DREAMS AND PERSONALITY INFLUENCE CREATIVITY

by

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DEDICATION

I would like to dedicate this project to my wife, Baley, and my family as a whole for their continuous support and understanding when undertaking my research and writing my project. I would also like to thank God for helping me through all the difficulties. I would not be where I am today without His guidance and support.

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LIST OF ABBREVIATIONS

Abbreviation	Description
ANOVA	Analysis of Variance
AUT	Alternative Uses Task
BiOtA	Broader form of the information overlap to abstract framework
CRAT	Compound Remote Associates Test
DRF	Dream Recall Frequency
EEG	Electroencephalography
IPIP	International Personality Item Pool
MADRE	Mannheim Dream Questionnaire
NEXTUP	Network Exploration to Understand Possibilities
OAT	Object Association Task
PSQI	Pittsburgh Sleep Quality Index
REM	Rapid Eye Movement

ABSTRACT

There is currently little research on how dreaming behaviors and personality may affect creativity. This thesis investigated how dream recall frequency (DRF), which is how often people can recall their dreams, and the Big 5 personality traits (i.e., neuroticism, conscientiousness, openness, extraversion, and agreeableness), affect divergent thinking and creative problem solving. Participants ($N = 76$) completed questionnaires about dreaming, sleep quality, and the Big 5 personality traits and completed five tasks. Two tasks measured a form of creativity known as divergent thinking, which refers to the flexible creation of multiple ideas and solutions. In the alternative uses task, participants were asked to come up with as many creative uses for six everyday objects (e.g., shoes) as possible within one minute. In the Cartoon Caption Task, participants were asked to look at five cartoon pictures and produce the most creative caption they could think of for each cartoon in one minute. Creative problem solving was also measured with two tasks. In the matchstick task, participants were given five minutes to complete each of four problems in which individuals looked at an incorrect math equation written in roman numerals with matchsticks, and they were asked to move one of the matchsticks to a different place in the equation to make the equation correct. In the Compound Remote Associates Test, participants were asked to look at three different words and figure out which fourth word could make a compound word with each of the three words that they were given. Two multiple regressions were conducted to determine if any personality traits or DRF predicted performance on divergent thinking or creative problem solving. Although the full model assessing predictors of divergent thinking was not significant, the results indicated that both DRF and openness positively predicted divergent-thinking performance. Neither DRF nor any personality traits predicted creative problem solving. These results support current theories that

suggest that dreaming that occurs during REM sleep promotes the discovery and exploration of novel connections in the mind that stimulate divergent thinking during waking. Furthermore, these results may have practical applications for improving divergent thinking in everyday life.

I. INTRODUCTION

Dreams have been defined in different ways. For example, it has been hypothesized that dreams could be a gateway to dramatic hallucinations occurring during sleep (Baylor & Deslauriers, 1986) or a group of experiences involving thoughts, images, and emotions that occur whilst sleeping (Zadra & Stickgold, 2022, p. 1). Dreaming can be thought of as an unknown world within our minds, a way to solve our problems, or just random ideas popping into our minds. Nobody knows for sure why people dream or why some people remember their dreams more than others. In addition, associations have been found between rapid eye movement (REM) sleep, a sleep stage when most typical dreaming is thought to occur, and creativity, suggesting that dreaming behavior may influence creativity once people are awake (Dement, 1997; Cai et al., 2009). However, there is currently little research directly examining how dreaming behaviors may affect creativity. Personality characteristics may also influence creativity (Baas et al., 2013). The American Psychological Association defines personality as individual differences in typical patterns of thinking, feeling, and behaving (n.d.). This thesis will investigate how dream recall frequency (DRF) and personality affect creativity.

Sleep

Sleep is a state of rest in the human body that alternates with a state of wakefulness on a circadian rhythm. There are several functions of sleep that are beneficial for the body to survive. A lot of growth hormone is released during slow-wave sleep, which helps children grow (Van Cauter & Plat, 1996). During sleep, antibodies are produced to protect the body from diseases, insulin levels are regulated, and proteins linked to Alzheimer's disease are cleansed from the brain (Lange et al., 2003; Spiegel et al., 1999; Xie et al., 2013). By promoting health, sleep protects the body from many biological harms that could occur without it. In fact, prolonged total

sleep loss can be fatal, as in the case of fatal familial insomnia (Cortelli et al., 1999). Another function of sleep is the reorganization of knowledge (Stickgold & Walker, 2013). It is thought that during sleep, newly learned information is reactivated and integrated with existing knowledge, which can strengthen memories and lead to the generation of novel insights.

In the 1930s, it was determined that there are four different stages of sleep by observing patterns in electroencephalographic (EEG) recordings during sleep (Millett, 2001). EEG involves placing electrodes on the scalp to record the electrical activity of the underlying brain tissue. While people are awake, they exhibit low-amplitude beta waves (15-20 Hz). When they start to get a little drowsy, they show the first signs of alpha waves (8-12 Hz), which are typically low frequency, high amplitude waves that become synchronized with one another (Verevkin et al., 2008). When people first fall asleep, Stage 1 occurs with frequencies of electrical oscillations on the higher end of the theta band (6-7 Hz; Neurofeedback Alliance, 2021). Stage 1 consists of the lightest sleep, breathing occurs at a regular rate, muscles start to relax, and it is quite easy to wake up from this stage. It lasts only a couple of minutes before giving way to Stage 2, which is a deeper sleep, so an individual is less likely to wake up and frequencies are in the lower theta range (4-5 Hz). During Stage 2, sleep spindles, which are 0.5-3 second bursts of high frequency activity (11-16 Hz), also occur (Berry et al., 2015). During stage 3, also known as slow wave sleep, sleep spindles can persist, eye movements are not frequent, and slow-moving 0.5-2 Hz frequencies are observed (Berry et al., 2015). Slow wave sleep becomes less frequent as sleep continues. Finally, there is REM sleep, in which the brain's activity resembles being awake, breathing is more irregular, and heart rate increases, but the body is not moving. There are irregular eye movements with initial deflections usually lasting less than 500 milliseconds, muscle tone is lost, and what are described as sawtooth waves due to the sharp frequency in the

EEG of 2-6 Hz usually right before a burst of rapid eye movements (Berry et al., 2015). REM sleep makes up about 20% of total sleep time and becomes more prominent the longer a person has been sleeping (Amici et al., 2014). All four of these stages together are known as the sleep cycle. Individuals will progress through the cycle four to five times per night in 90–120-minute chunks.

Dreams

During sleep, dreaming can also occur. However, dreams are difficult to measure. EEG recordings can display that an individual is in non-REM or REM sleep, but there is no way of knowing if they are dreaming from the EEG recording. The most frequently used method to measure dreaming is waking an individual up and asking them to provide a dream report (i.e., report what they were just dreaming about before being awoken), but the usefulness of this method depends on if the individual remembers if they were dreaming or not. Participants report that they were dreaming 90% of the time when they are awakened from REM sleep (Dement, 1997; van Wyk et al., 2019). The dreams in REM sleep are what most people would consider typical dreams, where an individual has vivid images and other sensory experiences while an ongoing storyline plays out in the mind. Some dreaming can occur during non-REM sleep as well. Dreaming is reported 70% of the time when individuals are awoken from non-REM sleep, but the nature of those dreams differs significantly from the dreams in REM sleep (Stickgold et al., 2001). In dream reports after waking from non-REM sleep, people do not report an ongoing storyline with vivid visual imagery. Instead, they report thinking about a problem, such as a problem in their social life (McNamara et al., 2010). Another method used to evaluate dreams is to have people complete dream journals. A dream journal is a way for a person to record their dreams every morning after waking and describe them in detail. If someone is using a dream

journal, then their use of the journal likely increases how often they will remember their dreams because they are paying more attention to whether they dreamt right after they wake up. However, dream content is difficult to measure from these reports because a dream journal contains people's subjective recall of the events in their dreams. Subjective recall may be inaccurate and is hard to evaluate. Another approach to measuring dreaming is to use DRF. This is a measure in which people are asked about how often they can remember their dreams and communicate what they are. DRF can be useful to get a rough measure of how many people and how often those people remember their dreams in the context of a research experiment.

