EXPLORING ATTENTIONAL CONTROL AS A MEDIATOR BETWEEN LUCID DREAMING ABILITY AND COGNITIVE FLEXIBILITY

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Abstract : This experiment explored the cognitive mechanisms underlying the association between lucid dreaming capability and waking cognitive flexibility by positing attentional control as a central mediator. In a cross-sectional survey, 161 university students filled out the Lucidity and Consciousness in Dreams (LuCiD) scale, the Cognitive Flexibility Inventory (CFI), and Attentional Blink (AB) test. Mediation analysis assessed hypothesized relationships between the measures. Results verified a significant positive connection between lucid dreaming and cognitive flexibility in favour of the hypothesis that increased dream awareness corresponds to greater adaptive functioning. No support for the central mediation hypothesis emerged. Attentional control by the AB test proved not significantly related to either lucid dreaming or cognitive flexibility and failed to moderate their connection. The analysis provided a vote of confidence in a direct-only impact from lucid dreaming to cognitive flexibility. The results indicate the relationship between these two states of consciousness is not accounted for by low-level temporal attention but is most likely fuelled by shared higher-order metacognitive operations, such as a monitoring of reality and self-monitoring. This clarifies the cognitive architecture of consciousness by favouring a framework of a higher-order executive level between dream and wakefulness. Limitations include reliance on self-report measures, the narrow operationalization of attentional control, and a predominantly female student sample, which limit generalizability and causal inference. Future research should incorporate diverse behavioural tasks, longitudinal or experimental designs, and neurocognitive measures to explore alternative mediators and underlying neural mechanisms. Overall, this study contributes to the growing evidence that lucid dreaming reflects higher-order cognitive and metacognitive capacities rather than mere variations in attentional control.

Index Terms - Lucid Dreaming, Cognitive Flexibility, Attentional Control, Attentional Blink, Mediation, Executive Functions.

I INTRODUCTION

1.1 Lucid Dreaming

Lucid dreaming has long intrigued both scientists and non-experts, and a clear definition remains elusive. At its most basic, a lucid dream involves explicit knowledge that one is actively dreaming while the dream is in progress (Voss, Holzmann, Tuin, & Hobson, 2009). Whereas the usual, non-lucid dream, with its largely associative cognitive processing and frequently non-critical sequencing, includes reflective consciousness to some extent, lucid dreams engage reflective consciousness to at least some extent (LaBerge, 1985). Most importantly, lucidity typically allows a sense of control: the dreamer can voluntarily control the dream scene, set objectives, or work toward personal goals within the dream storyline. Clarity of mind, though variable, distinguishes the lucid dream from the usual one, which typically never challenges fragmented or illogical sequences of event (Stumbrys, Erlacher, & Schredl, 2013). Lucid dreaming thus constitutes a hybrid state of cognition, wherein awareness, memory retrieval, volitional control, and executive function come together in the extraordinary stage of the sleeping mind (Stumbrys, Erlacher, & Schredl, 2013). Lucidity is rarely, if ever, an either-or condition. Most contemporary researchers conceptualize it on a continuum, ranging from fleeting, barely noticeable awarenesses of the dream state to totally stable, agentic lucidity (Voss et al., 2013). Low-level lucidity might be a fleeting awareness of something's feeling odd, without calling up deliberate control. High-level lucidity, by contrast, encompasses deliberate action, goal-setting, and higher-level metacognition in the dream. And, oddly, pre-lucid dreams, intermediate phenomena, usually entail challenging reality or spotting inconsistencies without achieving the level of awareness necessary for full blown lucidity (Blagrove & Hartnell, 2000). Comprehending this continuum is key: it frees research from either-or categorization and allows for more nuanced investigation of cognition supporting dream awareness.

In order to obtain conceptual distinctness, it will first be important to distinguish lucid dreams from other sleep experiences. Vivid dreams, for example, may contain realistic content of the senses but lack the self-consciousness at the heart of lucidity (Schredl, 2010). False awakenings involve the delusory belief of waking up while still in a dream, which may at times concurrently occur but is not the same thing as lucidity (LaBerge, 1985). Sleep paralysis is another closely related but distinct state; the individual is consciously wakeful but for an instant cannot awaken, typically accompanied by hallucinatory visual content (Sharpless & Barber, 2011). Out-of-body experiences, while phenomenologically so tempting, these typically occur at the cusp of wake and sleep and not in REM sleep proper (Alvarado, 2000). By thus drawing these demarcations, researchers may better isolate lucidity as a distinct entity at the level of cognition and neurophysiology.

