The Effects of Sleep, Stress, and Screen Time on Visual Episodic Memory in Adolescents

Eileen Chen

Abstract

Visual episodic memory refers to one's ability to remember the images and visuals of past experiences. Protecting one's visual episodic memory is important to support learning, problem-solving, and overall cognitive health in adolescence. Today's teens are living in a "Digital Age" marked by increasing screen usage and stress levels, and decreasing sleep, experiences which negatively affect brain structures and may possibly influence visual episodic memory. To further understand these connections, we designed and conducted a survey-based study, which explored the effects of sleep, stress, screen time, and social media use on visual episodic memory in 16 adolescents. This study was designed in such a way that most of the participants who enrolled completed the study, indicating that this study's approach is feasible and could be applied to future studies. However, in this study, no significant relationships were found between sleep, stress, screen time, and social media use on the percent of correct answers or reaction time on a visual episodic memory test (developed by CogniFit). This study has potential limitations, such as a small sample size and the influence of confounding variables, highlighting the complexity of isolating variables that affect cognition. More studies are needed to confirm if there is a lack of correlation.

Introduction

Every day, humans process a stream of images, some of which are quickly forgotten, while others are stored and later recalled. Visual episodic memory, a type of long-term memory, refers to the ability to recall images and visuals that were seen in the past, which can persist for years to even lifetimes (Schurgin and Flombaum, 2018). This differs from working memory, a type of short-term memory, which refers to remembering information and manipulating it to perform complex tasks like problem-solving, and is limited to remembering about 3-5 "chunks" of information for seconds to tens of seconds (Cowan, 2015; Cowan, 2010; Leroy et al., 2024).

Episodic memory is primarily controlled by the medial temporal lobe in the brain, including the hippocampus, which plays a crucial role in encoding and retrieving information from past events (Dickerson and Eichenbaum, 2009). Previous research suggests that numerous factors influence episodic memory, including the time between encounters, age, and diet, due to their effects on brain regions, such as the hippocampus (Schurgin and Flombaum, 2018; Kinugawa et al., 2013; Cansino et al., 2021).

Although the effects of sleep and stress on memory have been extensively studied, their effects on visual episodic memory remain areas of ongoing investigation. In addition, screen time is a relatively new variable of interest. In 2023, American adolescents spent an average of 6-9 hours on media-related activities each day, considerably higher than the recommended 2 hours (Santos et al., 2023). Moreover, in 2018, 97 percent of Americans aged 13 through 17 used at least one of the following social networking sites: YouTube, Instagram, Snapchat, Facebook, Twitter, Tumblr, and Reddit (Vidal et al., 2020). Excessive screen time is linked to increased risk of mental health disorders (e.g., depression and anxiety) and sleep issues, both of which may affect visual episodic memory performance (Nakshine et al., 2022). Understanding how these factors may impact visual episodic memory is crucial in order to protect one's ability

to recall previous experiences, which can aid in learning, problem-solving, and overall cognitive health, improving youth learning and mental health.

The purpose of this experiment is to examine how sleep duration, perceived stress, and daily screen time relate to visual episodic memory performance. Given evidence that lifestyle and environmental factors can influence cognitive functioning, this study seeks to better understand how these commonly experienced variables may affect both memory accuracy and processing speed. To address this question, participants completed self-report measures assessing sleep, stress, and screen use, as well as a standardized visual episodic memory task. Performance was evaluated using accuracy and reaction time as primary outcome measures.

Methods and Materials

A 9-question Qualtrics survey was created to assess participants' daily sleep, stress, and screen time use. The survey takes about 5 minutes to complete and asks participants to report the number of hours of sleep from the previous night, total screen time for the day, and amount of time on social media using short-answer text boxes. Participants were also asked to rate their current stress level from 1 to 10 (1 being the lowest, and 10 the highest). In addition, participants were asked to provide basic demographic information, including name, age, and gender. Participants were invited to take part in the study via direct outreach and instructed to complete the survey 2-3 times per week over a two-week period. They received reminder emails prompting completion. Informed consent was obtained, and approval was granted by an Institutional Review Board (IRB) consisting of a pediatrician, a high school biology educator, and a high school vice principal. Because this is an observational study, the review was expedited. Responses were linked to participants' legal names to allow for data tracking longitudinally (across the 2 weeks the study took place). To protect participants' data, all data was stored in a password-protected Qualtrics form on one password-protected computer.

After completing the questionnaire each time, participants were directed to CogniFit's free online visual episodic memory test, in which images appear sequentially, and respondents press the spacebar on their keyboard whenever an image repeats (Cognifit; Figure 1). Participants then recorded their percent correct and reaction time in the survey. A total of 17 participants completed the survey 66 times, and the Cognifit online visual episodic memory test was taken 66 times. Those who completed fewer than three survey entries were excluded from analyses, resulting in the removal of one participant (n=1 number of participants excluded), resulting in a final sample of 16 participants, whose 64 survey/test entries were analyzed.

Figure 1: CogniFit's Visual Episodic Memory Test

Image 1 Image 2 Image 3

In CogniFit's Visual Episodic Memory Test, images are shown one at a time to participants. Participants are prompted to press the spacebar on their keyboard when seeing an image that has been shown before in the test. It would be correct to not press the spacebar on Image 2 but press the spacebar on Image 3.