In addition to the story-like dreams of REM sleep and the "thinking"-based dreams of non-REM sleep, there are also other forms of dreaming. One of these is lucid dreaming, which is a type of dreaming in which an individual is aware that they are dreaming and can, to some degree, control what is happening in their dreams (Schredl & Erlacher, 2004). Nightmares are another form of dreams that are associated with negative experiences (American Academy of Sleep Medicine, 2014). While they are like other dreams that occur during REM sleep, they usually elicit negative emotions as well as cause individuals to wake up from sleep due to a disturbing sequence.

Why people dream has been a mystery researched for over a century. The concept was popularized by Sigmund Freud, who thought that dreams were wish fulfillment (Barrett, 2017). When people dream, their minds are attempting to fulfill wishes that they have in their subconscious. Freud believed that those wishes are repressed during waking and need to be "let out" during dreaming. Wegner and colleagues (2004) demonstrated that thoughts repressed prior to sleep frequently show up in dreams and provide a modern take on Freud's psychoanalytic wish fulfillment theory.

Another theory is the activation-synthesis hypothesis, which is that neurons projecting from the pons to the cortex appear to randomly fire during REM, resulting in seemingly random activity in the cortex (Hobson & McCarley, 1977). Therefore, the frontal lobe creates a storyline to make sense of the random activity of cortical neurons. Research done by Williams et al. (1992) found that bizarreness occurred more frequently in dream reports than in fantasy reports during waking. This is consistent with the activation-synthesis hypothesis, which suggests that decreased aminergic activity during REM leads to a lack of organization and an increase in bizarreness in the internal narrative generated.

A third theory about why people dream is an evolutionary theory coined the threat simulation theory. According to this theory, dreams function to simulate potential threats a person may face so the person can develop successful strategies to avoid or deal with these threats in real life (Revonsuo 2000a, 2001). Supporting this theory, Valli et al. (2005) looked at the contents of dream reports by severely traumatized and less traumatized Kurdish children and non-traumatized Finnish children. They found that the severely traumatized children reported more dreams and those dreams contained more threatening events. Also, the dream's threatening events were more severe in nature for the severely traumatized children.

A fourth theory is the network exploration to understand possibilities (NEXTUP) theory developed by Zadra and Stickgold (2022). According to this theory, during the process of memory consolidation, newly learned information is integrated with existing knowledge in the brain, which helps to identify previously unexplored, weak associations. If these newly found associations relate to a current problem or goal someone has, then they can create a storyline or "dream" around them. This theory is supported by animal studies that teach rats specific sequences of movements within a maze, which are represented by the firing of hippocampal

place cells in a precise order. During subsequent sleep, in addition to reactivation of these same sequences by hippocampal place cells, novel patterns of hippocampal place cell activity have also been observed, suggesting that they are dreaming about maze routes they had never taken (Gupta et al., 2010).

To summarize, dreams can reflect wish fulfillment, provide a safe space to figure out solutions to threats, or be the discovery of novel associations relevant to waking life. These different theories and processes about dreams led the way to establishing why dreams were essential for this thesis.

Dreams and Creativity

There has been a lot of debate about how to define creativity. One definition for creativity is the "tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others" (Franken, 2007, p. 396). Another definition simply states that creativity involves any creation of something new and useful (Mumford, 2003). Creativity has been measured in many ways using a diverse set of tasks. Some tasks are designed to measure divergent thinking, which refers to how flexible and original a person's thinking is through combining information in new ways to generate multiple novel insights or answers (Guilford & Vaughan, 1962; Guilford, 1968). One way to measure divergent thinking is by using the alternative uses task (AUT) developed by Guilford (1967), in which participants are asked to come up with as many creative uses for an item as they can within a minute. Another divergent thinking task is the Cartoon Caption Task developed by Chart et al. (2008), in which participants are asked to come up with the most creative captions they can think of for individual cartoons.

Creative problem-solving tasks are designed to go beyond divergent thinking by requiring participants to identify the single best solution to a certain problem that requires divergent thinking to achieve that solution (Guilford, 1967). This differs from analytical problem solving, in which logic and reason are used to achieve a solution. During creative problem-solving tasks, participants are asked to solve problems that require them to think about objects in new ways, form new associations, or mentally restructure problems. An example of a creative problem-solving task is the matchstick task (Gardner, 1967) in which participants are shown a mathematical equation where the numbers, written as Roman numerals, and operators (i.e., plus sign, minus sign, equals sign, etc.) are made with matchsticks. The equation is mathematically incorrect, and participants are asked to move one of the matchsticks to a new position to make the equation correct (Figure 1). Problems vary in difficulty based upon the extent to which they require mental restructuring (Knoblich et al., 1999). Each number and operator in an equation can be thought of as a "chunk" of knowledge comprised of multiple matchsticks (e.g., the roman numeral for 3 is one chunk, comprised of three vertical matchsticks; "III"). However, the difficulty in the problems varies based on whether a chunk is loose or tight. If a chunk is loose, then that means that the chunk can be easily decomposed. For example, it is easy to see that one matchstick from the roman numeral III could be moved to make the roman numeral II. If a chunk is tight, it is more difficult to realize that the chunk can be decomposed. Typically, operators are considered tight chunks, because most people are familiar with arithmetic and erroneously assume that operators cannot be split up. Likewise, the roman numeral for five, V, is also considered a tight chunk, because decomposing it does not create obvious meaningful units. Therefore, the difficulty of matchstick problems varies based on which chunks must be altered to make the equation correct.

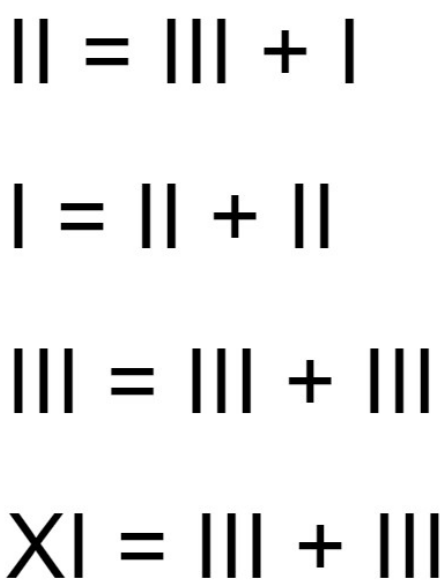

Figure 1. Four incorrect matchstick problems that need solutions.

Theoretically, both the activation-synthesis hypothesis and the NEXTUP theory predict that dreaming should increase creativity. According to the activation-synthesis hypothesis, the frontal lobe creates a narrative that combines information in novel ways during dreaming which could lead to multiple new insights that could aid in divergent thinking and lead to a single solution to creative problems. According to the NEXTUP theory, weak associations that were previously unexplored are considered during dreaming, which could also increase creativity in divergent-thinking tasks and aid in creative problem solving.