Lucid dreaming is anything but new; written accounts suggest humankind long ago was fascinated by the experience. Aristotle, no later than the 4th century BCE, noticed the possibility of consciousness of dreaming while in the dream state, observing on the mind's ability to “recognize that it is dreaming” (Aristotle, trans. 1984). Centuries later, practices such as Tibetan Dream Yoga developed protocols for training awareness of dreams, emphasizing mindfulness and intentional-ness (Thurman, 1998). Systematic interest in the West, however, took longer to gain ground. Early 20th-century psychologist Frederik van Eeden, in awe of dreams he himself had, coined the term “lucid dream” and documented dreams in which he was aware and had intentional control (van Eeden, 1913). These accounts, though anecdotal in large part, provided the groundwork for empirical exploration by situating lucidity in a conceptual framework of a definable, observable state, rather than a mysterious apparition of sorts.

Lucid dreaming was provided with a major impetus through the establishment of objective verification procedures. Keith Hearne's pioneering work in 1975 was the initial lab demonstration of the phenomenon, and he utilized pre-agreed signs of eye movements to indicate awareness in REM sleep (Hearne, 1978). Participants learned to make a specific sign—usually left-right-left-right eye movements—when recognizing that they were dream-ing, and this would then be captured in parallel with polysomnographic recording for verification of their REM status. Stephen LaBerge then developed and enhanced this method in the 1980s, generating sound evidence which demonstrated that lucid dreaming was not hallucinatory or anecdotal, but a realisable state of awareness (LaBerge, 1980; LaBerge, 1985). All of these advances relied on the development of eye-sign method: for the first time, dream experiences at the phenomenal level were time-locked against objective physiological measures, bridging the gap between phenomenology and neurobiology.

Lucid dreaming occupies the middle ground between the extremes of consciousness, sharing features of REM sleep and wakefulness (Voss et al., 2009). While in normative REM sleep, the prefrontal cortex is less active, there is evidence of parts of the mind involved in self-reflective cognition, volitional planning, and metacognition, which become reactivated within lucid dreams (Dresler et al., 2012). It is this middle ground, then, through which dreamers may simultaneously maintain critical awareness of the dream and engage in the dream environment's fluid, often surreal world.

Re-awakening of the Executive Self One of the hallmarks of lucid dreaming is the activity of the dorsolateral prefrontal cortex (dlPFC), frontopolar cortex, and inferior parietal lobules—the parts of the brain generally inactive in non-lucid REM (Holzinger et al., 2006). These parts underlie executive processes such as working memory, self-monitoring, and intentional behaviour. Neuroimaging studies commonly indicate heightened frontal activity at the moment of lucid instances, and the dreamer’s capacity for voluntary control is, therefore, hypothesized as related to the re-activation of these cortical networks (Baird et al., 2019).

You can learn to lucid dream by practicing specific skills, these are mental exercises, not spells. The method for having clear dreams, called Mnemonic Induction of Lucid Dreams, uses your ability to remember future tasks. It works by asking people to think about dreams, notice things that tell them they are dreaming, then use those things to become aware they are in a dream. Checking if you’re awake now, regularly, helps you think about your thinking. It builds a practice of wondering if things are real, as research shows (Stumbrys et al., 2012). The Wake-Back-to-Bed technique breaks up your sleep, so your brain becomes more active during dreams. This makes it more likely you'll realize you are dreaming while it's happening. These methods show that clear dreaming uses your thinking abilities, it's practice with focus, recall, intention, not just luck.

Many people dream lucidly, estimates show roughly 20 to 55 percent of adults have had at least one dream where they knew they were dreaming (Schredl & Erlacher, 2004). How often this happens differs from person to person. Age plays a role, with young adults experiencing it more often. Someone's personality matters too, specifically how curious they are, how much they enjoy thinking, or how much they believe they control their own destiny (Blagrove et al., 2010). This research indicates that being aware you are dreaming probably connects to general thinking styles, personal qualities, instead of just being a thing that happens during sleep.

