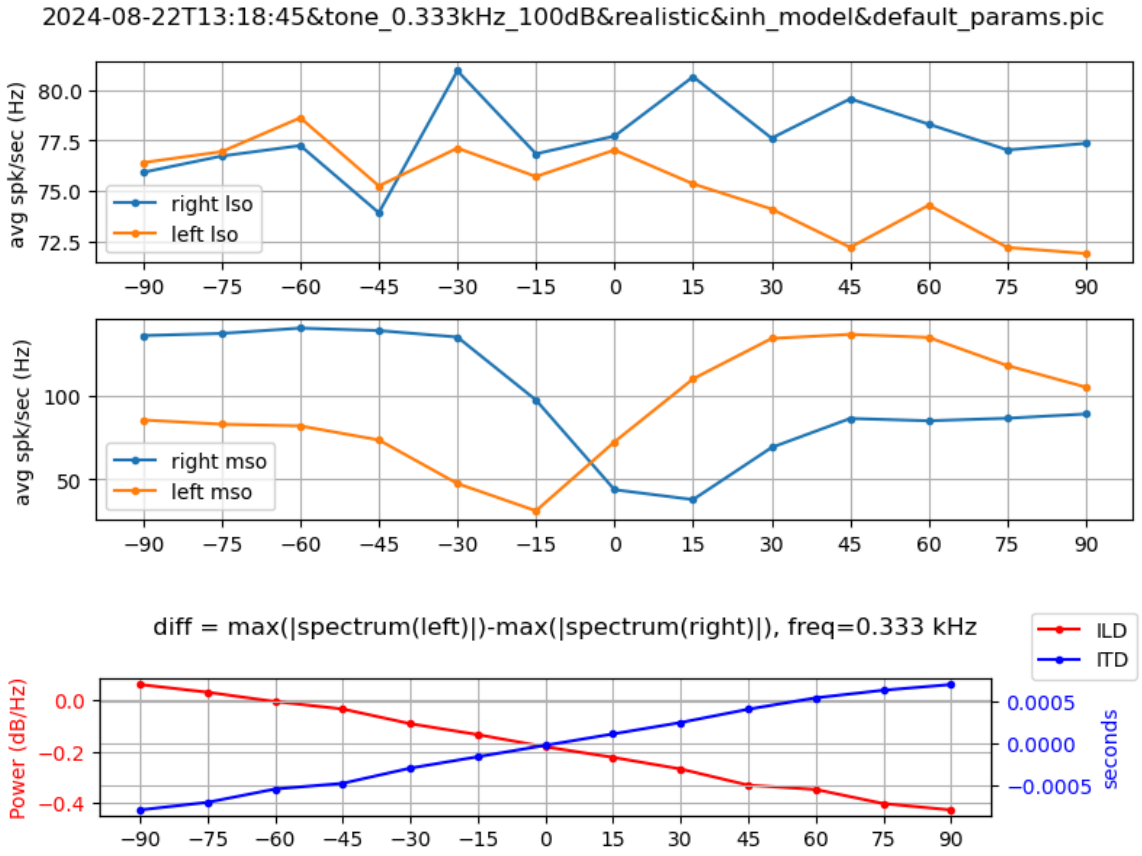
Parameters are the same for all these results, the only thing that changes is the frequency of the tone. Here are all parameters, followed by graphs for all frequencies. Sorry that they aren't ordered.

