

Assessing the Relationship between Chronotype and Cognitive Failures in Adolescent Students

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ABSTRACT: Chronotype refers to an individual's natural preference for the timing of sleep, wakefulness, and peak alertness. Adolescence is a developmental period during which changes in sleep-wake patterns may interact with academic demands and everyday cognitive functioning. The present study examined the relationship between chronotype and everyday cognitive failures among high school students. A quantitative, cross-sectional correlational design was demonstrated using a simulated dataset of 112 high school students. Chronotype was assessed using the Morningness-Eveningness Questionnaire (MEQ), and everyday cognitive failures were assessed using the 25-item Cognitive Failures Questionnaire (CFQ). CFQ scores were additionally classified into lower, middle, and higher sample-based groups using tertiles. Pearson's product-moment correlation was used to examine the association between continuous MEQ and CFQ scores overall and separately across four chronotype groups, while an independent-samples t-test was used to examine gender differences in cognitive-failure scores. Overall, MEQ scores showed a significant negative correlation with CFQ scores, $r = -.32$, $p = .001$. Significant negative correlations were observed within the Morning group, $r = -.52$, $p = .004$, and Moderately Morning group, $r = -.45$, $p = .017$. The relationship within the Intermediate group was not statistically significant, $r = -.09$, $p = .642$, whereas the Evening group demonstrated a significant positive correlation, $r = .50$, $p = .007$. Sample-based CFQ tertiles yielded mean scores of 33.11, 40.40, and 49.33 for the lower, middle, and higher groups, respectively. Gender differences in CFQ scores were also statistically significant, $t(110) = -2.33$, $p = .022$, with males obtaining a lower mean score ($M = 39.28$, $SD = 6.81$) than females ($M = 42.47$, $SD = 7.68$). The findings demonstrate the application of continuous correlation, subgroup analysis, sample-based classification, and gender comparison in examining chronotype and everyday cognitive failure. The findings demonstrate the application of continuous correlation, sample-based classification, and gender-comparison procedures in examining chronotype and everyday cognitive failures.

Keywords: Chronotype, morningness, eveningness, cognitive failures, cognitive functioning, adolescence, MEQ, CFQ

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1. INTRODUCTION

Chronotype refers to an individual's preferred timing for sleep, wakefulness, daily activity, and periods of peak alertness. It reflects individual differences in the timing of biological and behavioural rhythms and is commonly described along a continuum ranging from morningness to eveningness. Morning-oriented individuals tend to wake earlier and experience greater alertness and activity earlier in the day, whereas evening-oriented individuals generally prefer later sleep and waking times and may experience their highest levels of alertness later in the day. Between these two extremes lies a broad intermediate group. Chronotype is therefore not simply a matter of personal preference but represents an important individual difference associated with the timing of the circadian system and daily functioning (Adan et al., 2012).

Chronotype is influenced by a combination of biological, developmental, environmental, and social factors. Age is particularly relevant because circadian preferences change across the lifespan. During adolescence, there is a well-documented tendency toward later sleep timing. Biological changes in the circadian timing system, together with

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changes in sleep regulation and increasing social and academic demands, contribute to a shift toward eveningness during this developmental period (Crowley et al., 2018). Adolescence is therefore an important stage for examining chronotype because young people may increasingly prefer later bedtimes while still being required to wake early for school. This creates a potential mismatch between biological timing and externally imposed schedules.

The adolescent sleep pattern is shaped not only by biological changes but also by academic workload, examinations, homework, extracurricular activities, social interactions, and increasing use of electronic devices. These factors may delay bedtime and reduce opportunities for adequate sleep. At the same time, early school schedules often require students to wake at relatively fixed times regardless of their individual chronotype. Consequently, adolescents with later chronotypes may have difficulty obtaining sufficient sleep on school days. The combination of a delayed biological tendency and early social obligations has been described within the broader framework of the adolescent “perfect storm” of sleep, in which biological maturation and environmental demands interact to produce shortened or mistimed sleep (Crowley et al., 2018).

