Original Research Article

Sleep Quality and Its Association with Risk Taking and Decision Making in High School Students

Nuha Maryam and Janet B. Wolfe

Conestoga High School, 200 Irish Rd, Berwyn, PA 19312, United States

ABSTRACT

Insufficient sleep is linked to several negative health outcomes including obesity, type 2 diabetes, heart disease and impaired cognitive function. As of 2021, approximately 77% of high school students in the US were identified as suffering from sleep deprivation (SD). While the negative impact of short-term sleep deprivation on risk-taking tendencies in adults has been previously reported, there is a gap in research on how chronic partial sleep deprivation (SD) affects the adolescent population. This study investigated whether self-reported sleep quality is associated with adolescents' risk-taking behavior. Based on the prior knowledge about the correlation between SD and cognitive ability, we hypothesized that poorer sleep quality would be associated with lower risk-taking behavior due to cognitive fatigue. An *ex post facto* study was conducted with 61 participants in grades 9–12 at a high school in southeastern Pennsylvania. Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI), while risk taking and impulsivity were evaluated using the Balloon Analog Risk Task (BART) and the Delay and Probability Discounting Task (DPD). A statistically significant negative correlation was observed between PSQI scores and BART performance, indicating that worse sleep quality was associated with lower behavioral risk taking. However, no significant correlation was found between PSQI scores and DPD outcomes. These data suggest that poorer sleep quality was associated with lower behavioral risk taking in teens, mirroring patterns observed in adult populations. These findings contribute to the broader conversation about adolescent health and highlight the distinct ways sleep loss affects different dimensions of decision making.

Keywords: sleep deprivation; risk taking; students; adolescents; Balloon Analog Risk Task; Probability Discounting Task; Pittsburgh Sleep Quality Index

INTRODUCTION

The importance of adequate sleep in overall health and cognitive function is well established (1, 2). Insufficient sleep is linked to obesity, type 2 diabetes, heart disease and depression (3–7). According to the Centers for Disease Control and Prevention (CDC), over a third of US adults and children report getting less than the recommended amount of sleep. This number is even higher among adolescents. According to the CDC, approximately 77% of high school students in the US and 84% in Pennsylvania were identified as suffering from sleep deprivation (SD) as of 2021 (8). SD among students is often attributed to excessive schoolwork, extracurricular activities, jobs,

Corresponding author: Nuha Maryam, E-mail: 27maryamn@tesdk12.net; Janet B. Wolfe, E-mail: wolfej@tesd.net.

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and other commitments (9).

SD is defined as sleeping less than the recommended number of hours each night, which is eight hours for adolescents (8). In total SD, an individual stays awake for the entire night, and partial SD is defined as sleeping for only a portion of the recommended length of time. While acute SD can be of the duration of just one night, chronic SD is the lack of sleep for multiple nights in a row. Chronic partial SD is defined as a maximum of six hours of sleep for at least five consecutive nights (10).

The prevalence of SD among adolescents specifically has become an issue in the past few years due to a range of factors including excessive schoolwork, extracurricular activities, and the use of digital devices. Léger *et al.* reported that the sleep time in middle schoolers has decreased by 20 minutes from 2018 to 2025 (11). This study also showed an increase in the average amount of screen time each day among middle schoolers and high schoolers (11). This rise in sleep deprivation in the younger population calls for more research on sleep loss to better understand the implications of the issue.

Sleep deprivation greatly impacts the functioning of the prefrontal cortex, which is responsible for several cognitive abilities such as attention, working memory, executive control, and complex decision making (12, 13). Using a non-invasive brain scanning technique called high-density resting state electroencephalography, Verweij *et al.* showed that a total night of sleep deprivation leads to drastic changes in the prefrontal cortex, leading to shifts in memory, inhibition, and emotional regulation (14). In addition, SD disrupts several molecular pathways in the hippocampus, greatly affecting this area in the brain responsible for memory and other cognitive functions (15, 16). Specifically, SD reduces cAMP and protein kinase A signaling – responsible for plasticity and proper functioning in the brain – and increases the activity of phosphodiesterase 4, a protein that degrades cAMP (17). Consequences of SD on cognitive abilities vary depending on both its duration and severity (18).

Risk-taking is a key component of cognitive function that determines how people evaluate uncertainty, assess potential costs and benefits, and choose among competing actions when outcomes are not certain. Neuroimaging research has linked risk taking to mesolimbic frontal circuits, including the dorsolateral prefrontal cortex (19). These regions have been shown to interact with the ventral affective system and jointly influence risk-taking behavior (20). According to this dual-system model, the ventral affective system shapes emotional and reward-driven impulses that can increase willingness to take risks while the prefrontal cortex supports self-control and deliberative reasoning, helping people inhibit impulses and evaluate consequences (20).

Adolescents engage in starkly higher risk-taking behaviors compared to adults (21, 22). According to a widely accepted dual systems model, this pattern is caused by an early-maturing reward system, which increases reward-seeking, and an immature prefrontal cognitive system that controls self-regulation (23). Other researchers argue that neural asynchrony alone cannot fully explain the high risk-taking behavior in teenagers, and point to the environmental factors such as social context, opportunities, and peer influences (24).

Studies have been conducted relating SD with risk-taking behavior, including work by Acheson *et al*. (2007). Using the Automated Neuropsychological Assessment Matrix (ANAM), which measures brain activity, and several risk-taking tasks such as BART, Acheson *et al*. found that one night of total SD led to a decrease in risk taking in the BART task for women but not in men (25). These results suggest a correlation between SD and risk-taking behavior, although it may vary based on demographics. Although several studies have indicated that SD may influence risk-taking behaviors in adults (25, 26), the relationship between sleep loss and the tendency to take risks remains unexplored in adolescent populations. Moreover, most research on sleep deprivation (SD) and risk taking centers on short-term, complete SD, with little attention to long-term, partial SD. Adolescents facing SD most likely suffer from the latter type of SD. Therefore, this study examined whether self-reported sleep quality was associated with risk-taking behavior in high school students. We hypothesized that poorer sleep quality would be associated with lower risk-taking behavior.

METHODS AND MATERIALS

Research Design

Students at a high school in southeastern Pennsylvania between 9th and 12th grade were invited to participate in a quantitative ex post facto study to examine the association between self-reported sleep quality and measures of risk taking, delay discounting, and probability discounting. They were encouraged to participate at a table during the high school's research fair. Participants completed three tests to measure their sleep quality and risk taking: the Pittsburgh Sleep Quality Index (PSQI) questionnaire, Balloon Analog Risk Task

(BART), and Delay and Probability Discounting (DPD) questionnaire. Two different tests, namely, BART and the DPD, were conducted to measure risk-taking behavior to fortify the results of this study. The two tests measure risk taking in two different ways – BART focuses on behavioral risk while DPD focuses on risky decision making. Measuring risk taking with multiple tests allows this study to encapsulate details that the tests would not be able to uncover individually.