Keeping in mind that dream reports accompany awakenings from REM sleep 90% of the time, supporting the idea that dreaming increases creativity, several studies have demonstrated connections between REM sleep and creativity. For example, Cai et al. (2009) used a remote associates test in which participants were asked to figure out which word connected three other words together, such as “hammer, gear, and hunter”, which are all connected to the word “head.” Prior to sleep, participants attempted to solve these problems, but were not able to solve all of

them. However, participants were able to solve more of the previously unsolved problems after REM sleep compared with other sleep stages or if they remained awake. In another study, Wagner et al. (2004) had participants perform a complex cognitive task that they improved at over time, but they could also improve suddenly due to the discovery of a hidden rule that could be used to complete the task more easily. The results indicated that if participants slept after initial training in the task, they were more likely to discover the hidden rule. The results of these two studies have been interpreted within the broader form of the information overlap to abstract framework model (BiOtA), which suggests that during REM sleep, decreased synchrony between the hippocampus and neocortex and increased neural plasticity allows for novel connections to be formed, which could be useful for creative problem-solving (Lewis et al., 2018). However, how these neural processes relate to dreaming is currently unknown.

Less research has directly examined how dreaming behaviors influence creativity. One study demonstrated that individuals that were more creative (as measured by a modified Wollach-Kogan creativity battery; Wallach & Kogan, 1965) reported longer dreams, remembered their dreams more, and reported more creative dreams (as measured by the Auld, Goldenberg, & Weiss, 1968, Scale of Primary Process Thought; Livingston & Levin, 1991). However, further analyses demonstrated that when dream length was controlled for, no such relationship was present. Based on these results, Livingston and Levin (1991) suggested that perhaps dream length itself may influence creativity. In another study, Schredl and Erlacher (2007) found that approximately 8% of all dreams influenced waking-life creativity using a self-report questionnaire, and the frequency of dreams that influenced waking-life creativity was positively correlated with DRF, suggesting that creative dreaming leads to more creativity during waking. Also, Schredl et al. (2014) found that slightly more than 10% of individuals reported

having dreams that give them creative ideas and dreams that help to identify and solve problems at least once a year, suggesting that at least some people have dreams that influence how they perform in their waking life. Another study that measured divergent thinking with the alternative uses task (Guilford, 1967) found that individuals with high DRF showed increased divergent thinking relative to individuals with low DRF, and that individuals with high DRF showed higher levels of connectivity between brain regions within the default mode network at rest (Vallat et al., 2022). It has been speculated that activity in the default mode network may contribute to divergent thinking (e.g., Wei et al., 2014), although Vallat et al. did not observe a significant correlation between divergent thinking and default mode network connectivity in their experiment.

Personality and Creativity

There are various ways to conceptualize personality. Jung thought that personality came in the form of archetypes, which are basic images that form the core of a person's conscious and unconscious psyche, and each person has multiple archetypes that, together, form their personality (Cann & Donderi, 1986). Another way to conceptualize personality is the psychoanalytical approach involving Freud's ego, id, and superego (Freud, 1971). Each of these are separate parts of the mind that control different functions. The id controls the irrational and emotional parts of the mind, the superego controls the moral part of the mind, and the ego balances between the two and controls the rational and logical part of the mind. A third way to conceptualize personality is through the trait approach, which is currently the most predominant approach. Various researchers (Allport & Odbert, 1936; Cattell, 1957; Fiske, 1949) have attempted to describe personality through "traits," which are stable and enduring characteristics of a person. Starting from 18,000 traits, research across the past several decades has narrowed it

down to five traits thought to comprise each person's personality, and this is referred to as the Five Factor Model, otherwise known as the Big 5 Personality approach (Goldberg, 1981; McCrae & Costa, 1987).

Openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism comprise the Big 5 personality traits. These five traits are seen as continuous, and individuals can rate high or low on these various traits. They are considered orthogonal, so if a person is rated high on one personality dimension, then that does not mean that they will be rated low or high in another. Openness to experience reflects how willing an individual is to try new things, listen to new ideas, and take risks. Conscientiousness describes an individual's drive to succeed and how responsible they are. Extraversion reflects an individual's sociability and a preference for high levels of activity. Agreeableness involves a person's cooperation and avoidance of conflict. Finally, neuroticism describes an individual's tendency to feel negative or unstable emotions.

Although the Big 5 approach was mainly developed by studying individuals from western cultures, it can reasonably characterize personality from other cultures as well (McCrae & Costa, 1997; Yamagata et al., 2006; Gurven et al., 2013). There are some disagreements though. For example, Gurven et al. (2013) found that the Big 5 factor model did not show internal consistency, response stability, or external validity when these five factors were measured in illiterate, indigenous societies in Bolivia. Also, Allik and McCrae (2004) found that Western cultures tended to be higher in extraversion and openness to experience and lower in agreeableness than Eastern cultures.

The first measure of these five traits was the 50-item International Personality Item Pool (IPIP) developed by Goldberg (1999). In the original IPIP, there were ten items used to measure each trait. For each item, participants would see a statement such as "Accomplish my work on

time," which would relate to conscientiousness, and rate how much they agreed with it on a 5-point scale. The scores for the ten items for each trait were then combined into a single score for each trait. Later, this was shortened to 20 items and coined the mini-IPIP, which measures the Big 5 personality dimensions with four items per trait (Donnellan et al., 2006).

Individuals that are high in openness to experience have higher DRF compared with individuals low in this trait (Schredl & Göritz, 2017; Hill et al., 1997; Watson, 2003; Aumann et al., 2012). Therefore, frequent dreaming in open individuals could lead to increased creativity in open individuals. Multiple studies have shown positive associations between openness to experience and creativity (Feist, 1998; Tan et al., 2016). Feist (1998) argued that scientists and artists are relatively more creative than non-scientists and non-artists and compared personality traits in these groups of individuals through a meta-analysis to determine which personality traits were high in scientists and artists. They found that scientists and artists were more open and less conscientious than non-scientists and non-artists. Tan and colleagues (2016) also found that openness was positively associated with creativity. They measured creativity with two online questionnaires: a creative process engagement scale (Zhang & Bartol, 2010) and a self-perceived creativity questionnaire (Zhou & George, 2001), and suggested that participants high in openness may have higher intrinsic motivation to engage in creative tasks and creative thinking in their everyday life. Consistent with these findings, Schredl and Erlacher (2007) found that openness to experience was more closely associated with the frequency of creative dreams, which are dreams that give individuals creative ideas or help to solve problems, rather than DRF in general. Therefore, one possibility is that openness to experience may increase creative dreaming, which may result in higher creativity during waking. Another study found a relationship between creativity, measured through the Creative Activities Checklist (Runco & Okuda, 1988) and a

role-playing creative problem-solving task, and a fine-grained measure of conscientiousness, which they called achievement, which is thought to reflect a “self” focus and intrinsic motivation, as opposed to an "other” focus that is more related to the dependability aspect of conscientiousness (Reiter-Palmon et al., 2009).

In summary, most investigations of relationships between personality and creativity have used subjective or self-report measures of creativity. Although Reiter-Palmon et al. (2009) did obtain an in-person measure of creative problem solving, it was a single problem with no objective solution. Therefore, additional research is necessary to explore potential relationships more fully between personality, divergent thinking, and creative problem solving.

