

Creative intellect?

An EEG study of creativity and fluid intelligence



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Introduction

Creativity:

- Guilford's pioneer **psychometric approach** to creativity studies¹
- **Divergent thinking** as a reliable indicator of creative potential²
- **Novelty/originality** as a crucial constituent and metric of creativity measured by **statistical originality**³
- More responses = more novel responses and higher average novelty score³
- Campbell's „**Blind Variation Selective Retention**” theory: neuronal noise and stochastic resonance appear crucial for creative processes⁴

Creativity vs. Intelligence:

- More creative participants form remote associations more readily than the less creative when primed with a:
 - **helpful prime** before **close associations**
 - **neutral primes (information noise)** before **far associations**
- **No relationship with intelligence**⁵

Aim of the Study/Hypotheses

- **Reveal neuronal correlates of divergent thinking**
- Expected higher complexity of EEG in more creative individuals
- Expected interactions between fluid intelligence and creativity visible in task performance

Methods

Participants:

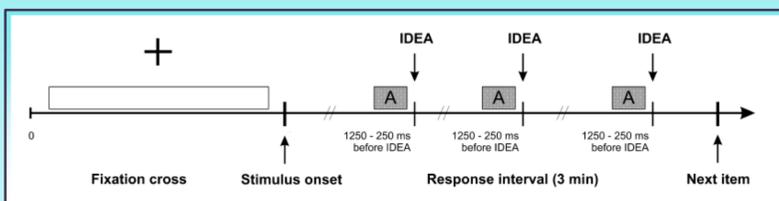
- N = 29 (F = 19, 65.5%), age 19-31 (M = 21.7, SD = 2.9)

Raven's Progressive Matrices - advanced (RPM):

- Measure of fluid intelligence

Alternative Uses Task (AUT):

- A computerized version of Guilford's Alternative Uses Task⁶
- „List as many alternative uses for the item presented as you can think of in 3 minutes”
- 5 items (umbrella, shoe, soap, pen, brick)



- Idea button to eliminate speech artifacts from EEG recordings
- EEG epochs of -1250 to 0 ms prior to the reported idea



- Responses evaluated on **number (NO)**, mean weighed **originality (ORI)** and **total originality (ORI.T = NO*ORI/100)**
- EEG recorded upon the AUT task and prior resting-state

EEG signal analysis:

- **Higuchi's fractal dimension (HFD) analysis** of the EEG signal measures the complexity of time series⁷; due to HFD's particular sensitivity to signal fluctuations it is an excellent tool for estimating brain function complexity dynamics
- Local activity in the gamma band (neuronal noise) (planned)

Task (word) difficulty assessment:

- **Emergent artificial intelligence** software: categorisation (planned)
- Total /mean amount of responses – the two extremes
 - the word with **most** responses : the „**easy**” task condition
 - the word with **least** responses : the „**hard**” task condition

Results

Participants divided into groups with respect to **fluid intelligence (higher/lower RPM score)**, and **creativity (higher/lower ORI.T score)**

1. CREATIVITY ANALYSIS

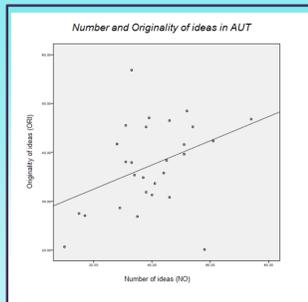


Fig.1. Correlation between **NO** and **ORI** of ideas ($r = 0.390$, $R^2 = 0.153$, $p = 0.004$)

2. CREATIVITY vs. FLUID INTELLIGENCE

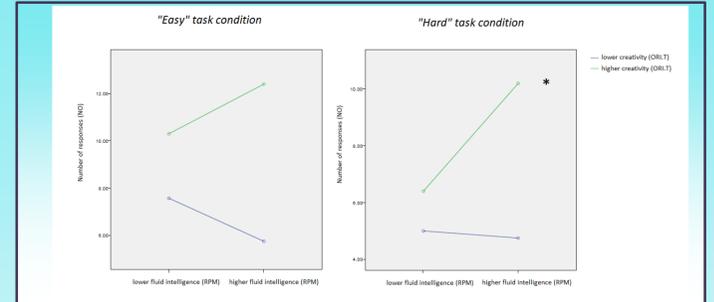


Fig.2. The effect of interaction between fluid intelligence and total creativity on the number of ideas ; task condition: „easy” (left) $p = 0.177$; „hard” (right) $p = 0.010$.

3. CREATIVITY vs. HFD COMPLEXITY ANALYSIS

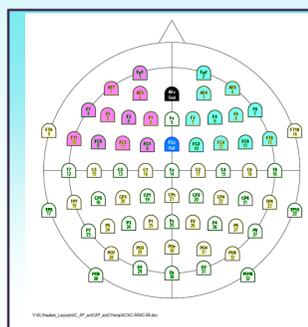


Fig.3. Definition of ROIs: frontal left (pink) and right (blue) areas

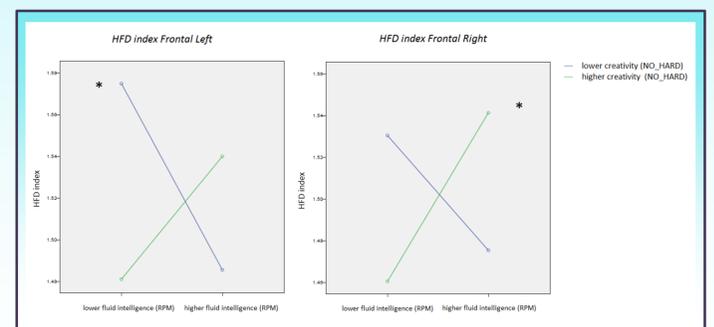


Fig.4. The effect of interaction between fluid intelligence and creativity (NO) in the „hard” task condition on frontal ROI HFD: left ROI (left) $p = 0.011$; right ROI (right) $p = 0.006$.

Conclusions

- Number of ideas correlates with their originality, however they are not the same thing, therefore a total creativity index was introduced: ORI.T, encompassing both NO and ORI.
- The preliminary results suggest that when the tasks becomes more difficult („hard” condition) individuals characterized by higher fluid intelligence and higher creativity give more answers than participants with higher creativity but lower fluid intelligence. There is no such difference in the „easy” task condition.
- HFD analysis revealed that exclusively in the „hard” task condition the complexity of the EEG bioelectric signal is lateralized depending on the level of both fluid intelligence and creativity.

Acknowledgements

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