Participants

A total of 74 students (grades 9–12) were recruited at the school research fair. Nine participants were excluded because their submissions contained nonresponsive or clearly invalid answers, and four responses were removed as invalid because parts of the survey were incomplete or answered incorrectly according to PSQI guidelines, yielding a final analyzed dataset of 61 valid participant responses.

Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a 9-question test that is widely used in studies aimed to measure average sleep quality over a span of one month (27). These 9 questions account for 7 different component scores that assess sleep quality including the amount of difficulty it takes to fall asleep, the average amount of sleep that one receives, the number of interruptions in one's sleep, etc. The PSQI questions and components are listed in Appendix I and II, respectively. Each component accounts for a score out of 3 which are added to calculate a final score out of 21, with a 0 indicating high quality of sleep and a 21 meaning an extremely poor quality of sleep. A PSQI score of less than or equal to 5 indicates good sleep quality while a score greater than 5 is associated with poor sleep quality.

Balloon Analog Risk Task (BART)

BART was conducted using the application from PsyToolkit, a free resource for psychological research (28,29). In BART, participants were asked to pump up a series of balloons, and each pump-up was worth five points. The number of points gained by each balloon was clearly shown on the screen (Figure 1). As the balloons expanded and accumulated points increased, participants could choose to stop pumping up the balloon at any time and bank their accumulated points in their overall score. However, if the balloon exploded, the participants lost all possible points associated with that balloon, and the next balloon would appear. The original BART from PsyToolkit includes 90 balloons, but to prevent participant survey fatigue, the BART application code, presented in Appendix III, was altered to include 30 balloons as it was in Acheson *et al.*'s paper (25). The application was altered by deleting the realdataBlockedBlue, realdataBlockedYellow, and realdataBlockedOrange blocks, which were 20 balloons each of specific colors. That left just the realdataMixed block, which had 30 balloons with randomized colors. For the analysis of BART, a higher average number of pumps per trial was used as an indicator of higher risk-taking.

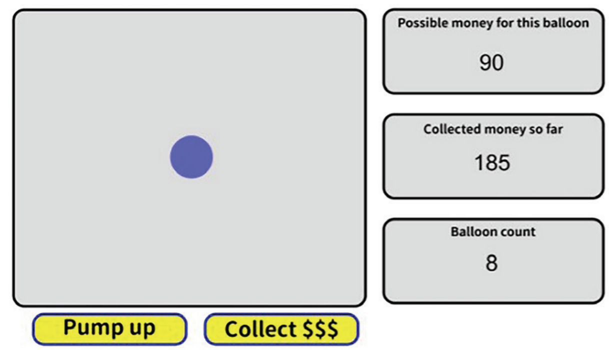

Figure 1. *Balloon analog risk task (BART) application user interface. A virtual uninflated blue balloon is shown in the center of the screen. A money-earned display labeled "Collected money so far", a display showing "Possible money for this balloon" and a display showing the current balloon count (out of 30 total balloons for an individual participant) are also shown. Participants could press the "Pump up" button to inflate balloon or "Collect $$$" button to discontinue inflation. Each pump-up was worth five points. The participants could receive a reward for each press of the "Pump up" button if the balloon continued to inflate or lose all their rewards if the balloon exploded. The next balloon would appear at this point or when the participants pressed "Collect $$$".*

Delay and Probability Discounting Task (DPD)

As an additional test to support the results from BART, the DPD was conducted to assess participants' risk-taking when it comes to the devaluation of rewards when it is delayed or uncertain (30). The test asked questions about the preference of receiving either an immediate or guaranteed theoretical monetary reward or a higher reward that is either delayed or uncertain. The delay questions were extracted from the Monetary Choice Questionnaire from Kirby *et al.*'s research methodology (31). A portion of the Probability Discounting Questionnaire was used for the probability section of the DPD (32). The full DPD questionnaire is presented in Appendix IV.

Statistical Analysis

For each participant, we calculated a PSQI score, a BART score (mean number of pumps on balloons that did not explode), a delay discounting value (k), and a probability discounting value (h) as described above. All statistical analyses were performed using GraphPad Prism 10. The relationship between sleep quality and each risk-taking measure was assessed using the Pearson correlation coefficient (r). Before running each correlation, we examined scatter plots of the paired variables to confirm that the relationships were approximately linear and to check for extreme outliers. For each correlation we report Pearson's r, the corresponding p-value, and the 95% confidence interval. Statistical significance was set at $p < 0.05$.

Ethical Considerations

This study was reviewed and approved by the school's Institutional Review Board (IRB). A formal waiver of parental/guardian permission was granted by the IRB on the grounds that the study posed minimal risk, involved no invasive procedures, and collected fully anonymous data. Participation was completely voluntary. Prior to participation, written assent was obtained after explaining the study structure (PSQI, BART, and DPD) and informing participants of their right to withdraw at any time without penalty. No direct identifiers or demographic variables (such as exact age or sex/gender) were collected to maintain anonymity and brevity. Each participant was assigned a code number stored in a password-protected file. The study adhered to the principles of the Declaration of Helsinki.

RESULTS

Sleep Quality Assessment

In total, we received and analyzed valid responses from sixty-one participating students. In accordance with the PSQI guidelines, incomplete submissions in which participants did not answer portions of the survey correctly were considered invalid and removed from the data to ensure data integrity. We performed the PSQI scoring from the students' responses following the method described by Buysse *et al* (27). For any responses where a range was given as an answer to any question, the answer was converted to the average value of the range. For questions 1 and 3 on bedtime and wakeup time, the responses were changed to a consistent time format (Appendix I). The answers to questions 2 and 4 on time duration were changed to numerical values to align the same units, namely, minutes and hours. Using descriptive statistics, the range of PSQI scores was calculated to be 0 to 16, and the mean PSQI score was 6. To further describe the context of the PSQI scores, the standard deviation was 2.617, indicating that most participants' scores fall close to the mean, reflecting minimal variation across the sample. As shown in Figure 2, 46% of participants had normal sleep quality (PSQI ≤ 5), 51% had poor sleep quality (PSQI 6–9), and 3% had very poor sleep quality (PSQI ≥ 10).

