



## **BEHAVIORAL RESEARCH &** **STATISTICAL METHODS**



**“REINFORCEMENT LEARNING AND  
MEMORY SPECIFICITY OVER AGES”**

**TEAM: REWARD**

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# THE EXPERIMENT



Citation:

NUSSENBAUM, KATE, AND CATHERINE A HARTLEY.  
"REINFORCEMENT LEARNING INCREASINGLY SHAPES  
MEMORY SPECIFICITY FROM CHILDHOOD TO ADULTHOOD."  
OSF, 27 NOV. 2023. WEB.

# THE EXPERIMENT

- Study the dynamic relationship between learning, decision-making, and memory across different life stages.
- Characterize how individuals of different age groups adapt the specificity of their representations during value-guided learning
- Two experiments conducted to explore how the specificity of these learned representations impacts subsequent memory by manipulating the reward structures.

# OBJECTIVES

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Use statistical tools to validate the results.

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Use statistical tools to validate the results.
- Address developmental questions about adaptive behavior and its significance for memory formation.
- Gain insights into the complex relationship between experience, cognition, and memory throughout life.



# DATA DESCRIPTION

# DATA



Comprises **behavioral data** collected from participants of different age groups through **two experiments** ( $N = 224$ )

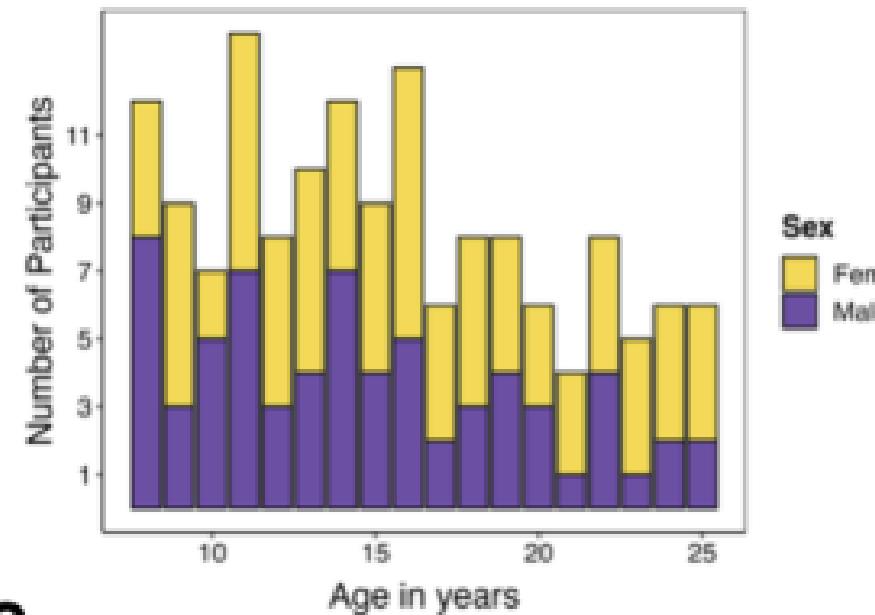


Provides insights into how reward shapes **learning strategies and memory formation** across developmental stages

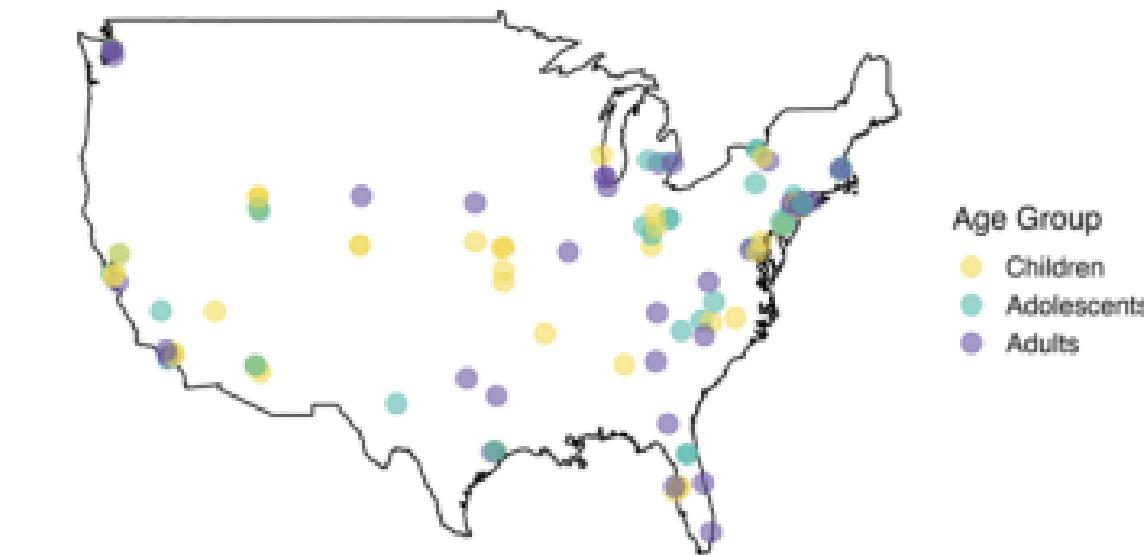


# PARTICIPANT DEMOGRAPHICS

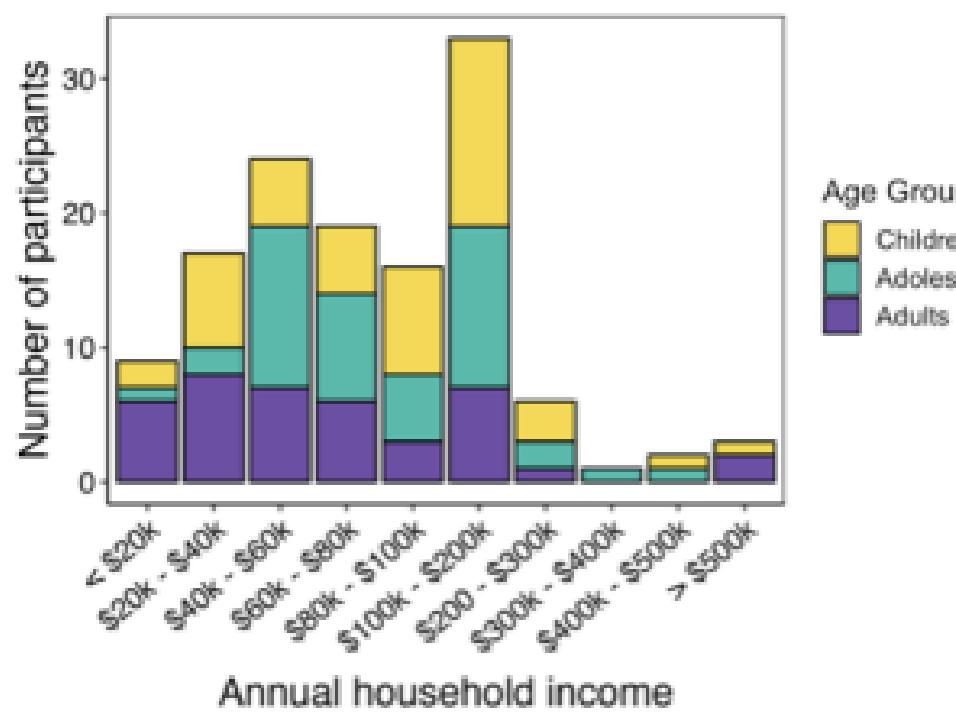
A.



