How Do Local Neural Populations Know About the Predictability of Sound Sequences

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Introduction

- In a previous study, we proposed the generic deviance detection principle [1], where deviance detection can be divided into two stages: regularity formation and change detection.
- In this study, we focused on the regularity formation in sound sequences.

How is the predictability of sound sequence represented in the auditory cortex?

Methods

- Network structure
- Short-term plasticity (STP)
- Asymmetry Index (AI) of W
- Simulated MEG signal

MEG observations [2]

1. RMS amplitude correlates with predictability.
   - Regular(REG) vs. Random(RAND)

2. Gradual increase in RMS amplitude (RAND → REG).
3. Quick decrease in RMS amplitude (REG→RAND).
4. On/Off responses and mismatch response.

Goal

- To explain the MEG observations (1, 2, 3) in [2].
- To find the important ingredients that facilitate the regularity formation in local neural circuits.

Results

1. Neural activity & connection pattern
   - Time (ms)
   - Input sequence
   - MEG signal
   - Network structure

2. Simulated MEG signals
   - E to E current
   - E to I current

3. Contribution of short-term plasticity
   - (a) Regularity (REG)
   - (b) Random (RAND)

Discussion

- We explain the MEG observations (1, 2, 3) in [2] as below:
  - Regularity is encoded in the connection pattern via STP. Therefore, the RMS amplitude (RAND → REG) increases gradually (2), as the AI of W/E and W/E takes a few repetitions to reach its plateau. (Fig. 1d)
  - Regularity is represented by the neural activity. Therefore, the RMS amplitude (REG→RAND) decreases quickly (3), because the sound sequence does not fit the connection pattern. (Fig.1c)
  - The inhibitory activities contribute to the level shift in MEG amplitude. (Fig. 2)

- Important ingredients for regularity formation:
  - The STP term a (on W/E) contributes to the On responses.
  - The STP term c (on W/I) accounts for the RMS amplitude as a function of regularity (1,4). (Fig. 3d-i)
  - The STP term b (on W/E) additionally accounts for the RMS amplitude as a function of alphabet sizes (1,4). (Fig. 3g-i)

References