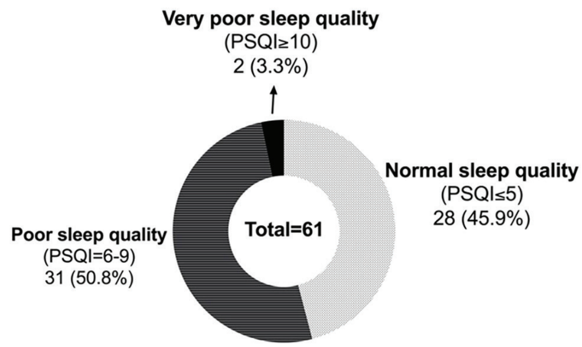

Figure 2. *The Pittsburgh Sleep Quality Index (PSQI) score distribution among participating students. The PSQI score was calculated based on a 9-question test to measure average sleep quality over the span of one month (Buysse et al., 1989). Participants with a PSQI score ≤ 5 were categorized as having "normal sleep quality", those scoring 6–9 as having "poor sleep quality", and those scoring ≥ 10 as having "very poor sleep quality".*

Correlation between sleep quality and risk-taking

We analyzed the BART scores in this study based on the scheme reported by Acheson *et al* (25), which defines the BART score as the average number of pumps for every balloon that did not explode for each individual participant. The mean BART score was 12.66 with a standard deviation of 9.458, indicating a wide variety of values. To answer the research question of "How poor sleep quality is associated with the tendency of high schoolers to take risks?", the results of PSQI and BART were plotted against each other on a scatter plot. As demonstrated by the plot in Figure 3, a statistically significant negative correlation was observed between PSQI and BART scores ($r = -0.36$, 95% CI [−0.558, −0.114], $p = 0.014$), indicating that higher PSQI scores were associated with lower average pump counts.

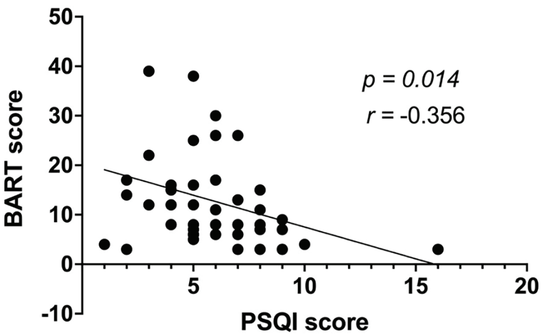

Figure 3. *The correlation between PSQI score and BART score. Scatter plot of BART score, a measure of risk-taking, versus PSQI score, a measure of sleep quality. PSQI, Pittsburgh Sleep Quality Index; BART, balloon analog risk task. Each dot represents an individual participating student (N=47). Data were plotted and analyzed using GraphPad Prism. p values <0.05 were considered significant.*

Correlation between sleep quality and delay and probability discounting (DPD)

Delay Discounting

We analyzed the data for DPD using the syntax for the questionnaire's calculations as described by Gray *et al* (33). For the Monetary Choice Questionnaire portion of the DPD, we converted the data to k, a free parameter that determines the discount rate. A higher k value indicates greater delay discounting or a higher preference for immediate rewards, which represents higher risk-taking. We arranged the range to be used for the geometric mean by ordering the questions by increasing k indifference point and converting participants' answers to binary form. Each participant's answer was marked 1 for the immediate option and 0 for the delayed option. Since the questions went up by increasing k – associated with greater impulsivity – the participants typically had a sequence of 1s followed by a transition to 0s at some switch point. Each question has a predefined indifference point for k, which is the point at which an individual with that k value would be equally likely to choose the immediate and delayed rewards. Using these indifference points, we calculated a k value for each participant. Specifically, if a participant chose the immediate reward for a question with a k indifference point of 0.10, the participant's k value would be higher than 0.10. Correspondingly, if the participant chose the delayed reward for a question with an indifference point of 0.25, his/her k would be less than 0.25. Hence, the participant's k value would be between 0.10 and 0.25. To calculate the specific k value, we determined the smallest range of indifference points for each participant and then computed the geometric mean of the two closest indifference points. Each participant's k value and binary item scores are presented in Appendix VI.

For example, Participant 1 chose the immediate rewards for questions 1 and 6, then he/she switched to the delayed reward for the rest of the questions. Therefore, the indifference points that served as the bounds for participant 1's k value were 0.0004 and 0.006, leading to a k value of 0.001549 (Table 1).

Calculations became more complicated when the participants' choices were inconsistent. For such responses, Gray *et al* (33) described an algorithm in SPSS, a statistical software suite used for advanced statistical analyses, that matches inconsistent responses with one of the 512 possibilities with predetermined k values. For simplicity, in this study we manually selected an appropriate indifference point based on the outlier responses. For example, for participant 43 (Table 2), while there is a switch from 1 to 0 after question 1, his/her response goes back to 1 on question 2, switches to 0 on question 5 and back to 1 on question 4.

Table 1. *k indifference values in ascending order.*

Question	1	6	2	3	5	7	4
k indifference value	0.00016	0.0004	0.006	0.006	0.041	0.1	0.25
Participant 1	1	1	0	0	0	0	0

Table 2. *k value for an inconsistent response.*

Question	1	6	2	3	5	7	4
k indifference value	0.00016	0.0004	0.006	0.006	0.041	0.1	0.25
Participant 43	1	0	1	1	0	0	1

Next, we plotted the k values versus the PSQI scores (Figure 4). The data plotted shows no correlation between the PSQI score and delayed discounting (k) (Pearson's $r = -0.082$, 95% CI [−0.327, 0.173], $p = 0.538$).

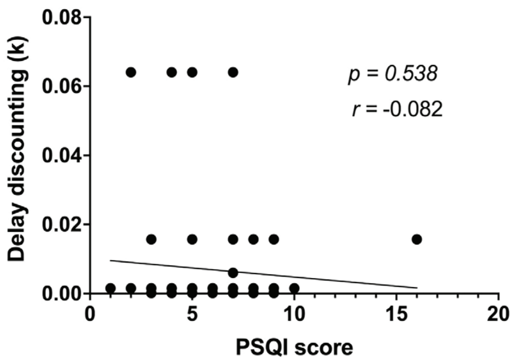

Figure 4. The correlation between PSQI score and delay discounting score (k). Scatter plot of k score, versus PSQI score, a measure of sleep quality. PSQI, Pittsburgh Sleep Quality Index. Each dot represents an individual participating student (N=61). Data were plotted and analyzed using GraphPad Prism. p values <0.05 were considered significant.

<u>Probability Discounting</u>

We followed a similar scheme to analyze the data from the Probability Discounting Questionnaire as that of the Monetary Choice Questionnaire. However, instead of generating a k constant, the probability portion consists of a constant h, with a lower h indicating greater risk-taking. The binary code used for this task was 0 for the smaller, guaranteed choices and 1 for the larger, uncertain choices. Therefore, to find the h value of each individual participant, the switch from 0 to 1 was found, and the geometric mean of the corresponding h indifference values was calculated to represent the h value. An example of the responses for the probability discounting portion is shown in Table 3. For this participant, the switch point is from question 6 to question 2, leading to a h value of 0.06186. The full table of each participant's h value and binary item scores can be found in Appendix VII. The plot of PSQI and probability discounting (h) values (Figure 5) showed no correlation (Pearson's $r = 0.133$, (95% CI [−0.123, 0.372], $p = 0.319$).

