# Project Research Report

## Brain Asymmetry and Visual Working Memory: Investigating the Impact of Negative Distractors

CCBS7002
Group 9

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# Outline

- Introduction
  - Literature review
  - Hypotheses
- Method
  - Participants
  - Procedures
    - Affect: PANAS
    - Visual Working Memory: Emotion N-Back + Surprise Memory Recognition
    - Brain Asymmetry: EEG Resting State
- Results
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  - Emotional Memory Task
  - Memory Recognition Task
  - Affect vs Brain Asymmetry
  - Affect vs Working Memory
  - Working Memory vs Brain Asymmetry
- Discussion

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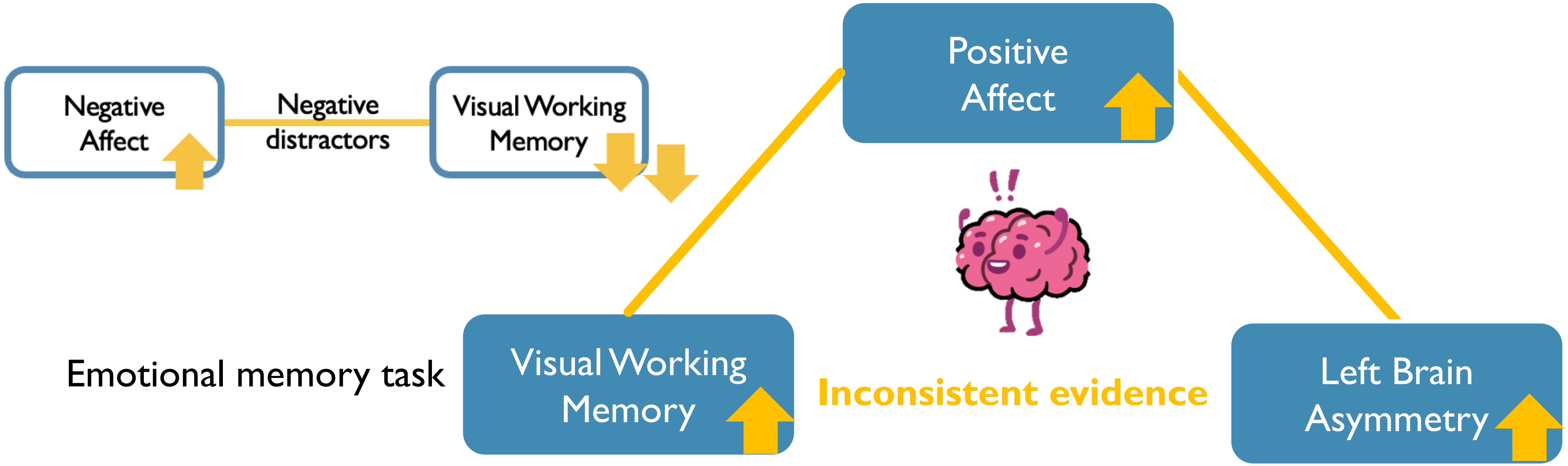
# From the literature review…

Positive Affectivity Negative Affectivity Schedule (PANAS)



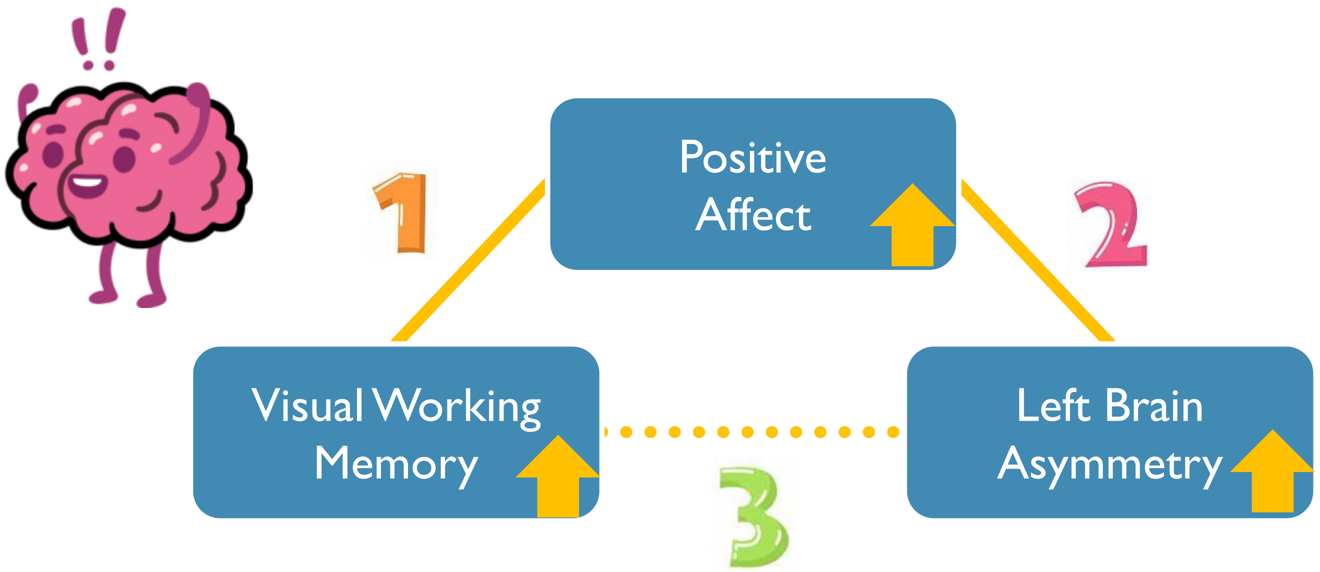

EEG alpha oscillations: largely reflect regulatory processes for inhibiting task-irrelevant cortical areas

# Hypotheses

1. Individuals with higher positive affect show better visual working memory.

2. Higher positive affect correlates with higher left brain asymmetry.

3. Individuals with higher left brain asymmetry show better visual working memory.



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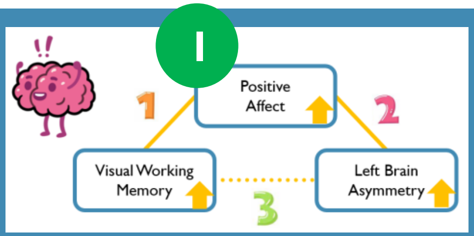
# Method – Participants

- Participants
  - 32 UM Students
  - The selection criteria
    - above18 years old in age
    - gender balanced
    - no color blindness
    - right-handed
  - Ethics approval is obtained from the Human Research Ethics Committee, University of Macau

✓ N = 5
✓ 1 subject is 50~60 years old
✓ Female only

# Method – Procedure




- Affects - Positive Affectivity Negative Affectivity Schedule (PANAS)
  - ✓ a self-rating measure of **positive affect** (PA; 10 items) and **negative affect** (NA; 10 items)
  - ✓ reflects transitory mood states
  - ✓ administer the PANAS to control for the potential effect of affective variability

Scoring instructions:

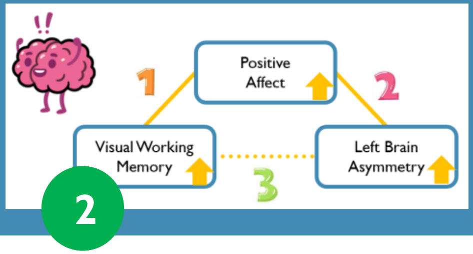
- Positive affect (sum up items): 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19
- Negative affect (sum up items): 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20

Positive and Negative Affect Schedule (PANAS-SF)