Purpose

Given the lack of research regarding how dreaming and personality may increase divergent thinking and creative problem solving, the purpose of this study is to evaluate how DRF influences divergent thinking and creative problem-solving ability and to determine if any of the Big 5 personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) also influence creativity using measures of creativity that have not previously been examined. Participants will first complete a questionnaire about dreaming to obtain a measure of DRF and to obtain information about other aspects of dreaming behaviors (Schredl et al., 2014) and a personality inventory (Donnellan et al., 2006). Next, participants will complete five tasks. Divergent thinking will be measured with two tasks described above, the AUT (Guilford, 1967), and the Cartoon Caption Task (Chart et al., 2008). There will also be two tasks previously used to measure creative problem solving; the matchstick task (as described above) and the Compound Remote Associates Test (CRAT). The CRAT (Bowden & Jung-Beeman, 2003) is similar to the remote associates test in that it requires finding distant

associations between words (e.g., Cai et al., 2009). However, unlike the remote associates test in which the solution word is just related or associated to the three problem words, in the CRAT, the solution word must be able to be combined with each of the three problem words to form a compound word. Both the matchstick task and the CRAT are typically considered insight problems, in that finding the solution often features an "Aha! experience." A fifth task, called the object association test (OAT; Abraham et al., 2012), will be used to measure analytical problem-solving ability to determine whether DRF is specifically related to creative problem solving or if it extends to other types of problem solving. The proposed hypotheses are that 1) high DRF will increase performance on divergent thinking and creative problem-solving tasks but will not have a relationship with analytical problem solving, and that 2) openness to experience and other personality traits will be positively related to divergent thinking and creative problem solving In addition to DRF, the additional questions asked about dreaming will allow for exploratory analyses regarding how other aspects of dreaming, including other trait-like dreaming behaviors that are rated over the past several months, and state-like dreaming behaviors that occurred during the past week, may impact creativity.

II. METHODS

Participants and procedure

Seventy-six undergraduate students (age 18 years and older) recruited from psychology classes at Texas State University in San Marcos, TX were given course credit for completing the study. This sample size was selected to achieve 80% power with a two-tailed alpha of .05 and a moderate effect size (Cohen, 1988) of $f^2 = .15$ (G*Power 3.1.9) to detect potential relationships between dream recall frequency (DRF), personality, and divergent thinking and creative problem solving using multiple regression.

Participants first signed a paper consent form and then completed a series of questionnaires administered through the online Qualtrics platform. Participants were allowed to skip any questions they did not feel comfortable answering. After completing the questionnaires, participants completed five tasks designed to measure divergent thinking, creative problem solving, and analytical problem solving.

Questionnaires

Demographics. Participants were asked to provide information on their age, gender, and race.

Dreaming Behaviors. Participants answered a subset of questions from the Mannheim Dream Questionnaire (MADRE; Schredl et al., 2014), which was developed to measure various aspects of dreaming behaviors. Most responses are recorded using a Likert scale. In addition to DRF, questions from the MADRE about dream intensity, the emotional tone of dreams, nightmare frequency, nightmare disturbance, nightmare relatability (recurring nightmares that relate to a situation experienced in waking life), childhood nightmares, attitude towards dreams, sharing of dreams, record of dreams, dreams affecting mood, dreams giving ideas, and dreams

helping to solve problems were included. Four additional questions asking specifically about recent dreams were also included ("Did you dream last night?" with response options of "Yes," "No," and "I can't remember", "If you answered yes to 'Did you dream last night?,' what was the emotional tone of your dream last night?" with responses recorded on a 5-point Likert scale, "If you answered yes to 'Did you dream last night?,' was the content of your dreams last night consistent with your typical dream content?" with response options of "Yes" and "No", "Within the last week, have any of your dreams helped you identify and solve your problems?" with response options of "Yes" and "No"). These additional questions were used for exploratory analyses examining how participants' most recent dreams might affect their divergent thinking and creative problem-solving abilities. For this sample, the modified MADRE and additional recent dreaming questions had good internal consistency ($\alpha = .74$, $M = 111.27$, $SD = 14.75$).

Sleep Quality. The Pittsburgh Sleep Quality Index (PSQI) was used to measure sleep quality during the past month (Buysse et al., 1989), as sleep quality may influence DRF and/or divergent thinking and creative problem solving. Participants answered 19 questions divided into seven subscales (sleep quality, sleep latency, sleep duration, habitual sleep efficacy, sleep disturbances, use of sleeping medication, and daytime dysfunction). Answers from the seven subscales are typically combined to form a global sleep quality score, ranging from 0-21. A score of less than 5 indicates good sleep quality, with higher scores indicating progressively worse sleep quality. For this sample, the PSQI had good internal consistency ($\alpha = .80$, $M = 30.46$, $SD = 8.67$).

Personality. The Mini-International Personality Item Pool (Mini-IPIP) measured the Big 5 personality dimensions in each participant (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism; Donnellan et al., 2006). Responses to 20

statements (e.g., “In general, I get chores done right away.”) were made on a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). Four statements were used to assess each trait and responses from the four statements were summed together to provide a measure of each personality dimension. Three personality dimensions had fair to good internal consistencies (extraversion: $\alpha = .78$, openness to experience: $\alpha = .67$, conscientiousness: $\alpha = .68$), whereas internal consistencies for neuroticism ($\alpha = .53$) and agreeableness ($\alpha = .43$) were poor. This is consistent with other studies using the Mini-IPIP and is likely due to the relatively small number of questions used to measure each trait (Cooper et al., 2010). Exploratory factor analyses have indicated the Mini-IPIP is best described with five factors, with minimal cross-loadings of items onto multiple factors, suggesting that despite low alpha values for some dimensions, the measure has acceptable reliability (Cooper et al., 2010).

Tasks

The order in which the tasks were administered was counterbalanced across participants, such that half of the participants completed the Object Association Task first, followed by the creative problem solving and divergent thinking tasks in the following order: matchstick task, Compound Remote Associates Test, Cartoon Caption Task, Alternative Uses Task. The other half of the participants completed the creative problem solving and divergent thinking tasks first (in the order specified above), and then completed the Object Association Task.

Matchstick Task. The matchstick task was used to measure creative problem-solving ability in each participant (Gardner, 1967, Knoblich et al., 1999). Participants were given five minutes to complete each of four problems. In this task, individuals looked at an incorrect math equation written in roman numerals with matchsticks (Figure 1), and they were asked to move one of the matchsticks to a different place in the equation to make the equation correct. The

matchsticks could be moved from one of the numbers or an operator (i.e., a plus sign, a minus sign, etc.) to make the equation correct. Problems were presented in order of increasing difficulty, as in Knoblich et al. (1999). The solution to the first problem involved the movement of a matchstick that represented a loosely chunked number (e.g., III; Type A). The solution to the second problem involved the movement of a matchstick from an operator to a number (Type B), the third problem solution involved the movement of a matchstick to change one operator into an equal sign (Type C), and the solution to the final problem required involving the movement of a matchstick from a tightly chunked number (e.g., X; Type D). These problems were presented on a computer screen one at a time. Participants were asked to choose which matchstick they wanted to move and to indicate which place in the equation it should be moved to make the equation correct. The experimenter confirmed if they moved the correct matchstick to the correct position. After they correctly solved the problem and the experimenter told them to advance, they moved on to the next problem by pressing a button on the computer. At the end of the task, the number of problems correctly solved were summed.