1.2. The Theoretical Nexus of Lucidity, Flexibility, and Attention

Dreaming while aware you are dreaming is not just interesting. It shows you can actively think, decide, control things happening in your dream. Thinking about your thinking, making choices intentionally, controlling your focus, these things work together to show that being aware seems like using your brain's management skills when your mind is free to wander (Voss et al., 2009). When you become aware you are dreaming, several things happen at once. You notice something is off, remember how things are when you are awake, then shift your focus. This complex process resembles how your brain functions when you are awake, managing your thoughts, actions, decisions. Staying aware requires constant checking, changing, much like being adaptable, focusing when you are awake (Baird et al., 2019). Clear dreaming shows how our minds work, acting like a special, unreal stage.

Moving from regular dreams to dreams where you know you are dreaming feels like a big change in how your mind works. When we dream, our minds shift from making free connections to thinking things over with a purpose. This change demands we react quickly, also think creatively, adapting to whatever happens (Blagrove & Hartnell, 2000). Dreaming lets you adjust to strange, unexpected happenings. It also helps you come up with new ways to act, or find answers to problems, within the dream itself. When you decide to fly in a dream, talk to people you meet there, or change the surroundings, it shows your brain is working in creative ways. The similarity between how easily we adjust when awake, versus feeling in control within dreams, indicates lucid dreaming could be a useful tool. Researchers can use it to study how our thinking adapts when we face new situations (Mota-Rolim et al., 2019).

Attentional control is arguably the foundational pillar for both achieving and maintaining lucid dreams (LaBerge, 1985). Detecting a dream anomaly—a misplaced object, a floating building, or an impossible narrative sequence—requires selective attention and conflict monitoring, akin to vigilance tasks performed in waking life (Dresler et al., 2012). Maintaining lucidity, however, is not a passive feat; it demands sustained attention to one's cognitive state, filtering out distractions embedded within the vivid, emotionally charged dream narrative (Holzinger et al., 2006). Executive attention further supports the execution of intentions within the dream, allowing the dreamer to act upon goals, inhibit habitual responses, and manipulate the dream environment effectively. Without these attentional capacities, lucidity is fleeting, often collapsing into ordinary REM dreaming.

1.3 Cognitive Flexibility

Cognitive flexibility, at times considered a core component of executive function, refers to the ability to change thinking and action under different demands, rules, or environmental contingencies (Scott, 1962; Diamond, 2013). It enables an individual to deselect previously relevant mental sets and create new ones, thereby helping in solving problems, creativity, and adaptive behavior under changing situations. Flexibility, in contrast to rigid styles of cognition, is the earmark of the ability to change strategies, shift attention, and accommodate new perspective views. Current research positions cognitive flexibility, especially, not only as a cognitive ability but also a key predictor of academic achievement, mental health, and social behavior (Ionescu, 2012; Zelazo, 2020).

1.3.1. Theories on Cognitive flexibility

1.3.1.1 Cognitive Flexibility Theory (Spiro et al., 1987). Cognitive Flexibility Theory (CFT) was developed to explain how individuals navigate *ill-structured domains*, where problems are complex, context-dependent, and resistant to rote solutions.

Spiro et al. (1988) emphasized that "knowledge must be represented in multiple, interconnected ways to support adaptive transfer," highlighting that flexible thinkers can reorganize prior knowledge to meet novel demands. This ability allows individuals to approach problems from multiple perspectives, adjust strategies, and respond effectively to dynamic contexts. CFT underscores that learning requires revisiting concepts across different contexts, described as "crisscrossing conceptual landscapes" (Spiro et al., 1992). Thus, cognitive flexibility is not merely about switching tasks but involves adaptive knowledge representation, transfer across novel situations, and creative problem-solving. In both education and broader cognition, CFT provides a framework for understanding how flexible thought supports adaptive reasoning, creativity, and the ability to handle uncertainty.

1.3.1.2 Dual Mechanisms of Control Theory (Braver, 2012). The Dual Mechanisms of Control (DMC) theory distinguishes between proactive and reactive modes of cognitive control. Proactive control involves sustained, anticipatory maintenance of goals, whereas reactive control is "just-in-time engagement triggered by environmental demands" (Braver, 2012). Cognitive flexibility relies heavily on reactive control to shift mental sets when rules or cues change unexpectedly, but proactive control is also essential for maintaining multiple potential task rules and preparing for future shifts. This balance enables adaptive cognition, where flexibility is the emergent outcome of dynamically regulating stability and adaptability. Neuroimaging studies support this framework: proactive control engages sustained prefrontal activation, while reactive control involves transient bursts in regions such as the anterior cingulate cortex (ACC) and lateral prefrontal cortex. Therefore, cognitive flexibility, under DMC theory, is both context-dependent and temporally dynamic, facilitating rapid adaptation and the efficient reconfiguration of task sets.