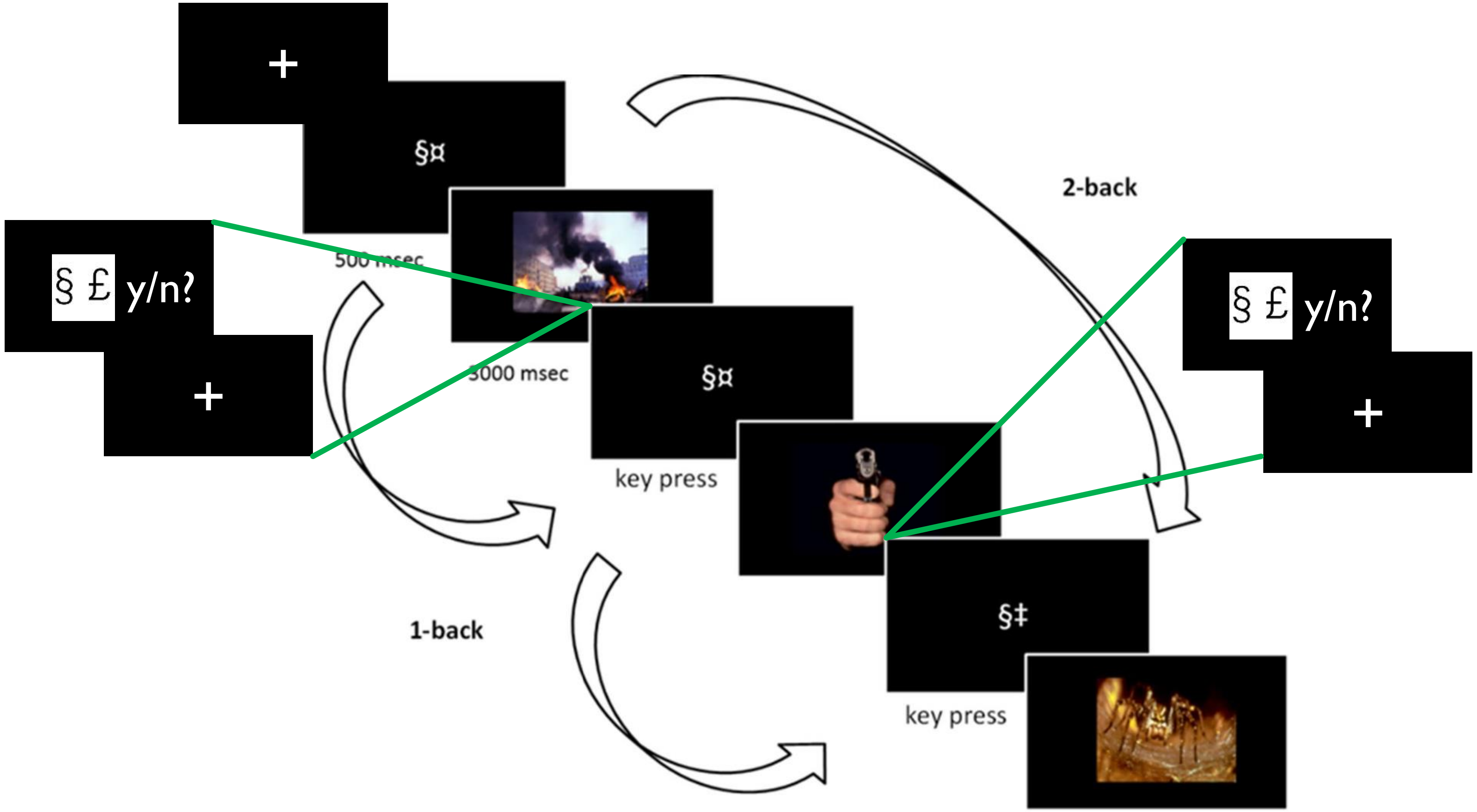
| | Indicate the extent you have felt this way over the past week. | Very slightly or not at all | A little | M |
|---|---|---|---|---|
| PANAS 1 | Interested | ☐ 1 | ☐ 2 | |
| PANAS 2 | Distressed | ☐ 1 | ☐ 2 | |
| PANAS 3 | Excited | ☐ 1 | ☐ 2 | |
| PANAS 4 | Upset | ☐ 1 | ☐ 2 | |
| PANAS 5 | Strong | ☐ 1 | ☐ 2 | |
| PANAS 6 | Guilty | ☐ 1 | ☐ 2 | |
| PANAS 7 | Scared | ☐ 1 | ☐ 2 | |
| PANAS 8 | Hostile | ☐ 1 | ☐ 2 | |
| PANAS 9 | Enthusiastic | ☐ 1 | ☐ 2 | |
| PANAS 10 | Proud | ☐ 1 | ☐ 2 | |
| PANAS 11 | Irritable | ☐ 1 | ☐ 2 | |
| PANAS 12 | Alert | ☐ 1 | ☐ 2 | |
| PANAS 13 | Ashamed | ☐ 1 | ☐ 2 | |
| PANAS 14 | Inspired | ☐ 1 | ☐ 2 | |
| PANAS 15 | Nervous | ☐ 1 | ☐ 2 | |
| PANAS 16 | Determined | ☐ 1 | ☐ 2 | |
| PANAS 17 | Attentive | ☐ 1 | ☐ 2 | |
| PANAS 18 | Jittery | ☐ 1 | ☐ 2 | |
| PANAS 19 | Active | ☐ 1 | ☐ 2 | |
| PANAS 20 | Afraid | ☐ 1 | ☐ 2 | ☐ 3 ☐ 4 ☐ 5 |

| No | PANAS | | Subject 1 | Subject 2 | Subject 3 | Subject 4 | Subject 5 |
|---|---|---|---|---|---|---|---|
| 1 | Interestd | 感兴趣的 | 4 | 4 | 5 | 1 | 2 |
| 2 | Distressed | 哀伤的 | 3 | 2 | 2 | 2 | 4 |
| 3 | Excited | 兴奋的 | 4 | 3 | 5 | 1 | 1 |
| 4 | Upset | 心烦的 | 2 | 1 | 1 | 1 | 5 |
| 5 | Strong | 强烈的 | 3 | 3 | 4 | 1 | 1 |
| 6 | Guilty | 内疚的 | 2 | 2 | 1 | 1 | 3 |
| 7 | Scared | 恐惧的 | 3 | 1 | 2 | 3 | 4 |
| 8 | Hostile | 敌对的 | 3 | 1 | 2 | 1 | 1 |
| 9 | Enthusiastic | 热情的 | 4 | 3 | 5 | 2 | 2 |
| 10 | Proud | 自豪的 | 3 | 4 | 5 | 1 | 1 |
| 11 | Irritable | 急躁的 | 2 | 2 | 2 | 1 | 4 |
| 12 | Alert | 警觉的 | 3 | 2 | 4 | 5 | 5 |
| 13 | Ashamed | 羞耻的 | 1 | 1 | 2 | 1 | 1 |
| 14 | Inspired | 有灵感的 | 4 | 3 | 4 | 2 | 2 |
| 15 | Nervous | 紧张的 | 4 | 2 | 1 | 4 | 5 |
| 16 | Determined | 坚决的 | 3 | 3 | 4 | 4 | 1 |
| 17 | Attentive | 专心的 | 3 | 2 | 5 | 4 | 2 |
| 18 | Jittery | 战战兢兢的 | 3 | 1 | 1 | 1 | 4 |
| 19 | Active | 积极活跃的 | 3 | 3 | 4 | 1 | 2 |
| 20 | Afraid | 害怕的 | 2 | 1 | 2 | 3 | 5 |
| | PA 33.3 (SD+/-7.2) | | 34 | 30 | 45 | 22 | 19 |
| | NA 17.4 (SD+/-6.2) | | 25 | 14 | 16 | 18 | 36 |

# Method – Procedures

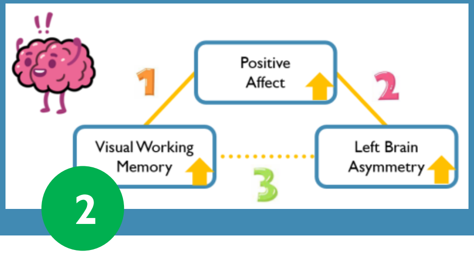



- Emotion N-Back Task Procedure
  - ✓ A modified version of a visual sequential letter working memory N-Back task
  - ✓ 240 stimuli standardized Emotion for valence and arousal
    - ➢ 80 positive ✓ 75 positive
    - ➢ 80 negative ✓ 75 negative
    - ➢ 80 neutral ✓ 75 neutral
  - ✓ Non-affective visual stimuli are 10 symbols
    - ➢ combined to obtain 20 different pairs of stimuli
    - ➢ used during the N-Back Task as target and non-target stimuli

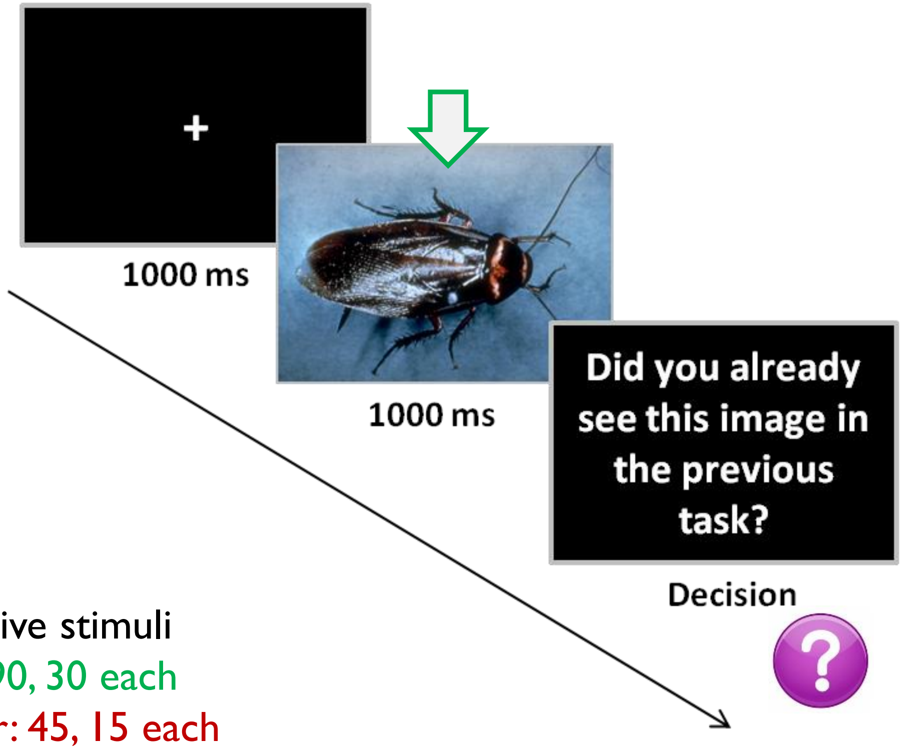



✓ Make Visual Working Memory much easier with high accuracy

# Method – Procedures

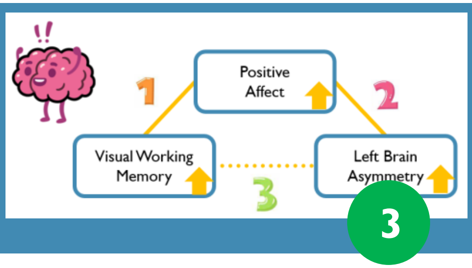



- Surprise Memory Recognition Task
  - ✓ Participants are 180 affective stimuli taken from the IAPS (Lang et al. 2008)
    - ➢ 120 affective stimuli (40 stimuli per valence): **familiar stimuli**, emotional distractors previously presented during the Emotional N-Back task
    - ➢ 60 affective stimuli (20 stimuli per valence): **unfamiliar stimuli**, stimuli are not presented during the previous task
  - ✓ Response is considered as
    - ➢ **correct** when they categorized as already seen the familiar stimuli and as unseen the unfamiliar ones
    - ➢ **incorrect** when they categorized as unseen the familiar stimuli and as seen the unfamiliar ones
  - ✓ Affective stimuli were presented in a fully randomized order