Results

Table 1: Demographic Data of Final Sample of Participants

Number of Participants	16
Number of Responses	64
Gender (m:f)	1:15
Age (mean, median, SD, range)	17.1, 17, 1.0, 4

Table 2: Summary of Results

	Mean	Median	Standard Deviation	Range
Sleep in Hours	7.7	8	2	12
Stress (1-10)	6.9	7	2.1	8
Screen Time in Hours	3	3	1.9	9
Time on Social Media in Hours	1.8	1.45	1.6	8
Percent Correct	97.8	98	2.6	9
Reaction Time in Seconds	0.7	0.68	0.1	0.5

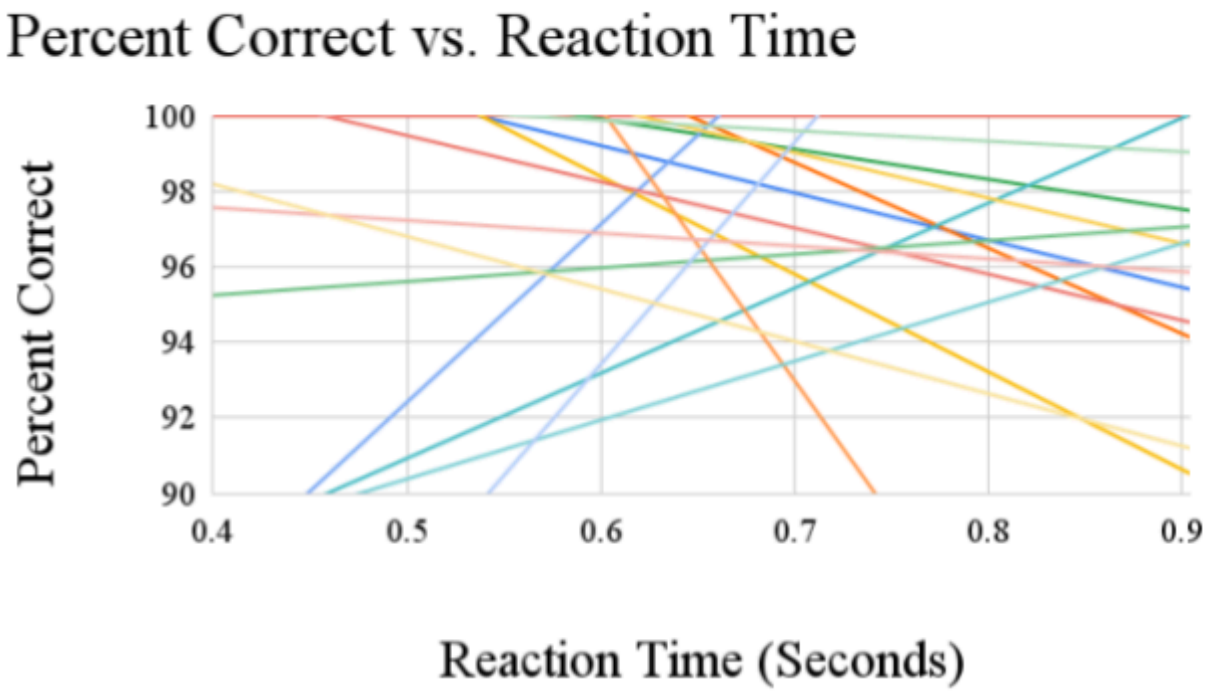

Figure 2. Percent Correct vs. Reaction Time. Each participant's percent correct on CogniFit's Visual Episodic Memory Test was plotted against their reaction time in seconds, and their correlation line was graphed. Each line represents one individual.