1.3.1.3 Developmental Theories of Cognitive Flexibility. Developmental theories highlight that cognitive flexibility emerges gradually with age and the maturation of executive functions. Piaget (1952) observed that young children "perseverate on one aspect of a problem," reflecting early rigidity due to egocentrism. Zelazo and Frye's (1997) Cognitive Complexity and Control (CCC) theory explains that flexibility develops as children acquire the capacity to embed rules hierarchically, enabling them to switch tasks effectively; for example, older children can alternate sorting dimensions in the Dimensional Change Card Sort task while younger children struggle. Neurodevelopmental evidence indicates that the maturation of the prefrontal cortex and its connections with parietal and subcortical regions underpins these improvements (Best & Miller, 2010). Overall, developmental perspectives frame cognitive flexibility as an emergent property of growing executive control, rule representation, and neural maturation, highlighting a progression from rigid, perseverative behaviour to adaptive, context-sensitive cognition.

Cognitive flexibility is a resultant of an interplay between developmental, neurological, psychological, and environmental forces. Age is of overriding importance, and marked improvements in flexibility happen in childhood and adolescence with maturation of prefrontal cortical circuits (Best & Miller, 2010). Neurological disorders, head trauma, schizophrenia, and Parkinson's disease almost always detract from flexibility, reflected in dysfunctions of fronto-striatal networks (Ravizza & Carter, 2008). Psychological problems, anxiety, and depression exhibit low levels of flexibility, perhaps through over-activation of limbic circuits (Gabrys et al., 2018). From the environment, bilingualism, enriched education, and exposure to new tasks have been demonstrated to lead to augmented levels of flexibility (Bialystok, 2015). Cognitive flexibility, then, is not an entity but persists throughout the life course under the aegis of vulnerabilities and protective forces

Recent studies have begun examining associations between dreams and cognitive flexibility, particularly between dreams and lucid dreams. Lucid dreamers typically display superior metacognitive awareness and attentional control, both of which converge on cognitive flexibility (Baird et al., 2019). Moreover, non-ordinary consciousnesses, such as mindfulness meditation, hypnosis, and psychedelic states, tend to enhance flexible thinking, suggesting shared neural substrates between waking and dream flexibility (Carhart-Harris & Friston, 2019). Such interconnections elucidate the importance of examining cognitive flexibility not only in waking executive function but equally within general consciousness research.

1.4. Attentional Control

While cognitive flexibility provides the mechanism of getting into the lucid state, attentional control provides the mechanism by which the state is evoked and sustained. Attentional control is a higher-level executive function and denotes the capacity to deliberately control allocation of cognitive resources toward information pertinent to the goal while simultaneously inhibiting distractions. It's the gateway through which information is chosen for intensive, conscious processing.

1.4.1 Types of Attention

From sustained attention to executive control attention is not a unitary but rather a group of connected operations supported by several, though intermingling, neural systems. Core components include:

1.4.1.1 Sustained Attention. It is the ability to maintain attention over a long-time interval on a given stimulus or task. It underlies vigilance and concentration.

1.4.1.2 Selective Attention. It refers to the ability to selectively receive a given stimulus or channel of information while actively suppressing rival, irrelevant stimuli. It is the mechanism that allows you to listen to one talker amidst a crowded room.

1.4.1.3Divided Attention. Capacity for processing and responding simultaneously to a series of tasks or stimuli. Even though the term multitasking is frequently used, parallel processing happens relatively seldom; instead, there is fast switching between tasks.

1.4.1.4 Executive Attention (or Executive Control). It is the top level of control of attention, and it plays a role in planning and decision-making and, most significantly, resolving rivalry between conflicting responses (e.g., naming the color of ink instead of reading the word in the Stroop task). It regulates the other attentional processes in the performance of complex, goal-related behavior.

1.4.2 The Dorsal Attention Network (DAN).

Operating in tandem, this right-bilateral network, of whose large nodes are in the intraparietal sulcus (IPS) and frontal eye fields (FEF), plays a role in top-down, goal-focused attention. It's called into action when we ourselves voluntarily shift attention to a place or characteristic, by our current intentions (e.g., scanning for a friend at a party).