One important concept arising from this mismatch is social jetlag. Social jetlag refers to the discrepancy between an individual's biological timing and the timing imposed by social commitments such as school or work. Wittmann et al. (2006) noted that later chronotypes may experience a greater difference between sleep timing on socially constrained days and free days, potentially resulting in accumulated sleep debt. This phenomenon is particularly relevant to adolescents because school schedules generally remain fixed even when students' preferred sleep timing shifts toward later hours. Thus, a student may not necessarily have an inherently inadequate sleep pattern but may experience insufficient or poorly timed sleep because the timing of sleep does not correspond with school-related demands.

The relationship between chronotype and functioning can also be understood through the concept of circadian synchrony. Cognitive and behavioural performance can vary depending on the alignment between an individual's internal biological timing and the time at which a task is performed. Research has suggested that individuals may perform better when activities occur at times that correspond to their preferred period of alertness. This is sometimes referred to as the synchrony effect. For example, an evening-oriented individual may demonstrate relatively better functioning later in the day, whereas a morning-oriented individual may perform more effectively earlier in the day (Fabbian et al., 2016). Consequently, differences in cognitive functioning among adolescents may not be attributable solely to differences in ability but may also be related to when cognitive demands are imposed.

Existing research has examined chronotype in relation to academic achievement and cognitive performance. For example, Preckel et al. (2011) reported associations between chronotype and academic achievement, with morningness generally being associated with more favourable academic outcomes. Similarly, Escribano et al. (2012) found that eveningness was negatively associated with academic performance among high school students even after several individual characteristics were taken into account. More recent research has also indicated that later chronotype and greater social jetlag can be associated with poorer performance on certain cognitive outcomes among adolescents, although the strength and nature of these associations may vary across cognitive domains and contextual factors (van der Vinne et al., 2025). A recent scoping review likewise concluded that the relationship between circadian preference and adolescent

performance is evident in several areas but is influenced by multiple factors, including the timing of assessment and the nature of the performance measure (Smyth et al., 2023). Cognitive functioning is a broad construct involving several interrelated processes, including attention, perception, memory, concentration, information processing, executive functioning, and response control. These processes are essential for successful academic functioning because students must continuously attend to classroom information, remember instructions, shift attention between tasks, organize information, make decisions, and monitor their own performance. Even relatively small disruptions in attention or memory can result in everyday mistakes. Such mistakes may not necessarily indicate a neurological or clinical disorder but can reflect temporary lapses in cognitive functioning.

One way of examining these everyday lapses is through the concept of cognitive failures. Cognitive failures refer to relatively minor errors or lapses occurring during everyday activities. Examples include forgetting names or information, losing one's train of thought, becoming distracted, failing to notice something, or making simple mistakes in routine activities. Broadbent et al. (1982) developed the Cognitive Failures Questionnaire (CFQ) to assess the frequency with which individuals experience such everyday cognitive errors. The CFQ provides a subjective measure of perceived cognitive lapses and has subsequently been widely used in psychological and behavioural research.

Sleep is closely connected to cognitive functioning. Adequate sleep contributes to attention, vigilance, memory consolidation, emotional regulation, and several aspects of executive functioning. Conversely, inadequate sleep can impair alertness and increase variability in attention and response speed. Killgore (2010), in a review of the effects of sleep deprivation, noted particularly consistent effects on alertness, attention, and vigilance, while also identifying effects on several higher-order cognitive processes. Since chronotype influences the timing of sleep and wakefulness, and since chronotype may interact with externally imposed schedules, the relationship between chronotype and everyday cognitive functioning warrants attention.

The relationship may be particularly meaningful during adolescence because cognitive development and educational demands are occurring simultaneously with substantial changes in sleep and circadian regulation. Adolescents are expected to maintain sustained attention during lessons, manage multiple academic tasks, prepare for examinations, and make increasingly independent decisions. At the same time, developmental changes may make later sleep timing more biologically likely. The resulting mismatch between preferred timing and required timing may contribute to sleep restriction, daytime sleepiness, reduced alertness, or difficulty sustaining attention. However, chronotype should not be viewed as a direct or sole explanation for cognitive functioning. Sleep duration, sleep quality, stress, academic workload, technology use, mental health, socioeconomic circumstances, and the timing of school activities may also influence cognitive performance.

An additional consideration is that the relationship between chronotype and cognition may not be uniform across all individuals. A simple comparison between morning and evening types may obscure differences among intermediate or moderately morning-oriented individuals. Examining chronotype along a continuum, as well as considering different chronotype groups, may provide a more nuanced understanding of how biological timing relates to everyday cognitive experiences. The use of continuous MEQ scores allows the degree of morningness-eveningness to be examined quantitatively, while subgroup analysis can explore whether the association with cognitive failures differs across chronotype categories.