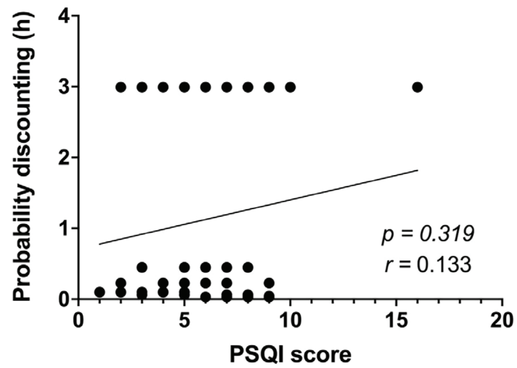

Figure 5. The correlation between PSQI and probability discounting score (h). Scatter plot of h score, versus PSQI score, a measure of sleep quality. Each dot represents an individual participating student (N=61). Data were plotted and analyzed using GraphPad Prism. p values <0.05 were considered significant. PSQI, Pittsburgh Sleep Quality Index.

DISCUSSION

The main aim of this study was to determine whether self-reported sleep quality is associated with risk-taking behavior in adolescents. We evaluated this relationship using behavioral tasks designed to assess risk taking, impulsivity, and decision making under uncertainty. The Balloon Analog Risk Task (BART) was used to measure risk-taking behavior, whereas the delay discounting task assessed impulsivity by measuring participants' preference for smaller immediate rewards over larger delayed rewards. In addition, the Delay and Probability Discounting (DPD) task was used to assess decision making between larger uncertain rewards and smaller guaranteed rewards. We hypothesized that poorer sleep quality would be associated with reduced risk-taking

Table 3. *h indifference values in ascending order.*

Question	1	6	2	3	5	7	4
h indifference value	0.0303	0.0612	0.0625	0.1579	0.3293	0.6111	14.6471
Participant 8	0	0	1	1	1	1	1

behavior. This hypothesis was only partially supported: we observed a statistically significant but modest negative association between PSQI and BART scores ($r = -0.36$), while neither the delay nor the probability discounting measure showed a significant relationship with sleep quality. Because the effect size was small and individual variability was high, and because the ex post facto design is observational and correlational, these results should be interpreted as an association rather than as evidence that poor sleep causes reduced risk taking.

These findings are consistent with previous research in adults showing that sleep deprivation reduced risk-taking on the BART but had no clear effect on risk-related behavior measured by probability discounting tasks (25). The similar pattern observed in adults exposed to short-term total SD and adolescents experiencing long-term partial SD suggests that different forms of sleep loss may affect risk-taking behavior in a comparable manner. Notably, the behavioral effects of SD in adolescents appear similar to those reported in adults, despite the general tendency for adolescents to show higher baseline levels of risk taking (23, 24).

These findings contrast with previous studies suggesting that SD increases risk taking (34, 35). One possible explanation for the findings of the present study is that mental or emotional fatigue associated with poor sleep may reduce adolescents' willingness to engage in activities that require sustained attention, effort, and energy. This interpretation is consistent with the idea that sleep-deprived individuals may become less responsive to potential rewards and less engaged in decision-making tasks that require attention and effort (36).

Another possible explanation for the negative association between SD and risk taking is that SD individuals may adopt more conservative decision-making strategies because of impaired cognitive functioning. Rather than increasing impulsivity, insufficient sleep may limit an individual's ability to process complex risk-reward scenarios, leading to more cautious or risk-averse behavior. This interpretation is consistent with prior research showing that SD affects the prefrontal cortex, a brain region involved in attention, executive function, and decision-making processes (14). In addition, SD may alter the perception of risk, causing individuals to interpret potential risks as greater threats (37). This heightened perception of threat may increase avoidance of risky decisions.

Several factors may explain the non-significant results obtained from the DPD tasks. SD may affect behavioral risk taking, as measured by the BART, differently than it affects the cognitive evaluation of delayed or uncertain rewards, as measured by the DPD. Delay discounting may involve relatively stable, long-term evaluation processes that are less sensitive to sleep loss than more behaviorally engaging tasks such as the BART (38,39). Thus, the lack of significant DPD findings may reflect differences in the cognitive demands and psychological processes involved in these tasks, rather than an absence of any relationship between sleep deprivation and decision making.

Circadian rhythm is another factor that may help explain why SD was not significantly associated with DPD performance. Previous sleep-related studies have often assessed participants at specific times of day, whereas time of day was not included as a factor in the present study (14, 18). Because circadian rhythms influence wakefulness, alertness, fatigue, and cognitive performance, future studies should account for the timing of behavioral testing. Such study designs may help clarify whether discounting behavior is affected by SD itself, circadian phase, or the interaction between the two.

Although the correlation between sleep deprivation and BART performance was weak, the statistically significant and consistent downward trend in BART scores with increasing PSQI scores suggests that the relationship may not be random and may reflect an underlying behavioral pattern. However, the small effect size indicates that other variables, such as personality, emotional state, peer influence, task engagement, fatigue, motivation, or time of day, may also contribute to individual differences in risk-taking behavior.

This study provides meaningful insight into the relationship between SD and risk taking in adolescents, but its conclusions are limited by the relatively small sample size and limited diversity of the sample. In addition, sleep was assessed with the PSQI, a validated self-report measure of overall sleep quality over the past month, rather than by objectively measuring sleep duration across consecutive nights; the global score therefore indexes poor or insufficient sleep broadly and should not be equated with a direct measurement of chronic partial sleep deprivation (27, 40). Future studies should include larger and more diverse populations to improve the generalizability of these findings. In addition, future research should account for factors that may influence risk-taking behavior, including time of day, personality, emotional state, fatigue, motivation, and task engagement. More comprehensive experimental designs incorporating a wider range of cognitive and behavioral tasks may provide a fuller understanding of how SD affects risk taking and decision making.

Overall, this study found a statistically significant negative association between poorer sleep quality and risk-taking behavior in adolescents. These findings contribute to the broader discussion of adolescent health, as both sleep and decision making are important for academic performance, social relationships, and long-term well-being. More specifically, this study adds to the limited research on how sleep deprivation affects risk-taking behavior in adolescents, a population for whom both sleep disruption and risk-related decision making are especially relevant.

Understanding how sleep influences risk-related behavior may help increase awareness among students, parents, and teachers about the potential behavioral effects of poor sleep. This awareness may encourage students to prioritize healthy sleep habits and may help families and educators better support adolescents. Overall, this study provides a foundation for future research examining how sleep deprivation influences decision-making and risk-taking behavior in youth.

