American Research Journal of Neurology

Volume 5, Issue 1, 01-05 Pages
Research Article | Open Access
ISSN (Online)- 2693-4795
DOI : 10.21694/2393-4795.26001

Behavioral Variables, Dreaming, and an Inferred Association with Dopamine Modulation

Yuejia Zhuang*, Nicole Jurdak
Westtown School, Private school in West Chester, Pennsylvania, United States

Correspondence to: Yuejia Zhuang, Westtown School, Private school in West Chester, Pennsylvania, United States.
E-mail: daisyzhuang2023@gmail.com

Received: April 18, 2026; **Accepted:** May 01, 2026

ABSTRACT

Dreams, mental experiences occurring during REM sleep, are closely connected with the regulation of dopamine. The study aimed to investigate the association between dopamine and dreaming activity through proxy variables such as aerobic exercise and sugary consumption, both demonstrated to affect dopamine levels. A sample of n=64 participants ranging from 13 to 71 years old with a mean age of 29.9 were asked researcher-developed questions through surveys on SurveyMars. All data was analyzed through Pearson Product Moment correlation using SPSS software. The r and p values were calculated and correlational scatter plots were created. In total, 64 responses were collected in part 1 of the survey and 307 responses were collected in part 2 of the survey. The findings of the study revealed that there is a significant positive correlation between higher sugary substance consumption and dream vividness. Additionally, there was a positive correlation between the amount and intensity of exercise and dream vividness. However, there was only a non-significant correlation between sugary substance consumption and higher amount and intensity of exercise and dream recall frequency. Future directions and limitations are discussed.

KEYWORDS: Dreaming; REM Sleep; Reward System; Neurotransmitters; Sleep Behavior; Survey-Based Study; Correlation Analysis; Dopaminergic Activity; Mental Processes.

INTRODUCTION

Dreams are dynamic mental experiences that occur during sleep, especially during rapid eye movement sleep (REM). Typically, dreams occurring in REM sleep are longer and more vivid compared to dreams in non-REM sleep. During dreams, people often perceive thoughts, emotions, visual images, and other event-like experiences [1]. In 1900, Sigmund Freud proposed that dreams originate from complex psychological settings that are completely different from real life experiences, while the physiological function of dreams remains somewhat unclear even today [1].

Dopamine and Dreams

Dopamine is a neurotransmitter that plays a crucial role in reward regulation in the brain [2]. Human nature encourages participation in behaviors that release more dopamine, and when doing something pleasurable, the brain releases more dopamine, stimulating motivation and craving within the body [2]. In recent years, the role dopamine exerts during REM sleep has been scientifically demonstrated. Research has demonstrated that the mesolimbic dopamine (ML-DA) system shows increasing neural activity during REM sleep. Generally, elevated dopamine levels in the ML-DA system during sleep play a crucial role in the generation of dreams [3]. The upregulation or downregulation of dopamine during REM sleep might affect the vividness of dreams, as previous experiments on narcolepsy showed that REM sleep is associated with hallucinatory experiences that are downregulated through the administration of anti-dopamine medications [4].

TYPES OF DREAMS

Dreams are intrinsically diverse. James (2025) [5] stated that normal dreams are the most common type of dream people will experience in the REM stage, when the brain is as equally active as when awake. Dreams often replay daily scenarios with familiar locations, familiar people and recent events, while displaying expressed thoughts or emotions. Even though the context of dreams varies, normal dreams do not typically leave a lasting impression on people upon waking. On the other hand, nightmares, often occurring during the REM stage of sleep, will leave a more long-lasting impression on people due to their emotional intensity and unsettling nature. Nightmares can be triggered by stress, anxiety, and traumatic events. Vivid dreams are another type of common dreams. With rich details, vivid dreams can evoke strong emotions that make people wonder if the dream is happening or has actually happened. Recurring, or repeating, dreams happen when the unconscious mind of human brains tries to process unresolved issues that need attention in real life. They also take place during REM, while dream context is commonly related to stress and anxiety as well. Lucid dreaming refers to dreams that happen when the dreamer is aware that they are dreaming and, during which, they may control their dream's context. Lucid dreams, also occurring during REM sleep, are often harmless but may cause unsettling feelings when the content becomes increasingly intense or frightening [5].

AEROBIC EXERCISE AND DOPAMINE

Dopamine and physical activity have a bidirectional relationship. Dopamine affects motivation to continue and practice physical activity due to its significant role in reward mechanisms. As a neurotransmitter, which supports cognitive control, dopamine encourages humans to pursue behaviors that bring satisfaction continuously, such as physical activity.