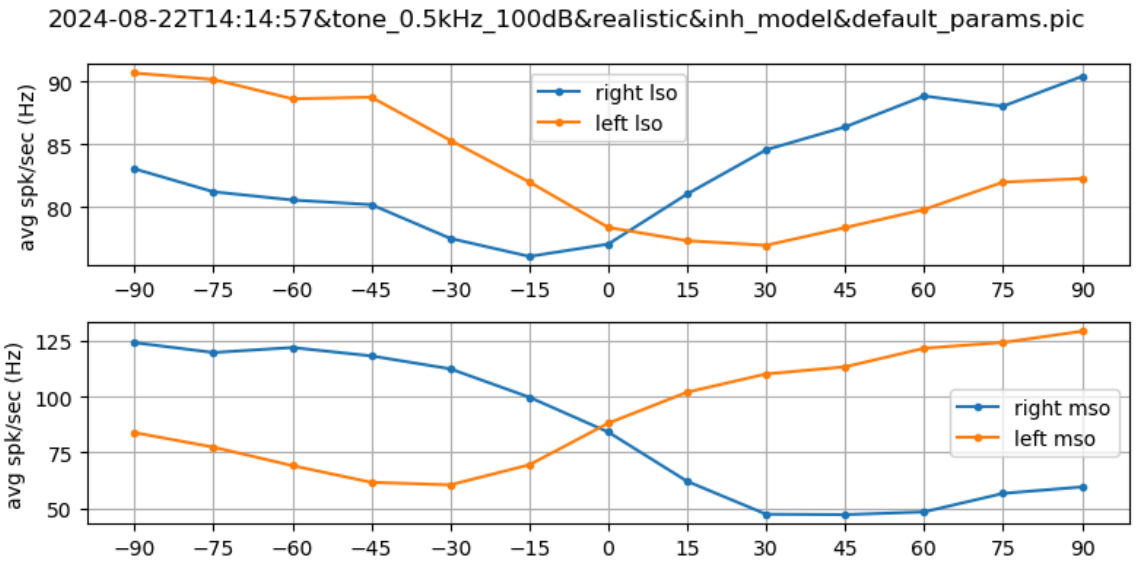
```
with open(join(results_dir,files[1]), 'rb') as f:
    res = dill.load(f, ignore=True)
    show_selected_info(files[1])
for selected in files:
    with open(join(results_dir, selected), "rb") as f:
        res = dill.load(f, ignore=True)
        if SHOW_RATE_VS_ANGLE_LSO or SHOW_RATE_VS_ANGLE_MSO:
            draw_rate_vs_angle(res, selected, SHOW_RATE_VS_ANGLE_LSO,
SHOW_RATE_VS_ANGLE_MSO)
        if SHOW_ITD_ILD:
            draw_ITD_ILD(res, selected)
        if SHOW_ADDITIONAL_STATS:
            show_stats(res)
```

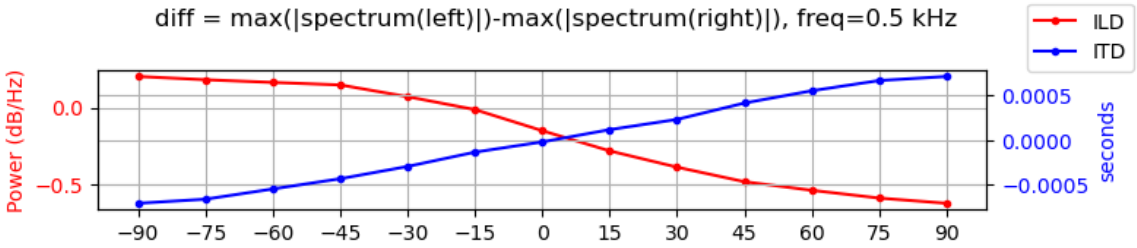
```
        if SHOW_PARAMS:
            show_selected_info(selected)
```