CONCLUSION

This study examined whether self-reported sleep quality is related to risk-taking behavior in high school students. We found a statistically significant negative correlation between PSQI and BART scores, meaning that students with poorer sleep quality tended to take fewer risks on the balloon task, and there was no significant relationship between sleep quality and either delay or probability discounting. Together, these results suggest that poorer self-reported sleep quality is associated with reduced behavioral risk taking in adolescents, similar to patterns reported in adults, but that it does not appear to change how they discount delayed or uncertain rewards. These findings matter for adolescent health because sleep and decision making both affect school performance and long-term well-being, and earlier work has focused on short-term total sleep loss in adults rather than the chronic partial sleep loss that teenagers more commonly experience. This study has several limitations. The sample was relatively small (61 students) and drawn from a single high school, which limits how far the results can be generalized, and we did not account for factors such as time of day, mood, motivation, or personality that may also influence risk taking. Future research should use larger and more diverse samples, control for these additional factors, and include a wider range of decision-making tasks to build a clearer picture of how sleep loss shapes risk taking in young people.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this work.

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APPENDIX

Appendix I. *PSQI Questionnaire.*

1. During the past month, what time have you usually gone to bed at night?
2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?
3. During the past month, what time have you usually gotten up in the morning?
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)

5. During the past month, how often have you had trouble sleeping because you . . .
   a) Cannot get to sleep within 30 minutes
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

5. During the past month, how often have you had trouble sleeping because you . . .
   b) Wake up in the middle of the night or early morning
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

5. During the past month, how often have you had trouble sleeping because you . . .
   c) Have to get up to use the bathroom
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

5. During the past month, how often have you had trouble sleeping because you . . .
   d) Cannot breathe comfortably
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

5. During the past month, how often have you had trouble sleeping because you . . .
   e) Cough or snore loudly
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

5. During the past month, how often have you had trouble sleeping because you . . .
   f) Feel too cold
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

Continued Appendix I. *PSQI Questionnaire.*

5. During the past month, how often have you had trouble sleeping because you . . .
   g) Feel too hot
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

5. During the past month, how often have you had trouble sleeping because you . . .
   h) Had bad dreams
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

5. During the past month, how often have you had trouble sleeping because you . . .
   i) Have pain
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

5. During the past month, how often have you had trouble sleeping because you . . .
   j) Other reason(s), please describe ____
   How often during the past month have you had trouble sleeping because of (above)?
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

6. During the past month, how would you rate your sleep quality overall?
   - Very good
   - Fairly good
   - Fairly bad
   - Very bad

7. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?
   - Not during the past month
   - Less than once a week
   - Once or twice a week
   - Three or more times a week

Continued Appendix I. *PSQI Questionnaire.*

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?
    - Not during the past month
    - Less than once a week
    - Once or twice a week
    - Three or more times a week

Appendix II. *PSQI Components.*

PSQIDURAT

DURATION OF SLEEP
IF Q4 $\geq$ 7, THEN set value to 0
IF Q4 < 7 and $\geq$ 6, THEN set value to 1
IF Q4 < 6 and $\geq$ 5, THEN set value to 2
IF Q4 < 5, THEN set value to 3
Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIDISTB

SLEEP DISTURBANCE
IF Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) = 0, THEN set value to 0

IF Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) $\geq$ 1 and $\leq$ 9, THEN set value to 1

IF Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) > 9 and $\leq$ 18, THEN set value to 2

IF Q5b + Q5c + Q5d + Q5e + Q5f + Q5g + Q5h + Q5i + Q5j (IF Q5JCOM is null or Q5j is null, set the value of Q5j to 0) > 18, THEN set value to 3

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQILATEN

SLEEP LATENCY
First, recode Q2 into Q2new thusly:
IF Q2 $\geq$ 0 and $\leq$ 15, THEN set value of Q2new to 0
IF Q2 > 15 and $\leq$ 30, THEN set value of Q2new to 1
IF Q2 > 30 and $\leq$ 60, THEN set value of Q2new to 2
IF Q2 > 60, THEN set value of Q2new to 3

Next
IF Q5a + Q2new = 0, THEN set value to 0
IF Q5a + Q2new $\geq$ 1 and $\leq$ 2, THEN set value to 1
IF Q5a + Q2new $\geq$ 3 and $\leq$ 4, THEN set value to 2
IF Q5a + Q2new $\geq$ 5 and $\leq$ 6, THEN set value to 3

Minimum Score = 0 (better); Maximum Score = 3 (worse)

PSQIDAYDYS

DAY DYSFUNCTION DUE TO SLEEPINESS
IF Q8 + Q9 = 0, THEN set value to 0
IF Q8 + Q9 $\geq$ 1 and $\leq$ 2, THEN set value to 1
IF Q8 + Q9 $\geq$ 3 and $\leq$ 4, THEN set value to 2
IF Q8 + Q9 $\geq$ 5 and $\leq$ 6, THEN set value to 3
Minimum Score = 0 (better); Maximum Score = 3 (worse)

Continued Appendix II. *PSQI Components.*

PSQIHSE	**SLEEP EFFICIENCY** Diffsec = Diffsec = Difference in seconds between times for Bed Time (Q1) and Getting Up Time (Q3). Diffhour = Absolute value of diffsec / 3600 newtib =IF diffhour > 24, then newtib = diffhour – 24 IF diffhour ≤ 24, THEN newtib = diffhour (NOTE, THE ABOVE JUST CALCULATES THE HOURS BETWEEN BED TIME (Q1) AND GETTING UP TIME (Q3) tmphse = (Q4 / newtib) * 100 IF tmphse ≥ 85, THEN set value to 0 IF tmphse < 85 and ≥ 75, THEN set value to 1 IF tmphse < 75 and ≥ 65, THEN set value to 2 IF tmphse < 65, THEN set value to 3 Minimum Score = 0 (better); Maximum Score = 3 (worse)
PSQISLPQUAL	**OVERALL SLEEP QUALITY** Q6 Minimum Score = 0 (better); Maximum Score = 3 (worse)
PSQIMEDS	**NEED MEDS TO SLEEP** Q7 Minimum Score = 0 (better); Maximum Score = 3 (worse)
PSQI	**TOTAL** DURAT + DISTB + LATEN + DAYDYS + HSE + SLPQUAL + MEDS Minimum Score = 0 (better); Maximum Score = 21 (worse) Interpretation: TOTAL ≤ 5 associated with good sleep quality TOTAL > 5 associated with poor sleep quality