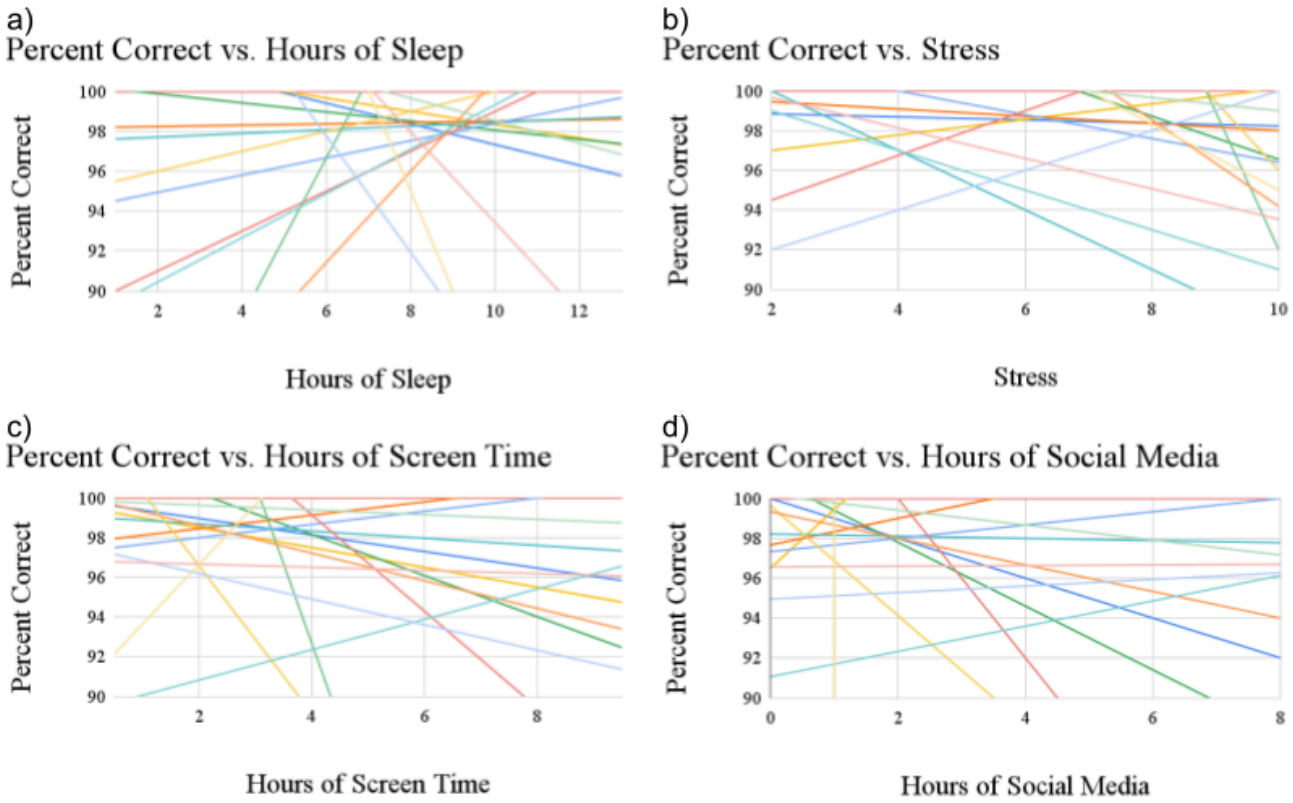

Figure 3: Sleep, Stress, Screen Time, and Hours on Social Media vs. Percent Correct. Each participant's percent correct on CogniFit's Visual Episodic Memory Test was plotted against their (a) number of hours of sleep, (b) amount of stress, (c) hours of screen time, and (d) hours of time spent on social media. Then their correlation line was graphed. Each line represents one individual, illustrating within-individual relationships between the four factors and reaction time across repeated measurements. (a) The relationship between sleep and percent correct was not statistically significant (mean correlation coefficient=-0.002, p=0.990). Similarly, (b) the relationship between percent correct and stress (mean correlation coefficient=-0.118, p=0.408), (c) hours of screen time (mean correlation coefficient=-0.253, p=0.121), and (d) hours of time spent on social media (mean correlation coefficient=-0.119, p=0.401) was not statistically significant. P-values were generated from a one sample *t*-test of the correlation coefficients against a null hypothesis of 0. A p-value of greater than p=0.08 indicates the results were not statistically significant. Overall, across all four variables, it was found that their relationship with percent correct is not statistically significant.