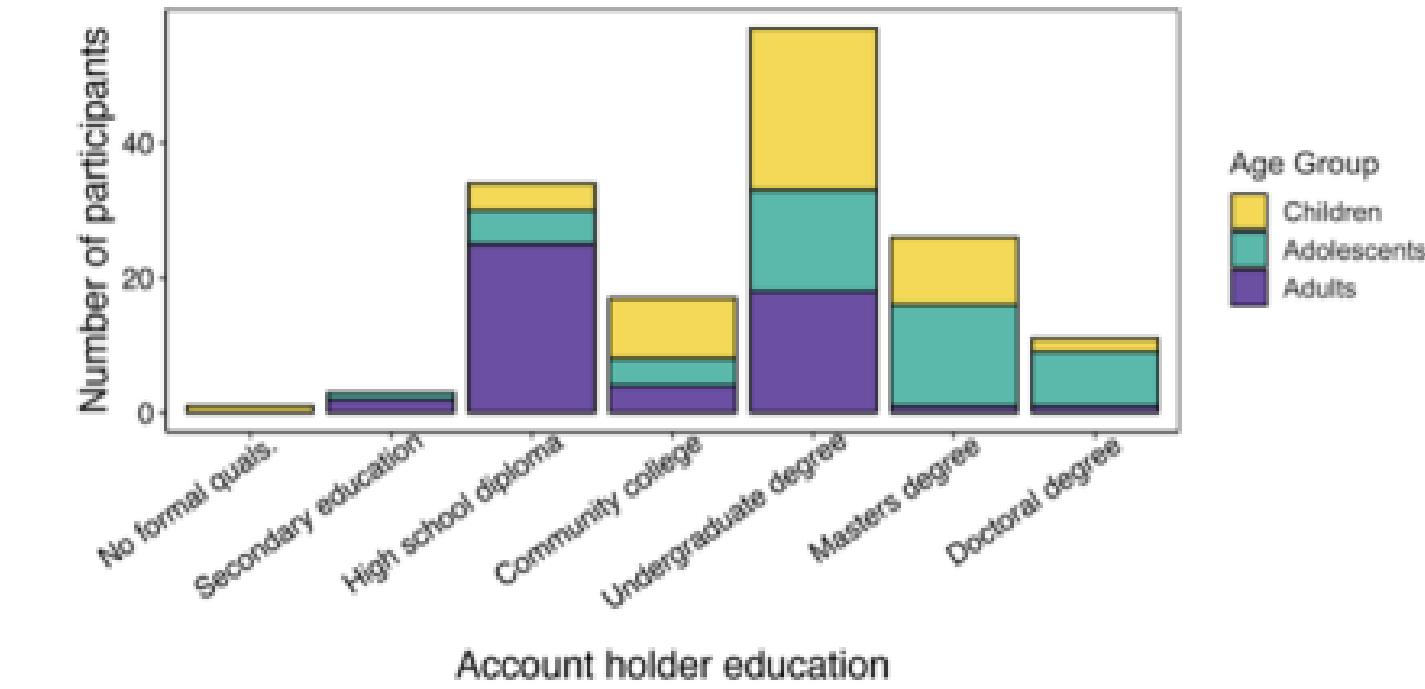
B.



C.



D.



# TABLES

18+

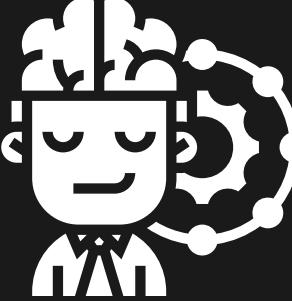
- subject IDs and ages

SUBJECT DATA



- Each row is a trial in RL task
- Has reaction times, points & decisions

LEARNING DATA



- Each row is a trial in RL task
- Has stimulus categories & block conditions

RL DATA



- Each row is a trial in Memory task
- Has accuracy, response time & confidence ratings

MEMORY DATA

# EXPERIMENTAL DESIGN



# EXPERIMENT 1

**Participants:** People of different ages, including children, adolescents, and adults.

9 unique stimuli, each with 3 exemplars from broader categories. Each picture had a corresponding reward, either tied to that specific picture or to a broader category it belonged to.

## RL TASK DESIGN



Participants encountered different pictures and had to make choices based on the association between pictures and rewards.

## LEARNING TASK



1 week after completing the RL task, subjects completed a test of recognition memory to decide whether stimuli were old or new on a four-point confidence scale.

## MEMORY TEST

**Objective** - To understand how individuals adjust the specificity of their mental representations during value-based learning and the subsequent impact of this adaptability on memory.

# EXPERIMENT 2

**Participants:** Included children (ages 8–12) and adults (ages 18–25). Excluded adolescents, focusing on age groups with expected significant performance differences.

Rewards made binary to introduce unpredictability and simulated a noisy environment for decision-making. Additional stimulus category with 5 novel stimuli and two novel exemplars per sampled category.

**TASK  
MODIFICATIONS**

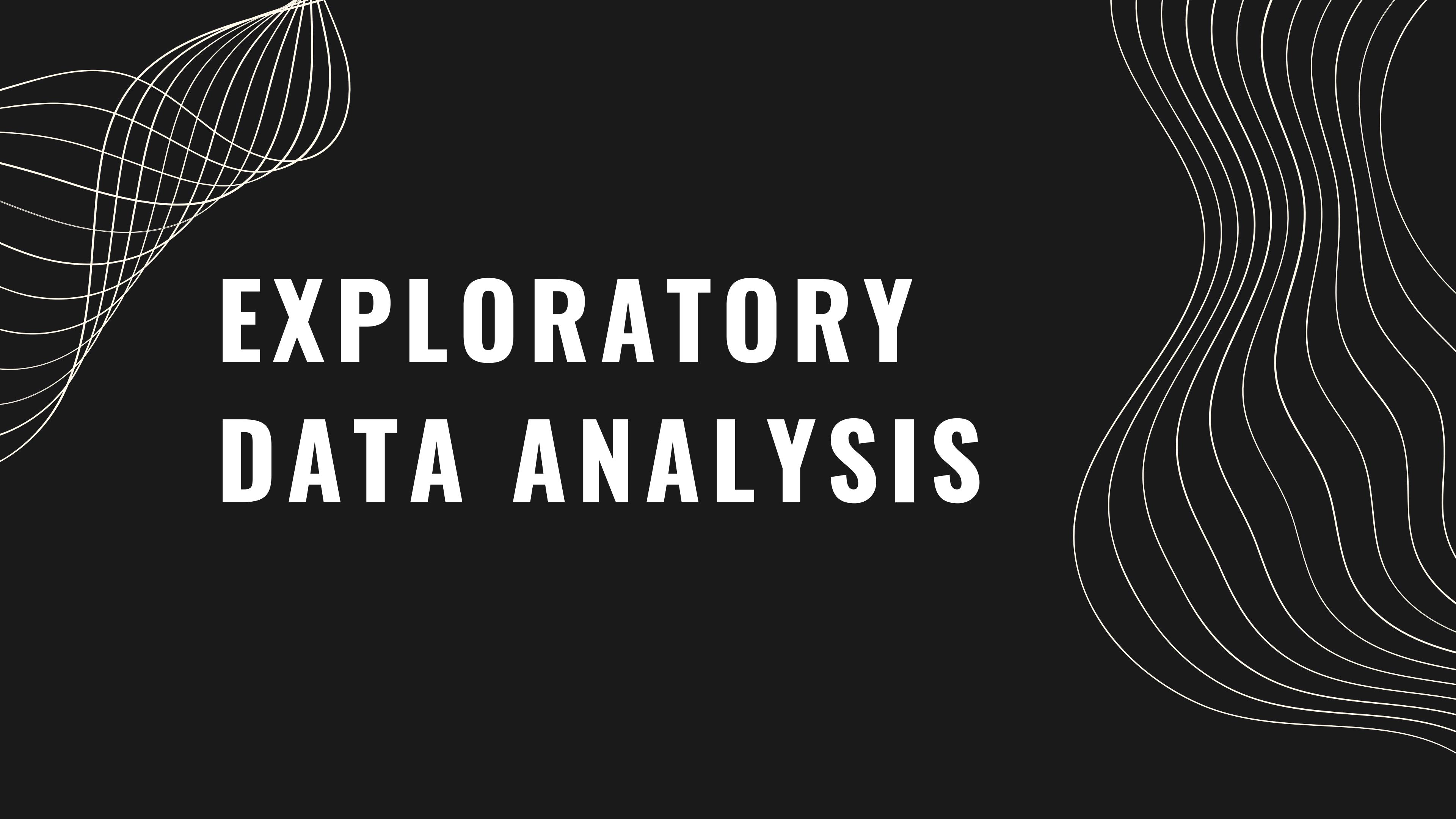
Participants encountered pictures with rewards tied to specific details or broader categories and had to choose from 3 options.