The present study focuses specifically on everyday cognitive failures rather than academic achievement or performance on a single objective cognitive task. This focus is important because everyday lapses may occur even when an individual does not demonstrate a measurable impairment on standardized cognitive testing. A student who frequently loses concentration, forgets recently received information, misplaces objects, or makes routine mistakes may experience these lapses as meaningful difficulties in daily academic life. Examining such experiences may therefore complement research that has focused primarily on grades, standardized cognitive performance, or sleep duration.

The present study also considers gender differences in cognitive failure scores. Although the primary focus is the relationship between chronotype and cognitive failures, examining gender differences can provide additional descriptive information about the distribution of reported cognitive lapses within the student sample. Such differences, where observed, should be interpreted cautiously because self-reported cognitive failures may be influenced by multiple psychological, behavioural, and contextual factors rather than by gender alone.

Despite increasing research on adolescent sleep and chronotype, there remains value in examining how chronotype relates specifically to subjective everyday cognitive failures among high school students. Much of the existing literature has focused on sleep duration, academic achievement, daytime sleepiness, or performance on specific cognitive tasks. Examining everyday cognitive failures provides a complementary perspective by considering how students perceive lapses in attention, memory, and everyday information processing. Furthermore, studying the association both across the overall sample and within different chronotype groups can help illustrate whether the relationship is consistent across the morningness-eveningness continuum.

Objectives

The study aimed to:

1. To examine the relationship between total Morningness-Eveningness Questionnaire (MEQ) scores and total Cognitive Failures Questionnaire (CFQ) scores among high school students.
2. To examine the relationship between MEQ scores and CFQ scores among students classified as Morning type.
3. To examine the relationship between MEQ scores and CFQ scores among students classified as Moderately Morning type.
4. To examine the relationship between MEQ scores and CFQ scores among students classified as Intermediate type.
5. To examine the relationship between MEQ scores and CFQ scores among students classified as Evening type.
6. To examine the difference in mean CFQ scores between male and female high school students.

Hypothesis

H1: There will be a significant relationship between total MEQ scores and total CFQ scores among high school students.

H2: There will be a significant relationship between MEQ scores and CFQ scores among students classified as Morning type.

H3: There will be a significant relationship between MEQ scores and CFQ scores among students classified as Moderately Morning type.

H4: There will be a significant relationship between MEQ scores and CFQ scores among students classified as Intermediate type.

H5: There will be a significant relationship between MEQ scores and CFQ scores among students classified as Evening type.

H6: There will be a significant difference in mean CFQ scores between male and female high school students

2. METHODOLOGY

Research Design

The study employed a quantitative correlational research design to examine the relationship between students' chronotype and everyday cognitive failures. The design was selected to examine associations between chronotype and cognitive functioning as measured through standardized self-report instruments..

Sample

The sample comprised 112 high school students studying in Grades XI and XII. The participants were assumed to be adolescents within the typical high-school age range. The sample included both male and female students. For the purpose of the statistical exercise, participants were represented across four chronotype categories derived from their Morningness-Eveningness Questionnaire (MEQ) scores: **Morning type, Moderately Morning type, Intermediate type, and Evening type.**

Sampling Technique

A convenience sampling technique was used for the representing the recruitment of students who were readily accessible to the researcher within the school setting. Participation was conceptualized as voluntary, and responses were collected through an online questionnaire format.

Tools Used

- The Morningness-Eveningness Questionnaire (Horne and Östberg, 1976)

The questionnaire identifies individual differences in preferred timing of activity and sleep and allows individuals to be classified according to their morningness or eveningness tendencies. The questionnaire provides a quantitative score reflecting the individual's position on the morningness-eveningness continuum. Higher scores indicate greater morning orientation, whereas lower scores indicate greater evening orientation. Based on established MEQ scoring procedures, participants were classified into chronotype categories for subgroup analysis. In the present teaching exercise, four groups were used: Morning type, Moderately Morning type, Intermediate type, and Evening type.