Appendix III. *BART Application Code.*

```
options
  fullscreen
  scale
  resolution 1920 1080
  background color white
  set &balloonX -350 # for positioning balloon
  set &balloonY -65
  var out &bartScoreSoFar &earnings # this makes data analysis easier
  set &&blueExplosionPoints 49 101 65 25 74 100 18 31 49 128 71 100 89 37 110 20 26 114 70 3 89 27 36 101 95 109
5 52 34 92
  set &&yellowExplosionPoints 3 26 1 10 24 30 11 7 22 26 18 1 24 23 17 21 26 18 6 6 20 3 22 21 21 23 6 26 10 8
  set &&orangeExplosionPoints 5 4 1 4 7 4 2 3 5 5 1 7 8 2 3 2 2 8 4 3 4 6 5 2 1 1 5 3 6 7
  set &&mixedBlockTypes 2 2 2 2 2 2 2 2 2 2   3 3 3 3 3 3 3 3 3 3   4 4 4 4 4 4 4 4 4 4  ## 10 of each 3 types
  set &pointsPerBalloon 5 # in the original paper, it is 5 cents per balloon

bitmaps
  instructions1
  instructions2
  instructions3
```

```
  pumpButton
  collectButton
  collectButtonGrey
  screenoutline
  explode1
  explode2
  arrows
  startButton   # for instructions
  nextPage      # for instructions
  previousPage  # for instructions
  reportLayout        # for report after block with stats
  greenContinueButton # for report after block with stats

fonts
  arial 50
task bart
  ##--first choose the correct explosion point for trial----------------------------------------
  if &blockType = 0 ## green training trials
    set %balloonColor "green"
    set $explosionPoint 10
    set $currentRed   0
    set $currentGreen 128
    set $currentBlue   0
  fi
  if &blockType = 1 ## mixed color balloons, it can be randomly of any color. We know there are 30 trials, so we use
blocktype 2, 3 , 4, but then randomly interleaved
    set &blockType &&mixedBlockTypes remove random
    set $inMixedBlock = 1 # actually, &blockType should not really be changed, but it is convenient for choosing one of
following
  fi
  ## now if it was blockType 1, not the blocktype will actually have been chosen to be 2,3,4
  if &blockType = 2 ## blue balloons (mean explosion point at 64)
    set %balloonColor "blue"
    set $explosionPoint &&blueExplosionPoints remove first
    set $currentRed   100
    set $currentGreen 100
    set $currentBlue  255
  fi
  if &blockType = 3 ## yellow balloons (mean explosion point at 16)
    set %balloonColor "yellow"
    set $explosionPoint &&yellowExplosionPoints remove first
    set $currentRed   255
    set $currentGreen 255
    set $currentBlue   0
  fi
  if &blockType = 4 ## orange balloons (mean explosion point at 4)
    set %balloonColor "orange"
    set $explosionPoint &&orangeExplosionPoints remove first
```

```
  set $currentRed   255
  set $currentGreen 128
  set $currentBlue   0
 fi
 ##-- potential earnings calculation ---------------------------------------------------------
 set $potentialEarningsThisBalloon expression ( $explosionPoint - 1 ) * &pointsPerBalloon
 set &potentialEarnings increase $potentialEarningsThisBalloon
 ##-------------------------------------------------------------------------------------------
 if $inMixedBlock = 1 # this is only for next trial, so that we select correct color
  set &blockType 1
 fi
 ##-------------------------------------------------------------------------------------------
 set &&averageRTarray clear # for calculating average time it took to press pump up button
 set &balloonCount increase
 ##--setup screen
 show bitmap screenoutline  # 1
 show bitmap pumpButton -595 450  # 2
 show bitmap collectButtonGrey -80 450 # 3
 set $balloonSize 10
 show text &earnings 550 -50 black # 4
 show text $earningsThisBalloon 550 -350 black # 5
 show text &balloonCount 550 250 black # 6
 show circle &balloonX &balloonY $balloonSize $currentRed $currentGreen $currentBlue # 7 , in training we show
green balloon
 if &blockType = 0
  show text "TRAINING BLOCK" 570 450 black
 fi
 while $timesPumped < $explosionPoint && $collected != 1
  ## now check what decision participant makes
  if $timesPumped = 0
   readmouse l 2 999999 range 2 2 # if $timesPumped is 0, you cannot click collect, you are forced to pump at least
once
  else
   readmouse l 2 999999 range 2 3
  fi
  set &&averageRTarray append RT
  if UNDER_MOUSE = 2 ## people pump up
   if $timesPumped = 0
    update bitmap 3 collectButton # make collectButton yellow instead of unclickable grey
   fi
   set $timesPumped increase
   if $timesPumped != $explosionPoint
    set $earningsThisBalloon increase &pointsPerBalloon
       set $balloonSize increase 3
    update circle 7 &balloonX &balloonY $balloonSize $currentRed $currentGreen $currentBlue
    update text 5 $earningsThisBalloon
   else
    set $explosion 1 # code that explosion happened
```

```
      fi
      scale 2 105
      delay 50
      scale 2 110
      delay 50
      scale 2 100
    fi
    if UNDER_MOUSE = 3
      set $collected 1 # this way you end
      set &earnings increase $earningsThisBalloon
      set &&bartScoreArray append $timesPumped # this is the adjusted score for calculating average later
      set &bartScoreSoFar &&bartScoreArray roundmean
    fi
  while-end
  if $explosion = 1
    clear 7 # remove balloon
    show animation &balloonX &balloonY 200 explode1 explode2
    delay 100
    clear -1
    show text "balloon exploded..." &balloonX &balloonY black
    update text 6 "earnings lost"
    delay 500
    clear -1
  fi
  if $collected = 1
    # now show arrows moving from current to earned amount
    for $y in -270 to -220 by 10
      show bitmap arrows 550 $y
      delay 50
      clear -1
    for-end
  fi
  ## -- we keep a count for exploded and unexploded balloons
  if $explosion = 1
    set &balloonCountExploded increase
  else
    set &balloonCountUnexploded increase
  fi
  ## -- we need to calculate the average response time for this balloon
  set &averageRT &&averageRTarray roundmean
  save BLOCKNAME %balloonColor &balloonCount $timesPumped $explosion $earningsThisBalloon &earnings
&bartScoreSoFar &averageRT $potentialEarningsThisBalloon &potentialEarnings

task showReport
  set $xpos 360
  set &missedPotential expression &potentialEarnings - &earnings
  text color black
  text align left
```

```
  show bitmap reportLayout -140 0
  show text &potentialEarnings      $xpos -390
  show text &earnings               $xpos -260
  show text &missedPotential        $xpos -130
  show text &balloonCount           $xpos 0
  show text &balloonCountUnexploded $xpos 130
  show text &balloonCountExploded   $xpos 260
  show text &bartScoreSoFar         $xpos 385
  delay 2000
  show bitmap greenContinueButton   780 392
  readmouse l SHOW_COUNTER 999999 range SHOW_COUNTER SHOW_COUNTER

##########################################################################################
## blocks
##########################################################################################

block training
  set &blockType 0 # training, green balloons
  pager option mouse previousPage 0 490 nextPage 300 490 startButton 650 490
  pager instructions1 instructions2
  task bart 3

block feedback1
  task showReport 1

block realdataMixed
  # first reset various variables
  set &potentialEarnings 0
  set &earnings 0 # reset training
  set &balloonCount 0 # reset count
  set &balloonCountUnexploded 0 # reset count
  set &balloonCountExploded 0 # reset count
  set &bartScoreSoFar 0
  set &&bartScoreArray clear
  #
  set &blockType 1 # mixed, there are 30 trials
  message instructions3 mouse
  delay 1000
  message greenContinueButton mouse
  task bart 30

block feedback2
  task showReport 1
```