- ✓ 135 affective stimuli
- ✓ Familiar: 90, 30 each
- ✓ Unfamiliar: 45, 15 each

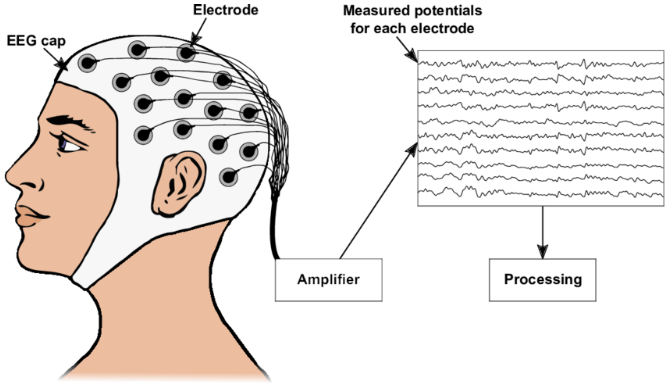
# Method – Procedures




- Brain Asymmetry – EEG Resting State
  - ✓ 64 electrode BioSemi
  - ✓ 5-min resting period with lights dimmed
  - ✓ Instruct participants to keep their eyes closed while remaining alert
  - ✓ Remove the first 30 s and the last 10 s of the resting state data prevent state transitional influence
  - ✓ Filter data, 1 Hz high-pass and 45–55 Hz notch FIR filters, then epoch into segments of 2 s each
  - ✓ Detect noisy channels and epochs using an automatic procedure, which followed by both manual review and rejection

✓ 32 electrode BioSemi, bad Fp1

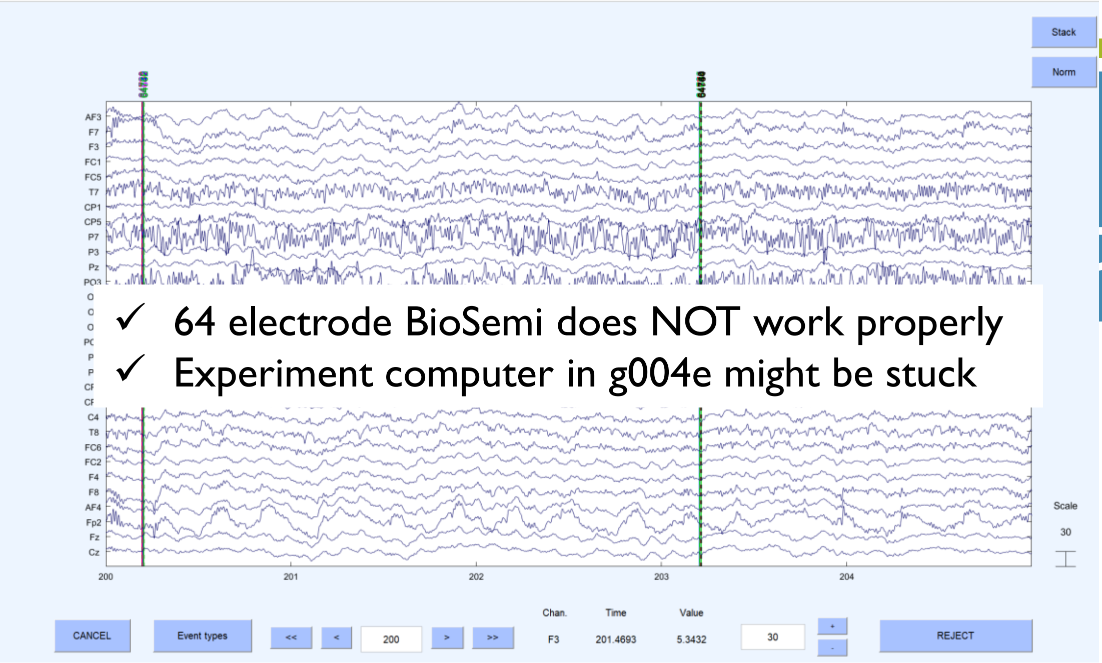
✓ Epochs not figured out



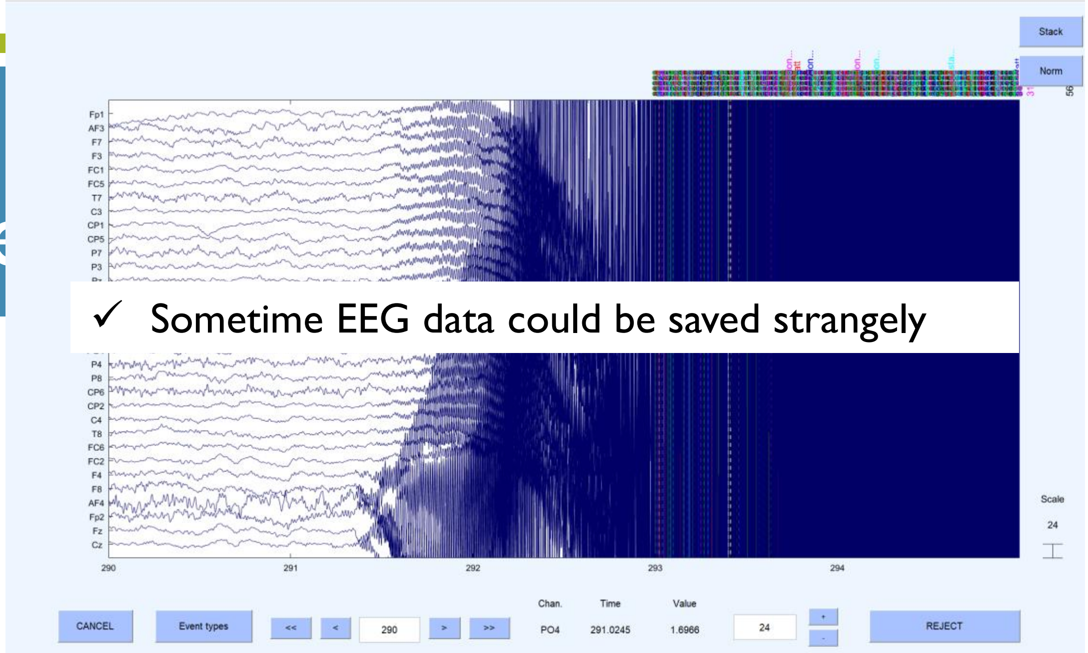

```
%% Get user input
% Decide which channel is right and which is left
[indLeft, lChosen]  = listdlg('PromptString','Pick a left channel:',...
                              'SelectionMode','single',...
                              'ListString', labels);
[indRight, rChosen] = listdlg('PromptString','Pick a right channel:',...
                              'SelectionMode','single',...
                              'ListString', labels);
if lChosen && rChosen
    tmpData = mean(EEG.data, 3);
    L = tmpData(indLeft, :);
    R = tmpData(indRight, :);
else
    error('E02 ERROR! One or both channel were not chosen. Pick both.');
end
% Pick frequency range
prompt = {'Enter minimal freq [Hz]:','Enter maximal freq [Hz]:'};
dlg_title = 'Specify frequency range';
defaultans = {'8','12'};
answer = inputdlg(prompt,dlg_title,1,defaultans);
FREQ_1 = str2num(cell2mat((answer(1))));
FREQ_2 = str2num(cell2mat((answer(2))));
%% Compute power spectrum for left channel
WIND = hamming(floor(length(L))/2.0);   % Get 2.0 sec time windows
OVER = floor((length(L))/2.0/2);        % 50% overlap
SIGN = L';                              % Get signal
[s, freqs, t, power] = spectrogram(SIGN, WIND, OVER, [], EEG.srate);
indFreqs = find(freqs>FREQ_1 & freqs<FREQ_2);
POW_L = power(indFreqs);
%% Compute power spectrum for right channel
WIND = hamming(floor(length(R))/2.0);   % Get 2.0 sec time windows
OVER = floor((length(R))/2.0/2);        % 50% overlap
SIGN = R';                              % Get signal
[s, freqs, t, power] = spectrogram(SIGN, WIND, OVER, [], EEG.srate);
indFreqs = find(freqs>FREQ_1 & freqs<FREQ_2);
POW_R = power(indFreqs);
%% Compute whole FAA
FAA = mean(log(POW_L)-log(POW_R))
```