- The Cognitive Failures Questionnaire (Broadbent et al. 1982)

The scale was used to assess everyday cognitive failures. The questionnaire examines common lapses involving areas such as attention, memory, perception, and motor functioning. The CFQ consists of **25 items** assessing the frequency of everyday cognitive slips involving areas such as attention, memory, perception, and action. Items are scored on a **5-point response scale from 0 to 4**, producing a possible total score ranging from **0 to 100**. Higher scores indicate a greater frequency of self-reported everyday cognitive failures.

For the present study, the total CFQ score was treated as the primary continuous measure of cognitive failures. In addition, participants were divided into three sample-based groups using tertile cut-points: lower, middle, and higher cognitive-failure groups. These categories were derived from the distribution of CFQ scores within the present sample and were used only for descriptive purposes; they do not represent clinical or standardized CFQ cut-offs.

Statistical Analysis

The following statistical procedures were conducted:

1. **Descriptive statistics** - Mean, standard deviation, frequency, and percentage were calculated to summarize demographic variables, MEQ scores, CFQ scores, chronotype groups, and sample-based CFQ tertile groups.
2. **Pearson's product-moment correlation** - Pearson's r was used to examine the relationship between continuous MEQ and CFQ scores for the overall sample ($N = 112$).
3. **Subgroup Pearson correlations** - Pearson's r was separately calculated within each of the four chronotype groups to examine the relationship between continuous MEQ and CFQ scores among Morning, Moderately Morning, Intermediate, and Evening groups.
4. **Sample-based CFQ tertile analysis** - CFQ scores were divided into lower, middle, and higher tertiles based on the distribution of scores in the sample. Frequencies, percentages, means, and standard deviations were reported for these groups. These groups were used as descriptive classifications rather than validated clinical categories.
5. **Independent-samples t-test** - An independent-samples t -test was conducted to examine whether mean CFQ scores differed significantly between male and female students.

Ethical Considerations

Ethical principles were followed throughout the conduct of the study. Participation was voluntary, and participants were informed about the general purpose of the research before completing the questionnaire. They were informed that they could choose whether or not to participate and could discontinue their participation without penalty.

Confidentiality and privacy were maintained throughout the study. Personally identifying information was not unnecessarily collected, and participants' responses were used solely for academic and research purposes. The data were reported in aggregated form to ensure that individual participants could not be identified.

Participants were informed that there were no right or wrong responses and were encouraged to respond honestly. They were also informed that they could refrain from answering any question that caused discomfort. Appropriate consent procedures applicable to research involving high school students were followed. The study adhered to the principles of voluntary participation, informed consent or assent, confidentiality, anonymity, non-maleficence, and respect for participants' autonomy.

3. RESULT AND DISCUSSION

The present study examined the relationship between chronotype and everyday cognitive failures among 112 high school students. The analysis included descriptive statistics, Pearson's product-moment correlations, subgroup correlations across four chronotype categories, sample-based CFQ tertile classification, and an independent-samples t -test examining gender differences.

The descriptive results showed that the overall mean MEQ score was 42.00 ($SD = 10.09$), while the mean CFQ score was 40.88 ($SD = 7.40$). The MEQ score represented students' position on the morningness-eveningness continuum, with higher scores indicating greater morning orientation. The CFQ score represented the reported frequency of everyday cognitive failures, with higher scores indicating more frequent cognitive slips.

Table 1

Descriptive Statistics for MEQ and CFQ Scores

Variable	N	M	SD	Minimum	Maximum
MEQ total score	112	42.00	10.09	21.00	61.00
CFQ total score	112	40.88	7.40	20.28	61.46

Note. MEQ = Morningness–Eveningness Questionnaire; CFQ = Cognitive Failures Questionnaire.

When participants were examined according to the four chronotype categories, the Morning group had the highest mean MEQ score ($M = 55.00$, $SD = 3.00$), followed by the Moderately Morning group ($M = 46.00$, $SD = 2.50$), Intermediate group ($M = 38.00$, $SD = 2.00$), and Evening group ($M = 29.00$, $SD = 4.00$). The corresponding CFQ means were 38.00 for the Morning group, 39.50 for the Moderately Morning group, 42.00 for the Intermediate group, and 44.00 for the Evening group. Thus, the descriptive pattern showed progressively higher mean cognitive-failure scores across groups with greater evening orientation.

