

[#1924] Inferior colliculus activity correlates with the subjective unpleasantness of dissonant music

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Introduction

Dissonance, inferior colliculus, and unpleasantness

- Dissonant chords sound unpleasant; universal without exposure to Western polyphonic music [Fritz et al., 2009, Curr Biol]
- Frequency following response (FFR), mainly from inferior colliculus (IC), encodes dissonance [Bidelman et al., 2009, J Neurosci]

Individual differences in dislike of dissonance and IC structure and function

- The lower gray matter volume in IC, the more dislike of dissonance [Fritz et al., 2013, Eur J Neurosci]
- The higher agreement between FFR and natural harmonic series, the more dislike of dissonance [Bones et al., 2014, Neuropsychologia]

Research question

- Why not in BOLD signal?
- What about functional connectivity of the IC?

Hypothesis

- The more you dislike it, the less your IC processes it?
- Functional connectivity of the IC is reduced?

Methods

fMRI Data [Mueller et al., 2015, NI]

- **Participants:** 23 healthy adults
- **Stimuli:** 20 Consonant (original) vs. 20 dissonant musical excerpts
- **Design:** 30-s music listening followed by in-scanner subjective rating of each excerpt from 1="pleasant" to 4="very unpleasant"
- **Imaging:** Fast (TR=1s) EPI of the ventral half of brain

Index of dislike of dissonance

$$\Delta R = \frac{1}{20} \sum_{i=1}^{20} (R(d_i) - R(c_i))$$

$R(\cdot)$, subjective rating; $d(i)/c(i)$, the i -th dissonant/consonant excerpt

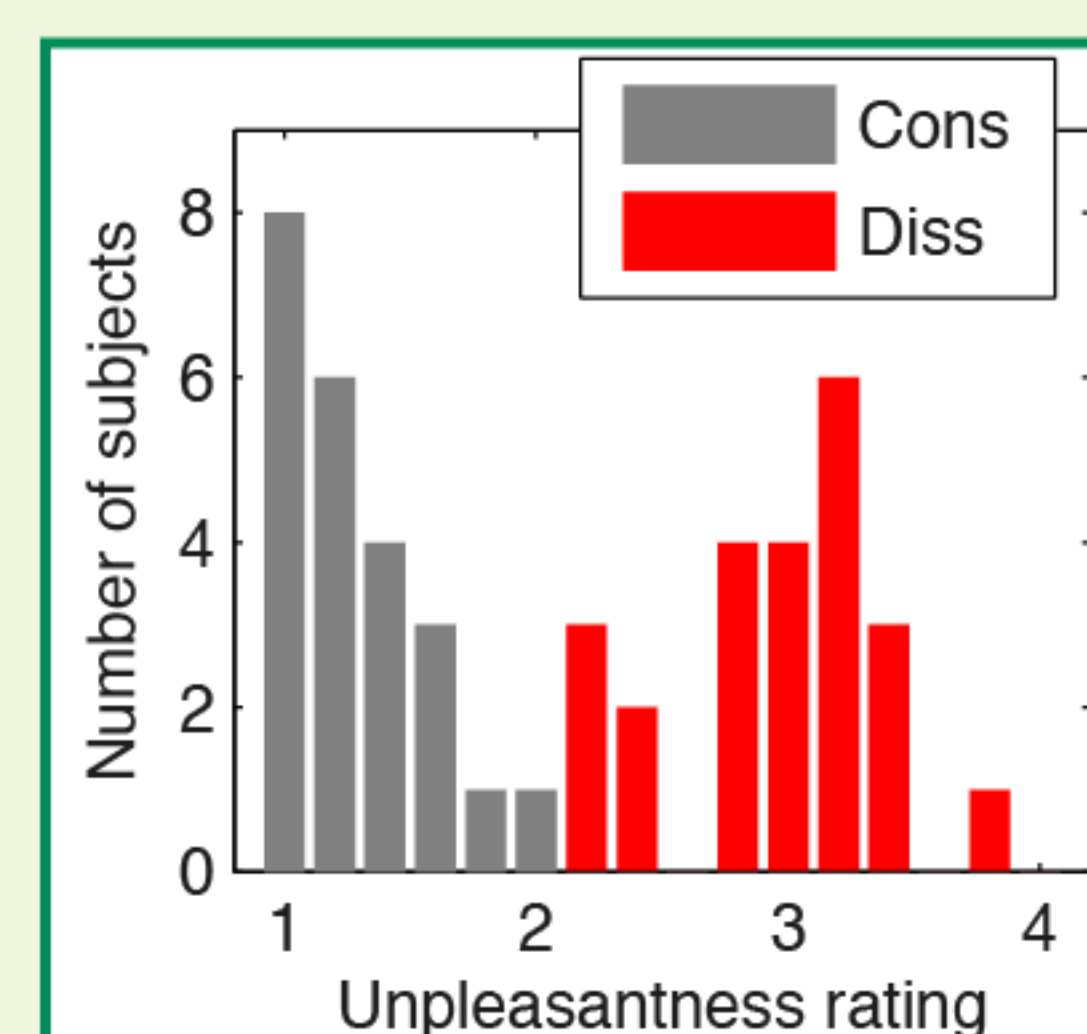
Neural response to dissonance (contrast image)