**LEARNING TASK**

Participants were tested on their memory performance for stimuli encountered in different learning conditions.

**MEMORY TEST**

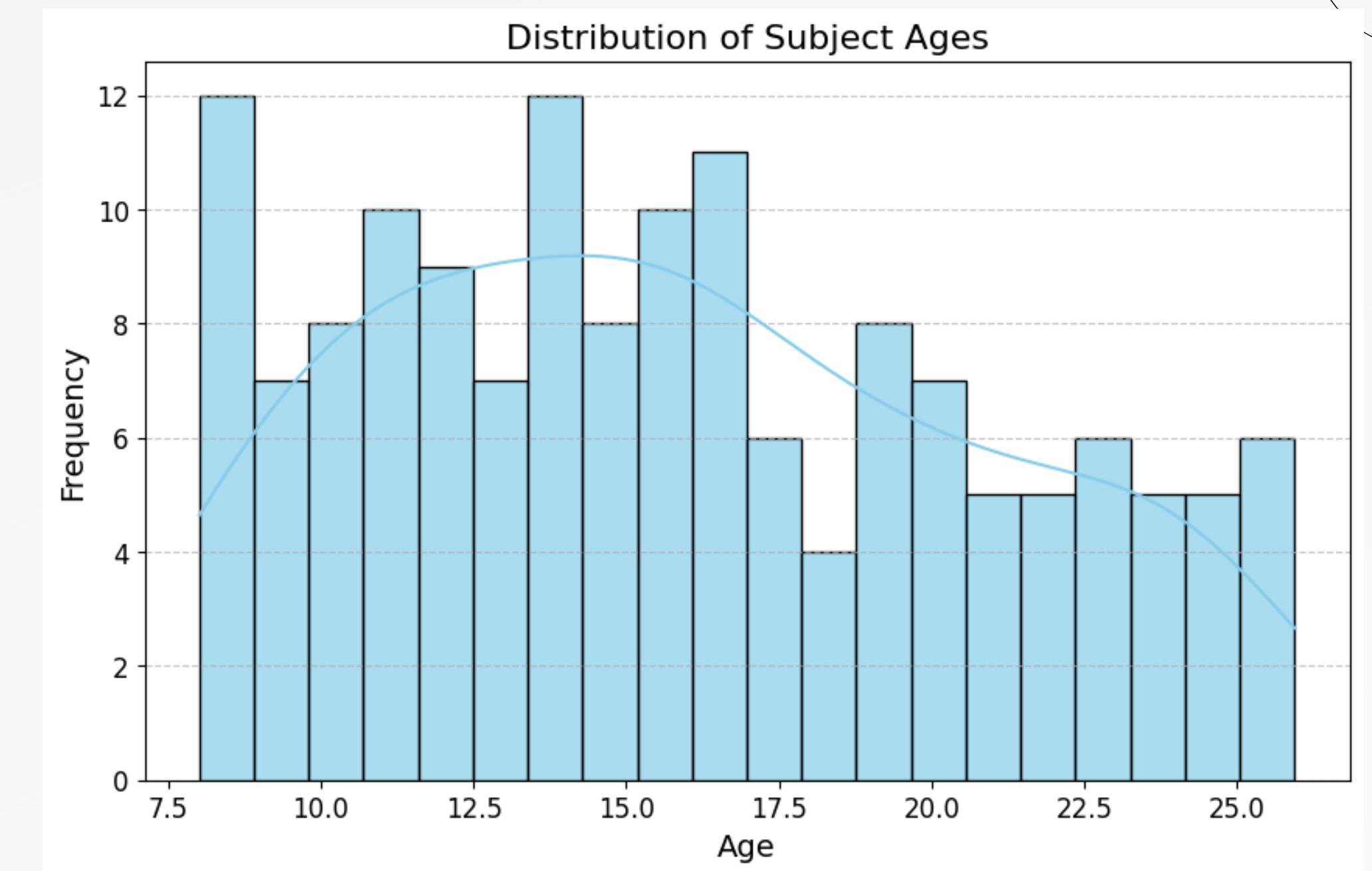
**Objective** – To validate and extend Experiment 1 findings by introducing task modifications. Explore potential age-related differences in adaptive processes during learning, decision-making, and memory.