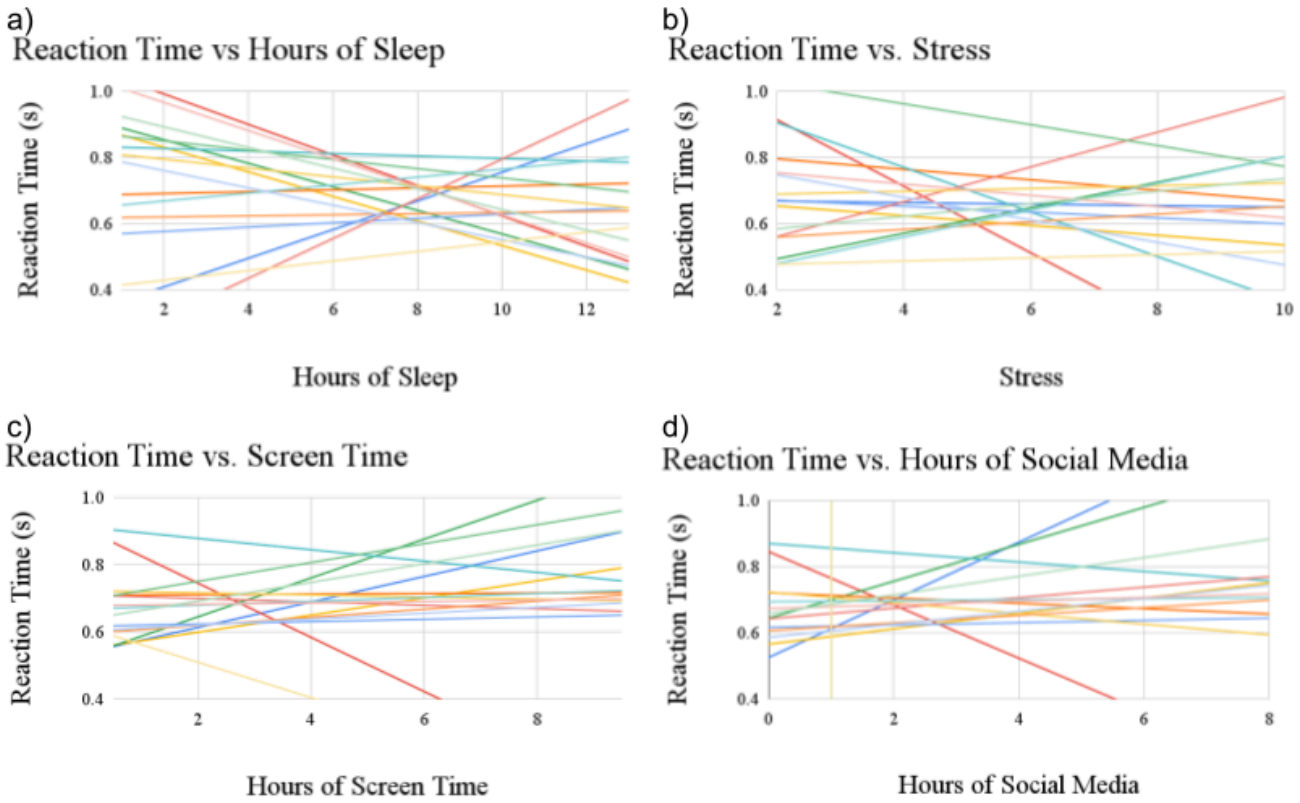

Figure 4: Sleep, Stress, Screen Time, and Hours on Social Media vs. Reaction Time. Each participant's reaction time on CogniFit's Visual Episodic Memory Test was plotted against their (a) number of hours of sleep, (b) amount of stress, (c) hours of screen time, and (d) hours of time spent on social media. Then their correlation line was graphed. Each line represents one individual, illustrating within-individual relationships between the four factors and percent correct across repeated measurements. (a) The correlation between sleep (mean correlation coefficient=-0.090, p=0.540), (b) stress (mean correlation coefficient=-0.131, p=0.371), (c) screen time (mean correlation coefficient=0.192, p=0.200), and (d) hours on social media (mean correlation coefficient=0.168, p=0.176) showed no significant relationship with reaction time. All average correlation coefficients were small, indicating weak linear relationships. P-values were generated from a one sample *t*-test of the correlation coefficients against a null hypothesis of 0. A p-value of greater than p=0.08 indicates the results were not statistically significant. Overall, across all four variables, it was found that their relationship with reaction time is not statistically significant.

A total of 64 responses from 16 participants were analyzed. The sample was heavily skewed towards high school females and had a narrow age range (ages 16-20). The mean percent correct was 97.8% with a standard deviation of 2.6%, and the mean reaction time was 0.7 seconds with a standard deviation of 0.1 seconds (Table 2). The mean amount of sleep was 7.7 hours with a standard deviation of 2.1 hours, the mean amount of screen time was 3.0 hours with a standard deviation of 1.9 hours, and the mean time spent on social media was 1.8 hours with a standard deviation of 1.6 hours (Table 2).

For sleep vs. percent correct, the participants' correlations largely varied in direction, suggesting high variability across participants rather than a consistent relationship (mean correlation coefficient=-0.002, p=0.990; Figure 3a). Similarly, correlations for stress and percent correct showed mixed directions with no consistent pattern (mean correlation coefficient=-0.118, p=0.408; Figure 3b). For screen time vs percent correct, the correlations also differed in direction between individuals (mean correlation coefficient=-0.253, p=0.121; Figure 3c). Correlations between hours on social media and percent correct showed similar patterns of mixed correlation directions (mean correlation coefficient=-0.119, p=0.401; Figure 3d). Sleep, stress, screen time, and hours on social media all showed mixed correlation directions with percent correct, and none reached significance.

For sleep vs. reaction time, the participants' correlations largely varied in direction, suggesting high variability among individuals and no consistent relationship (mean correlation coefficient=-0.090, p=0.540; Figure 4a). Similarly, correlations between stress and reaction time showed mixed directions across participants (mean correlation coefficient=-0.131, p=0.371; Figure 4b). For screen time vs. reaction time, the correlations showed some variability in direction between individuals (mean correlation coefficient=0.192, p=0.200; Figure 4c). Correlations between hours on social media and reaction time showed similar patterns of mixed correlation directions (mean correlation coefficient=0.168, p=0.176; Figure 4d). Sleep, stress, screen time, and hours on social media all showed mixed correlation directions with reaction time, and none of the relationships were statistically significant.

Discussion

The study demonstrated that all average correlation coefficients were small, indicating weak linear relationships. Overall, none of the factors studied (sleep, stress, screen time, and time on social media) showed statistically significant relationships with percent correct or reaction time.