Successful cognitive control is essential for continuous engagement in physical activity; on the other hand, excess or diminished dopamine will lead to mental disorders such as depression. In turn, physical activity influences the central dopaminergic system. While physical activity is known to increase dopamine receptor availability in the central nervous system, an increase in physical activity corresponds with upregulation of neurotransmitter activity, additionally, reducing levels of anxiety and depression [6]. 5-HT is known for its effects on sleep and rodents that receive large amounts of exercise will have higher 5-HT in various areas of the brain while the level of dopamine only increases in the striatum. After 8 weeks of food-reinforced running-wheel exercise, rats are found to have upregulated concentrations of dopamine in brain homogenates, resulting from the exercise-induced higher levels of serum calcium [7].

Dreams, Dopamine, Imaging, and What's Next

While dopamine has been extensively studied in reward processing in relation to aerobic exercise and sugary food intake [10-12], current dream research often requires invasive and clinical methods [12]. Neuroimaging techniques have been applied in brain studies since the 1990s, in combination with electroencephalography. Positron Emission Tomography (PET) uses radioactive tracers that will measure and visualize physiological information, including glucose consumption and dopamine release. In addition, the detection of radioactive decay as an accumulated component will assist the imaging of H 2 15 O to reveal the blood flow across the whole brain, indicating neuronal activities. Functional MRI became the most commonly used studying human cognitive process technique in the early 1990s. While fMRI is less invasive compared to PET due to less radiation exposure, a major shared constraint is their high costs [12].

In addition, although neuroimaging provides insights into the distribution of brain activity, dream reports are not easily obtained and functional neuroimaging is hard to operate during REM or NREM sleep [10]. Moreover, current dream studies often rely on dream reports, where dream experiences are not fully represented. And the potential information loss in complex series of cognitive operations between the transfer from dream content to dream reports lead to inaccurate reports [11]. There is minimal research related to dream characteristics occurring in real-life settings as individuals can neither report their activities in dreaming nor researchers are able to collect and validate an individual's experience [13]. In other words, researchers can only assess dream consciousness based on reports rather than direct observation; therefore, understanding the difficulty to predict any specific dreams, researchers investigate the properties of all dreams instead of any individual dream activity [14].

This project aimed to investigate dopamine-modulating behaviors such as aerobic exercise and sugary food intake and their relationship to dreaming activity. This study intended to provide new evidence about how daily behaviors, serving as proxy variables, impact dreaming. The use of proxy variables is a low-cost and effective method that enables investigations without specialized equipment, providing for broader use in different communities. Results of this research methodology can be easily understood and communicated with participants, other researchers, and wider societies, increasing awareness of sleep, dreaming, daily behaviors–and, potentially, infer dopaminergic activity. Further research employing survey type data combined with neuroimaging could provide a more direct and extensive evaluation of dopamine modulation; this research direction is suggested.

MATERIALS AND METHODS

Participant Characteristics

This research required human participants and all data were collected through 100% confidential and anonymous surveys. No identifiable information was collected except for age and the city/state the participant is based in. Data collected were only used in this research.

Human participants were either based in China or the US without any gender limitations, ranging from high school teenagers to adults. No vulnerable populations were involved.

Survey Procedure

Survey questions were developed by the researcher in discussion with the mentor and surveys were created on SurveyMars, an online survey platform. The survey employed was a 2-part document; part 1 aimed to collect general information of participants, and part 2 more specifically investigated factors that affect 24-hour dreaming activity. Part 2 required regular recording of dream content for 1 week continuously. Participants were instructed to complete both parts of the survey within 2 weeks of receipt. Participants indicated their consent prior to accessing the survey on an electronic consent form. Participants under 18 asked their parents/legal guardians to provide consent as well (the assent process). The consent form and the introduction to the survey clearly stated that participation was completely voluntary and participants should stop at any time they feel uncomfortable. Additionally, participants were instructed to reach out to professional help if they have any survey-content-related lasting negative effects. Generally, participants were asked to report their usual and daily exercise pattern, sugary food intake, sleeping routine and characteristics of their dreams.

RESULTS

Data Analysis

The anonymously collected data were analyzed through SPSS software. Basic statistical characteristics, such as mean, ranges, standard deviations and distributions, were initially calculated for all variables including dreaming frequency, intensity of aerobic exercise, amount of sugary food intake, etc. Additionally, to test the hypothesis, the correlation between dream frequency and vividness and level of exercise and dream frequency and vividness and sugary food intake were analyzed with Person Product Moment (PPM) correlations through SPSS.