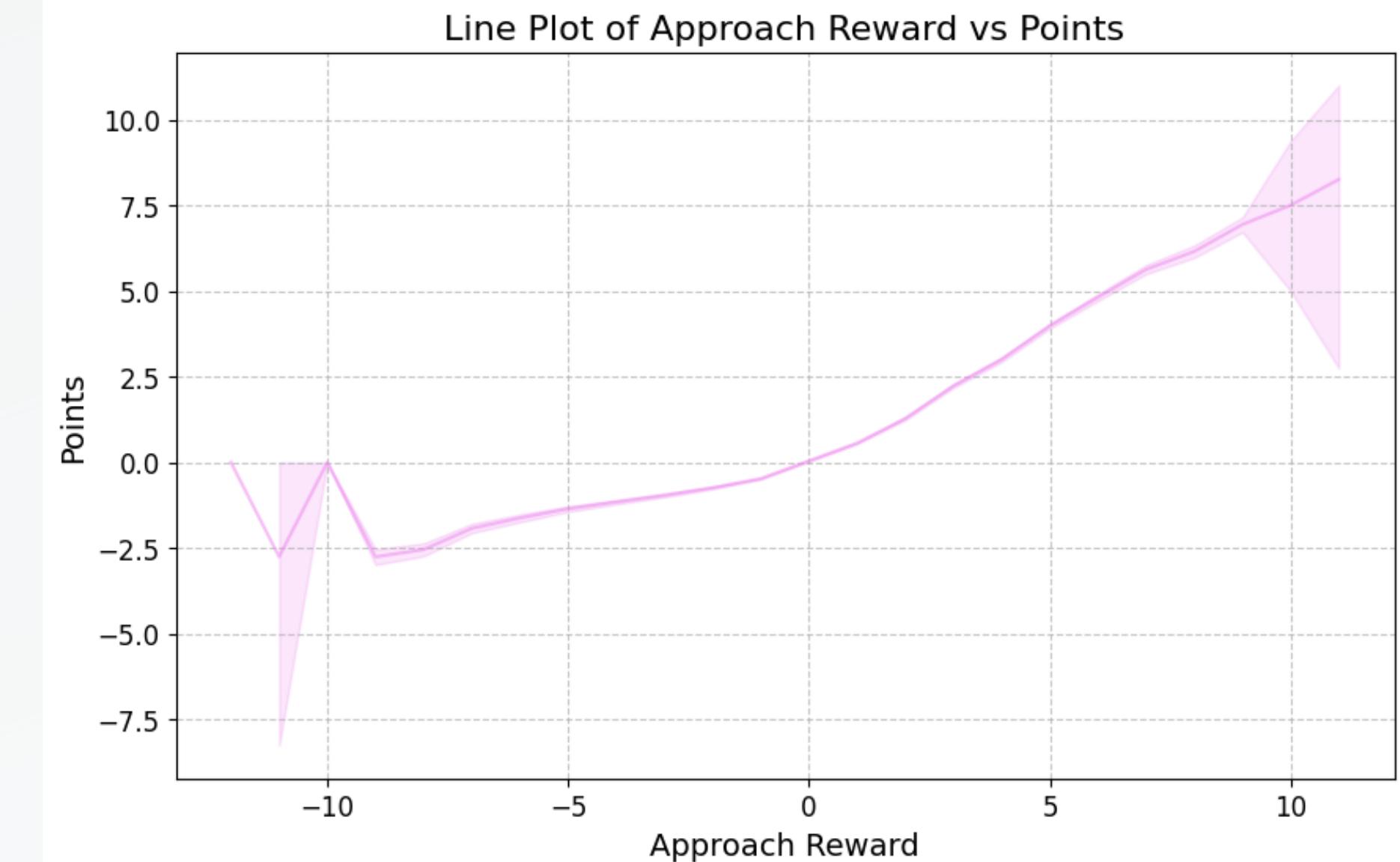
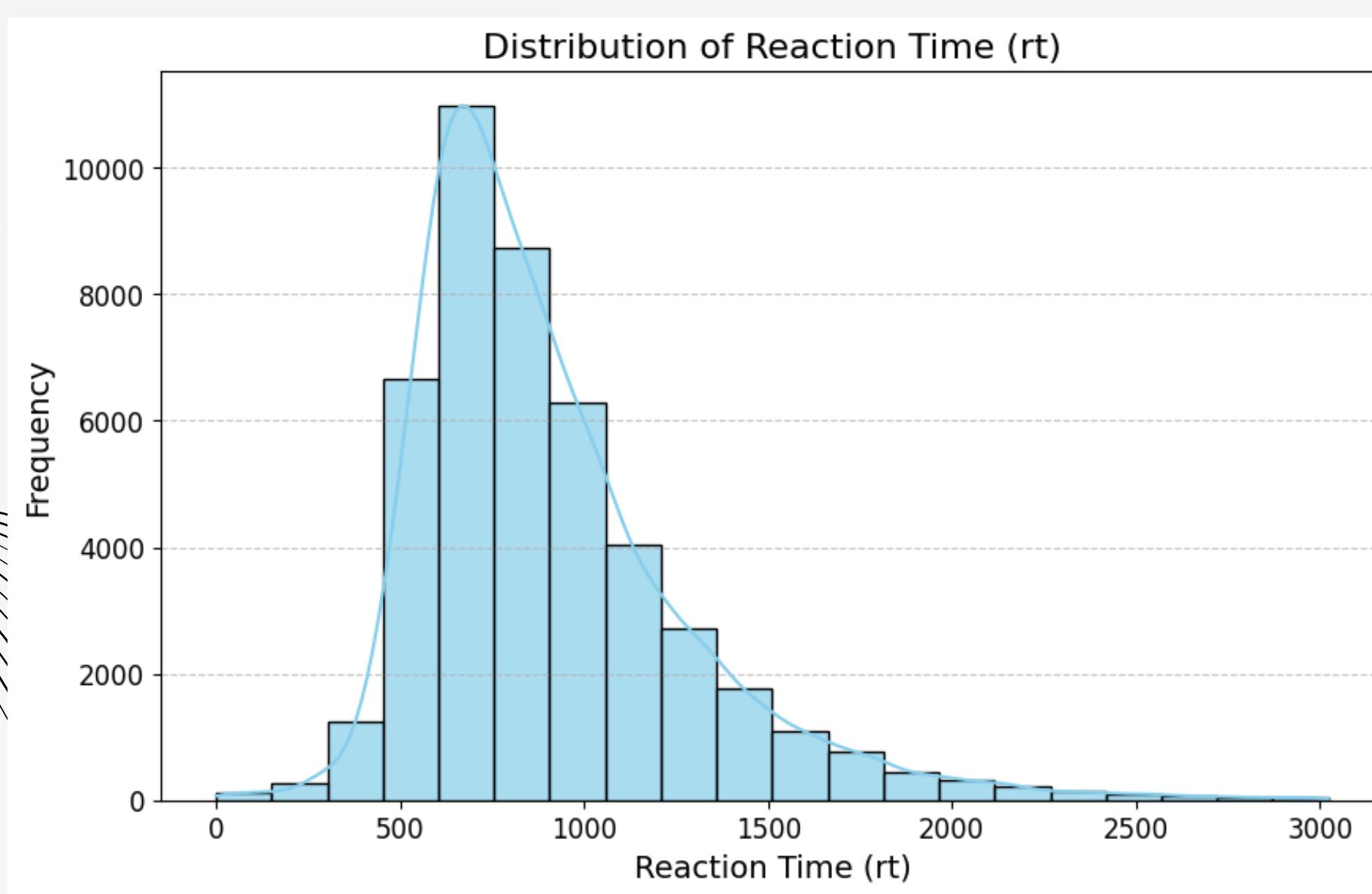
# **EXPLORATORY DATA ANALYSIS**