Compound Remote Associates Test. The Compound Remote Associates Test (CRAT) was also used to measure creative problem-solving ability in each participant (Bowden & Jung-Beeman, 2003). Participants were asked to look at three words on the computer screen and figure out a fourth word that could be combined with each of the other three words to form a compound word (i.e., the answer to "master, toss, finger" is "ring"). Participants were given 30 seconds to complete each problem for a total of 30 problems: 10 easy problems, 10 medium problems, and 10 hard problems taken from Bowden and Jung-Beeman (2003). Norms for how frequently participants were able to solve each problem were developed by Bowden and Jung-Beeman (2003). The criteria for a problem being easy was that 30% of participants solved the item within

7 seconds. The criteria for a medium-difficulty problem was that 12-30% of participants solved the item within 7 seconds. The criteria for a problem being hard was that less than 12% of participants solved the item within 7 seconds. They answered the problems by speaking aloud the solution word and their first answer was taken. If participants did not answer the problem correctly or did not answer at all, the computer moved on to the next problem after each 30 second interval. If they completed the problem before the 30 second interval, the researcher immediately advanced the computer to the next problem.

Alternative Uses Task. The Alternative Uses Task (AUT) was used to measure creativity in each participant (Guilford, 1967). Participants were asked to come up with as many creative uses for six everyday objects (eyeglasses, shoes, key, button, wooden pencil, automobile tire) as possible within one minute. Each object was presented as a word one at a time on a computer screen. The participant typed their answers on a keyboard into a word document and the computer moved on to the next object after one minute each. Three raters scored the responses for each object based on two criteria: how vivid were the uses generated and how difficult it was to generate the uses. Each rater gave each response a single score on a 5-point Likert scale (1 = *Not creative*, 5 = *Very creative*). If raters differed in the scores that they assigned, then the following procedures were followed. If there was agreement among two or more raters, that was the final score. If an average could easily be found (i.e., raters rating 3, 4, and 5 on an item), then the middle rating was taken (i.e., 4) for the final score. If there were wider disputes about ratings (i.e., raters rating 1, 2, and 5 on an item), then discussion ensued until an agreement was reached about the final score. The ratings for each object were summed to get a final score.

Cartoon Caption Task. The Cartoon Caption Task was also used to measure creativity in each participant (Chart et al., 2008). Participants were asked to look at five cartoon pictures (taken from The New Yorker Radio Hour, Eli Stein Cartoons, Modern Dog Magazine, and Monthly Prescribing Reference) individually on a computer screen and produce the most creative caption they could think of by typing their answer on a keyboard. Participants had one minute to think of a caption for each picture. Captions were rated by three raters for consistency on a 5-point Likert scale (1 = *Not creative*, 5 = *Very creative*). Creativity was rated based on cleverness, humor, originality, and task appropriateness. A composite score was formed by summing the individual ratings on each picture. If raters differed in the scores that they assigned, then a final score was reached using the following procedure. If there was agreement among two or more raters, that was the final score. If there were ratings where an average could easily be found (i.e., raters rating 3, 4, and 5 on an item), then the middle rating was taken (i.e., 4) for the final score. If there were wider disputes about ratings (i.e., raters rating 1, 2, and 5 on an item), then discussion ensued amongst raters until an agreement was reached about the final score.

Object Association Task. The Object Association Task (OAT) was used to measure analytical problem solving in each participant (Abraham et al., 2012) to investigate whether relationships between DRF and problem solving are specific to creative problem solving or if DRF is also related to other types of problem solving that involve less creative thinking. In this task, participants are typically asked to look at five different object cues (plus one practice cue, newspaper; sword, plant, lamp, computer, spatula) one at a time on a computer screen and type into a Microsoft Word document as many other objects typically associated with that object as possible within one minute for each object. However, due to experimenter error, participants were instead asked to type in as many other uses that they could think of within one minute for

each object. Due to this error, a reliable measure of analytical problem solving was not obtained and data from this modified OAT will not be used in subsequent analyses.

Statistical Analyses

A total divergent-thinking score was computed by converting raw scores from the Cartoon Caption Task and the AUT into z-scores and then calculating the average of the two z-scores, given the different scales employed by each measure. A total creative problem-solving score was computed by converting raw scores from the matchstick task and the CRAT into z-scores, again, owing to different scales, and then calculating the average of those two z-scores. Divergent-thinking scores and creative problem-solving scores were then compared between participants who completed the OAT first and participants who completed the OAT last to determine if task order influenced the results. Two multiple regressions were conducted to determine if any personality traits or DRF predicted performance on the divergent-thinking tasks or the creative problem-solving tasks. To determine if demographic or sleep quality co-variates should be entered into each regression, Pearson correlations were used to assess potential relationships between sleep quality (PSQI score), age, and each dependent measure and two one-way ANOVAs were conducted to assess the relationship between the demographic variables of gender and race for each of the two dependent variables (divergent thinking, creative problem solving), for a total of four ANOVAs. Neither divergent thinking nor creative problem solving differed based on any demographic factors or sleep quality, so those variables were not included in the corresponding multiple regression(s).

To determine if DRF or any of the Big 5 personality traits predict performance on any of the dependent measures, two simultaneous bootstrapped multiple regressions, using 1000 95th percentile bootstrap resamples, were conducted with the divergent-thinking score as the

dependent variable in one model and the creative problem-solving score as the dependent variable in the second model. The alpha level was set at 0.05.

This experiment was powered to test whether DRF and personality factors influence creativity. However, other dreaming measures were obtained for exploratory follow-up analyses. First, zero-order correlations were completed to determine if other questions about dreaming behaviors from the MADRE are related to DRF. If yes, this would suggest that other trait-like aspects of dreaming may also be associated with divergent thinking (Table 7). Second, one zero-order correlation and three one-way ANOVAs were completed to determine if the questions regarding recent dreaming were associated with DRF. If yes, this would suggest that state-like aspects of dreaming may also be associated with divergent thinking.

III. RESULTS

Demographics

Of the 76 individuals who completed the study, there were 9 males (11.8%), 65 females (85.5%), and 1 non-binary/third gender (1.3%) participant. Fifty participants were 18 years old (65.8%), 19 were 19 years old (25%), four were 20 years old (5.3%), one was 22 years old (1.3%), one was 25 years old (1.3%), and one was 28 years old (1.3%). Thirty participants were non-Hispanic White (39.5%), six were Black/African American (7.9%), 36 were Hispanic/Latino (47.4%), and four were multiracial (5.3%) (Table 1).

Table 1. Demographic Information.

Variable	%	*N*
Gender		
Male	11.8	9
Female	85.5	65
Non-binary/third gender	1.3	1
Age		
18	65.8	50
19	25	19
20	5.3	4
22+	3.9	3
Race/Ethnicity		
Black/African American	7.9	30
Non-Hispanic White	39.5	6
Hispanic/Latino	47.4	36
Multiracial/Biracial	5.3	4

Note. $N = 76$.

Sleep Quality

Sleep quality scores from the PSQI ranged from 0-20 with an average score of 8.38 ($SD = 4.04$), indicating relatively poor overall sleep quality in the current sample.

Task Performance

Mean performance on each of the tasks can be found in Table 2. The matchstick task scores (Figure 2) and the CRAT scores (Figure 3) were converted to *z*-scores and averaged to

create a creative problem-solving score and the Cartoon Caption Task scores (Figure 4) and AUT scores (Figure 5) were converted to *z*-scores and averaged to create a divergent-thinking score.

