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Relationship between musical complexity, preference, and relative phase of brain network

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Introduction

Musical Preference and Complexity

- Previous studies have suggested that complexity could be a key factor in musical preferences.
- Complexity has been quantified as **information content (IC)** and entropy, using the **Information Dynamics of Music (IDyOM) algorithm[1].**
- An inverted U-shaped relationship was observed between the **IC** and liking ratings among general listeners.

Questions:

1. Do experts have preferences similar to those of non-experts?
2. If so, what factors in music contribute to these differences?
3. Do they translate into distinct brain responses?

Relative Phase Measure of EEG

To show the information flow, we suggest **relative phase**, ϕ_j, concept[2,3].

$$\sin \boldsymbol{\phi_j} = \sin\left(\boldsymbol{\theta_j} - \boldsymbol{\Theta}\right) \text{ , } \boldsymbol{Re^{i\Theta}} = \frac{\mathbf{1}}{\boldsymbol{N}} \sum_{\boldsymbol{k=1}}^{\boldsymbol{N}} \boldsymbol{e^{i\theta_k}} \text{ ,}$$

where $\boldsymbol{\theta_j}$ indicates the absolute phase of signal $\boldsymbol{j}$ and $\boldsymbol{\Theta}$ indicates global mean phase.

Methods

Experimental Design

Music Stimuli: 20 songs | Complexity: Measured by IDyOM

- 18 classical (18-20 C) and 2 baseline melodies were chosen.
- Controlled tempos and the same violin timbre were used.
- The melodies were generated via MIDI with VST sounds.

Trained by 903 Western tonal melodies, including 152 Canadian, 566 German folk songs, and 185 Bach Chorales (same as Gold *et al*., 2019.)[1]

IDyOM
Information Dynamics Of Music

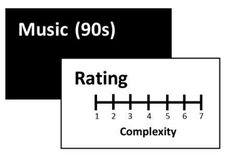
We calculated the Information Content (IC) of stimuli and divided into three groups: **Low IC (2-4)**, **Mid IC (4-6)**, **High IC (6+).** Adjacent group averages differ by less than 2.20. The number of songs in each group was six (without the **Baseline**).

Inside Scanner

ON sessions (EEG-fMRI)

- The sequences of **a** and **b** were conducted in an intermixed manner.
- Structural scans (T1, DTI) were also conducted.

a. Listening & Rating



: Rating with 7-point Likert scale after the listening] X 20

b. Visual Tasks

Eyes Open (EO), Eyes Closed (EC), & Checkerboard (CB) tasks

OFF sessions (EEG Only)

After the ON sessions, the tasks of **b** were conducted once again to make references for analysis of EEG data with the scanner on.