Table 2

Descriptive Statistics by Chronotype Group

Chronotype group	n	MEQ		CFQ	
		M	SD	M	SD
Morning	28	55.00	3.00	38.00	7.22
Moderately morning	28	46.00	2.50	39.50	6.91
Intermediate	28	38.00	2.00	42.00	7.21
Evening	28	29.00	4.00	44.00	7.17
Total	112	42.00	10.09	40.88	7.40

Note. MEQ = Morningness–Eveningness Questionnaire; CFQ = Cognitive Failures Questionnaire.

The overall Pearson correlation revealed a statistically significant negative relationship between MEQ and CFQ scores, $r(110) = -.32$, $p = .001$. This indicates that, within the sample, higher MEQ scores were associated with lower CFQ scores. Therefore, H1 was supported. The magnitude of the correlation suggests a moderate association, indicating that chronotype was related to everyday cognitive failures but did not account for all variation in CFQ scores.

Table 3

Pearson Correlation Between MEQ and CFQ Scores

Variables	N	r	p
MEQ total – CFQ total	112	-.32	.001

This finding is broadly consistent with literature suggesting that sleep timing and chronotype may be associated with cognitive functioning during adolescence. Adolescence involves substantial changes in circadian timing, with many adolescents

experiencing a tendency toward later sleep and wake schedules. When these schedules are combined with fixed school timings, a mismatch between preferred and required sleep-wake schedules may occur. Research has linked later sleep timing and evening orientation with some poorer cognitive and academic outcomes, although the evidence is not uniform and does not establish a causal relationship.

The subgroup analysis provided a more detailed picture of the association. A significant negative correlation was observed in the Morning group, $r(26) = -.52$, $p = .004$. This indicates that within this simulated group, higher MEQ scores were associated with lower CFQ scores. The Moderately Morning group also demonstrated a statistically significant negative correlation, $r(26) = -.45$, $p = .017$. Accordingly, H2 and H3 were supported.

Table 4

Pearson Correlations Between MEQ and CFQ Within Chronotype Groups

Chronotype group	n	r	p	Interpretation
Morning	28	-.52	.004	Significant
Moderately morning	28	-.45	.017	Significant
Intermediate	28	-.09	.642	Not significant
Evening	28	.50	.007	Significant

In contrast, the Intermediate group showed a very small and statistically nonsignificant relationship between MEQ and CFQ scores, $r(26) = -.09$, $p = .642$. Therefore, H4 was not supported. The Evening group showed a statistically significant positive correlation, $r(26) = .50$, $p = .007$, supporting H5. Because MEQ scores are lower among more evening-oriented individuals, the positive correlation within this subgroup should not be interpreted in isolation as meaning that eveningness itself causes cognitive failures. Rather, it indicates an association between variation in MEQ scores and CFQ scores within the Evening group.

The differing correlations across the four groups may suggest that the relationship between chronotype and cognitive failures is not necessarily identical throughout the chronotype continuum. However, these subgroup results should be interpreted cautiously. Each subgroup contained only 28 participants, considerably fewer than the overall sample of 112. Consequently, subgroup correlations are more vulnerable to sampling variation and have lower statistical power. The difference in correlation coefficients across groups also does not by itself establish that the correlations are statistically different from one another. A formal comparison of correlations would be required to test that question.

The sample-based CFQ classification divided participants into three approximately equal groups. The lower group consisted of 38 students, the middle group included 37 students, and the higher group included 37 students. Their mean CFQ scores were 33.11, 40.40, and 49.33, respectively. The pattern demonstrates clear separation in the distribution of cognitive-failure scores across the three sample-based groups.

Table 5
Sample-Based CFQ Tertile Groups

CFQ group	n	M	SD	Score range
Lower	38	33.11	3.61	22.37–37.62
Middle	37	40.40	1.72	37.63–43.45
Higher	37	49.33	3.90	43.59–61.46

These groups were created from the distribution of scores within the present sample and should not be interpreted as validated levels of cognitive impairment or clinical severity. This distinction is particularly important because the CFQ is a measure of self-reported everyday cognitive failures rather than a diagnostic measure of cognitive impairment. The tertile procedure was therefore useful for demonstrating descriptive classification while retaining the continuous CFQ score for the primary correlational analysis.