Table 2. Descriptive Information for DRF, Personality Factors, Creativity Measures, and Analytical Problem Solving

Variable	*M*	*SD*
DRF	4.61	1.46
Neuroticism	12.16	2.95
Openness	14.75	2.93
Extraversion	12.75	2.57
Agreeableness	16.17	2.24
Conscientiousness	14.66	3.48
Matchstick Task	1.89	1.01
CRAT	7.76	2.57
Cartoon Caption Task	10.06	2.84
AUT	16.39	5.04
OAT	23.74	8.62

Note. $N = 76$. CRAT = Compound Remote Associates Test. AUT = Alternative Uses Task. OAT = Object Association Task.

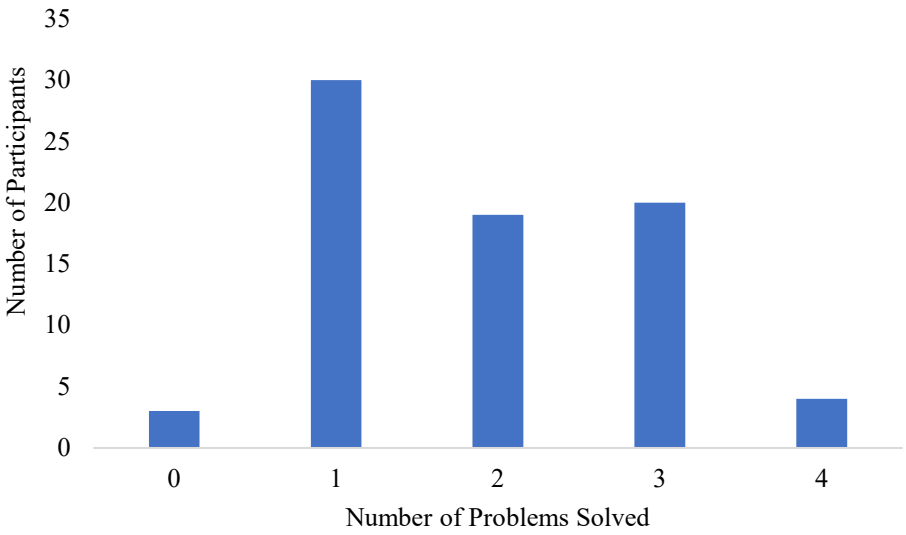

Figure 2. Distribution of scores for the matchstick task.

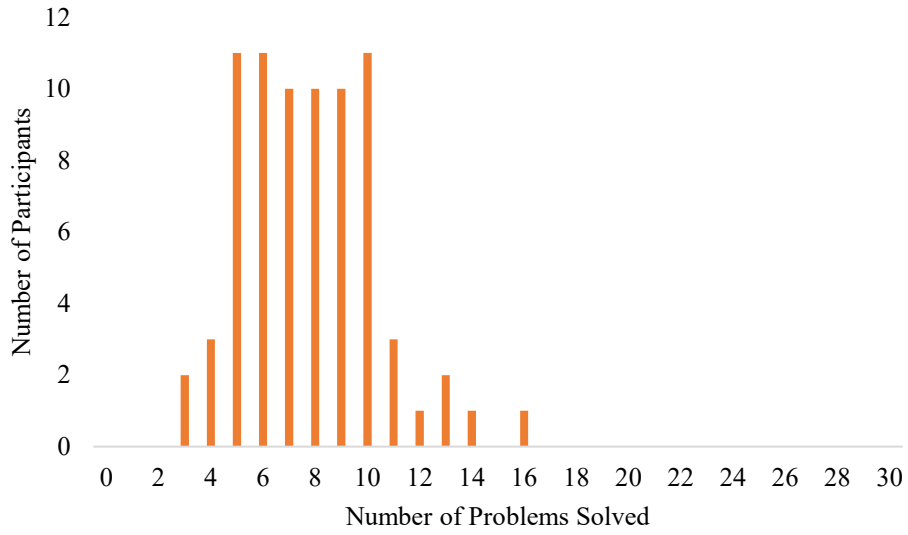

Figure 3. Distribution of scores for the Compound Remote Associates Test (CRAT).

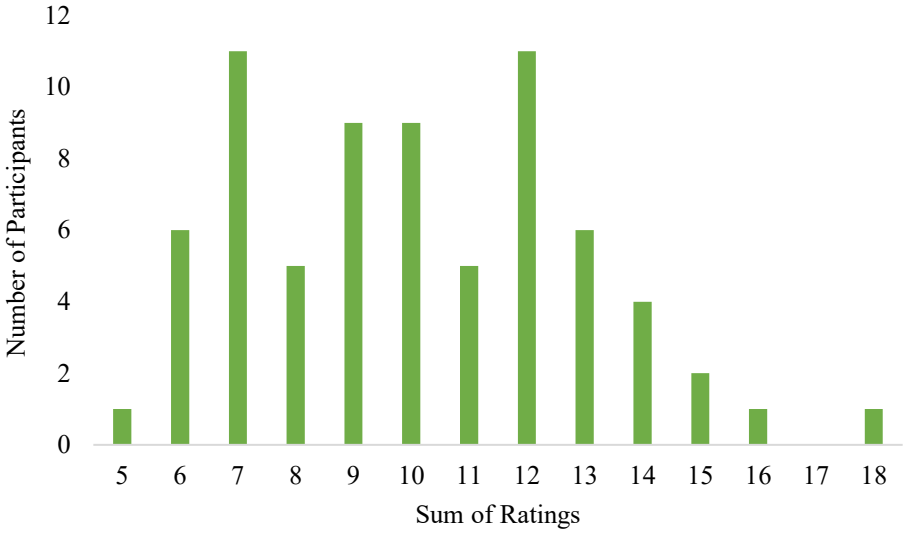

Figure 4. Distribution of scores for the Cartoon Caption Task.

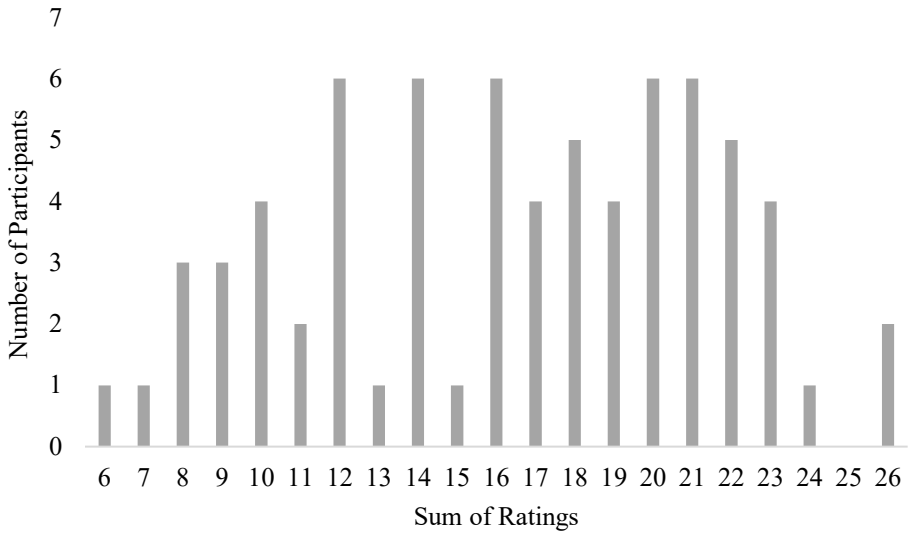

Figure 5. Distribution of scores for the Alternative Uses Task (AUT).

