Analyzing Brain Age THROUGH Entity-Centric Analysis:

Narratives in Picture Description Tasks

Building an advanced framework for linguistic analysis of cognitive decline

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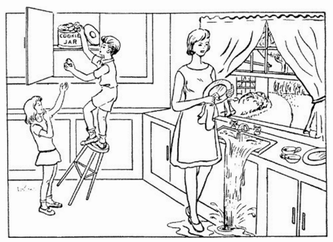
INTRODUCTION

1. **Brain Aging**
   - Brain Aging is the process by which the brain changes over time. Brain Age is distinct from biological age, and is predicted using machine learning models based on MRI images.
2. **Picture Description Tasks**
   - The subject is asked to "describe everything you see in this picture". Their response is transcribed for later analysis. For this project, the picture in question was "Cookie Theft", shown below.
3. **Previous work**
   - Previous work analyzing Cookie Theft only used simple metrics like parts of speech tagging and keyword analysis, and Cookie Theft has never been used in the context of Brain Aging.



Cookie Theft

METHODOLOGY

A three-dimensional approach to analyze discourse in the context of brain aging:

1. Lexical Richness

Analyzing word-level metrics including frequency, imageability, familiarity, and age of acquisition, helps us to measure the sophistication of language use among participants.

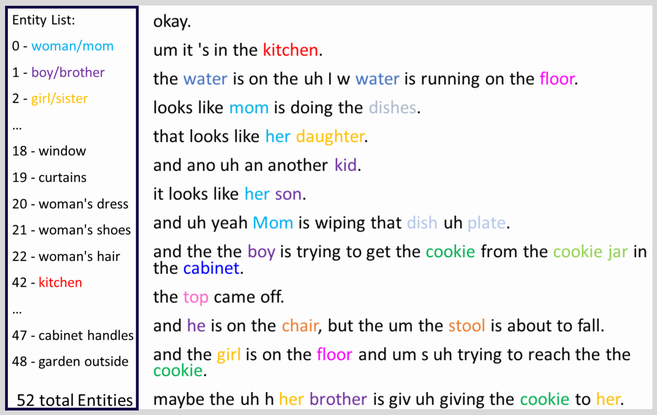
2. Syntactic Complexity

Using the Emory Language and Information Toolkit (ELIT), we quantify syntactic complexity by counting the number of descendents of each noun and verb in both dependency and constituency parse trees.

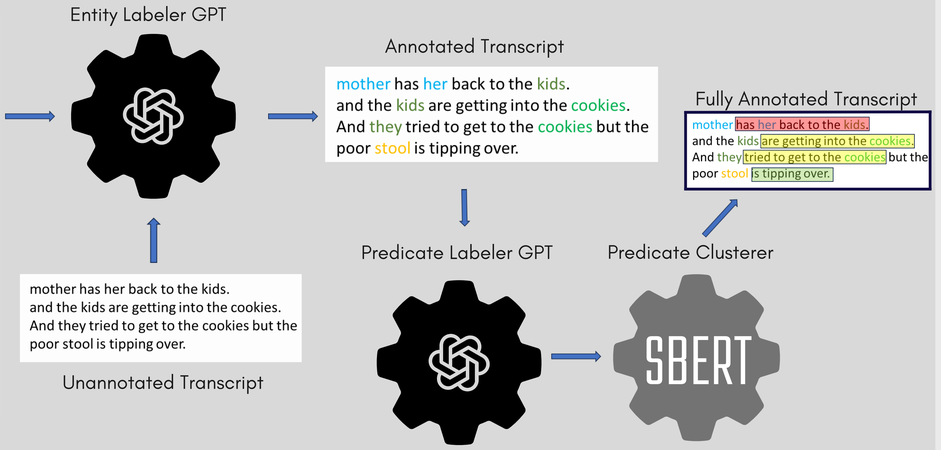
3. Semantic Content

We focus on the identification and linking of entities and predicates. Using GPT-4, we first identify mentions and links of entities in the picture "Cookie Theft", and then extract predicates associated with those entities. To link predicates, we cluster them with Sentence-BERT.

EXAMPLE PIPELINE



Entity List + Annnotated Transcript



RESULTS

Participants were sorted by brain age into 10 groups, to optimize for smoother graphs. Word level metrics indicated that participants in older age groups tended to use words with lower familiarity scores (A). Contrastingly, the number of verb descendents from each noun and verb increased slightly, then plummeted (A), suggesting a reduction in syntactic complexity. Older age groups tended to use a broader range of entities, but fewer predicates (B). This could indicate they discuss more entities without going into the same level of detail. Other results are displayed in Figure 2.

FIGURE 1. Various Metrics vs. Brain Age Groups

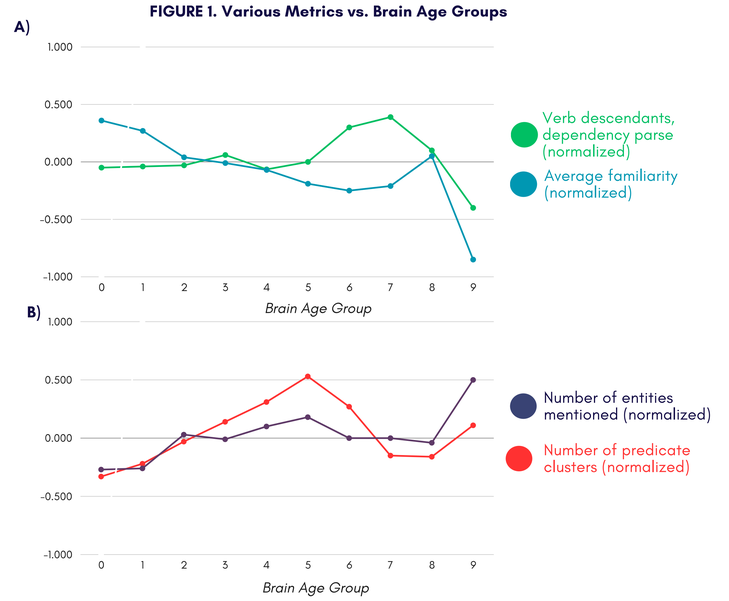
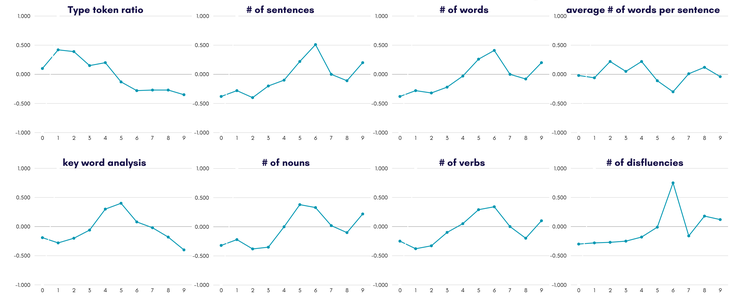


FIGURE 2. Other metrics (normalized) vs. Brain Age Groups



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