However, it must be noted that this study has potential limitations. There was a small sample size of 16 individuals with a similar age range (16-20 years) and heavily skewed towards females, making the sample not representative of all youth. Furthermore, there was a lack of variation in some individuals, such as getting 100 percent correct on all visual episodic memory tests taken or getting the same amount of sleep across all days, reducing the reliability of the calculated correlation coefficients. Repeatedly taking the visual episodic memory test may have also caused participants to improve their accuracy with more practice. Furthermore, participants had an average accuracy of 97.8% correct. This ceiling effect likely reduced variability in scores, limiting the ability to detect within-person associations. Future studies could address this by conducting more challenging memory tasks, such as increasing the number of items or increasing retention time. Various confounding variables may have also influenced the data. For instance, the time of day each memory test was taken differed across individuals, possibly influencing the data based on how well people focus during a certain time of day. Diet or learning disabilities, due to their effect on regions in the brain, may have also played a role.

Most of the participants who enrolled completed the study, indicating that this study's approach is feasible and could be used for further in-depth studies. Future research could improve this study by using a larger sample that is more representative of the population of youth. The survey could also run for more time and have each individual take more tests to

allow for more accurate comparisons between factors and their effects on visual episodic memory.

Conclusion

The purpose of this experiment is to study the effects of sleep, stress, and screen time on visual episodic memory. Most of the participants who enrolled completed the study, indicating that further in-depth studies could be conducted using similar methods. No significant relationships were found between sleep, stress, screen time, and hours of social media on percent correct or reaction time in CogniFit's online visual episodic memory test, possibly due to limitations in the study like small sample size and the presence of confounding variables.

In today's Digital Era, where long screen times, sleep deprivation, and high stress are prevalent among teens, understanding how factors such as sleep, stress, screen time, and time on social media may impact visual episodic memory is crucial to protecting one's ability to recall past experiences. Although this study found no significant relationships, future research should be conducted to better understand how these factors influence visual episodic memory, which can promote learning and help an individual support their overall brain health.

Acknowledgements

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Conflict of Interests

The author declares that there are no conflicts of interest related to this work.

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Appendix

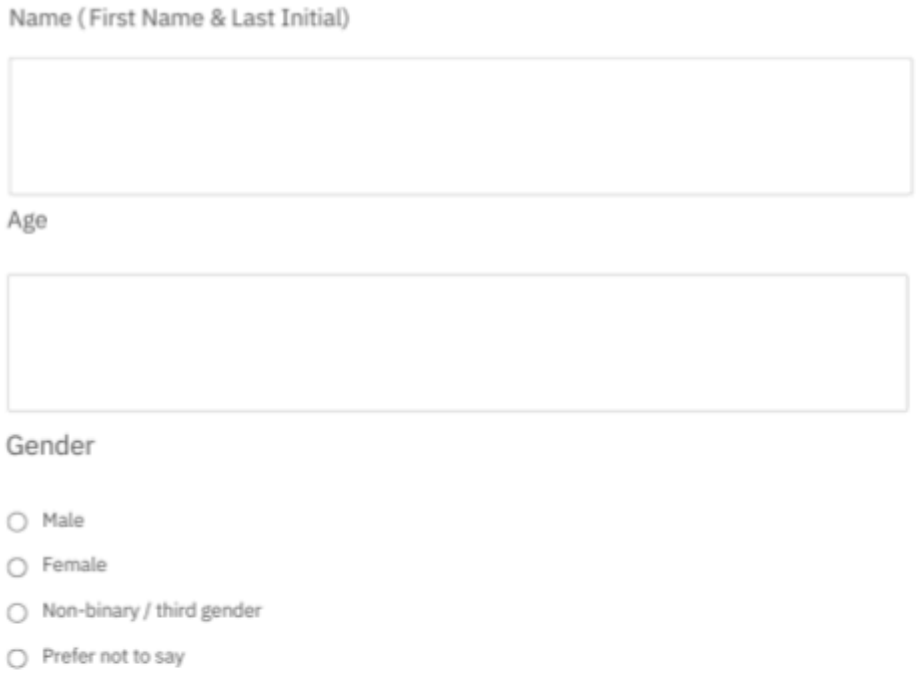


Figure 5. Survey Questions for Demographic Data

Figure 6. Survey Questions for Sleep, Stress, Screen Time, and Hours of Social Media