Task Order

Two independent samples *t*-tests were conducted to compare divergent-thinking scores and creative problem-solving scores between participants who took the OAT first and participants who took the OAT last. There was not a significant difference between the divergent-thinking scores for participants who took the OAT last (M = -.14, SD = .76) and those who took it first (M = .22, SD = .83), $t(67)$ = -1.88, p = .065. There was also no difference in creative problem-solving scores for participants who took the OAT last (M = -.15, SD = .66) and those who took the OAT first (M = .15, SD = .94), $t(74)$ = -1.61, p = .112.

Demographic Predictors

Two one-way ANOVAs were conducted with divergent thinking as the dependent variable and gender or race as the independent variable. The ANOVA with race as the independent variable only included the four groups specified in Table 1 since the other groups did not have any participants and the ANOVA with gender did not include the gender level of non-binary/third gender due to small cell size (n = 1). There was not a significant effect of

gender (male, female) on divergent thinking, $F(3, 65) = .69$, $p = .559$. There also was not a significant effect of race (Asian/Pacific Islander, Black/African American, Hispanic/Latino, Native American/Alaskan Native, Multiracial/Biracial, Non-Hispanic White, Other) on divergent thinking, $F(3, 65) = 2.37$, $p = .079$. Also, Pearson's correlations indicated that age was not associated with divergent thinking, $r = .144$, $p = .327$, nor were PSQI scores associated with divergent thinking, $r = -.140$, $p = .253$.

Two one-way ANOVAs were conducted with creative problem solving as the dependent variable and gender or race as the independent variable. The ANOVA with race as the independent variable only included the four groups specified in Table 1 since the other groups did not have any participants and the ANOVA with gender did not include the gender level of non-binary/third gender due to small cell size ($n = 1$). There was not a significant effect of gender on creative problem solving, $F(3, 72) = 1.10$, $p = .356$. There also was not a significant effect of race on creative problem solving, $F(3, 72) = 2.39$, $p = .076$. Also, Pearson's correlations indicated that age was not associated with divergent thinking, $r = .133$, $p = .252$, nor were PSQI scores associated with creative problem solving, $r = -.016$, $p = .893$.

Multivariate Analyses

The first multiple linear regression model assessed predictors of divergent thinking and included DRF and the five personality measures as predictor variables (Table 3). The model was not significant but was approaching significance, $F(6, 62) = 2.04$, $p = .074$, $R^2 = .17$. In addition, higher DRF ($\beta = .253$) and higher levels of openness ($\beta = .252$) were associated with higher divergent-thinking scores (Table 4).

Table 3. Correlation Coefficients (*r*) Between DRF, Personality Factors, Creativity Measures, and Analytical Problem Solving

Variable	1	2	3	4	5	6	7	8	9
1 DRF	-								
2 Neuroticism	.030	-							
3 Openness	.154	-.051	-						
4 Extraversion	.190	.077	.075	-					
5 Agreeableness	.212	.089	.318**	.114	-				
6 Conscientiousness	-.077	.148	.113	.005	.206	-			
7 Creative Problem Solving	.027	-.125	.187	-.062	.088	-.066	-		
8 Divergent Thinking	.309**	-.002	.302*	.058	.161	-.046	.254*	-	
9 Analytical Problem Solving	.206	-.004	.186	-.133	.081	-.142	.248*	.449**	-

Note. DRF = Dream Recall Frequency. * = $p < .05$, ** = $p < .01$.

Table 4. Results of Simultaneous Multiple Regression Analysis with Divergent Thinking as the Dependent Measure

Variable	*B*	*SE*	*p*	95% CI
DRF	.14	.07	.041	[.01, .27]
Neuroticism	.00	.03	.920	[-.06, .07]
Openness	.07	.03	.047	[.00, .14]
Extraversion	-.00	.04	.916	[-.08, .07]
Agreeableness	.02	.05	.704	[-.07, .11]
Conscientiousness	-.02	.03	.543	[-.07, .04]

Note. DRF = Dream Recall Frequency.

The second multiple linear regression model assessed predictors of creative problem solving and included DRF and the five personality measures as predictor variables. The model was not significant, $F(6, 69) = .76$, $p = .607$. No predictor variables were significantly associated with creative problem solving (Table 5). One possible reason for the lack of significance in this model may be that several participants got all the easy problems correct, resulting in little variance in the sample. Therefore, CRAT scores were computed for only the medium and hard problems (20 problems) for each participant, converted to *z*-scores, and averaged with the *z*-score from the matchstick task for each participant to generate a new creative problem-solving score

with increased variance across participants and another regression analysis was performed. The model was not significant, $F(6, 69) = .92$, $p = .483$. In addition, no predictor variables were significantly associated with creative problem solving (Table 6), indicating that the inclusion of easy CRAT problems in the analysis cannot account for the lack of significant findings.

Table 5. Results of Simultaneous Multiple Regression Analysis with Creative Problem Solving as the Dependent Measure

Variable	*B*	*SE*	*p*	95% CI
DRF	-.00	.07	.978	[-.14, .14]
Neuroticism	-.03	.03	.386	[-.10, .04]
Openness	.05	.04	.164	[-.02, .12]
Extraversion	-.02	.04	.539	[-.10, .05]
Agreeableness	.03	.05	.596	[-.07, .12]
Conscientiousness	-.02	.03	.493	[-.08, .04]

Note. DRF = Dream Recall Frequency.

Table 6. Results of Simultaneous Multiple Regression Analysis with Creative Problem Solving as the Dependent Measure when only Medium and Hard CRAT Problems Were Included in Creative-Problem Score

Variable	*B*	*SE*	*p*	95% CI
DRF	-.02	.07	.744	[-.16, .11]
Neuroticism	-.05	.03	.174	[-.11, .02]
Openness	.05	.04	.153	[-.02, .12]
Extraversion	.02	.04	.663	[-.06, .09]
Agreeableness	.01	.05	.797	[-.08, .11]
Conscientiousness	-.02	.03	.440	[-.08, .04]

Note. DRF = Dream Recall Frequency.

Exploratory Analyses

Zero-order correlations between responses to questions about other dreaming behaviors from the MADRE and DRF revealed that the majority of responses showed significant associations with DRF. Dream intensity, nightmare frequency, childhood nightmares, attitude towards dreams, sharing dreams, getting creative ideas from dreams, and using dreams to help identify and solve problems all were positively associated with DRF (Table 7). Nightmare relatability was negatively associated with DRF.

Table 7. Correlation Coefficients Between DRF and other Dreaming Behaviors

Dreaming Behavior	*r*	*p*
Dream Intensity**	.390	<.001
Emotional Tone of Dreams	-.021	.858
Nightmare Frequency**	.489	<.001
Nightmare Disturbance	.144	.226
Nightmare Relatability*	-.245	.033
Childhood Nightmares*	.288	.012
Attitude of Dreams**	.324	.004
Sharing of Dreams**	.682	<.001
Recording of Dreams	.179	.122
Dreams Affecting Mood	.219	.057
Creative Dreams**	.298	.009
Dream Problem Solving**	.307	.007

Note. DRF = Dream Recall Frequency. * = $p < .05$, ** = $p < .01$.