Participant Characteristics

There are 64 participants in total for this study, ranging from 13 to 71 years old while the mean age was 29.9 years old with a standard deviation of 15.34. The minimum hours of sleep was 4 hours while the maximum was 12 hours, with a mean of 7.08 hours with a standard deviation of 1.34. The average time of weekly exercise was 226.1 minutes. The average number of sugary substances consumed per day was 1.7 with a minimum of 0 and a maximum of 4.

Correlational Data

Using Pearson Product Moment correlations via SPSS, three positive correlations were found. The first positive correlation of .239 was found between the number of sugary substances consumed and vividness of dreams with a significance level of .021. Participants indicated the number of sugary substances they consumed yesterday and rated the vividness of their dreams on a scale of 5, 1 means very poor and 5 means very vivid. The second positive correlation of .392 was found between the amount/duration of exercise and the

vividness of dreams. Participants indicated the duration of exercise of the day and rated the vividness of their dreams on a scale of 5. The third positive correlation of .336 was found between the intensity of exercise and the vividness of dreams. Participants indicated their exercise intensity and dream vividness on a scale of 5.

The first positive correlation of .239 was found between the number of sugary substances consumed and vividness of dreams with a significance level of .021.

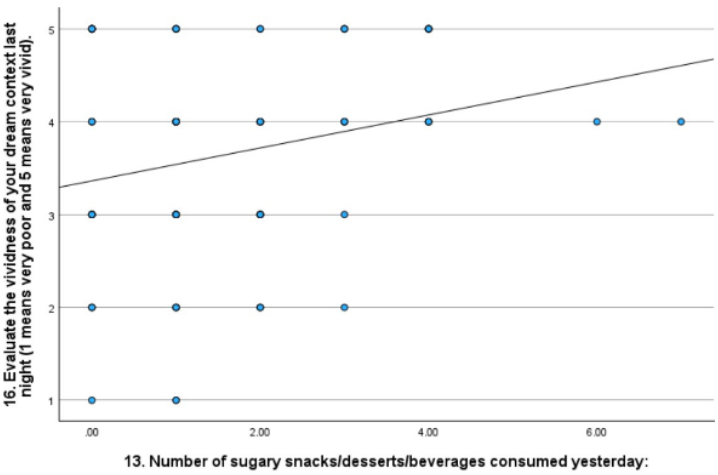

Figure 1: Significant Correlation between Sugary Substance Consumption and Dream Vividness

Note: This figure reveals the significant correlation between sugary substance consumption and dream vividness. Participants indicated the number of sugary substances they onsumed yesterday and rated the vividness of their dreams on a scale of 5, 1 means very poor and 5 means very vivid. The second positive correlation of .392 was found between the amount/duration of exercise and the vividness of dreams with a significance level of .015.

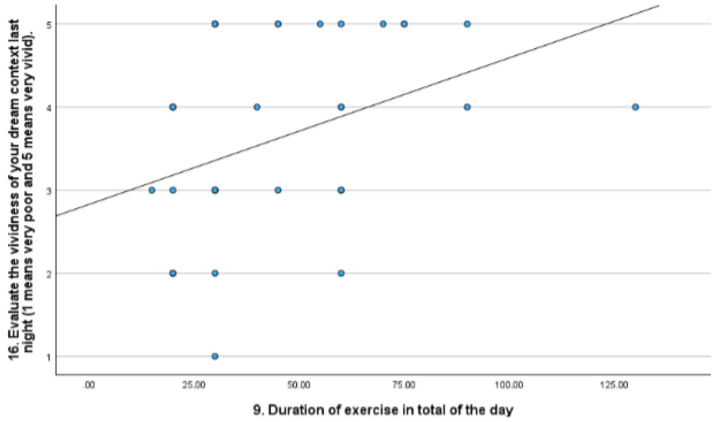

Figure 2: Significant Correlation between the Amount of Exercise and Dream Vividness

Note: This figure demonstrates the correlation between the amount/duration of exercise and dream vividness. Participants indicated the duration of exercise of the day in minutes and rated the vividness of their dreams on a scale of 5. The third positive correlation of .336 was found between the intensity of exercise and the vividness of dreams with a significance level of .022.