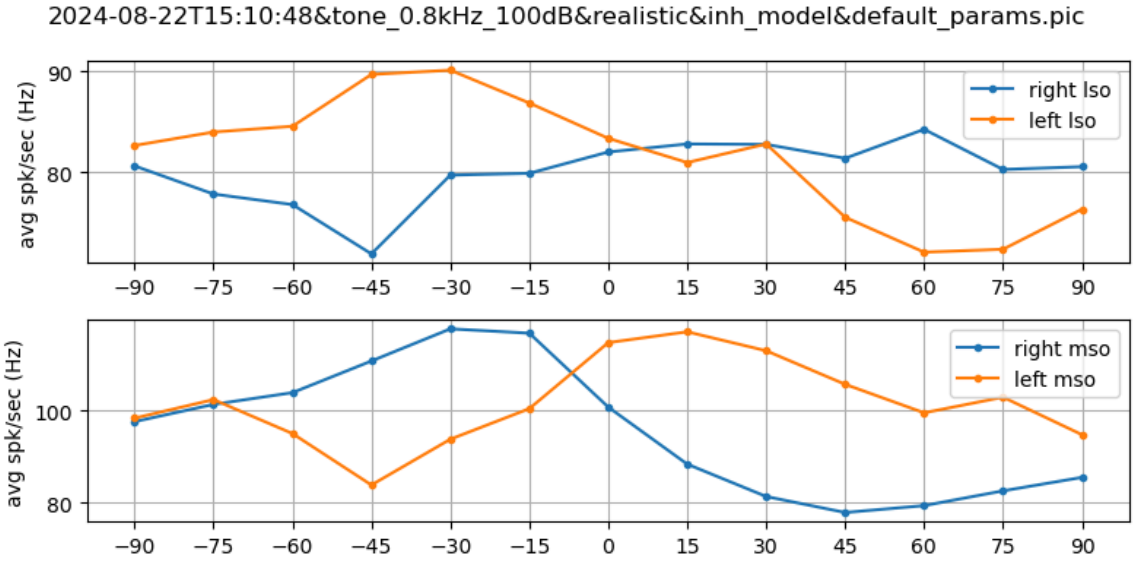
```
   name  : Inhibitory model, mso iaf_cond_beta
   sndkey: tone_0.5kHz_100dB
   coctyp: realistic
   params: {'key': 'default_params',
'cochlea': {'realistic': {'subj_number': 0,
                          'noise_factor': 0.2,
                          'refractory_period': 1},
           'ppg': {}},
'n_ANFs': 35000,
'SBCs2MSOs': 5,
'SBCs2LSOs': 5,
'n_SBCs': 8750,
'n_GBCs': 1750,
'n_MSOs': 1750,
'n_inhMSOs': 1750,
'V_m': -70,
'V_reset': -70,
'C_m_sbc': 1,
'C_m_gcb': 1,
'cap_nuclei': 1,
'C_mso': 1,
'CONFIG': {'STORE_POPS': {'ANF',
                          'GBC',
                          'LSO',
                          'MNTBC',
                          'MSO',
                          'SBC'},
           'NEST_KERNEL_PARAMS': {'resolution': 0.1,
                                  'rng_seed': 42}},
'DELAYS': {'GBCs2MNTBCs': 0.45,
           'SBCs2MSO_exc_ipsi': 1,
           'SBCs2MSO_inh_ipsi': 1.3,
           'SBCs2MSO_exc_contra': 1,
           'MNTBCs2MSO_inh_contra': 0.44,
           'LNTBCs2MSO_inh_ipsi': 1.3},
'SYN_WEIGHTS': {'ANFs2SBCs': 16.0,
                'ANFs2GBCs': 8.0,
                'SBCs2MSO': 1,
                'SBCs2MSO_inh': -30,
                'SBCs2LSO': 8.0,
                'MNTBCs2MSO': -30,
                'GBCs2MNTBCs': 16.0,
                'MNTBCs2LSO': -2.0},
'POP_CONN': {'ANFs2SBCs': 4,
```

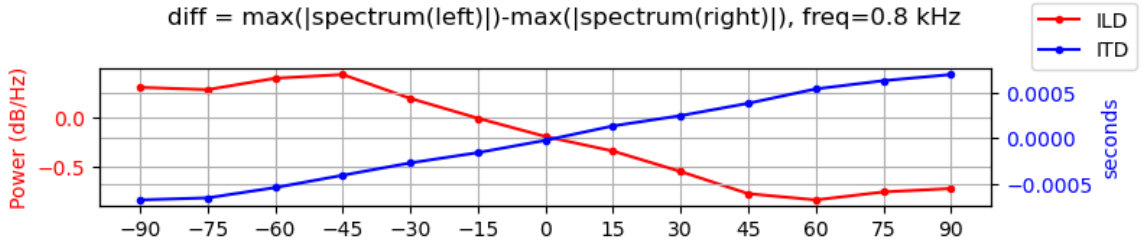
```
             'ANFs2GBCs': 20},
 'MSO_TAUS': {'rise_ex': 0.2,
              'rise_in': 0.1,
              'decay_ex': 0.5,
              'decay_in': 0.1}}
```