# EXPERIMENT 1 : SUBJECT AGE

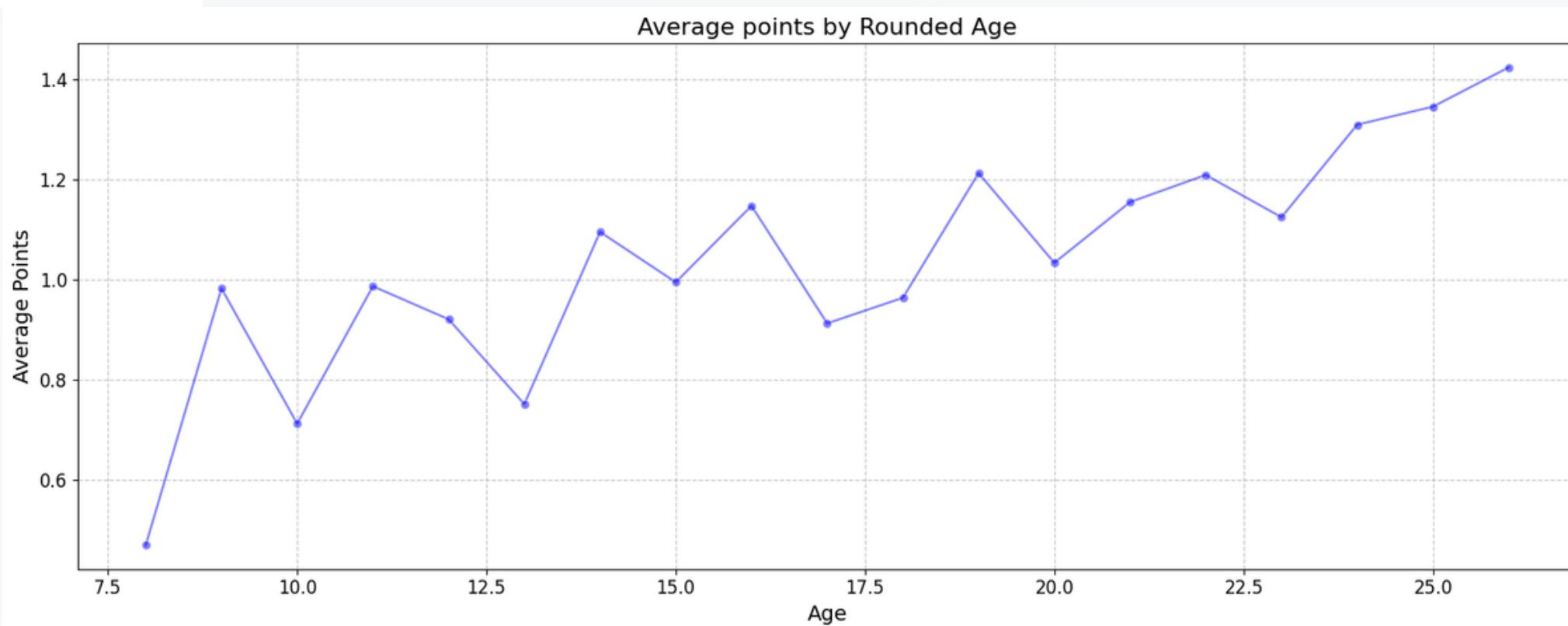
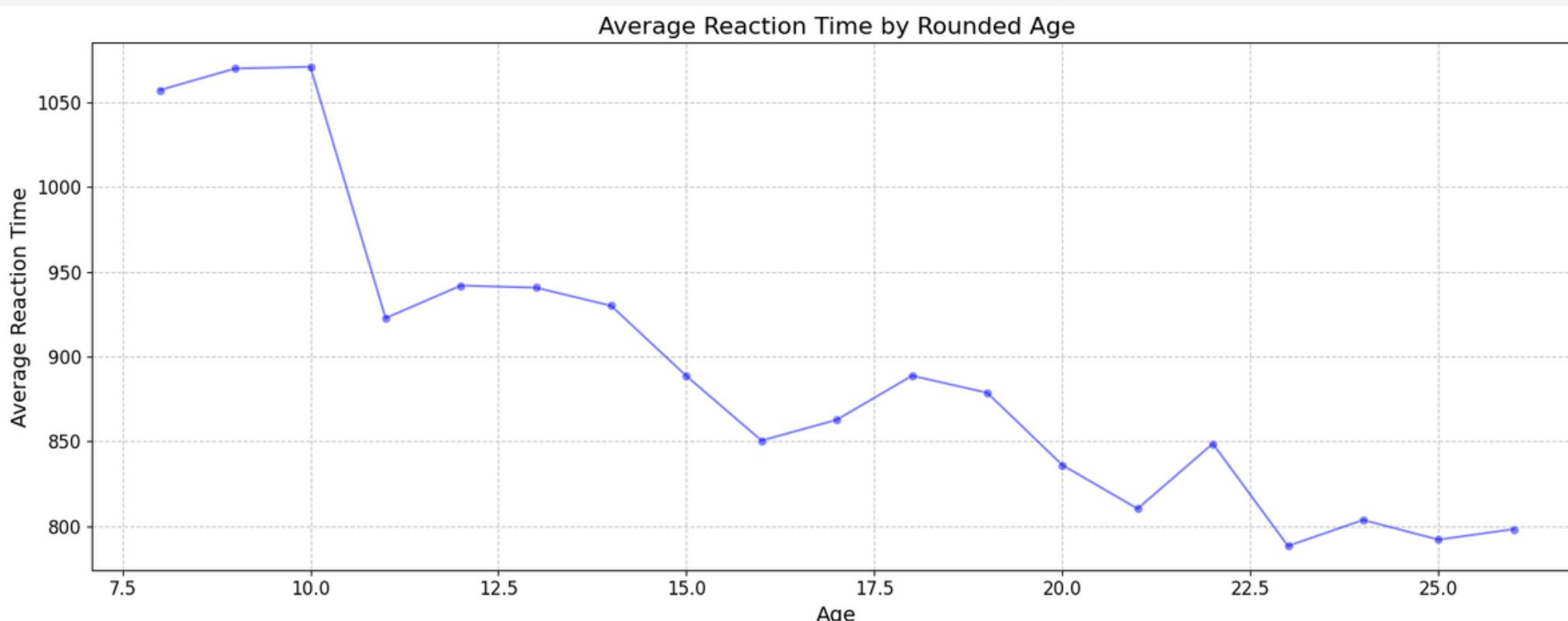
- There are 151 subjects.
- The age range is 8-25 years.
- The average age is 15.8 years .