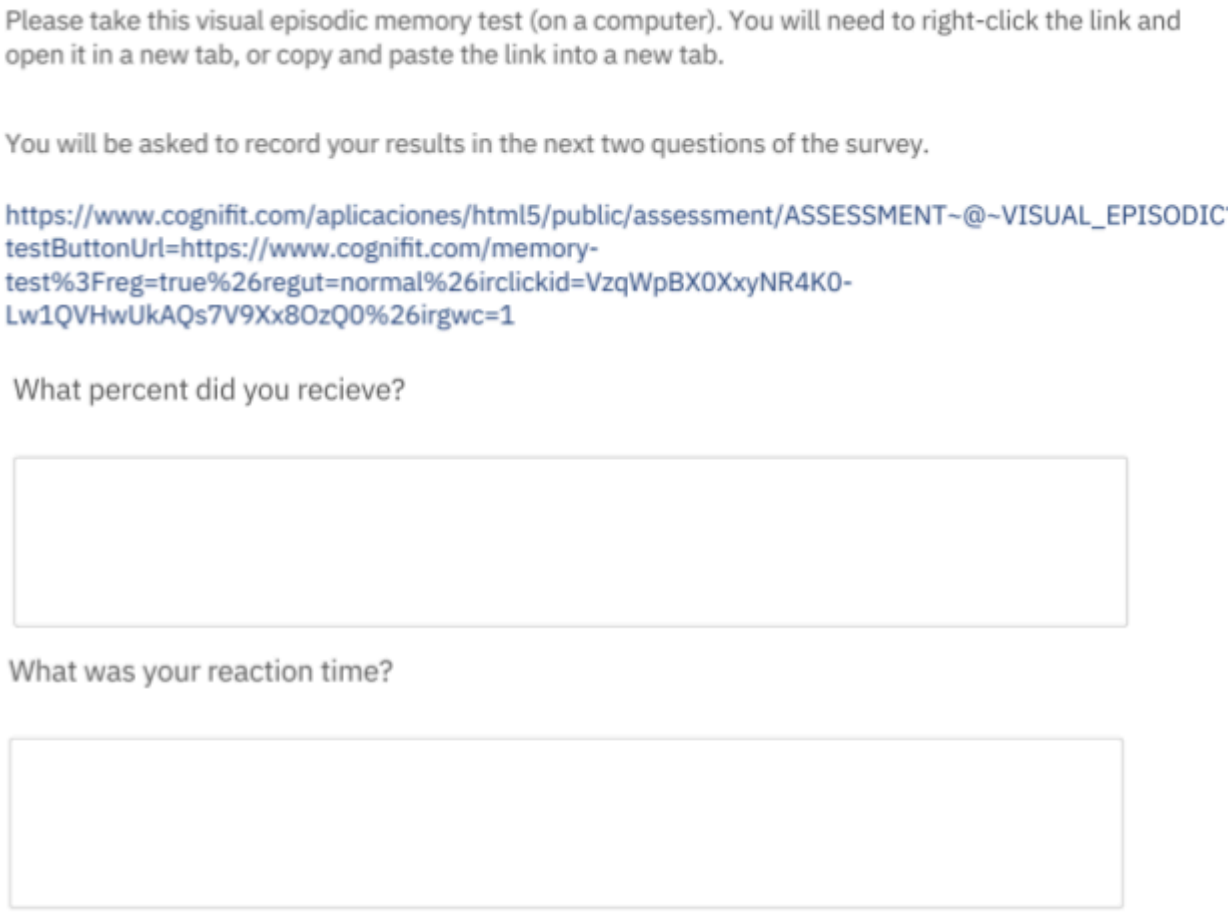
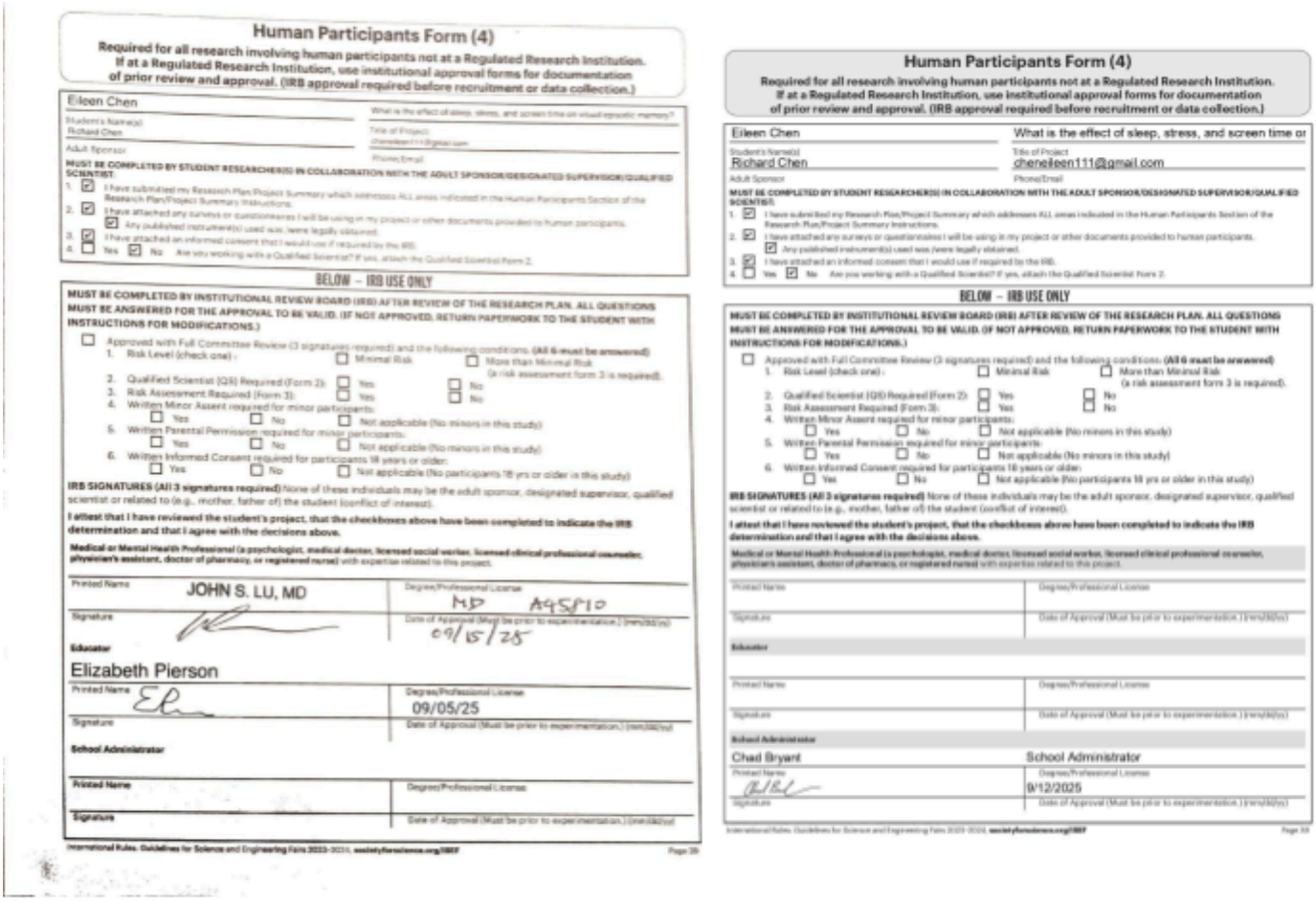