$$\Delta B = \hat{B}(d) - \hat{B}(c)$$

Modulation of functional connectivity (PPI)

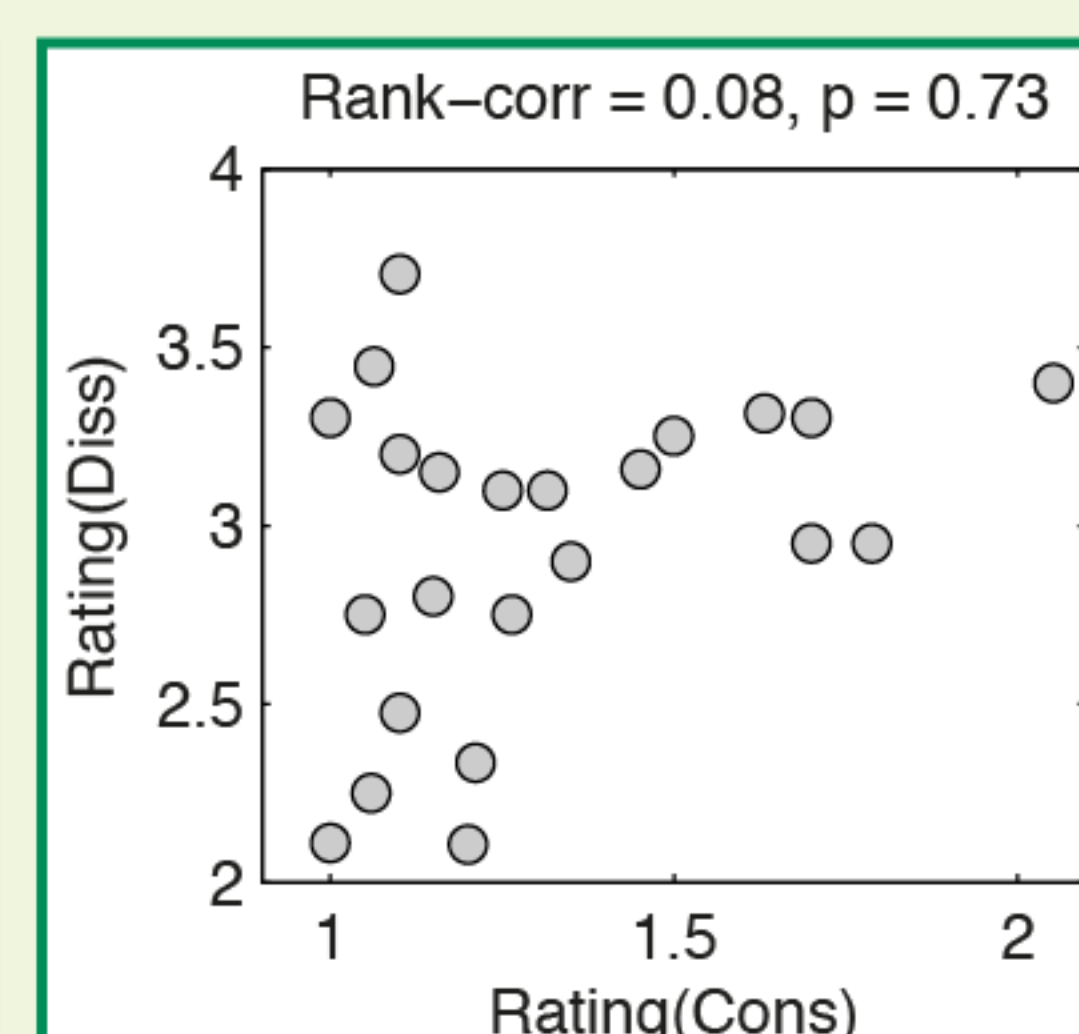
- (Diss. - Cons.) x Inf. colliculus