Left

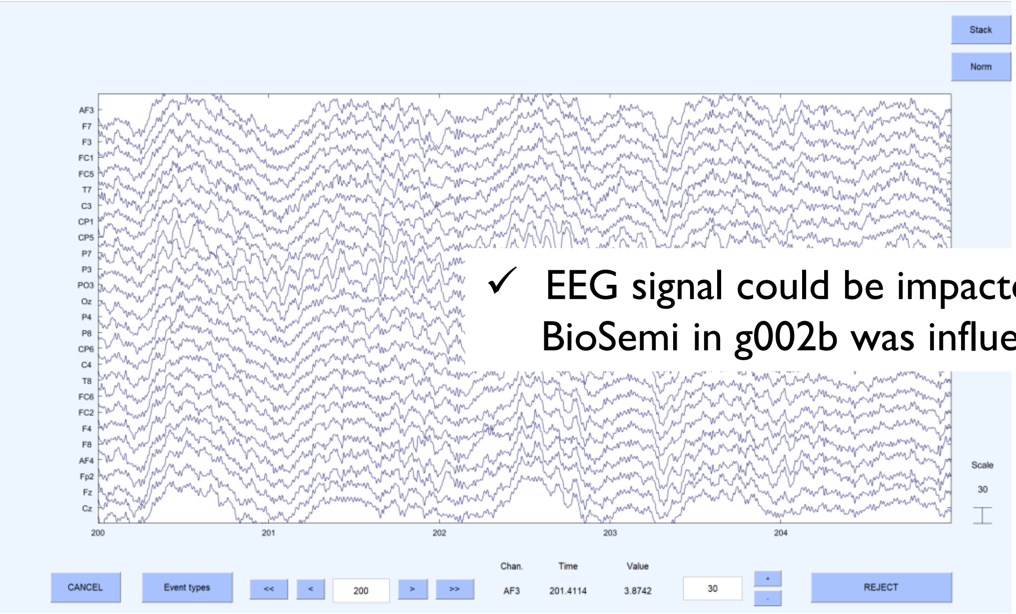
Right



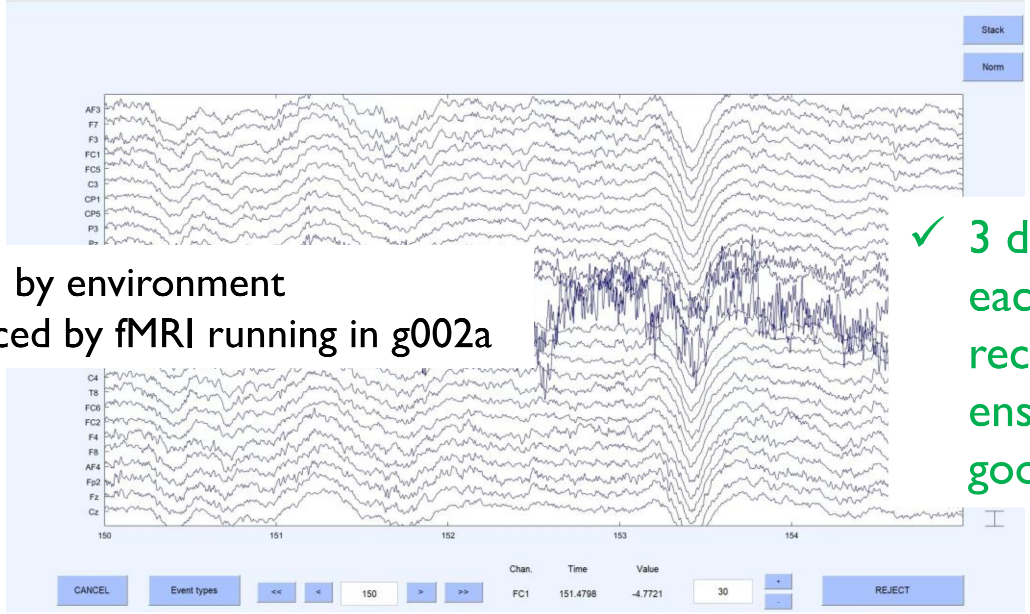

- ✓ 64 electrode BioSemi does NOT work properly
- ✓ Experiment computer in g004e might be stuck




- ✓ Sometime EEG data could be saved strangely




- ✓ EEG signal could be impacted by environment
  BioSemi in g002b was influenced by fMRI running in g002a




- ✓ 3 data collection for each subject is highly recommended to ensure getting a good quality data

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# Results – Participants

- Participant
  - ✓ 5 UM Students
    - ➢ Gender: All Females
    - ➢ Age: Range 22-60, $M_{age}$=29.2, $SD_{age}$=12.42
    - ➢ Education: All Receiving Master's Education
    - ➢ A **median-split** of the standardized PA scores
  - ✓ Results
    - ➢ Only female participants included to control for gender influence.
    - ➢ Age impact noted: 4 participants aged 22-24.

分组结果:

| | Subject | PANAS-NA | PANAS-PA | PA_Group |
|---|---|---|---|---|
| 0 | Subject 1 | 25 | 34 | High |
| 1 | Subject 2 | 14 | 30 | High |
| 2 | Subject 3 | 16 | 45 | High |
| 3 | Subject 4 | 18 | 22 | Low |
| 4 | Subject 5 | 36 | 19 | Low |

| Variable | Range | M | SD | t Value | p Value |
|---|---|---|---|---|---|
| Age | 22-60 | 29.2 | 12.42 | -0.13 | 0.90 (＞0.05) |
| Gender | Females | / | / | / | / |
| PANAS-PA Score | 19-45 | 30.0 | 9.23 | 0.0 | 1.0 |

**Table 1. Demographic Data of the Participants in the Study**

# Results- Emotional Memory Task

- Emotion Memory Task- Valence:
  - ✓ Data analysis- Accuracy
    - ➢ Accuracy:

$$Accuracy = \frac{Number\ of\ correct\ responses}{Total\ number\ of\ responses} \times 100\%$$

    - ➢ Average accuracy scores across 5 subjects for neg, neu, and pos stimuli.
  - ✓ Results Explanation
    - ➢ Expected Results: neg < pos < neu
    - ➢ Our Result: neg < neu < pos
    - ➢ Relative to neutral affect:
    - Negative affect **impairs** working memory accuracy.
    - Positive affect **enhances** working memory accuracy.

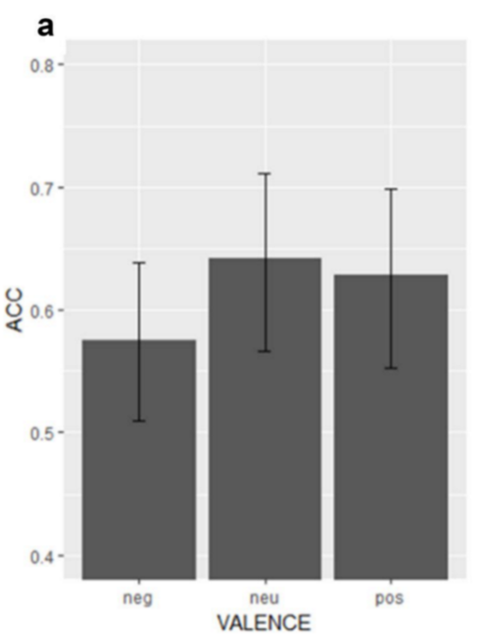



**Figure 2 . Expected Result- Main Effect of Valence**

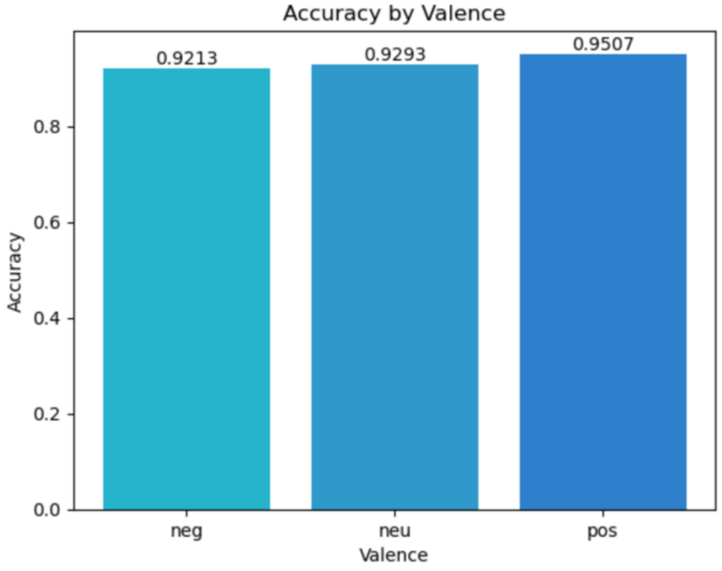



**Figure 3. Main Effect of Valence**

# Results- Emotional Memory Task

- Emotion memory task- cognitive load:
  - ✓ Data analysis- Accuracy
    - ➢ Average total accuracy across tasks per participant
    - ➢ Pearson correlation tests within the group:
    - • The correlation between PANAS scores and accuracy
    - ➢ T-tests between groups:
    - • The accuracy between load_1 and load_2
  - ✓ Results explanation
    - ➢ All data:
    - • Significant difference between 1 back and 2 back tasks
    - • Weak correlation between PANAS scores and accuracy
    - ➢ Excluding age incompatible data:
    - • **Significant difference** between 1 back and 2 back tasks
    - • **Significant correlation** between PANAS scores and accuracy