Figure 7. Survey Questions for CogniFit's Free Online Visual Episodic Memory Test Results



Human Participants Form (4)

Required for all research involving human participants not at a Regulated Research Institution.
If at a Regulated Research Institution, use institutional approval forms for documentation
of prior review and approval. (IRB approval required before recruitment or data collection.)

Eileen Chen — What is the effect of sleep, stress, and screen time on
Student's Name(s) — Title of Project
Richard Chen — chenelleen111@gmail.com
Adult Sponsor — Phone/Email

MUST BE COMPLETED BY STUDENT RESEARCHER(S) IN COLLABORATION WITH THE ADULT SPONSOR/DESIGNATED SUPERVISOR/QUALIFIED SCIENTIST.

1. ☑ I have submitted my Research Plan/Project Summary which addresses ALL areas indicated in the Human Participants Section of the Research Plan/Project Summary Instructions.
2. ☑ I have attached any surveys or questionnaires I will be using in my project or other documents provided to human participants.
   ☑ Any published instrument(s) used was/were legally obtained.
3. ☑ I have attached an informed consent that I would use if required by the IRB.
4. ☐ Yes ☑ No Are you working with a Qualified Scientist? If yes, attach the Qualified Scientist Form 2.

BELOW – IRB USE ONLY

MUST BE COMPLETED BY INSTITUTIONAL REVIEW BOARD (IRB) AFTER REVIEW OF THE RESEARCH PLAN. ALL QUESTIONS MUST BE ANSWERED FOR THE APPROVAL TO BE VALID. (IF NOT APPROVED, RETURN PAPERWORK TO THE STUDENT WITH INSTRUCTIONS FOR MODIFICATIONS.)

☐ Approved with Full Committee Review (3 signatures required) and the following conditions. (All 6 must be answered)

1. Risk Level (check one): ☐ Minimal Risk ☐ More than Minimal Risk (a risk assessment form 3 is required).
2. Qualified Scientist (QS) Required (Form 2): ☐ Yes ☐ No
3. Risk Assessment Required (Form 3): ☐ Yes ☐ No
4. Written Minor Assent required for minor participants: ☐ Yes ☐ No ☐ Not applicable (No minors in this study)
5. Written Parental Permission required for minor participants: ☐ Yes ☐ No ☐ Not applicable (No minors in this study)
6. Written Informed Consent required for participants 18 years or older: ☐ Yes ☐ No ☐ Not applicable (No participants 18 yrs or older in this study)

IRB SIGNATURES (All 3 signatures required) None of these individuals may be the adult sponsor, designated supervisor, qualified scientist or related to (e.g., mother, father of) the student (conflict of interest).

I attest that I have reviewed the student's project, that the checkboxes above have been completed to indicate the IRB determination and that I agree with the decisions above.

Medical or Mental Health Professional (a psychologist, medical doctor, licensed social worker, licensed clinical professional counselor, physician's assistant, doctor of pharmacy, or registered nurse) with expertise related to this project.

Printed Name	Degree/Professional License
JOHN S. LU, MD	MD A45710
Signature	Date of Approval (Must be prior to experimentation.) (mm/dd/yy)
	09/15/25

Educator

Elizabeth Pierson

Printed Name	Degree/Professional License
Elizabeth Pierson	09/05/25
Signature	Date of Approval (Must be prior to experimentation.) (mm/dd/yy)

School Administrator

Printed Name	Degree/Professional License
Chad Bryant	School Administrator
Signature	Date of Approval (Must be prior to experimentation.) (mm/dd/yy)
	9/12/2025

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Student's Name(s) — Title of Project
Richard Chen — chenelleen111@gmail.com
Adult Sponsor — Phone/Email

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3. Risk Assessment Required (Form 3): ☐ Yes ☐ No
4. Written Minor Assent required for minor participants: ☐ Yes ☐ No ☐ Not applicable (No minors in this study)
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Medical or Mental Health Professional (a psychologist, medical doctor, licensed social worker, licensed clinical professional counselor, physician's assistant, doctor of pharmacy, or registered nurse) with expertise related to this project.