1.4.3 The Ventral Attention Network (VAN).

Lateralized strongly right and including the temporoparietal junction (TPJ) and ventral frontal cortex (VFC), this network is a bottom-up, stimulus-driven "circuit breaker". It does not maintain attention but is committed to the detection of salient, surprising, or behaviorally significant stimuli presented outside the current attentional focus. Upon identification of such a stimulus, the VAN breaks the ongoing top-down control, provided by the DAN, and attention can shift rapidly.

Interactions between the DAN and VAN, which are active, allow for flexible responses to large-scale transformations of the environment and firm goal-orientation of behavior.

1.4.4 The Attentional Blink Paradigm

AB always involves a method called Rapid Serial Visual Presentation (RSVP). When a person does an RSVP task, a series of items (e.g., letters, digits, or pictures) are presented in the same physical location extremely rapidly, typically 10-12 items per second (i.e., each item for only 80-100 ms). Two targets among this fast stream of distractors must be identified by the subject. AB paradigm's major discovery is a serious deficiency of conscious awareness. If a person correctly recognizes the first target (T1), he/she is drastically bad at recognizing or detecting the second target (T2) if T2 falls within a critical time interval of approximately 200-500 ms after T1 presentation. It's if the attention system "blinks" and becomes temporarily blind to subsequent relevant information. It's not a consequence of masking at the sensor level, though, since control conditions under which participants' instructions involve the ignoring of T1 show no such loss for T2. AB instead reveals a central processing bottleneck: selecting, recognizing, and registering T1 into a permanent structure of work memory takes limited resources of attention, and there's a consequent refractory time period during which these resources cannot be utilized to process T2.

II NEED OF THE STUDY.

Despite increasing empirical interest, the cognitive architecture underlying lucid dreaming remains insufficiently delineated. Current theoretical models position lucid dreaming as a hybrid state involving reactivation of prefrontal executive networks and metacognitive monitoring processes. Concurrently, cognitive flexibility is conceptualized as a higher-order executive function dependent on adaptive set-shifting, evaluative restructuring, and the efficient integration of contextual cues. The putative role of attentional control—as a foundational mechanism supporting both metacognition and flexible cognition—has been suggested but inadequately tested within unified empirical frameworks. Existing literature frequently examines these constructs in isolation, with substantial methodological heterogeneity across studies. Few investigations employ robust behavioural indices of attentional control, such as the Attentional Blink paradigm, alongside validated psychometric tools for lucidity and cognitive flexibility. Moreover, findings regarding the attentional correlates of lucid dreaming are inconsistent, partly due to reliance on self-report attention measures or insufficiently powered samples. Given these gaps, a systematic analysis of whether attentional control mediates the relationship between lucid dreaming ability and cognitive flexibility is warranted. Clarifying this mechanism has theoretical significance for models of consciousness and executive function, and applied relevance for understanding how metacognitive awareness during dreaming may reflect broader cognitive adaptability in waking life.

III RESEARCH METHODOLOGY

The methodology section outline the plan and method that how the study is conducted. This includes Universe of the study, sample of the study, Data and Sources of Data, study's variables and analytical framework. The details are as follows;

3.1Population and Sample

The population for the present study comprised undergraduate and postgraduate students enrolled at PSG College of Arts & Science, Coimbatore. A total of 183 students participated in the data collection phase, of which 161 valid responses were retained after screening for completeness and theoretical validity (specifically: participants whose attentional blink data showed short-lag T2 accuracy greater than long-lag T2 accuracy were excluded).

3.2 Data and Sources of Data

The present study employed primary data collected directly from participants through a structured, technology-assisted procedure. All data were obtained using a custom-designed web-based platform developed exclusively for the research, which integrated the informed consent form, demographic questionnaire, Lucidity and Consciousness in Dreams (LuCiD) scale, Cognitive Flexibility Inventory (CFI), and the Attentional Blink (RSVP) task within a single interface. Participants accessed the platform using their personal digital devices under supervised classroom conditions to ensure standardization of administration and minimise external distractions. The platform automated data capture, scoring, and storage, thereby reducing manual entry errors and ensuring uniformity in stimulus presentation, particularly for the behavioural attentional task. Responses were stored securely in a Neon cloud database, with all identifiers removed to maintain participant anonymity. No secondary or archival datasets were used. All measures included in the data collection were selected based on established reliability, construct validity, and relevance to the study variables. This approach ensured the acquisition of high-quality, systematically collected primary data suitable for robust statistical analysis.