Appendix IVA. *Delay Discounting Questionnaire with Corresponding k Values.*

Smaller immediate reward (dollars)	Larger delayed reward (dollars)	Delay (days)	k at indifference
54	55	117	0.00016
47	50	160	0.0004
55	75	61	0.006
19	25	53	0.006
14	25	19	0.041
15	35	13	0.10
31	85	7	0.25

Appendix IVB. *Probability Discounting Questionnaire with Corresponding h Values.*

Smaller guaranteed reward (dollars)	Larger uncertain reward (dollars)	Probability	h at indifference
20	80	0.01	0.0303
20	80	0.02	0.0612
20	80	0.05	0.0625
20	80	0.83	0.158
40	100	0.18	0.329
40	60	0.55	0.611
20	80	0.83	14.647

Appendix V. *Participant Scores on PSQI, BART, and Discounting Tasks.*

Participant ID	PSQI score	BART score	k	h	Participant ID	PSQI score	BART score	k	h
1	0	7	0.00155	0.099	15	2	3	0.00155	0.099
2	9	3	0.00155	0.099	16	3	22	0.00155	0.062
4	9	9	0.00155	0.228	17	3	39	0.00155	2.992
5	5	38	0.06403	2.992	18	7	13	0.00016	0.449
6	7	26	0.00155	2.992	19	6	11	0.00155	2.992
7	5	6	0.00016	0.449	20	4	12	0.00155	0.449
8	10	4	0.15811	0.062	21	6	26	0.00155	14.647
9	4	15	0.00155	2.992	22	5	7	0.00016	0.228
10	5	8	0.00155	0.099	23	5		0.00155	2.992
11	7		0.00600	0.062	24	3	39	0.06403	0.449
12	9	7	0.06403	2.992	25	5	12	0.00155	2.992
13	7	8	0.00155	0.228	26	7	13	0.00155	0.228
14	8	15	0.00155	0.228	27	6	6	0.00155	0.449

Continued Appendix V. *Participant Scores on PSQI, BART, and Discounting Tasks.*

Participant ID	PSQI score	BART score	k	h	Participant ID	PSQI score	BART score	k	h
28	6	11	0.00155	0.228	48	3	12	0.00016	0.030
29	2	14	0.00155	0.449	49	3		0.00016	0.099
30	6	8	0.00155	0.030	50	7	3	0.00155	2.992
31	5	5	0.00155	0.228	51	3		0.00155	2.992
32	7	13	0.06403	14.647	52	8		0.01568	2.992
34	4	8	0.00155	2.992	53	6	17	0.00155	0.449
35	8	3	0.00155	0.228	54	7	6	0.00155	2.992
37	4	16	0.00155	0.228	55	6	6	0.00016	0.043
38	7		0.00016	0.030	56	16	3	0.00025	0.030
39	8	8	0.00016	14.647	57	9	3	0.00155	0.228
40	5		0.00016	2.992	59	2	17	0.00025	0.030
41	4		0.00016	0.099	60	1	4	0.00155	2.992
42	5	25	0.25000	0.449	61	8		0.00016	0.062
43	9		0.01568	0.043	62	5		0.01568	0.099
44	8	7	0.01568	0.030	63	5	16	0.00016	2.992
45	3		0.01568	0.449	64	6	30	0.00155	2.992
46	6		0.00016	0.449	65	8	11	0.01568	2.992
47	6		0.00016	2.992					

Appendix VI. *Participant Scores on Delay Discounting Task.*

Participant #	$54 today, or $55 in 117 days?	$47 today, or $50 in 160 days?	$55 today, or $75 in 61 days?	$19 today, or $25 in 53 days?	$14 today, or $25 in 19 days?	$15 today, or $35 in 13 days?	$31 today, or $85 in 7 days?	Index of switch	k
1	1	1	0	0	0	0	0	3	0.001549
2	1	1	0	1	0	0	0	3	0.001549
4	1	1	0	0	0	0	0	3	0.001549
5	1	1	1	1	1	0	0	6	0.064031
6	1	1	0	1	0	0	0	3	0.001549
7	0	0	0	0	0	0	0	1	0.00016
8	1	1	1	1	1	1	0	7	0.158114
9	1	1	0	0	0	0	0	3	0.001549
10	1	1	0	0	0	0	0	3	0.001549
11	1	1	1	0	1	0	0	4	0.006
12	1	1	1	1	1	0	0	6	0.064031
13	1	1	0	0	1	0	0	3	0.001549

Continued Appendix VI. *Participant Scores on Delay Discounting Task.*

Participant #	$54 today, or $55 in 117 days?	$47 today, or $50 in 160 days?	$55 today, or $75 in 61 days?	$19 today, or $25 in 53 days?	$14 today, or $25 in 19 days?	$15 today, or $35 in 13 days?	$31 today, or $85 in 7 days?	Index of switch	k
14	1	1	0	1	0	0	0	3	0.001549
15	1	1	0	0	0	0	0	3	0.001549
16	1	1	0	1	1	1	0	3	0.001549
17	1	1	0		0	1	0	3	0.001549
18	0	0	0	0	0	0	0	1	0.00016
19	1	1	0	0	0	0	0	3	0.001549
20	1	1	0	0	0	0	0	3	0.001549
21	1	1	0	0	0	0	0	3	0.001549
22	0	0	0	0	0	0	0	1	0.00016
23	1	1	0	0	1	0	0	3	0.001549
24	1	1	1	1	1	0	0	6	0.064031
25	1	1	0	1	1	0	0	3	0.001549
26	1	1	0	0	0	0	0	3	0.001549
27	1	1	0	0	0	0	0	3	0.001549
28	1	1	0	0	0	0	0	3	0.001549
29	1	1	0	0	0	0	0	3	0.001549
30	1	1	0	1	1	0	0	3	0.001549
31	1		0	0	0	0	0	3	0.001549
32	1	1	1	1	1	0	1	6	0.064031
34	1	1	0	1	0	0	0	3	0.001549
35	1	1	0	1	1	0	0	3	0.001549
37	1	1	0	1	1	0	0	3	0.001549
38	0	0	0	0	0	0	1	1	0.00016
39	0	0	0	0	0	0	0	1	0.00016
40	0	1	0	1	1	0	0	1	0.00016
41	0	1	0	1	0	0	1	1	0.00016
42	1	1	1	1	1	1	1		0.25
43	1	0	1	1	0	0	1	5	0.015684
44	1	1	1	1	0	1	0	5	0.015684
45	1	1	1	1	0	0	1	5	0.015684
46	0	1	0	1	0	0	0	1	0.00016
47	0	0	0	0	0	0	0	1	0.00016
48	0	0	0	0	0	0	0	1	0.00016
49	0	1	0	0	0	1	0	1	0.00016
50	1	1	0	0	0	0	0	3	0.001549

