Exploring brain behavior connections in narrative engagement using EEG inter-subject correlation

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Background

- Engagement with narrative remains hard to characterize.[1]
- Interdisciplinary work is necessary to connect theories of engagement across behavioral and neuroscientific approaches.
- One method that may help bridge the gap is **electroencephalography inter-subject correlation** (EEG-ISC). This neuroscience approach is good for naturalistic stimuli such as full, complex narratives,[4] with a high sensitivity to changes over time and single-stimuli presentation.

Study Design & Procedure

Electroencephalography (EEG) uses sensors placed on the surface of the head to measure electrical activity of the brain.

Participants

- 14 fluent English speakers aged 18-25 years old with no diagnosed learning differences

Stimuli

- 6 auditory narrative excerpts - selected based on content or usage in previous research[5,6]; each was approximately five minutes long.
- Narratives evenly divided into social texts (focused on characters and relationships) and non-social texts (focused on world-building or non-character description).

Procedure

- 128-channel (sensors) EEG recorded while participants heard 4 of the narrative excerpts (counterbalanced across participants).
- After listening, participants reported how interesting, enjoyable, and compelling they found the excerpt on 1-9 scale.

Analysis & Preliminary Results

Content analysis

- Each narrative excerpt was analyzed for the number of perception (“look”), cognitive (“think”), and social (“care”) words using LIWC and its inbuilt dictionaries.[7]
- Non-social texts used more perception words but fewer cognitive and social words than social texts.
  - The exception was the LeGuin text, which used slightly more social words than the Berry text.

Behavioral ratings

- Means were computed per question (enjoyment, interest, and compulsion), Pearson pairwise correlations were computed per excerpt, and t-tests run at the category (social vs. non-social) level.
- No differences in behavioral ratings were observed per question ($p > 0.62$) across categories.
- Per-stimulus pairwise correlations suggested differences in both interest and compulsion, but were underpowered.
- Therefore, **behavioral ratings were averaged into one score representing mean interest, compulsion, and enjoyment per stimulus.**

EEG-ISC

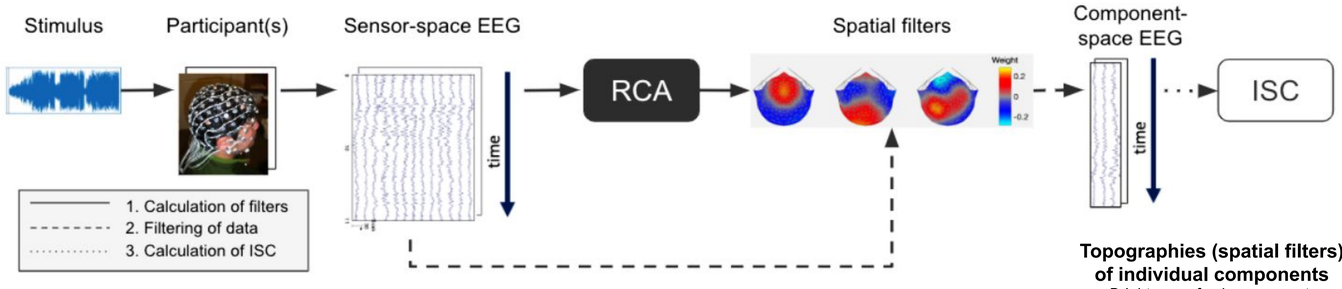
- EEG data were optimized for inter-subject correlation using a technique called Reliable Components Analysis (RCA).[2]
- Inter-subject correlations (ISC) were computed on a per-stimulus, per-component basis by correlating each data trial against all other trials.
- We group averaged ISC across the three maximally correlated components (RC1–RC3).[e.g., 2,3]
- The spatial EEG components highlight both auditory and non-auditory regions and our group averaged ISC values are similar to other recent auditory EEG-ISC studies.[e.g., 2-4]
- The group-averaged ISC was highest for the LeGuin text followed by the Gilb and Smithsonian texts, suggesting that neural engagement was highest for these three texts.

Key Questions

EEG-ISC has been shown to index engagement (“emotionally laden attention”)[2] with narrative tension in film excerpts.

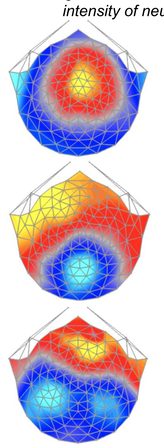
1. Can EEG-ISC index engagement with auditory narrative excerpts?
2. Will EEG-ISC be sensitive to broad narrative categories (e.g., social vs. non-social) or individual excerpts?
3. Will EEG-ISC correlate with behavioral measures of engagement?

We present preliminary results from an in-progress study that is designed to address these questions.



Title	Author	Category	Behavioral rating	Group averaged ISC
Uncle Rock	Dagoberto Gilb	Social	6.07	0.0496
Corrie	Alice Munro	Social	4.53	0.0375
Nothing Living Lives Alone	Wendell Berry	Social	3.46	0.0293
How the Potato Changed the World	The Smithsonian	Non-social	5.97	0.0421
Mountain Ways	Ursula K. LeGuin	Non-social	4.73	0.0548
The Forest Unseen	David Haskell	Non-social	4.27	0.0240

Topographies (spatial filters) of individual components
Brightness of color represents intensity of neural activity



Conclusions & Future Directions

- The current paradigm supports ecologically valid investigations into narrative engagement using neuroscientific methods.
  - It also provides first insights into the relationships between EEG-ISC, subjective behavioral ratings, and surface-level content analysis of narrative excerpts.
- We overall find that a neural metric of engagement can be correlated with behavioral ratings, and that both are sensitive to individual narrative excerpts; interestingly, our science fiction text demonstrated the highest EEG-ISC (but not rating).
- Future iterations will incorporate the remaining participants (n=22) to examine if preliminary results hold.
  - Additionally, we intend to examine how the Narrative Engageability Scale[8] aligns with our subjective ratings and EEG-ISC data.
  - We also plan to investigate how more fine-grained content analysis may relate to neural engagement across the timescale (e.g., with particular moments in the narrative).

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