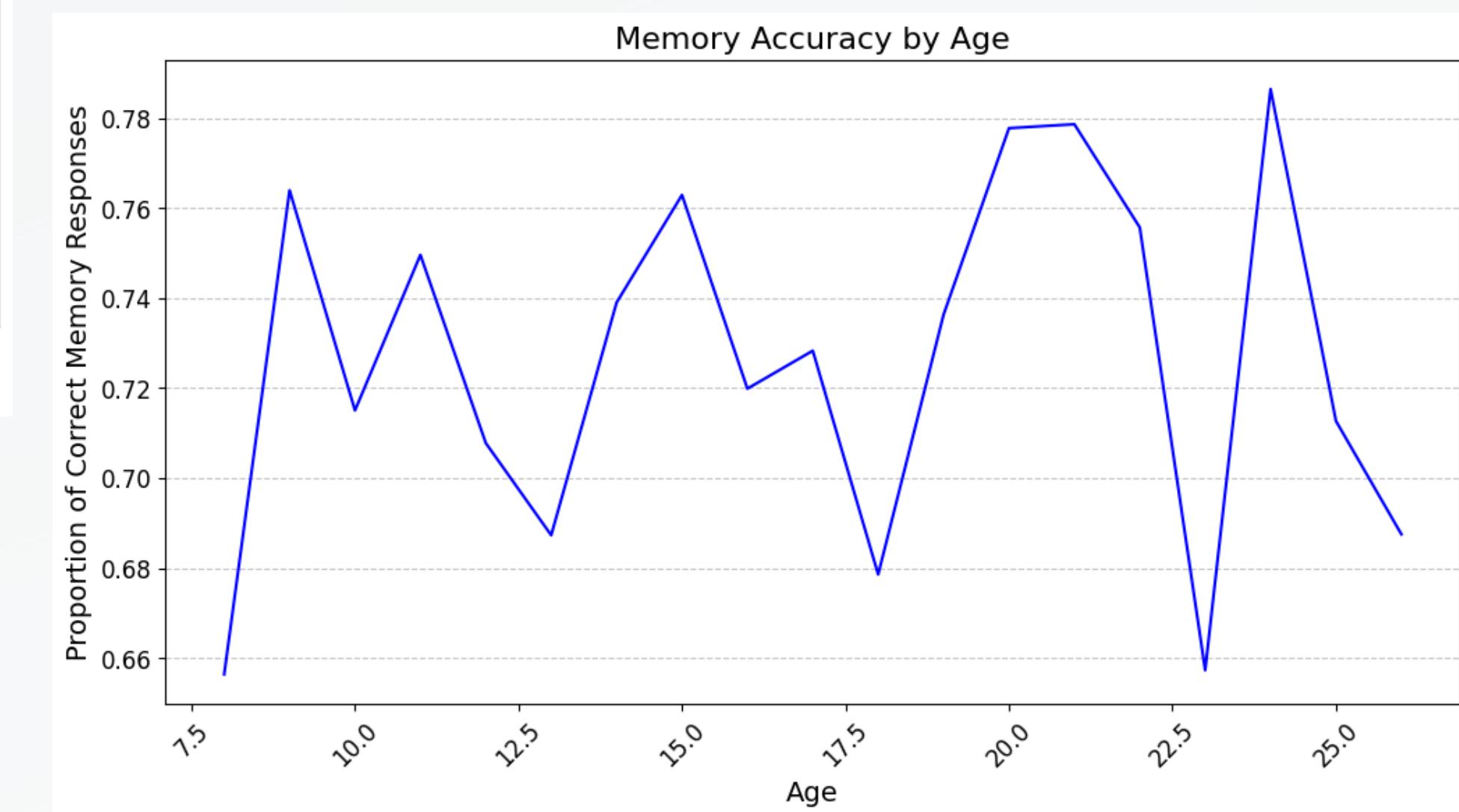
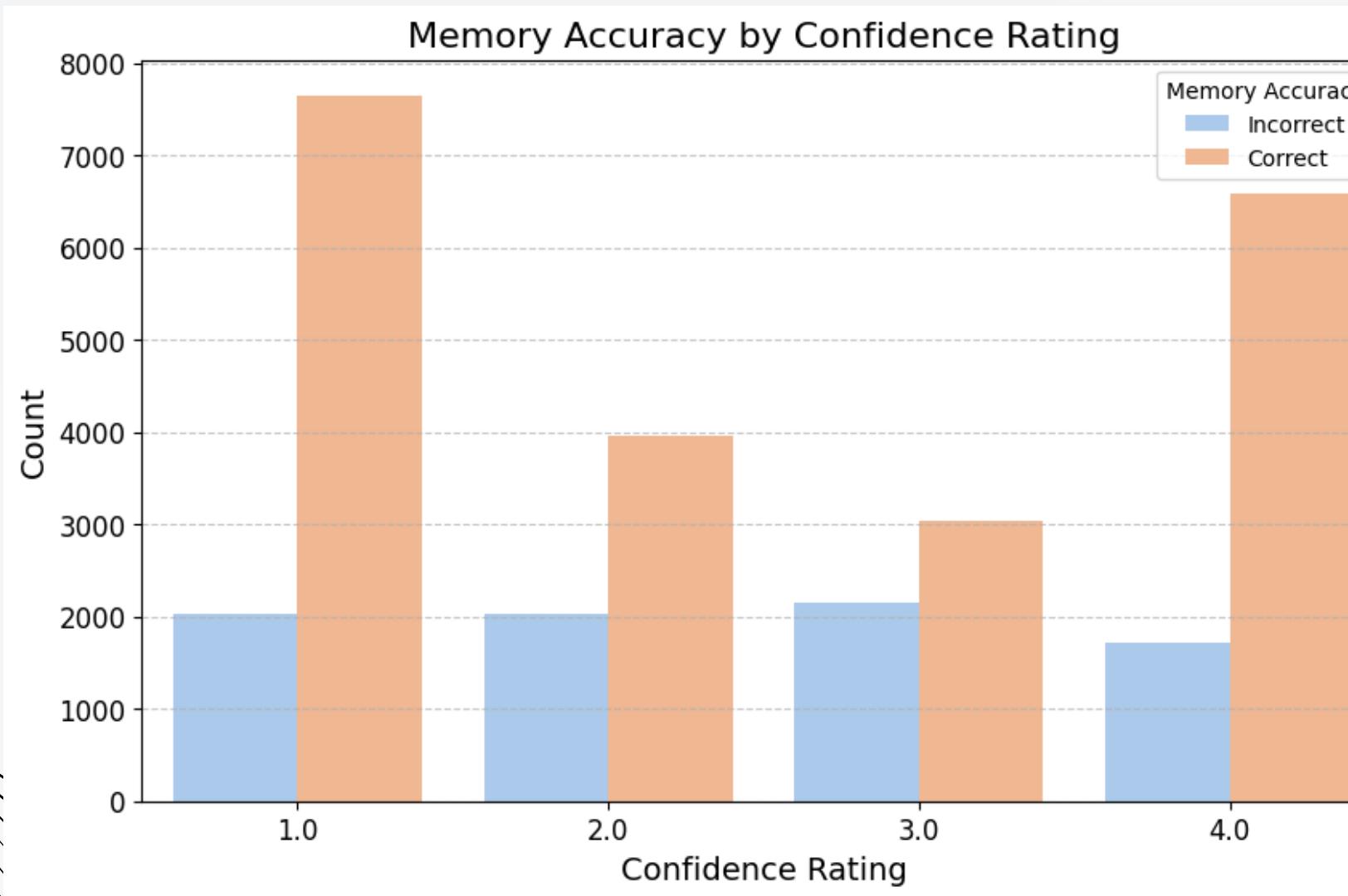
# EXPERIMENT 1 : LEARNING DATA