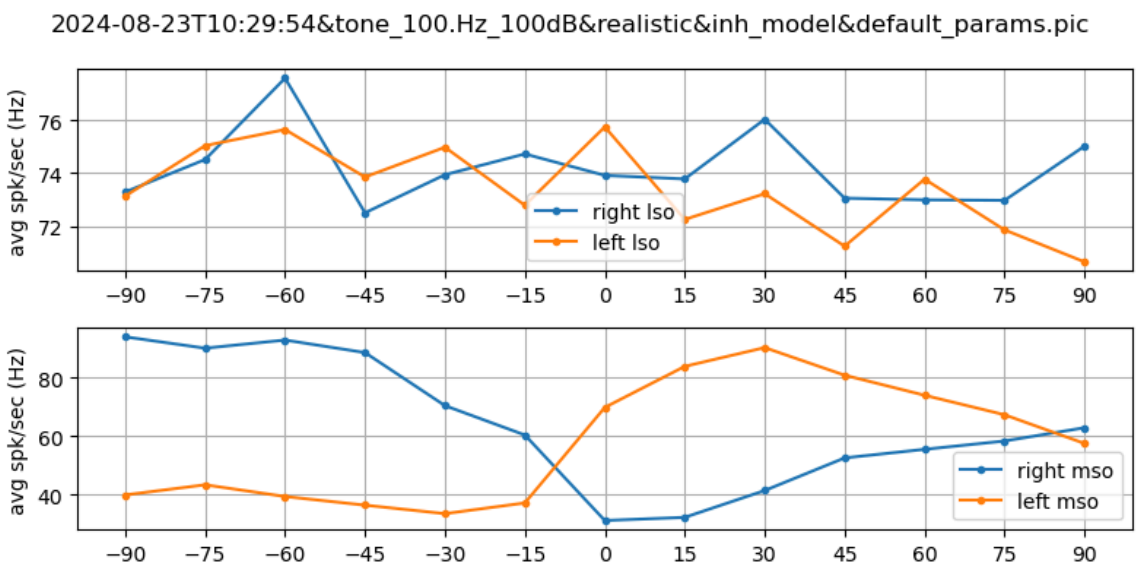


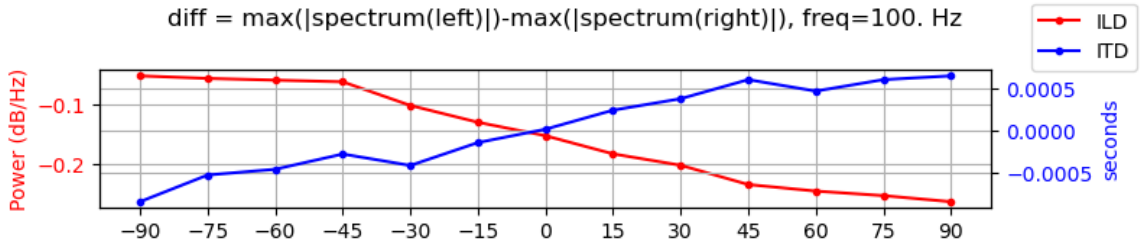

2024-08-22T14:14:57&tone_0.5kHz_100dB&realistic&inh_model&default_params.pic
avg spk/sec (Hz)
right lso
left lso
avg spk/sec (Hz)
right mso
left mso