Subjective Rating of Unpleasantness



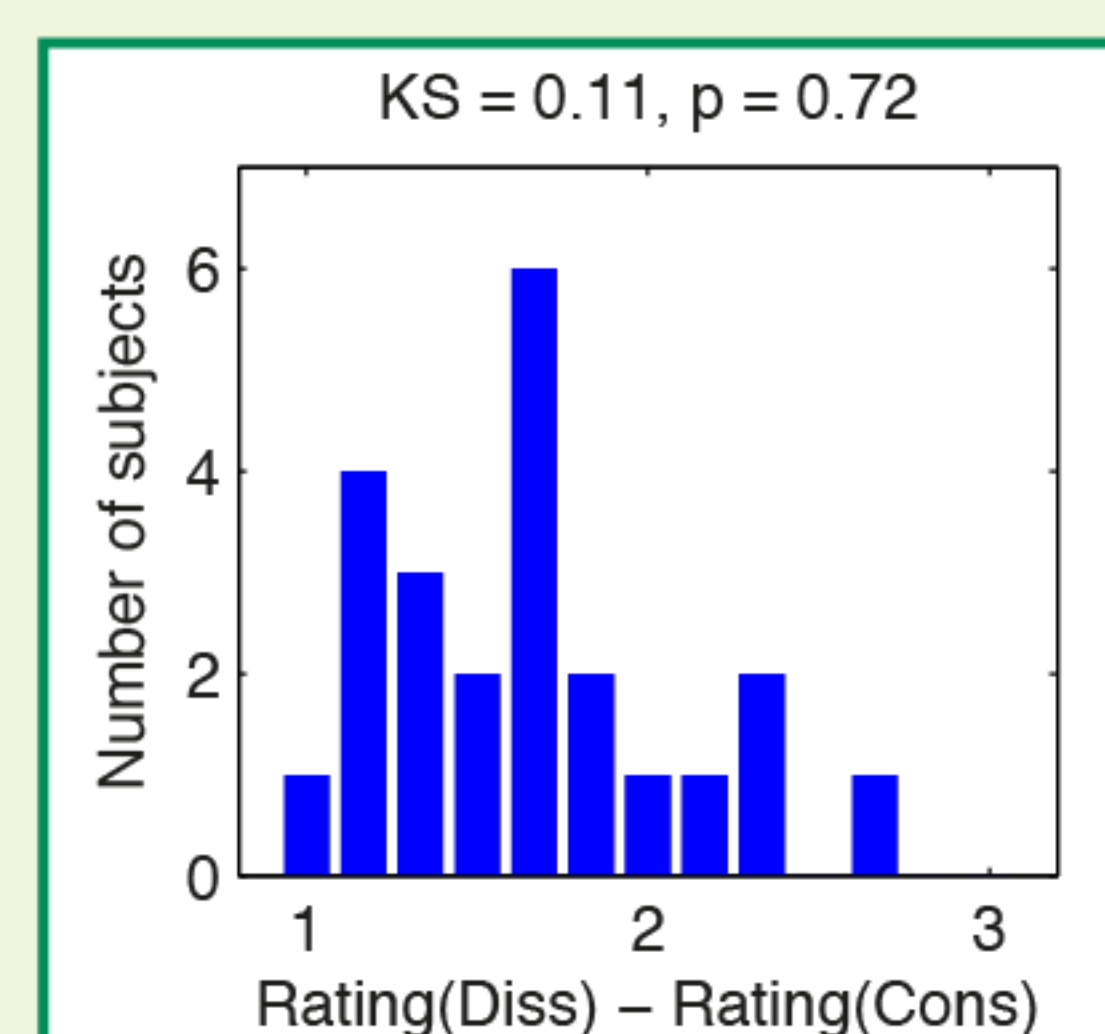
Individual differences in ratings of original musical excerpts