Continued Appendix VI. *Participant Scores on Delay Discounting Task.*

Participant #	$54 today, or $55 in 117 days?	$47 today, or $50 in 160 days?	$55 today, or $75 in 61 days?	$19 today, or $25 in 53 days?	$14 today, or $25 in 19 days?	$15 today, or $35 in 13 days?	$31 today, or $85 in 7 days?	Index of switch	k
51	1	1	0	0	0	0	1	3	0.001549
52	1	1	1	1	0	0	0	5	0.015684
53	1	1	0	0	0	0	0	3	0.001549
54	1	1	0	1	0	0	0	3	0.001549
55	0	1	0	0	1	0	0	1	0.00016
56	1	0	0	0	0	0	0	2	0.000253
57	1	1	0	0	1	0	0	3	0.001549
59	1	0	0	0	0	0	0	2	0.000253
60	1	1	0	0	0	1	0	3	0.001549
61	0	1	0	0	0	0	0	1	0.00016
62	1	1	1	1	0	0	0	5	0.015684
63	0	0	0	0	0	0	0	1	0.00016
64	1	1	0	1	0	0	0	3	0.001549
65	1	1	1	1	0	0	1	5	0.015684

Appendix VII. *Participant Scores on Probability Discounting Task.*

Participant #	$20 guaranteed or $80 with a 1% chance?	Would you prefer $20 guaranteed or $80 with a 2% chance?	Would you prefer $40 guaranteed or $100 with a 4% chance?	Would you prefer $20 guaranteed or $80 with a 5% chance?	Would you prefer $40 guaranteed or $100 with an 18% chance?	Would you prefer $40 guaranteed or $60 with a 55% chance?	Would you prefer $20 guaranteed or $80 with an 83% chance?	Index of switch	h
1	0	1	0	1	0	1	1	4	0.09934
2	0	0	0	1	0	1	1	4	0.09934
4	0	1	0	0	1	1	1	5	0.228013
5	0	0	0	0	0	0	1	7	2.991819
6	0	0	0	0	0	0	1	7	2.991819
7	0	0	0	0	0	1	1	6	0.448575
8	0	0	1	1	1	1	1	3	0.061859
9	0	0	0	0	0	0	1	7	2.991819
10	0	0	0	1	1	1	1	4	0.09934
11	0		1	1	1	1	1	3	0.061859
12	0	0	0	0	0	0	1	7	2.991819
13	1	0	0	0	1	0	1	5	0.228013
14	0	0	0	0	1	1	1	5	0.228013

Continued Appendix VII. *Participant Scores on Probability Discounting Task.*

Participant #	$20 guaranteed or $80 with a 1% chance?	Would you prefer $20 guaranteed or $80 with a 2% chance?	Would you prefer $40 guaranteed or $100 with a 4% chance?	Would you prefer $20 guaranteed or $80 with a 5% chance?	Would you prefer $40 guaranteed or $100 with an 18% chance?	Would you prefer $40 guaranteed or $60 with a 55% chance?	Would you prefer $20 guaranteed or $80 with an 83% chance?	Index of switch	h
15	0	0	0	1	1	1	1	4	0.09934
16	0	0	1	1	1	1	1	3	0.061859
17	0	1	0	1	0	0	1	7	2.991819
18	0	0	0	0	0	1	1	6	0.448575
19	0	0	0	0	0	0	1	7	2.991819
20	0	0	0	0	0	1	1	6	0.448575
21	0	0	0	0	0	0	0		14.64706
22	0	0	0	0	1	1	1	5	0.228013
23	0	0	0	0	0	0	1	7	2.991819
24	0	0	0	0	0	1	1	6	0.448575
25	0	0	0	0	0	0	1	7	2.991819
26	0	0	0	0	1	0	1	5	0.228013
27	0	0	0	0	0	1	1	6	0.448575
28	0	0	0	0	1	1	1	5	0.228013
29	0	0	0	0	0	1	1	6	0.448575
30	1	1	1	1	1	1	1	1	0.030303
31	0	0	0	0	1	1	1	5	0.228013
32	0	0	0	0	0	0	0		14.64706
34	0	0	0	0	0	0	1	7	2.991819
35	0	0	0	0	1	0	1	5	0.228013
37	0	0	0	0	1	1	1	5	0.228013
38	1	1	1	1	1	0	1	1	0.030303
39	0	0	0	0	0	0	0		14.64706
40	0	0	0	0	0	0	1	7	2.991819
41	0	0	0	1	0	1	0	4	0.09934
42	0	0	0	0	0	1	0	6	0.448575
43		1	1	1	1	1	1	2	0.043073
44	1	1	1	1	1	1	1	1	0.030303
45	0	0	0	0	0	1	1	6	0.448575
46	0	0	0	0	0	1	1	6	0.448575
47	0	0	0	0	0	0	1	7	2.991819
48	1	1	1	1	1	1	1	1	0.030303

Continued Appendix VII. *Participant Scores on Probability Discounting Task.*

Participant #	$20 guaranteed or $80 with a 1% chance?	Would you prefer $20 guaranteed or $80 with a 2% chance?	Would you prefer $40 guaranteed or $100 with a 4% chance?	Would you prefer $20 guaranteed or $80 with a 5% chance?	Would you prefer $40 guaranteed or $100 with an 18% chance?	Would you prefer $40 guaranteed or $60 with a 55% chance?	Would you prefer $20 guaranteed or $80 with an 83% chance?	Index of switch	h
49	0	0	0	1	1	1	1	4	0.09934
50	0	0	0	0	0	0	1	7	2.991819
51	0	0	0	0	0	0	1	7	2.991819
52	0	0	0	0	0	0	1	7	2.991819
53	0	0	1	0	0	1	1	3	0.448575
54	0	0	0	0	0	0	1	7	2.991819
55	0	1	1	1	0	1	0	2	0.043073
56	1	1	1	0	1	1	1	1	0.030303
57	0	0	0	0	1	1	1	5	0.228013
59	1	1	1	1	1	1	1	1	0.030303
60	0	0	0	0	0	0	1	7	2.991819
61	0	0	1	1	1	1	1	3	0.061859
62	0	0	0	1	1	1	1	4	0.09934
63	0	0	0	0	0	0	1	7	2.991819
64	0	0	0	0	0	0	1	7	2.991819
65	0	0	0	0	0	0	1	7	2.991819