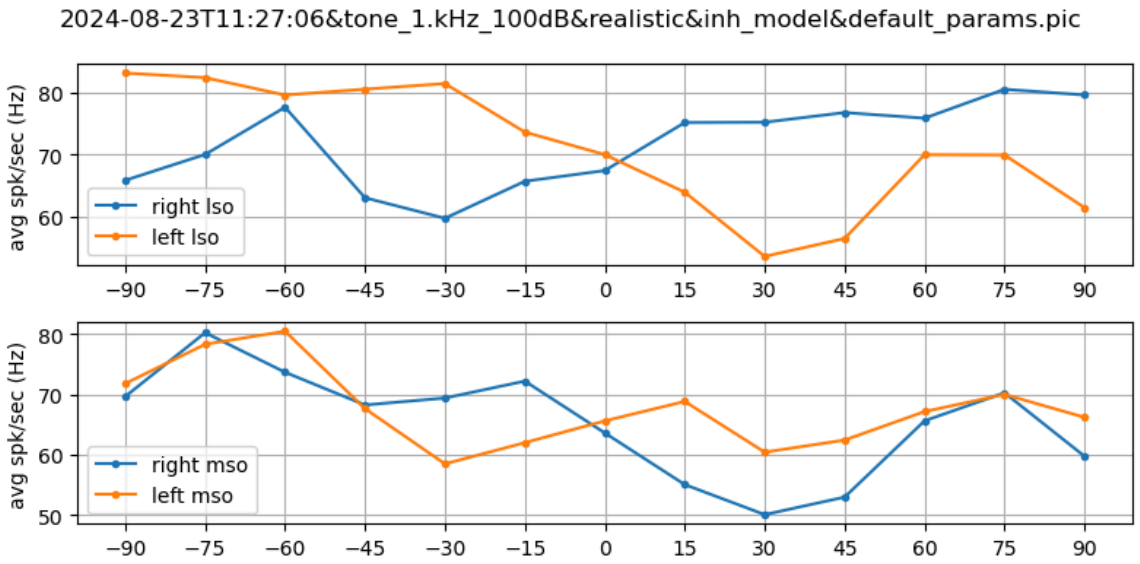

diff = max(|spectrum(left)|)-max(|spectrum(right)|), freq=0.5 kHz
ILD
ITD
Power (dB/Hz)
seconds

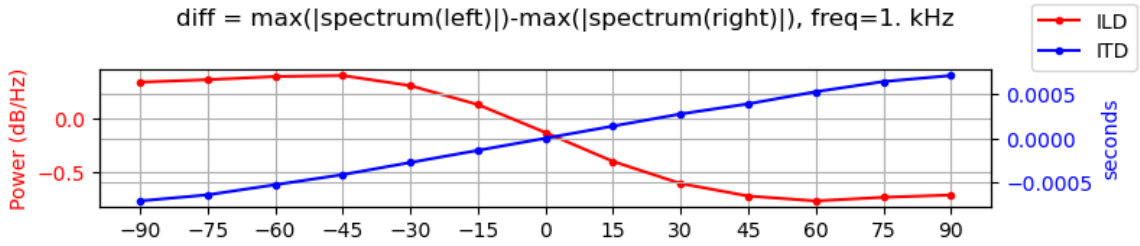

2024-08-22T15:10:48&tone_0.8kHz_100dB&realistic&inh_model&default_params.pic
avg spk/sec (Hz)
right lso
left lso
avg spk/sec (Hz)
right mso
left mso