**Excluding Age Incompatible Data**

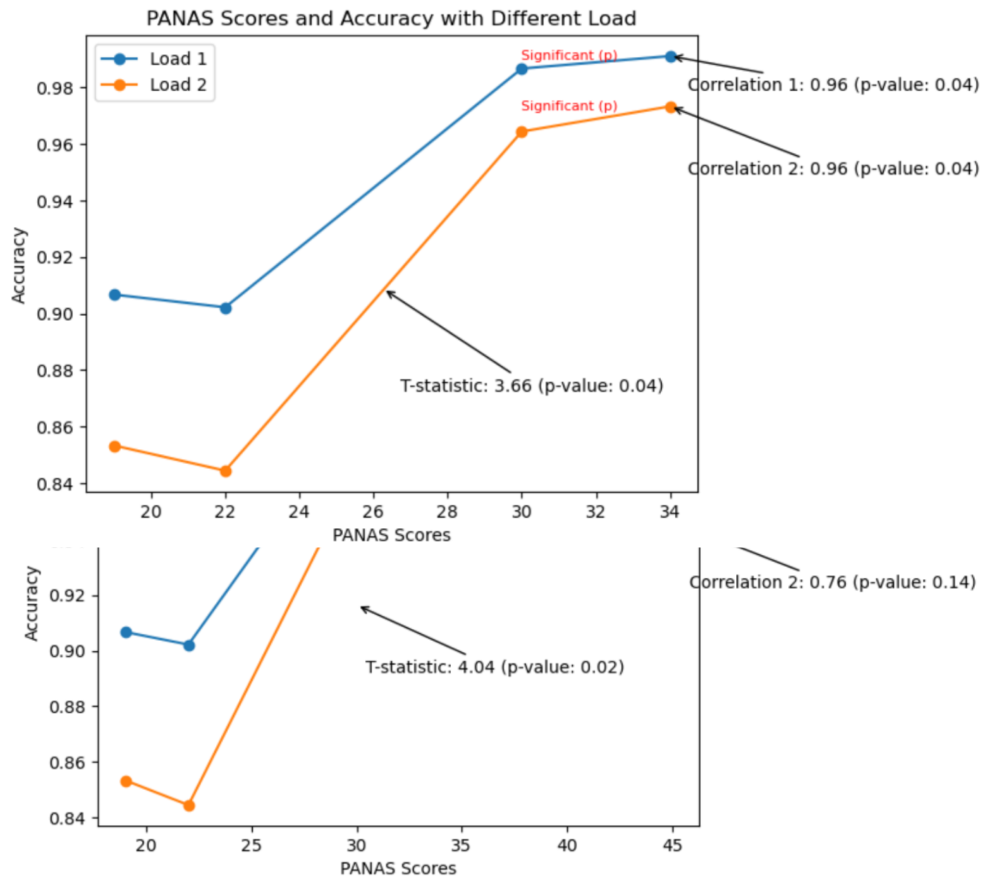



Figure 4. Interaction between PANAS Scores and Cognitive Load

# Results – Memory Recognition Task

- Surprise Memory Recognition Task
  - ✓ Data analysis- Accuracy
    - ➢ Average accuracy scores across 5 subjects for neg, neu, and pos stimuli.
  - ✓ Results Explanation
    - ➢ Expected Results: neu < pos < neg
    - ➢ Accuracy: neu < neg < pos
    - ➢ Positive emotion images more memorable than negative & neutral
    - ➢ Negative emotion images easier to recall than neutral


**Expected**

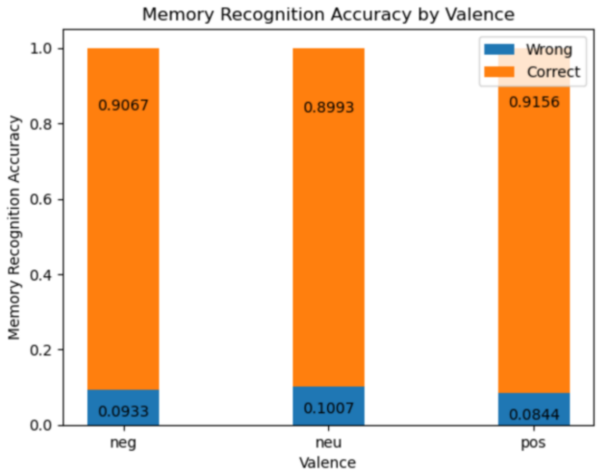
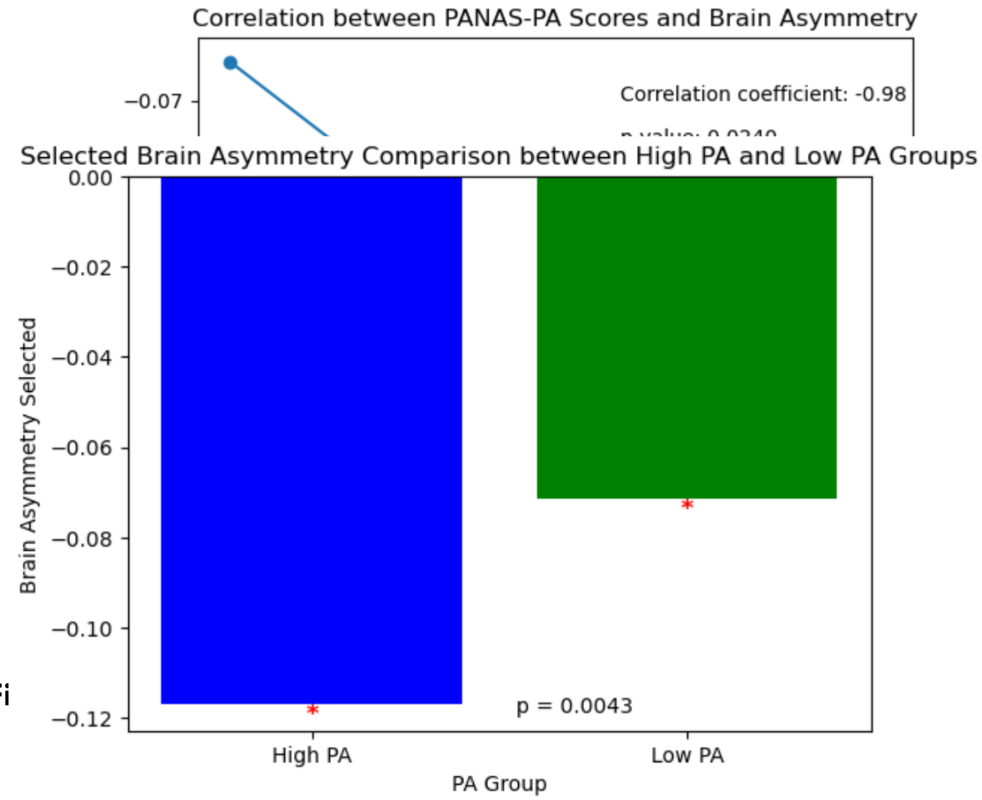



**Figure 5. Accuracy in the Memory Recognition Task**

# Results – Affect & Brain Asymmetry

- Affect vs Brain Asymmetry
  - ✓ Data analysis
    - ➢ Data Collection: Each participant had two resting-state EEG measurements. Due to Data Quality, most subjects have only one usable dataset, resulting in no averaging.
    - ➢ Pearson Correlation Tests:
    - • The Correlation Between PANAS-PA Scores and Brain Asymmetry
  - ✓ Results Explanation
    - ➢ All data:
    - • Weak Correlation Between PANAS-PA Scores and Brain Asymmetry ($p > 0.05$)
    - ➢ Excluding Age Incompatible Data:
    - • **Significant Correlation** Between PANAS-PA Scores and Brain Asymmetry ($p < 0.05$)
    - • **Higher affect** had lower brain asymmetry value which referred to higher right alpha power (**left brain more active**).