3.3 Theoretical framework

The theoretical grounding of this study draws from contemporary models of consciousness and executive functioning, particularly those describing lucid dreaming as a hybrid cognitive state marked by reflective awareness and volitional control. Foundational accounts propose that lucid dreaming arises when metacognitive monitoring processes—typically diminished during REM sleep—are reactivated, enabling the dreamer to recognize the dream state (LaBerge, 1985). Neurocognitive evidence supports this view, demonstrating increased activation of prefrontal and frontoparietal regions associated with introspection and cognitive control during lucid experiences (Dresler et al., 2012). Lucidity is further conceptualized as a multidimensional construct involving insight, dissociation, thought processes, and emotional regulation, suggesting that individuals with higher lucid dreaming ability may display enhanced metacognitive sensitivity (Voss et al., 2009; Baird, Mota-Rolim & Dresler, 2019).

Within the broader executive function framework, cognitive flexibility represents the capacity to adapt mental operations, shift between alternative perspectives, and modify cognitive strategies in response to changing situational demands. It has long been characterised as a core facet of adaptive problem solving (Scott, 1962), and contemporary formulations emphasize both the ability to reappraise situations and to generate alternative explanations (Dennis & Vander Wal, 2010). Theoretical models position cognitive flexibility as dependent on dynamic interactions among inhibitory control, working memory updating, and higher-order metacognition (Ionescu, 2012; Zelazo, 2020). Because flexibility allows individuals to navigate changing internal and external environments, it is frequently examined in relation to constructs involving reflective awareness, including dream lucidity.

Attentional control provides the regulatory substrate that enables both metacognitive monitoring and flexible cognitive operations. It encompasses the executive mechanisms governing selective attention, sustained engagement, resistance to distraction, and rapid updating of mental representations (Diamond, 2013). Behaviourally, attentional control can be operationalised using the Attentional Blink (AB) paradigm, which captures the temporal processing bottleneck that occurs when two stimuli are presented in close succession (Raymond, Shapiro & Arnell, 1992). The magnitude of the AB reflects individual differences in attentional resource allocation, processing efficiency, and the capacity to manage rapid information flow (Neider et al., 2011). Given that lucid dreaming involves heightened internal monitoring and selective cognitive engagement, and cognitive flexibility relies on efficient reallocation of attention across shifting demands, attentional control emerges as a theoretically plausible mechanism linking the two constructs. This interconnected framework provides the conceptual rationale for testing attentional control as a potential mediator between lucid dreaming ability and cognitive flexibility in the present study.

3.4 Statistical tools and econometric models

This section explains the statistical procedures and analytical models used to transform the collected data into meaningful empirical inferences. The choice of techniques was guided by the study's objectives, the characteristics of the variables, and the structural requirements of a mediation framework. Each statistical method is described in terms of its purpose, underlying process, and specific application to the present study.

3.4.1 Descriptive Statistics

Descriptive statistics were used to summarise the demographic characteristics of the participants and to provide an initial overview of the main study variables. Frequencies and percentages helped organise categorical data such as age, sex, and academic year, ensuring that the sample distribution was clearly understood before further analysis. For continuous variables—lucid dreaming ability, cognitive flexibility, and attentional control—measures such as mean, minimum, maximum, and standard deviation were calculated to assess variability and identify general behavioural trends. This preliminary analysis established the basic structure of the dataset and informed subsequent decisions regarding the appropriateness of parametric and non-parametric statistical procedures used in the study.

3.4.2 Tests of Normality

Following descriptive analysis, the distributional properties of the variables were assessed through the Kolmogorov–Smirnov test to determine whether each variable adhered to the assumptions of normality required by many parametric techniques. The process involved comparing the empirical distribution of each variable against an ideal normal distribution and evaluating deviations in terms of statistical significance. The results revealed that lucid dreaming ability and cognitive flexibility followed approximately normal patterns, whereas attentional control demonstrated significant deviation. This lack of normality in attentional control influenced methodological decisions for subsequent analyses, prompting the use of a combination of parametric and non-parametric techniques to ensure analytical accuracy. Thus, the normality test not only described the data but guided the methodological pathway of the study by determining which inferential techniques were most appropriate for the dataset.