- Individual preference in musical styles (e.g., classical, swing, ethnic)



No rank correlation between ratings

- Dislike of dissonant harmony was not constant but varied across individuals



The index of dislike of dissonance (ΔR) formed normal distribution

- Mean ± std: 1.63 ± 0.43
- Range: [0.91, 2.61]

GLM

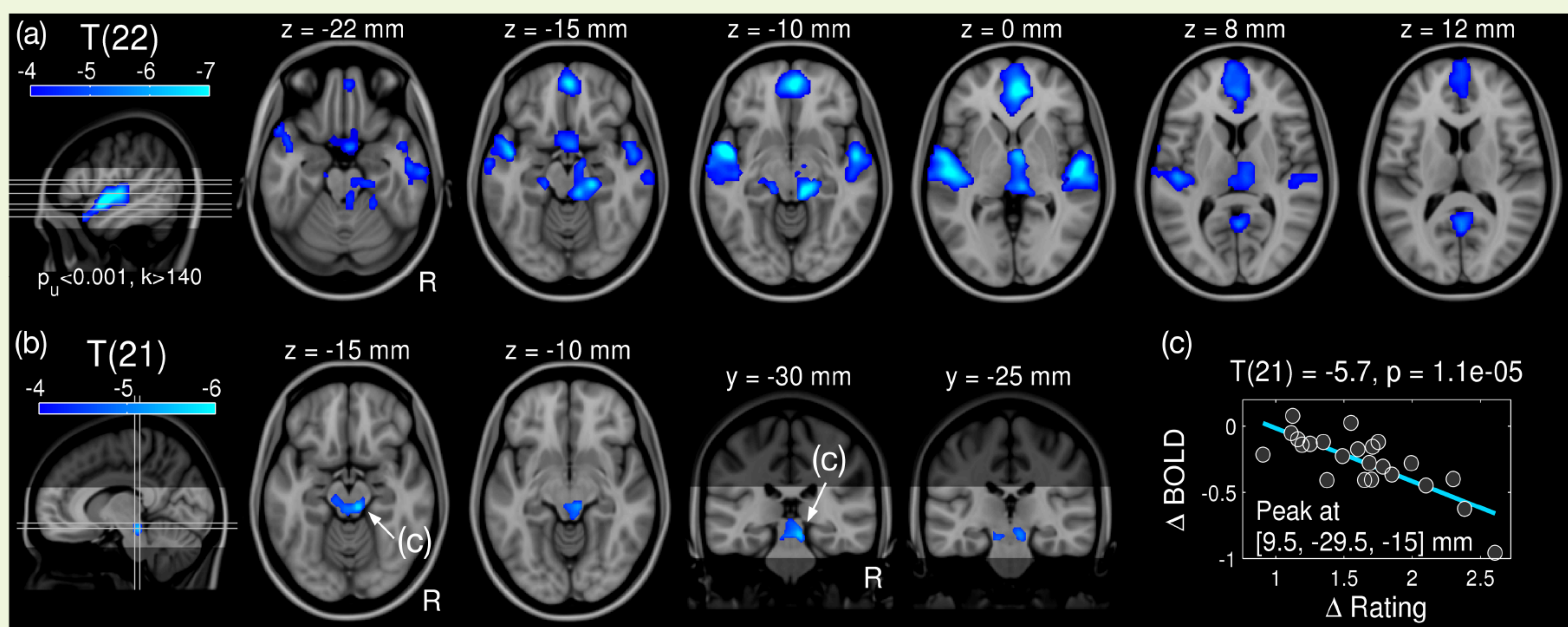
(a) Common effect of dissonance

$$\Delta B = \beta_0 + \varepsilon$$

(b-c) Correlation between individual differences in BOLD signal change (ΔB) and rating change (ΔR)

$$\Delta B = \beta_0 + \Delta R \beta_1 + \varepsilon$$

- The more a participant disliked dissonance, the more signal in the IC was decreased to dissonant excerpts.



PPI

(a) Physiological factor: IC

- Extensive positive correlation over cortical/subcortical areas

Psychological factor: diss.

- GLM (a)

(b) Interaction: IC x diss.

- Functional coupling between the IC and the left anterior STG was weakened while listening to dissonant music in average of all subjects