**Selected Data & Excluding Age Incompatible Data**



# Results – Affect & Working Memory

- Affect vs Working Memory
  —— Emotional Memory Task
  - ✓ Data analysis
    - ➢ Average Accuracy of 2 Tasks per Subject
    - ➢ Pearson Correlation Tests:
    - The Correlation Between PANAS-PA Scores and Accuracy
  - ✓ Results Explanation
    - ➢ All Data:
    - Weak Correlation between PANAS-PA Scores and Accuracy
    - ➢ Excluding Age Incompatible Data:
    - **Significant Correlation** between PANAS-PA Scores and Accuracy
    - Subject with **Higher PANAS-PA Scores** got **Higher performance of Working Memory**

**Excluding Age Incompatible Data**

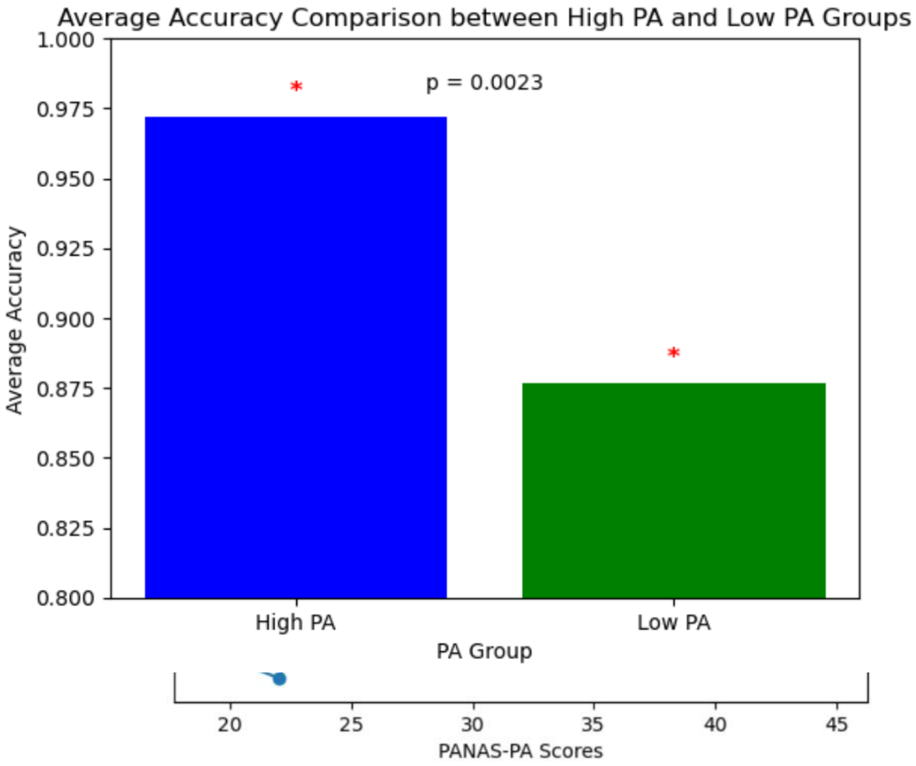



**Figure 8. Correlation between PANAS Scores and Working Memory in Emotional Memory Task**

# Results – Affect & Working Memory

- Affect vs Working Memory

  —— Surprise Memory Recognition Task

  ✓ Data analysis
  - ➢ Average Accuracy of Memory Task per Subject
  - ➢ Pearson Correlation Tests:
  - The Correlation Between PANAS-PA Scores and Accuracy

  ✓ Results Explanation
  - ➢ All Data:
  - Weak Correlation between PANAS-PA Scores and Accuracy (P > 0.05)
  - ➢ Excluding Age Incompatible Data:
  - Weak Correlation between PANAS-PA Scores and Accuracy (P > 0.05)

**Selected Data & Excluding Age Incompatible Data**

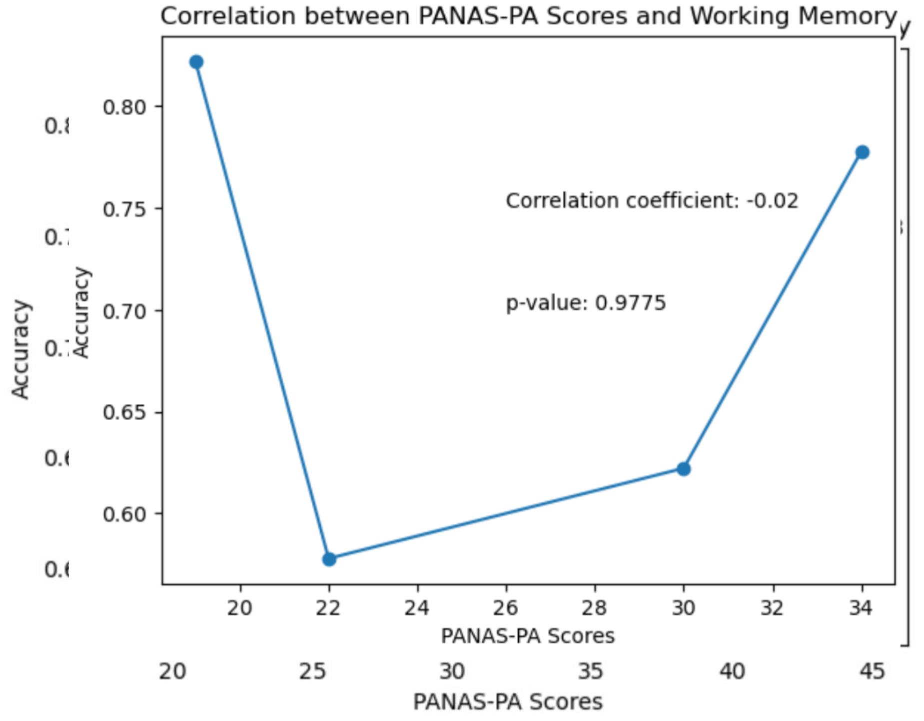



**Figure 9. Correlation between PANAS Scores and Working Memory in Surprise Memory Recognition Task**

# Results – Working Memory & Brain Asymmetry

- Working Memory vs Brain Asymmetry
  —— Emotional Memory Task
  - ✓ Data analysis
    - ➢ Pearson Correlation Tests:
    - The Correlation Between Accuracy and Brain Asymmetry
  - ✓ Results Explanation
    - ➢ All data:
    - **Significant correlation** between accuracy and brain asymmetry ($P < 0.05$)
    - **Higher working memory ability** had lower brain asymmetry value which referred to higher right alpha power (**left brain more active**).
    - ➢ Excluding Age Incompatible Data:
    - Significant correlation between PANAS-PA scores and brain asymmetry ($p < 0.05$)

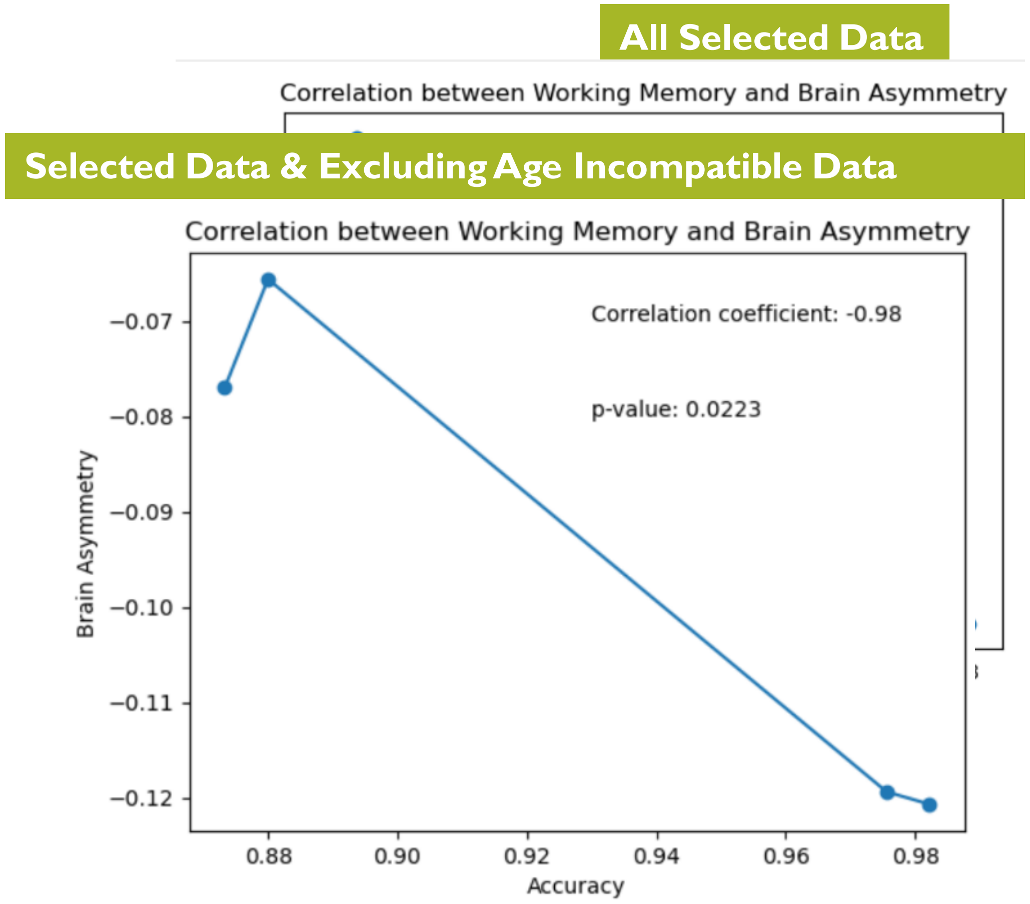



**Figure 10. Correlation between Working Memory and Brain Asymmetry in Emotional Memory Task**

# Results – Working Memory & Brain Asymmetry

- Working Memory vs Brain Asymmetry
  —— Surprise Memory Recognition Task
  - ✓ Data analysis
    - ➢ Pearson Correlation Tests:
    - The Correlation Between Accuracy and Brain Asymmetry
  - ✓ Results Explanation
    - ➢ All data:
    - Weak Correlation Between Accuracy and Brain Asymmetry ($p < 0.05$)
    - ➢ Excluding Age Incompatible Data:
    - Weak Correlation Between PANAS-PA Scores and Brain Asymmetry ($p < 0.05$)