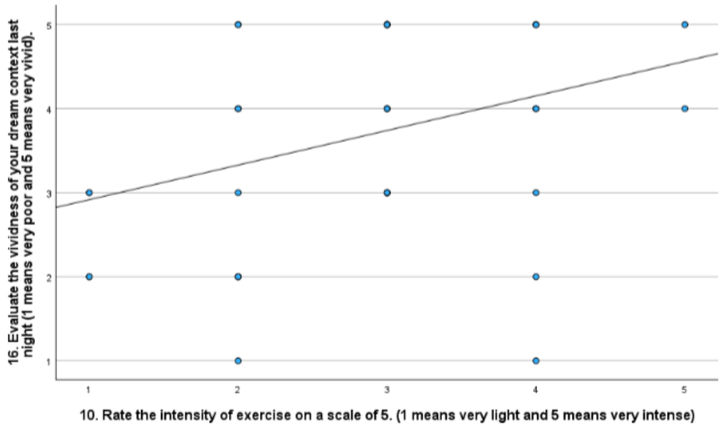

Figure 3: Significant Correlation between the Exercise Intensity and Dream Vividness

Note: This figure suggests the correlation between exercise intensity and dream vividness. Participants indicated both their exercise intensity (1 means very light and 5 means very intense) and dream vividness on a scale of 5.

Additional Findings

There was no correlation found between sugary substance consumption and dream recall. A slightly negative and non-significant correlation of -.095 was found between exercise intensity and dream recall. The negative correlation has a p value of .291 which is above the 5% (.05) significance level. The duration of exercise and dream recall was not significantly correlated while there is a trend towards positive correlation. However, the positive correlation has a p value of .127 that is above the 5% (.05) level of significance.

DISCUSSION

Outcomes and Previous Research

The current research outcomes were profound. Sugary substance consumption had a significant positive correlation with dream vividness. Additionally, both the intensity and amount of exercise had a significant positive correlation with the dream vividness. There were a trio of significant positive correlations as part of the research findings. However, the sugary substance consumption did not have a significant correlation with dream recall. The amount and intensity of exercise were not significantly correlated with dream recall either. Interestingly, though, there was a trend towards significance and a larger sample size might have produced significant positive/negative correlations among these variables.

The ML-DA (mesolimbic dopamine) system shows increasing neural activities during REM sleep and plays a crucial role in generation of dreams [3]. Previous research on narcolepsy shows that REM sleep is associated with hallucinatory experiences that are downregulated through the administration of anti-dopamine medications; therefore, the increasing or decreasing amount of dopamine might affect dream vividness [4]. In the current study, the amount of intensity of exercise and sugary substance consumption, both previously demonstrated to affect the dopamine level, were significantly positively correlated with dream vividness. It is suggested then that when dopamine levels increase, the vividness of dreams increases as well–this relationship is mediated by exercise intensity and sugary substance consumption.

A study on Parkinson's Disease patients revealed that the ML-DA (mesolimbic dopamine) system plays a role in certain aspects of dreaming activities. The correlation was found between functional neuroanatomical correlates of dream recall and PD (Parkinson's disease) patients, who are in a hypodopaminergic state. The study also found that visual vividness of dreams is associated with amygdala volumes and the mPFC (medial prefrontal cortex) thickness [15]. Another study revealed that a thicker cortex was correlated with a smaller amount of dopamine release while cortical thickness is also related to drug-induced striatal dopamine release. However, in various disease states, alterations in both striatal dopamine and thickness of the frontal cortex have been observed [16]. While cortex thickness remains different individually and it is not investigated in this study, its association with dopamine release further affects the vividness of dreams. In this study, dopamine and vividness of dream show positive correlations. Potential further investigations could measure striatal dopamine and the thickness of the frontal cortex in combination with dream surveys in healthy participants; as an extrapolation of the present research.

Limitations

A sample size of 64 participants might not have been ideally sufficient and a larger sample size may have produced more significant correlations among the study variables. Given that participants were either from China or the US, the sample size and results were not globally representative. Additionally, the participant sample was very homogeneous in terms of socioeconomic and behavioral patterns; these factors may have affected the results. Research outcomes could have been different with a more diverse participant sample. For example, a larger and more varied participant sample would have made the analysis more comprehensive and representative. In part 2 of the survey, participants were asked to report 1 week of data daily. There was data loss during the week when participants forgot to fill out the survey. Lack of consistency might have also resulted in data loss. Since all data is self-reported, participants might have different interpretations for their own data, leading to a potential inaccuracy; the participant bias effect. Further, there were numerous missing data points which generally affects the validity and statistical power of the data analysis.

Future directions

The use of proxy variables like aerobic exercise and sugary substance consumption is a low-cost and effective method that enables investigations without specialized equipment, providing broader use in different communities. Results of this research can be easily communicated with society given the universality of the variables studied. Further research employing survey type data combined with neuroimaging could provide a more direct and extensive evaluation of dopamine modulation; this research direction is suggested. Visualizing increased dopaminergic activity during periods when participants report vivid dreaming would expand our understanding of this dynamic relationship.