A one-way ANOVA was conducted with DRF as the dependent variable and the response to the question "Did you dream last night?" (Yes, No, I can't remember) as the independent variable. There was a significant main effect of response on DRF, $F(2, 73) = 12.95$, $p < .001$, $\eta_p^2 = .26$. Post-hoc parameter estimates indicated that participants that responded "yes" had higher DRF than participants that responded "no", $p < .001$, and than participants that responded "I can't remember", $p = .008$. A second one-way ANOVA was conducted with DRF as the dependent variable and the response to the question "Within the last week, have any of your dreams helped you identify and solve your problems?" (Yes, No) as the independent variable. There was not a significant effect of the response on DRF, $F(1, 74) = .27$, $p = .605$. The other two recent dreaming questions were contingent on if participants responded "yes" to dreaming last night. Thirty-one participants responded "yes," so only they were included in the following zero-order correlation and one-way ANOVA. A zero-order correlation between DRF and the response to the question "What was the emotional tone of your dream last night?" (Very negative, Somewhat negative, Neutral, Somewhat positive, Very positive) revealed that responses was not significantly correlated with DRF, $r = -.169$, $p = .362$. A one-way ANOVA

was conducted with DRF as the dependent variable and the response to the question “Was the content of your dreams consistent with your typical dream content?” (Yes, No) as the independent variable. There was not a significant effect of the response on DRF, $F(1, 29) = 1.32$, $p = .260$.

IV. DISCUSSION

The goal of this thesis was to determine whether DRF or any of the Big 5 personality traits predict divergent thinking and creative problem-solving ability. Univariate analyses revealed that there were no differences in performance on divergent-thinking or creative problem-solving tasks based on gender, age, race, or sleep quality. Although our sample overall had poor sleep quality, unfortunately this is typical for college students (e.g., Li et al., 2020). Supporting the hypothesis that dreaming and personality may influence creativity, both DRF and openness positively predicted divergent-thinking scores. Although the overall regression model did not quite reach significance, the presence of these relationships suggests that both DRF and openness can account for variability within divergent-thinking performance. However, neither DRF nor any personality traits were associated with creative problem solving. Collectively, these results indicate that both dreaming and personality can influence creativity.

Consistent with current theories suggesting that new associations and novel insights are created during dreaming (Hobson & McCarley, 1977; Zadra & Stickgold, 2022), this study demonstrated that frequently recalling dreams was associated with increased divergent thinking. According to the BiOta model, the neurobiological conditions present during REM sleep, including de-synchrony between the hippocampus and the neocortex and high levels of neuroplasticity, can lead to the discovery of novel or distant and underexplored associations, resulting in an increase in creativity during waking (Lewis et al., 2018). In the current study, it is impossible to know if participants' reports of DRF were based on dreaming during REM or dreaming during other sleep stages. However, given that most typical dreams occur during REM, the present results appear to provide additional support for this model.

Similarly, both the activation-synthesis hypothesis (Hobson & McCarley, 1977) and the NEXTUP theory (Zadra & Stickgold, 2022) also predict that dreaming may promote divergent thinking, although the current results cannot differentiate between the two models. According to the activation-synthesis hypothesis, novel connections are formed as the frontal lobe creates a storyline from random activity of neurons in the cortex during REM sleep, which could increase divergent thinking during waking. The NEXTUP theory would argue that more frequent dreaming leads to greater awareness of previously unexplored, weak associations that could benefit divergent thinking.

The personality dimension of openness to experience measures how willing an individual is to try new things and take risks. In the current study, openness was positively associated with divergent thinking in the regression model. Previous studies have found a relationship between openness and creativity (Feist, 1998; Schredl & Erlacher, 2007; Tan et al., 2016). Tan and colleagues (2016) suggested that the relationship between openness and creativity could be due to highly open participants having higher intrinsic motivation that motivates them to engage in creative tasks and creative thinking in their everyday life. By engaging in creative thinking more often due to this intrinsic motivation, it is possible that participants that are high in openness could perform better in divergent-thinking tasks.

Frequently recalling dreams did not increase the ability to creatively solve problems, despite previous evidence pointing to such a relationship (Schredl & Erlacher, 2007; Schredl & Göritz, 2017; Barrett, 2017). However, other studies have failed to find relationships between sleep and creative problem solving, although dreaming was not measured in these studies (Brodt et al., 2018; Landmann et al., 2016; Schönauer et al., 2018). One reason no relationship between DRF and creative problem solving was found in the current study may be that participants used

an analytical strategy to solve the matchstick and CRAT problems instead of experiencing an insightful "Aha!" moment that leads to the correct solution, as suggested by Sio et al. (2012). Unfortunately, the current participants were not asked to report the strategy they used in the creative problem-solving tasks, but if participants did not experience insightful moments when coming up with solutions to problems, it could be argued that the tasks used in the current study failed to measure creative problem-solving ability. Similar arguments could be used to explain why no personality traits had a relationship with creative problem-solving either. Another possibility is that participants in the current study did not rely on insight to solve problems because they were not motivated to perform well, given that participants performed rather poorly, solving less than 50% of the problems in both creative problem-solving tasks. Participants from Danek and colleagues (2016) found that 82.2% of participants solved a Type B problem on the matchstick task, whereas in the current study, only 51.3% of participants solved the Type B problem. Also, in an experiment using a similar version of the CRAT, participants solved 42% of problems on average, whereas in the current study, participants only solved 26.67% of problems on average (Chein & Weisberg, 2014).

The exploratory analyses showed that DRF was highly correlated with scores from the majority of the other dreaming measures from the MADRE, which asks participants to report on their trait-like dreaming behaviors, by asking them to think about their dreams over the past several months. Because DRF was highly correlated with other trait-like dreaming behaviors, it could suggest that multiple aspects of an individual's dreaming behaviors could predict creativity. Dream intensity, nightmare frequency, childhood nightmares, attitude towards dreams, sharing of dreams, creative dreams, and dream problem solving are all dreaming measures that may also be related to creativity. DRF also was significantly higher for participants that had

dreamt the previous night. However, DRF did not significantly predict responses to other questions about recent dreaming (within the past week or the previous night). Overall, this indicates that dreaming behaviors across time (i.e., trait-like dreaming behaviors) may be more predictive of divergent-thinking ability than state-specific dreams or dreaming behaviors that take place just prior to the measurement of divergent thinking, although future research is necessary to test this possibility.

This study has both strengths and limitations. First, a strength is that this is one of the first studies to look at the relationship between dreams, personality, and creativity by measuring creative ability through tasks completed in the lab rather than with subjective surveys of creativity. Seventy-six participants were a part of this sample, which is large for an in-person study, but it is not large enough to do a mediation analysis, which would allow causal relationships between the three variables of interest (DRF, personality traits, divergent thinking) to be explored. Another limitation of this study was that data from the analytical problem-solving task could not be analyzed due to an administrative error regarding the instructions given to participants about the OAT. Future studies in this area should include a corrected OAT or analytical problem-solving task to adequately compare creative problem-solving with non-creative problem solving. Another limitation of this study was that the current sample only included undergraduate students. While this age group represents a population of interest, this limits generalizability to other age groups. We also had an uneven distribution based on gender, with females overwhelmingly representing our sample (85.5% of participants). Finally, since the data on dreaming behaviors were collected through self-report, the results may differ from objective dream data collected through other methods, such as waking individuals from REM

sleep and asking them to report their dreams (Ribeiro et al., 2018). Future studies in this area would benefit by using more diverse populations and methodologies.

Collectively, these results suggest that frequent dreaming can promote divergent thinking and that individuals high in openness show better divergent-thinking skills than those low in this dimension. These results support current theories that suggest that REM sleep and dreaming promote the discovery and exploration of novel connections in the mind that stimulate divergent thinking during waking (Lewis et al., 2018; Zadra & Stickgold, 2022). Furthermore, these results may have practical applications for improving divergent thinking. Improving dream recall and openness could help improve creativity, which would be useful in many aspects of everyday life.

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