**Selected Data & Excluding Age Incompatible Data**

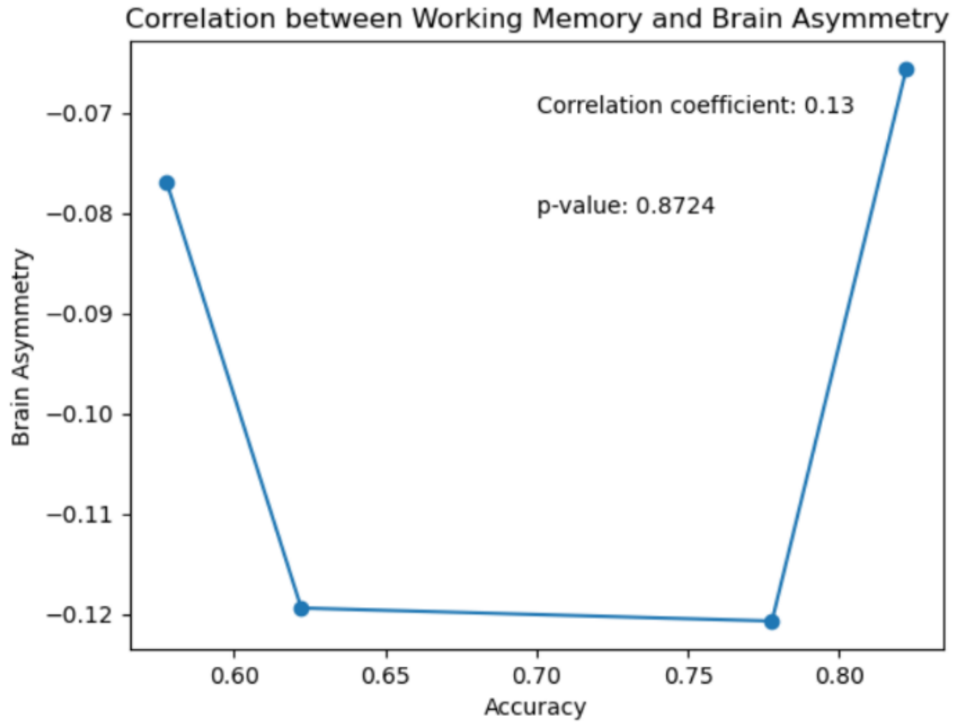



**Figure 12. Correlation between Working Memory and Brain Asymmetry in Surprise Memory Recognition Task**

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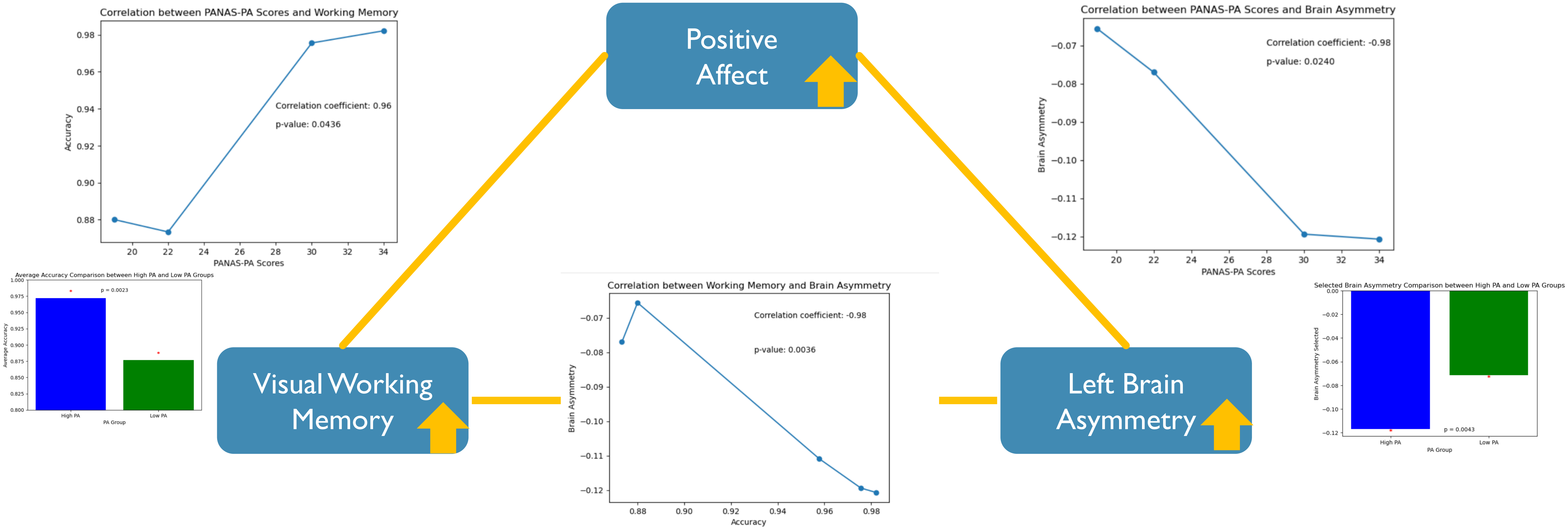
# Discussion

**The results are consistent with our 3 hypotheses:**



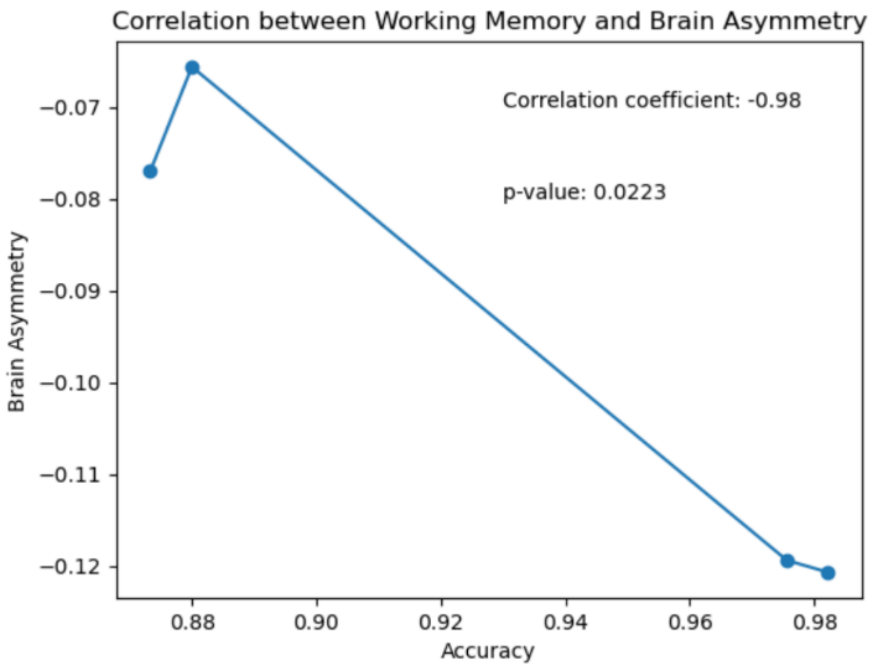
# Discussion

- **When studying the relationship between visual working memory and brain asymmetry, one of the five subjects falls into a different age group (50-60 years old)**
  - **Age factor of emotional memory task**
    - McDowell et al. (1994) found that older subjects exhibited a **deficit in the perception of unpleasant emotions** when compared to young subjects.
  - **Age factor of brain asymmetry**
    - The **right hemi-aging model**, which proposes that the right hemisphere shows greater age-related decline than the left hemisphere.
    - The **hemispheric asymmetry reduction in old adults (HAROLD) model**, which proposes that frontal activity during cognitive performance tends to be less lateralized in older than in younger adults. (Cabeza, 2002)
    - Cherry et al. (1995) found that the patterns of left-right asymmetries were comparable for younger and older participants.

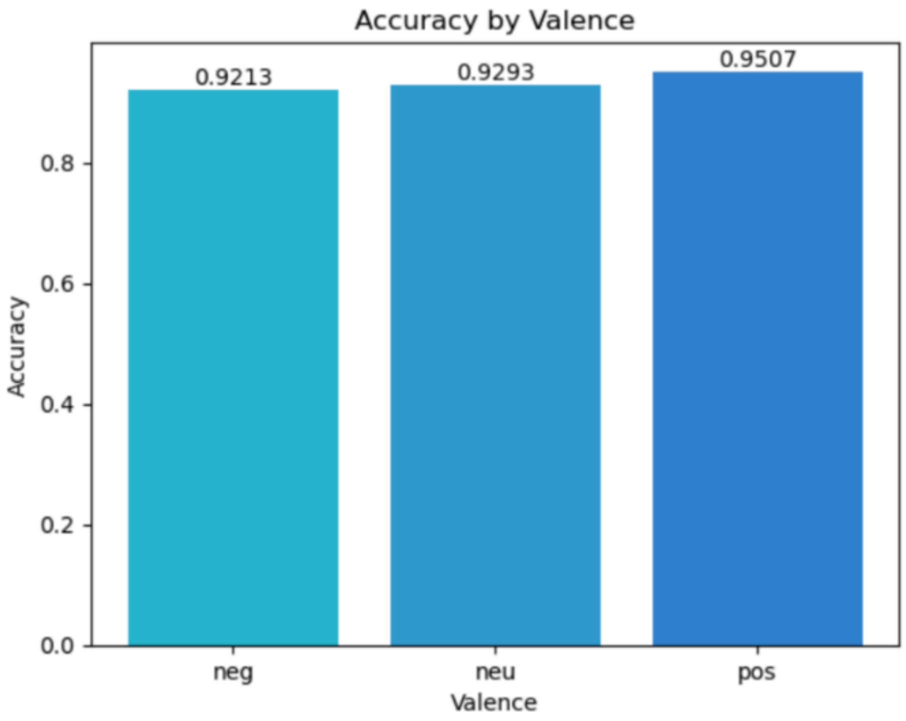
# Discussion

- **When studying the relationship between visual working memory and brain asymmetry, one of the five subjects falls into a different age group (50-60 years old)**