There are other methods that surveys can be combined with modern imaging techniques.

Positron Emission Tomography has been commonly used in neuroimaging since it was first discovered in 1985 by Heiss et al. However, PET radiotracers have been primarily used in changes in dopamine levels but not yet expanded into studies of other neurotransmitters.

Conventional PET methods also often estimate the BP ND based on kinetic models to assume the system is at equilibrium when under investigation; however, this assumed equilibrium can often be diminished when using pharmacological or behavioral stimuli to invoke dopamine release intentionally, therefore producing biased BP ND estimation. New methods that allow detection for non-constant dopamine levels have been developed, describing dopamine release as an exponential decay. lp-ntPET is also a more flexible method compared to conventional PET, while it is sensitive to noises and results in limited accuracy. The effectiveness of these different methodologies is still being explored.

CONCLUSION

The positive correlations between sugary substance consumption, the amount of exercise, and exercise intensity and dream vividness provide robust evidence of the role of dopamine in dreaming context. An increase in dopamine level will potentially lead to more vivid dreams. While the correlation between sugary substance consumption, the amount of exercise, and exercise intensity and dream recall is not significantly demonstrated in this research, future studies employing survey type of data and neuroimaging techniques can provide more evidence into the field.

REFERENCES

1. Tsunematsu T (2023) What are the neural mechanisms and physiological functions of dreams? Neuroscience Research 189: 54-59.
2. Cleveland Clinic (2022) Dopamine Retrieved December 10, 2025.
3. Perogamvros L and Schwartz S (2012) The roles of the reward system in sleep and dreaming. Neuroscience & Biobehavioral Reviews 36(8): 1934-1951.

4 McNamara P (2016) Dopamine and Dreams. Psychology Today. Retrieved December 12, 2025.

5 James H (2025) The Different Types of Dreams. Dreams. Retrieved December 22,
2025.

6 Marques A, Marconcin P, Werneck AO, Ferrari G, Gouveia ER, et al. (2021) Bidirectional Association between Physical Activity and Dopamine Across Adulthood—A Systematic Review. Brain Sci 11(7): 289.

7 Lin TW and Kuo YM (2013) Exercise benefits brain function: The monoamine connection. Brain Sciences 3(1): 39-53.

8 Qin D, Qi J, Shi F, Guo Z, Li H (2025) Sugar Addiction: Neural Mechanisms and Health Implications. Brain and Behavior 15(7).

9 Jacques A, Chaaya N, Beecher K, Ali SA, Belmer A, et al. (2019) The impact of sugar consumption on stress driven, emotional and addictive behaviors. Neuroscience & Biobehavioral Reviews 103: 178-199.

10 Kussé C, Muto V, Mascetti L, Matarazzo L, Foret A, et al. (2010) Neuroimaging of dreaming: State of the art and limitations. International Review of Neurobiology: 87-99.

11 Mallett R, Konkoly KR, Nielsen T, Carr M, Paller KA (2024) New strategies for the cognitive science of dreaming. Trends in Cognitive Sciences 28(12): 1105-1117.

12 Pereira M, Chen X, Paltarzhytskaya A, Pacheco Y, Muller N, et al. (2025) Sleep neuroimaging: Review and future directions. Journal of Sleep Research 34(6).

13 Horton CL (2020) Key concepts in dream research: Cognition and consciousness are inherently linked, but do no not control! Control"! Frontiers in Human Neuroscience 14.

14 Nir Y and Tononi G (2010) Dreaming and the brain: From phenomenology to neurophysiology. Trends in Cognitive Sciences 14(2):88-100.

15 De Gennaro L, Lanteri O, Piras F, Assogna F, Ferrara M, et al. (2015) Dopaminergic system and dream recall: An MRI study in Parkinson's disease patients. Human Brain Mapping, 37(3): 1136-1147.

16 Casey KF, Cherkasova MV, Larcher K, Evans AC, Baker GB, et al. (2013) Individual differences in frontal cortical thickness correlate with the d-Amphetamine-Induced striatal dopamine response in humans. The Journal of Neuroscience 33(38): 15285-15294.

Citation: Zhuang Y, Jurdak N “Behavioral Variables, Dreaming, and an Inferred Association with Dopamine Modulation”, American Research Journal of Neurology, Vol 5, no. 1, 2026, pp. 01-05.