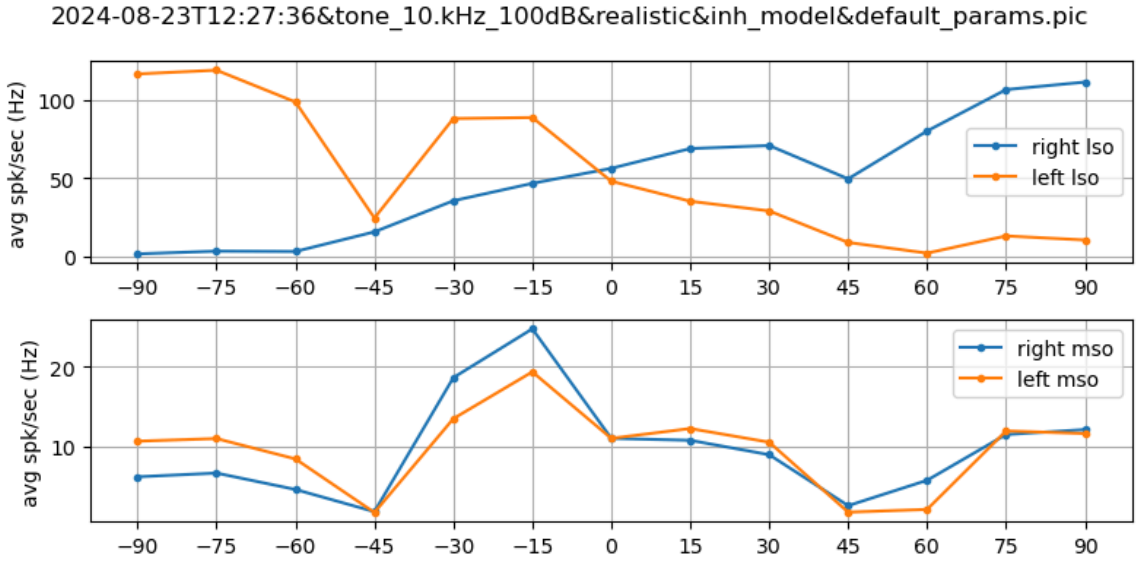

diff = max(|spectrum(left)|)-max(|spectrum(right)|), freq=0.8 kHz
ILD
ITD
Power (dB/Hz)
0.0
−0.5
0.0005
0.0000
−0.0005
seconds
−90 −75 −60 −45 −30 −15 0 15 30 45 60 75 90

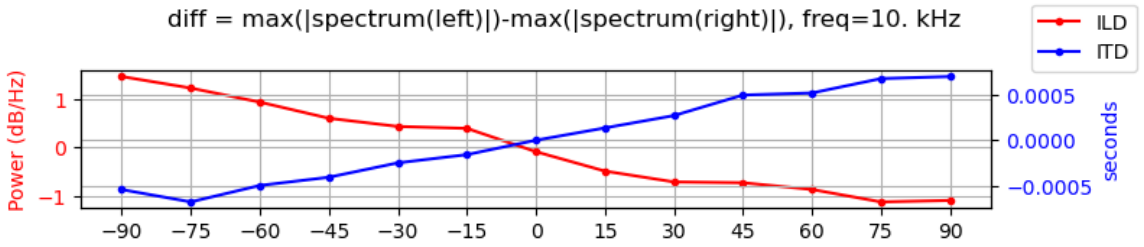

2024-08-23T10:29:54&tone_100.Hz_100dB&realistic&inh_model&default_params.pic
avg spk/sec (Hz)
76
74
72
right lso
left lso
−90 −75 −60 −45 −30 −15 0 15 30 45 60 75 90
avg spk/sec (Hz)
80
60
40
right mso
left mso
−90 −75 −60 −45 −30 −15 0 15 30 45 60 75 90


diff = max(|spectrum(left)|)-max(|spectrum(right)|), freq=100. Hz
ILD
ITD
Power (dB/Hz)
−0.1
−0.2
0.0005
0.0000
−0.0005
seconds
−90 −75 −60 −45 −30 −15 0 15 30 45 60 75 90


2024-08-23T11:27:06&tone_1.kHz_100dB&realistic&inh_model&default_params.pic
avg spk/sec (Hz)
right lso
left lso
right mso
left mso
−90 −75 −60 −45 −30 −15 0 15 30 45 60 75 90


diff = max(|spectrum(left)|)-max(|spectrum(right)|), freq=1. kHz
ILD
ITD
Power (dB/Hz)
seconds
0.0
−0.5
0.0005
0.0000
−0.0005
−90 −75 −60 −45 −30 −15 0 15 30 45 60 75 90


2024-08-23T12:27:36&tone_10.kHz_100dB&realistic&inh_model&default_params.pic
avg spk/sec (Hz)
right lso
left lso
right mso
left mso
−90 −75 −60 −45 −30 −15 0 15 30 45 60 75 90


diff = max(|spectrum(left)|)-max(|spectrum(right)|), freq=10. kHz
ILD
ITD
Power (dB/Hz)
1
0
−1
0.0005
0.0000
−0.0005
seconds
−90
−75
−60
−45
−30
−15
0
15
30
45
60
75
90