The gender comparison showed a statistically significant difference in CFQ scores. Male students had a mean CFQ score of 39.28 (SD = 6.81), whereas female students had a mean score of 42.47 (SD = 7.68). The independent-samples t-test indicated that this difference was statistically significant, $t(110) = -2.33$, $p = .022$. Therefore, H6 was supported.

Table 6
Independent-Samples t-Test for Gender Differences in CFQ Scores

Gender	n	M	SD	$t(110)$	p
Male	56	39.28	6.81	-2.33	.022
Female	56	42.47	7.68		

The gender finding indicates that the two gender groups differed in their mean self-reported cognitive-failure scores within the simulated dataset. However, this should not be interpreted as demonstrating that gender causes differences in cognitive failures. Self-reported cognitive failures may be influenced by a range of factors, including sleep quality, academic workload, stress, attentional demands, personality characteristics, and response tendencies. Furthermore, gender differences in cognitive and attentional functioning cannot be reduced to a single explanatory factor.

The findings as a whole are compatible with the possibility that chronotype is relevant to everyday cognitive functioning during adolescence. Morning-oriented students in the simulated dataset generally showed lower CFQ scores, whereas the Evening group showed higher CFQ scores. This pattern may be understood in relation to the developmental shift toward later circadian timing that commonly occurs during adolescence. When school schedules require early waking despite a later biological preference for sleep, adolescents may experience insufficient or poorly aligned sleep, potentially affecting attention, memory, and everyday cognitive functioning.

The relationship between chronotype and cognitive functioning may also depend on the timing of cognitive demands. Research on adolescents has discussed the possibility of a synchrony effect, in which cognitive performance may vary depending on whether testing occurs at a time that corresponds to an individual's preferred period of functioning. Morning-oriented and evening-oriented individuals may therefore perform differently depending on the timing of academic or cognitive activities. However, the

present analysis did not measure testing time, sleep duration, sleep quality, or social jetlag. Consequently, these mechanisms cannot be directly evaluated.

4. LIMITATIONS

Several limitations should be considered when interpreting the results.

- First, all numerical results were generated from simulated data and therefore cannot be generalized to actual adolescents.
- Second, the cross-sectional correlational design does not permit conclusions regarding causation.
- Third, the MEQ and CFQ are self-report measures and may be affected by recall and response biases.
- Fourth, the subgroup analyses were based on relatively small groups of 28 participants each.
- Finally, potentially relevant variables such as sleep duration, sleep quality, school start time, academic stress, screen use, and time of cognitive assessment were not incorporated into the analysis.

Despite these limitations, the study demonstrates a coherent approach to examining chronotype and everyday cognitive failures. The overall Pearson correlation showed a significant relationship between MEQ and CFQ scores, while subgroup analyses demonstrated statistically significant relationships in the Morning, Moderately Morning, and Evening groups but not in the Intermediate group. The sample-based CFQ tertiles provided a descriptive representation of lower, middle, and higher levels of reported cognitive failures, while the independent-samples t-test demonstrated a statistically significant gender difference in CFQ scores.

Overall, the simulated findings illustrate how chronotype may be examined as a continuous individual-difference variable in relation to everyday cognitive functioning. The results also demonstrate the importance of distinguishing statistical association from causation and of avoiding unsupported clinical interpretations of sample-based CFQ categories.

5. IMPLICATIONS

Students can benefit from understanding their own sleep-wake preferences and developing routines that provide sufficient and regular sleep. Evening-oriented students may particularly benefit from planning demanding academic activities around periods when they are most alert, where their schedules allow.

Schools can also promote sleep awareness and healthy routines among adolescents. Educating students about the relationship between sleep, attention, and learning may encourage healthier academic habits.

6. CONCLUSION

The present study demonstrates an association between chronotype and everyday cognitive failures among high school students. The overall correlation indicated that MEQ and CFQ scores were significantly related, with significant associations also observed within the Morning, Moderately Morning, and Evening groups, while the Intermediate group showed no significant relationship. Sample-based CFQ tertiles provided a descriptive representation of cognitive-failure levels, and gender differences in CFQ scores were statistically significant. These findings highlight the relevance of individual sleep-wake preferences when examining adolescent cognitive functioning. However, the simulated nature of the dataset limits generalization, and future research should use larger samples and objective sleep measures.

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