Printed Name	Degree/Professional License
Signature	Date of Approval (Must be prior to experimentation.) (mm/dd/yy)

Educator

Printed Name	Degree/Professional License
Signature	Date of Approval (Must be prior to experimentation.) (mm/dd/yy)

School Administrator

Printed Name	Degree/Professional License
Chad Bryant	School Administrator
Signature	Date of Approval (Must be prior to experimentation.) (mm/dd/yy)
	9/12/2025

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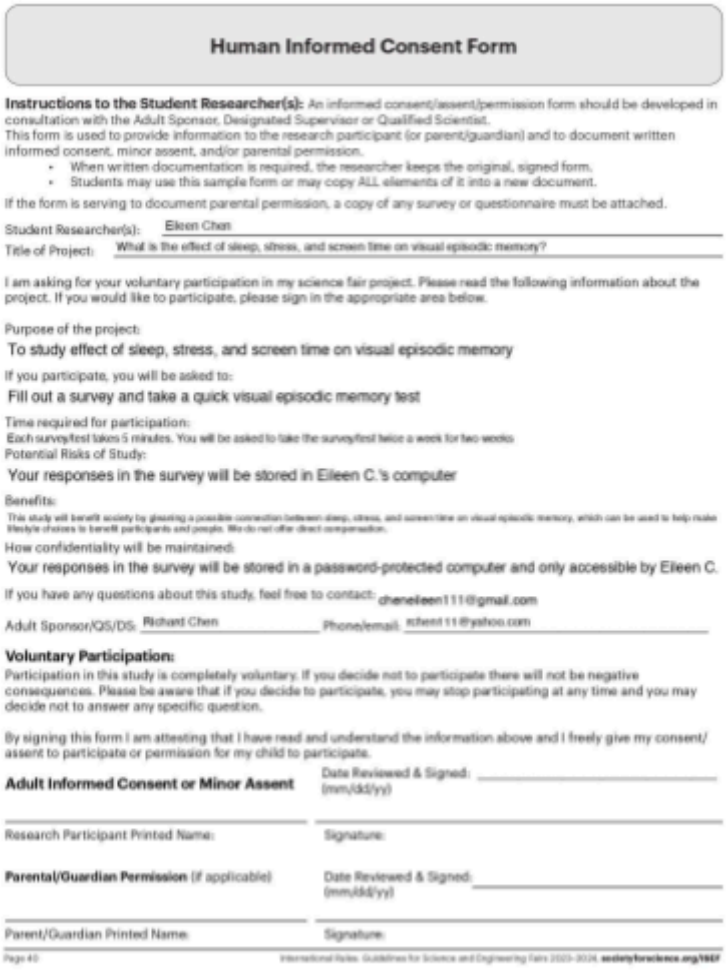
Figure 8. IRB Approval Signatures



Human Informed Consent Form

Instructions to the Student Researcher(s): An informed consent/assent/permission form should be developed in consultation with the Adult Sponsor, Designated Supervisor or Qualified Scientist.
This form is used to provide information to the research participant (or parent/guardian) and to document written informed consent, minor assent, and/or parental permission.

- When written documentation is required, the researcher keeps the original, signed form.
- Students may use this sample form or may copy ALL elements of it into a new document.

If the form is serving to document parental permission, a copy of any survey or questionnaire must be attached.

Student Researcher(s): Eileen Chen

Title of Project: What is the effect of sleep, stress, and screen time on visual episodic memory?

I am asking for your voluntary participation in my science fair project. Please read the following information about the project. If you would like to participate, please sign in the appropriate area below.

Purpose of the project:
To study effect of sleep, stress, and screen time on visual episodic memory

If you participate, you will be asked to:
Fill out a survey and take a quick visual episodic memory test

Time required for participation:
Each survey/test takes 5 minutes. You will be asked to take the survey/test twice a week for two weeks

Potential Risks of Study:
Your responses in the survey will be stored in Eileen C.'s computer

Benefits:
This study will benefit society by showing a possible connection between sleep, stress, and screen time on visual episodic memory, which can be used to help make lifestyle choices to benefit participants and people. We do not offer direct compensation.

How confidentiality will be maintained:
Your responses in the survey will be stored in a password-protected computer and only accessible by Eileen C.

If you have any questions about this study, feel free to contact: chenelleen111@gmail.com

Adult Sponsor/QS/DS: Richard Chen Phone/email: richent11@yahoo.com

Voluntary Participation:
Participation in this study is completely voluntary. If you decide not to participate there will not be negative consequences. Please be aware that if you decide to participate, you may stop participating at any time and you may decide not to answer any specific question.

By signing this form I am attesting that I have read and understand the information above and I freely give my consent/assent to participate or permission for my child to participate.

Adult Informed Consent or Minor Assent Date Reviewed & Signed: _____ (mm/dd/yy)

_____ _____
Research Participant Printed Name: Signature:

Parental/Guardian Permission (if applicable) Date Reviewed & Signed: _____ (mm/dd/yy)

_____ _____
Parent/Guardian Printed Name: Signature:

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Figure 9. Human Informed Consent Form