Outside Scanner

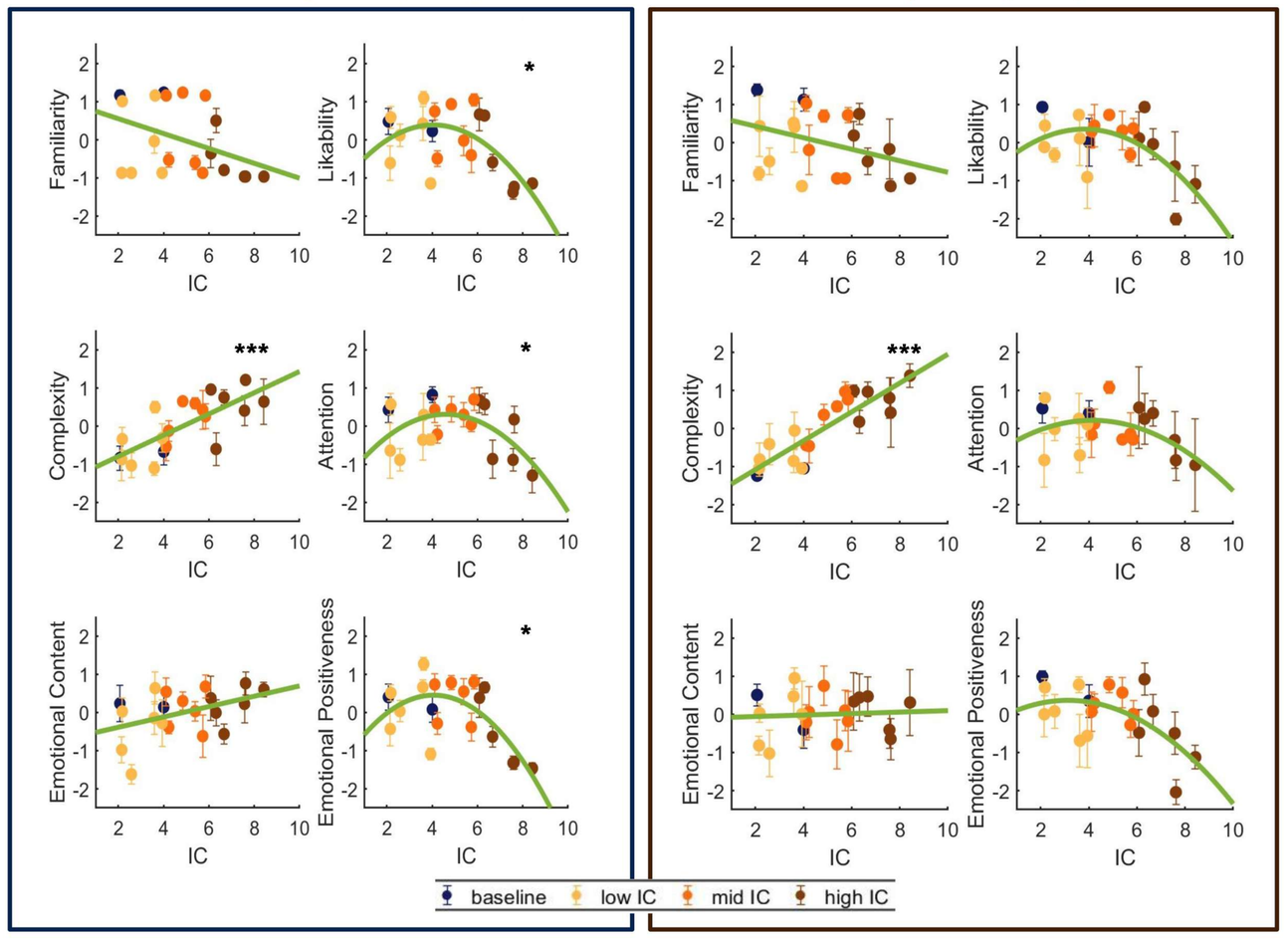
- Participants carried out Goldsmiths Musical Sophistication Index (Gold-MSI), Cultural Capital Survey, and Big 5 Personality Traits.
- The surveys were used to classify the participants as Non-Experts or Experts.

EEG Data Analysis

- 64-channel EEG recording facilities were used.
- Alpha waves (8-12Hz) were used for analysis.
- Relative phase was computed across whole channels for each time point.
- By applying K-means clustering across whole time points of EEG relative phase topography, each time point was classified into one of the four modes.
- The probability distribution for each mode and transition probabilities between modes were calculated.

Results

Information Content (IC) of Music and Ratings



[Both non-experts and experts]

- There exists a significant correlation ($p<0.001$***) between IC and complexity ratings.
- However, both showed no statistically significant results in the relationships of IC with familiarity and emotional content ratings.

[Non-experts]

They showed an inverted U-shaped relationship in likability, attention, and emotional positiveness ratings.

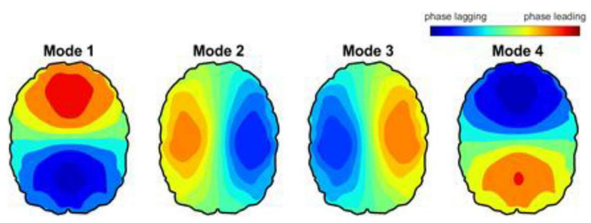
[Experts]

They could be fitted with an inverted U-shape in likability, attention, and emotional positiveness ratings.

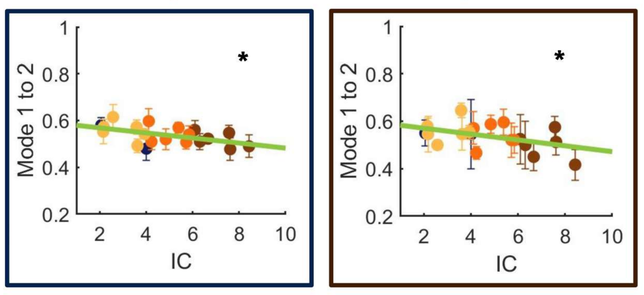
Information Content (IC) of Music and EEG Relative Phase

K-means Clustering

- We performed the **K-means clustering analysis** on the EEG relative phase of each time frame.
- We found that **four dominant modes** exist.



Non-Experts **Experts**



[Both non-experts and experts]

They showed a negative correlation* between IC and the Mode 1 to 2 transition: music with higher IC decreased the probability of the Mode 1 to 2 transition. High IC music will reduce the transition from Mode 1.

Discussion

- Our results suggest that participants could identify the complexity of each music stimulus as defined by the IDyOM, **anyhow of their expertise**.
- Also, There was a **golden zone** of the IC that participants favored the most.
- Finally, an **EEG correlate** of recognized musical complexity was observed by the **relative phases**.

Contact us

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References

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