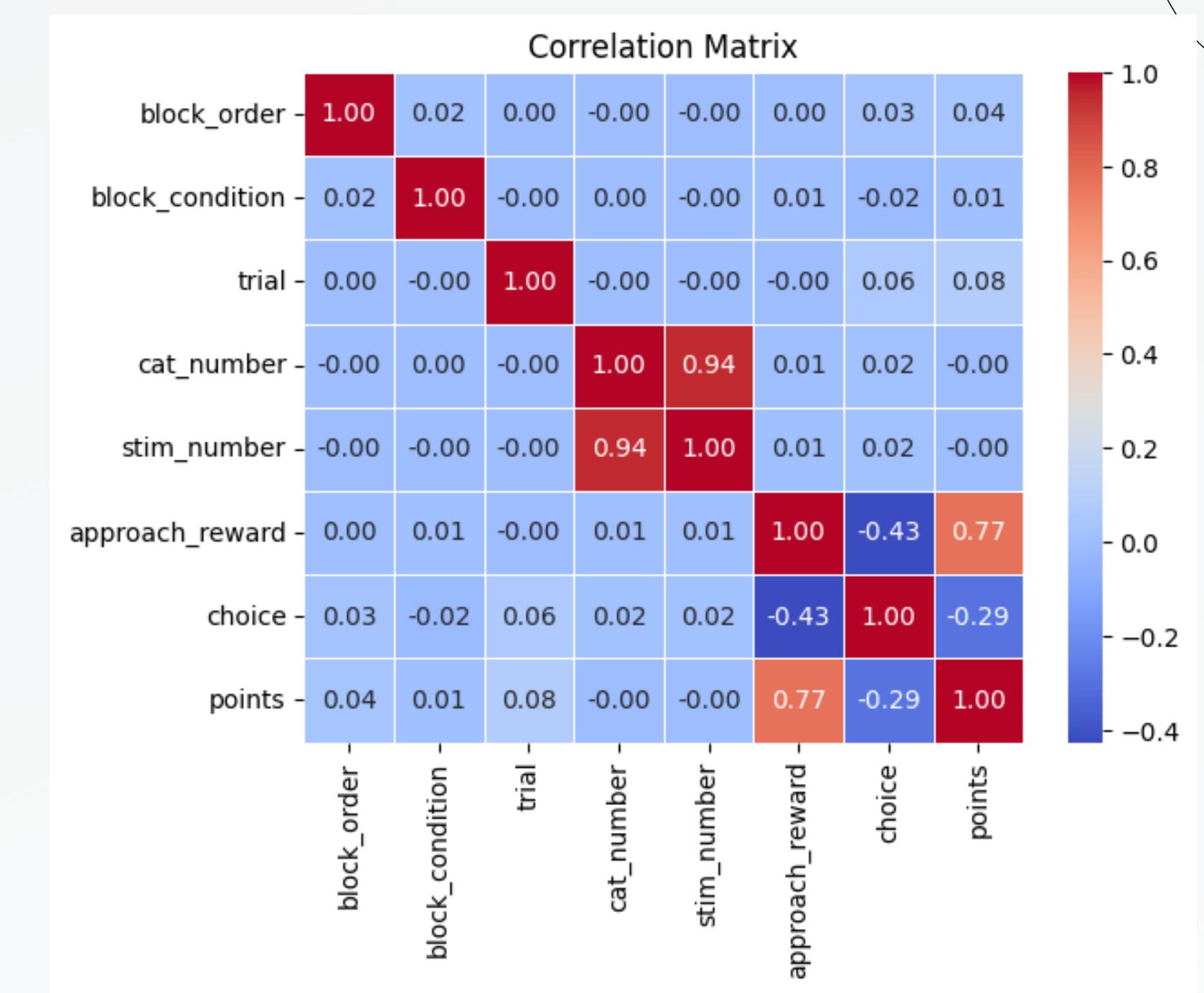
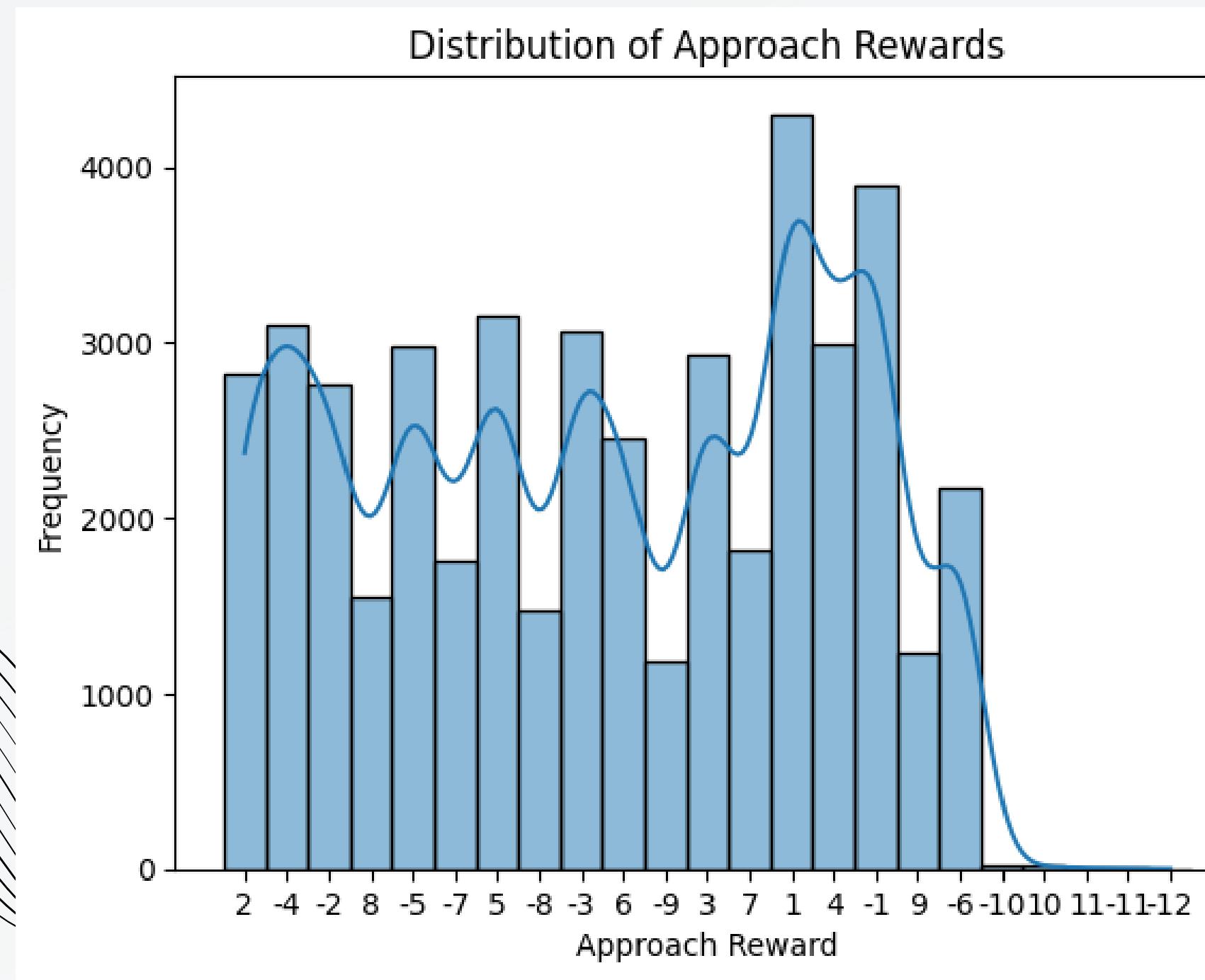
# EXPERIMENT 1 : ANALYSIS ACROSS AGE