3.4.3 Correlation Analysis

Correlation analysis was used to examine the degree to which lucid dreaming ability, attentional control, and cognitive flexibility were related. Because the study included both normally and non-normally distributed variables, the analysis incorporated two correlation methods. Pearson's product-moment correlation was applied to the variables that satisfied normality assumptions, while Spearman's rank-order correlation was used for relationships involving the non-normally distributed attentional control measure. The process involved computing correlation coefficients that quantified the strength and direction of associations between pairs of variables. In this study, the correlation analysis revealed whether lucid dreaming was meaningfully related to cognitive flexibility and whether attentional control shared a significant association with either construct. Establishing these associations was crucial, as mediation analysis requires certain preliminary relationships between predictor, mediator, and outcome variables. Therefore, the correlation analysis not only provided foundational insights but also determined whether the empirical conditions for mediation were met.

3.4.4 Regression Analysis

Regression analysis was conducted to evaluate the predictive relationships among the variables and to establish the structural paths required for mediation. The process began by estimating whether lucid dreaming ability could predict attentional control, followed by an assessment of whether attentional control predicted cognitive flexibility. A third regression examined the direct predictive influence of lucid dreaming ability on cognitive flexibility. For each regression, the model estimated the degree to which changes in one variable accounted for changes in another, generating unstandardised coefficients, significance levels, and measures of explained variance. Within this study, regression analysis clarified whether the relationships were sufficiently strong and statistically meaningful to justify testing a mediating mechanism. The regression results formed the empirical backbone of the mediation model by determining which paths were viable and how strongly they contributed to the outcome.

3.4.5 Mediation Model (Process Model 4)

To examine whether attentional control functioned as a mediating mechanism between lucid dreaming ability and cognitive flexibility, the study employed a mediation model estimated using the PROCESS Macro (Model 4) with bootstrapping procedures. The mediation process involved partitioning the total effect of lucid dreaming ability on cognitive flexibility into direct and indirect components. The indirect effect represented the extent to which lucid dreaming influenced cognitive flexibility through attentional control. Bootstrapping, a resampling procedure, was used to generate confidence intervals for the indirect effect without relying on normal distribution assumptions, making it a robust method for mediation testing in behavioural research. In practice, the model computed thousands of simulated samples drawn from the original dataset, producing an empirical distribution of the indirect effect. The mediation was considered statistically supported only if the resulting confidence interval did not include zero. For this study, the mediation model allowed to rigorously evaluate whether attentional control acted as a cognitive pathway linking lucid dreaming and cognitive flexibility or whether the relationship operated through a direct effect alone.

IV. RESULTS AND DISCUSSION

4.1 Results of Descriptive Statistics of Study Variables

Table 4.1: Descriptive Statistics

Variable	Category	n	%
Age	1	20	12.1
	2	17	10.3
	3	37	22.4
	4	20	12.1
	5	54	32.7
	6	14	8.5
	7	3	1.8
Sex	Female	119	72.1
	Male	46	27.9
Year	I UG	27	16.4
	II UG	23	13.9
	III UG	34	20.6
	I PG	30	18.2
	II PG	51	30.9

The descriptive statistics presented in Table 4.1 indicate that the total sample consisted of **165 participants**, with a **significant female majority (72.1%)** compared to males (27.9%). The age distribution demonstrates a pronounced concentration in **Category 5 (32.7%)**, suggesting that most respondents were in the mid-adult range typical of postgraduate students. Smaller proportions were recorded in Categories 1, 2, 4, and 6, while Category 7 accounted for only 1.8% of the sample, indicating limited representation in the oldest age bracket. Academic-year frequencies reveal that while undergraduate students (I UG, II UG, III UG) collectively constitute a substantial proportion of the sample, the **II PG group represented the single largest academic category (30.9%)**, followed by III UG (20.6%) and I PG (18.2%). This distribution reflects a participant pool with considerable academic exposure, which is relevant given the cognitive nature of the constructs assessed.

4.2 Results of Tests of Normality

Table 4.2: Tests of Normality (Kolmogorov–Smirnov)

Variable	D	df	Sig.
Lucid Dreaming Behaviour	.051	165	.200*
Cognitive Flexibility	.055	165	.200*
Attentional Control	.085	165	.005

Table 4.2 indicate differential distribution patterns across the psychological variables examined. Lucid dreaming behaviour exhibited a test statistic of **D = .051, p = .200**, and cognitive flexibility showed **D = .055, p = .200**, meaning both variables failed to reach statistical significance and therefore **did not deviate from normality**. These results confirm that the distributions of lucid dreaming scores and cognitive flexibility scores approximate a normal curve at the 5% significance level. In contrast, attentional control demonstrated **D = .085, p = .005**, indicating a statistically significant deviation from normality. This suggests that performance on the attentional blink task was **not normally distributed**, potentially reflecting task difficulty, variability in attentional capacity, or individual differences in temporal processing. These distributional findings guided methodological decisions, whereby analyses involving attentional control required the inclusion of non-parametric procedures to ensure statistical validity.