  The results remain statistically significant after removing the data (p=0.0223)



# Discussion




**Accuracy in emotional memory task**

- Previous study: negative < positive < neutral
- Our study: negative < neutral < positive

Result **consistent** with previous studies:

- Negative distractors consume more attentional resources (Panasiti et al., 2019)

Result **inconsistent** with previous studies: possible reasons and the future plans:

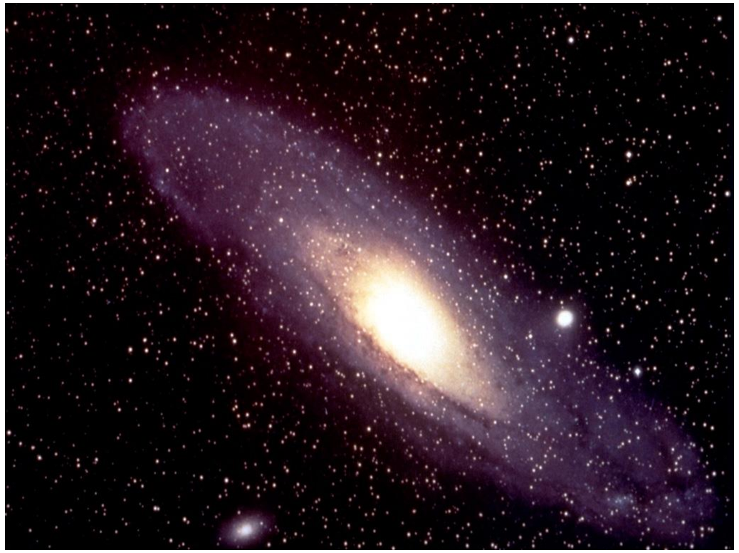
- Ceiling effect of the task: prevents the demonstration of different results between valence conditions

  → Increase the task difficulty: emotional N-back

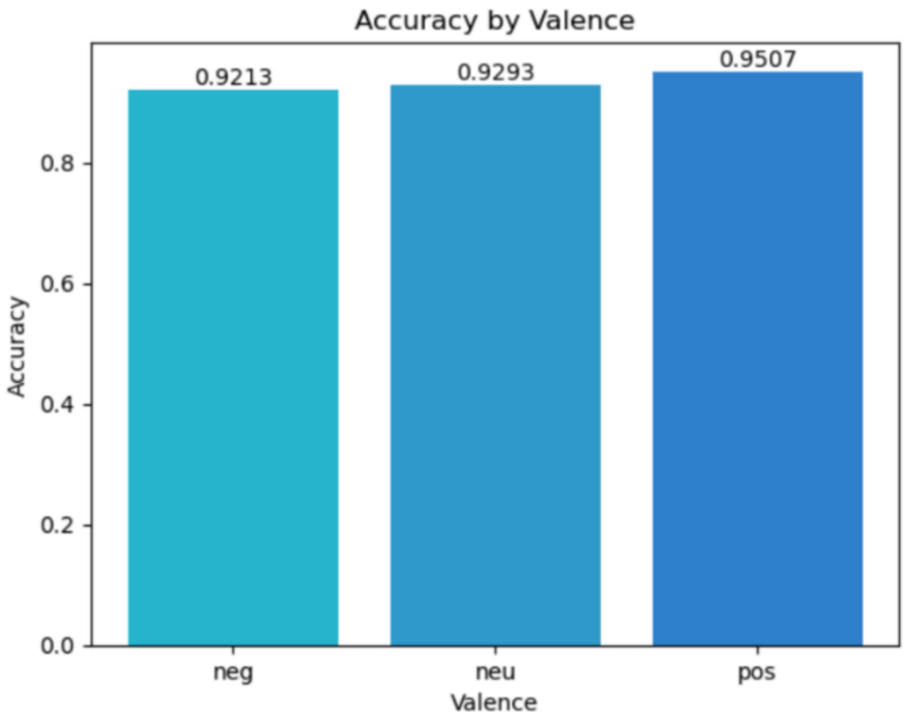
- The subjects' judgments of valence showed inconsistency compared to the International Affective Picture System (IAPS), particularly in neutral and positive photos.

IAPS: Neutral
Subject: Positive

IAPS: Positive
Subject: Neutral



# Discussion

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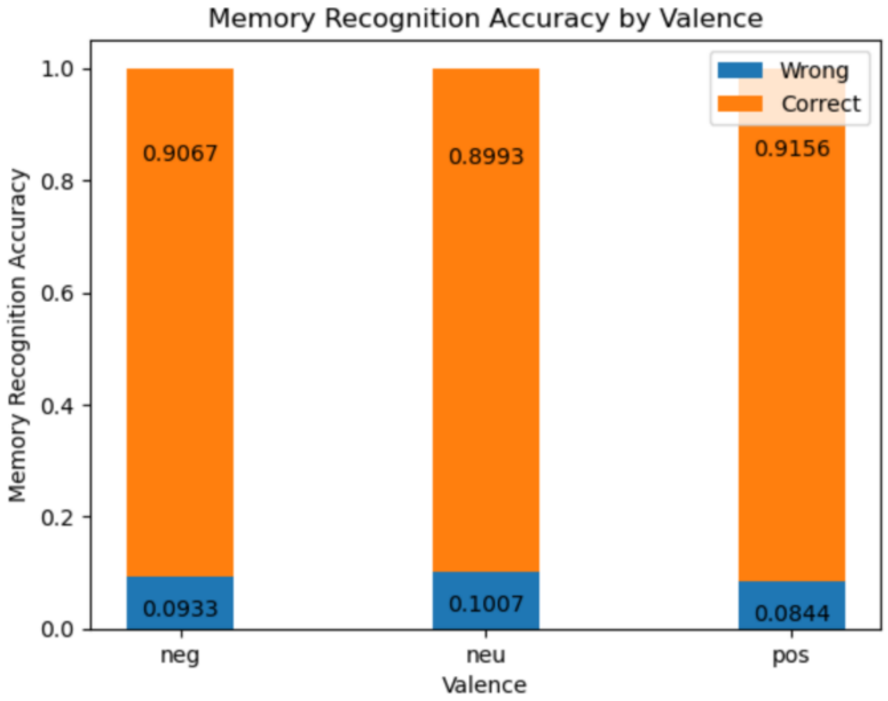
  - → Increase the task difficulty: emotional N-back
- The subjects' judgments of valence showed inconsistency compared to the International Affective Picture System (IAPS), particularly in neutral and positive photos.
  - → Increase the sample size
  - → Collect valance rating result from subjects

# Discussion




**Accuracy in memory recognition task**

- Previous study: neutral < positive < negative
- Our study: neutral < negative < positive

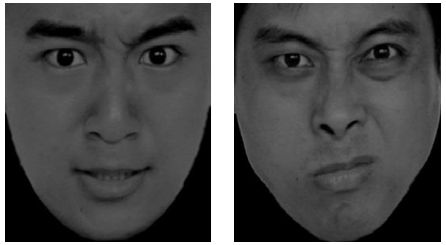
Result **consistent** with previous studies:

- Neutral distractors consume less attentional resources (Panasiti et al., 2019)

Result **inconsistent** with previous studies: possible reasons and the future plans:

- Negative distractors comprise face photos, leading to heightened memory difficulties, whereas positive and neutral distractors do not involve face photos.

  → Maintain consistency in the number and types of photos used for the three emotional distractors: nature scenes, food, utensils, animals, humans



# Discussion: other limitations and future plans

**Study design**

- This study only include female subjects, thus limits the applicability of its findings to general population
  - Males and females may exhibit distinct patterns of brain activation and connectivity during cognitive tasks and emotional processing (Davidson et al., 1976)

  → Include a group of males
- Investigating asymmetry in other EEG oscillations
  - Theta oscillations are associated with emotion regulation and memory encoding (Knyazev et al., 2007)
  - Beta oscillations are involved in attentional activation (Herrmann et al., 2016)
- Investigating negative affects
  - Positive and negative affect are independent in terms of how much people feel in their lives over longer time periods (Diener & Emmons, 1984)

# Discussion: other limitations and future plans

**Methodology**

Resting state EEG data recording

- EEG Paradigm: repeat the 5-minute paradigm at least three times to reduce noise through averaging
- Equipment: 64-/128-channel EEG cap
- Environment: in a setting free from environmental artifacts such as fMRI

Affects

- PANAS is a subjective measure, meaning individuals may interpret emotional words differently and have varying levels of self-awareness regarding their actual affective states.
- Objective measure: physiological (e.g. heart rate variability, skin conductance), behavioral (e.g. frequency and intensity of smiles or frowns in a social interaction)

# Project Research Report- Group 9

Brain Asymmetry and Visual Working Memory: Investigating the Impact of Negative Distractors

**Thank you for your listening!**