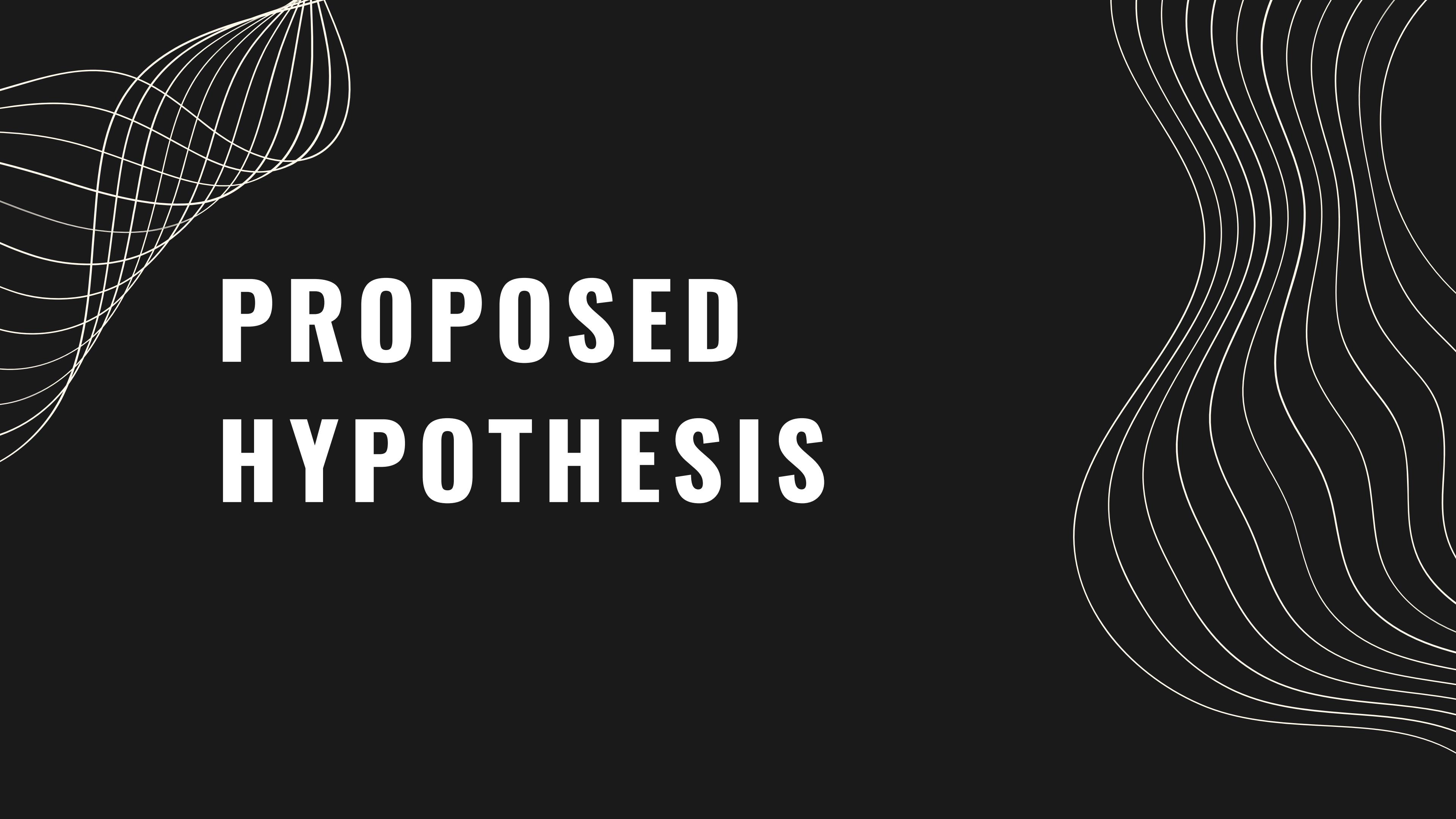


# EXPERIMENT 1 : MEMORY DATA



# EXPERIMENT 1 : RL DATA





# PROPOSED HYPOTHESIS

# HYPOTHESES

H0: There is no significant relationship between age and the adaptation towards more specific representations.

H1: Adaptation towards more specific representations increases with age.

# HYPOTHESES

H0: The specificity of stimuli used does not influence the specificity of information representation in memory.

H2: The specificity of stimuli used influences the specificity of information representation in memory.

# HYPOTHESES

H0: Individual differences in the specificity of learning computations will not be reflected in subsequent memory representation.

H3: Individual differences in the specificity of learning computations will be reflected in subsequent memory representation.

# HYPOTHESES

H0: The influence of learning on memory will not strengthen across development.

H4: The influence of learning on memory will strengthen across development.



# **DATA ANALYSIS PLAN**

# HYPOTHESIS TESTING

sample test  
**t-test**  
size  
hochberg correction  
bonferroni correction  
pearson correlation  
benjamini-hochberg  
cohen  
whitney u test  
moderation analysis

# PROPOSED TESTS

1



## Specificity in Learning Flexibility

- Conduct **descriptive statistics** to analyze the distribution of responses across age groups.
- **Two-sample Test:** To compare means of continuous variables between different age groups.
- **Effect Size (Cohen's d):** To quantify the magnitude of differences between age groups

## Influence of Specificity on Memory

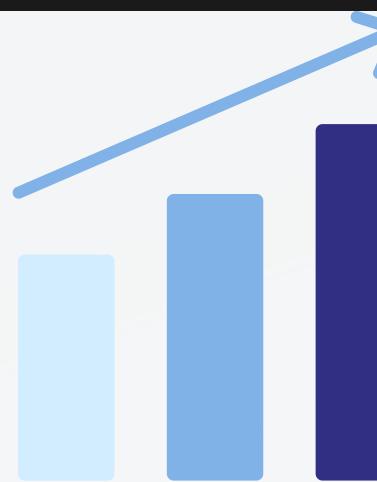
- Compute memory specificity scores based on the **proportion** of correctly recognized stimuli and confidence ratings.
- **Pearson correlation** coefficient to assess the relationship between memory specificity and specificity in decision-making.

2



# PROPOSED TESTS

3



## Individual and Developmental Differences

- Compare memory specificity scores across individuals with varying preferences using **Independent samples t-test**
- **Mann-Whitney U Test:** To compare memory specificity scores between individuals with different learning preferences.

## Strengthening Influence with Age

- **Pearson Correlation:** To examine the relationship between age and the specificity of learning computations on memory specificity.
- **Bootstrapping or Permutation Test:** To test whether age moderates the relationship between learning specificity and memory specificity.

4



# PROJECT TIMELINE



## FEBRUARY

- Define Project Objectives
- Initial EDA
- Data Cleaning
- Start Hypothesis 1 Testing

## MARCH

- Complete Hypothesis Testing for 1, 2 and 3
- Create visualizations to illustrate key results

## APRIL

- Complete Hypothesis Testing for 4
- Incorporate feedback from Instructors
- Prepare final presentation and report

# THANK YOU

*TEAM REWARD*

*Shreeya Singh*

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