4.3 Results of Correlational Analysis

Table 4.3: Correlation Matrix (Pearson r / Spearman ρ)

Variables	Lucid Dreaming	Cognitive Flexibility	Attentional Control
Lucid Dreaming	—	.243** / .248**	-.024 / -.017
Cognitive Flexibility	.243** / .248**	—	-.072 / -.035
Attentional Control	-.024 / -.017	-.072 / -.035	—

Table 4.3 demonstrates a **significant positive association** between lucid dreaming and cognitive flexibility, with Pearson's correlation of **r = .243 (p < .01)** and Spearman's rho of **ρ = .248 (p < .01)**. This indicates that participants reporting higher lucidity in dreams also tended to exhibit stronger abilities to shift mental sets and adapt cognitive strategies. This association supports theoretical assertions linking metacognitive processes involved in lucid dreaming to higher-order executive functioning. Conversely, attentional control did not correlate significantly with lucid dreaming (r = –.024, ρ = –.017) or cognitive flexibility (r = –.072, ρ = –.035). These negligible coefficients suggest that temporal limits in attentional processing—as captured by the attentional blink task—do not share a linear or monotonic relationship with either dream awareness or cognitive adaptability. This absence of association indicates that the attentional blink paradigm taps a narrower dimension of attention that may not fully represent the broader attentional regulatory mechanisms involved in metacognition or executive function.

4.4 Results of Regression Analysis

Table 4.4: Regression Analysis Results

Predictor → Outcome	R	R^2	F	p
Lucid Dreaming → Attentional Control	.024	.001	.090	.764
Attentional Control → Cognitive Flexibility	.072	.005	.848	.359
Lucid Dreaming → Cognitive Flexibility	.243	.059	10.201	.002

Table 4.4 demonstrate that lucid dreaming significantly predicted cognitive flexibility (**R = .243, R^2 = .059, F = 10.201, p = .002**). This indicates that lucid dreaming ability accounted for approximately **5.9% of the variance** in cognitive flexibility, suggesting a modest but meaningful predictive relationship between dream-based metacognition and executive adaptability.

In contrast, lucid dreaming did not significantly predict attentional control (**R = .024, p = .764**), implying negligible explanatory value for temporal attention processes. Similarly, attentional control did not significantly predict cognitive flexibility (**R = .072, p = .359**), demonstrating that variability in participants' attentional blink performance did not translate into differences in cognitive flexibility. These regression patterns collectively indicate that while lucid dreaming contributes uniquely to cognitive flexibility, attentional control—as measured by the attentional blink—does not function as an intermediary or contributing predictor.

4.5 Results of Mediation Analysis

Table 4.5: Mediation Model (PROCESS Model 4, 5000 Bootstraps)

Path	B	SE	t	p	95% CI
LD → AC	-.043	.143	-.298	.766	[-.325, .240]
LD → CF (direct)	5.764	2.539	2.270	.024	[.751, 10.778]
AC → CF	-.875	1.006	-.869	.386	[-2.861, 1.112]
Indirect Effect	.037	.187	—	ns	[-.362, .465]

Table 4.5 revealed that the indirect pathway from lucid dreaming to cognitive flexibility through attentional control was **non-significant**, as indicated by an indirect effect of **B = .037, SE = .187**, with a **95% CI ranging from –.362 to .465**, which crosses zero. This confirms the absence of mediation. The direct effect of lucid dreaming on cognitive flexibility remained significant (**B = 5.764, SE = 2.539, t = 2.270, p = .024**), demonstrating that lucid dreaming contributes directly to enhancing cognitive flexibility independent of attentional control processes. The path from lucid dreaming to attentional control was non-significant (**B = –.043, p = .766**), as was the path from attentional control to cognitive flexibility (**B = –.875, p = .386**), reinforcing that the attentional blink task does not capture the attentional mechanisms linking dream awareness to executive functioning. Taken together, these findings indicate a **direct-only model**, in which lucid dreaming predicts cognitive flexibility without transmission through attentional control. This underscores the likelihood that **higher-order metacognitive processes**—rather than narrow temporal attentional dynamics—play a central role in connecting dream lucidity with flexible cognition.

DISCUSSION

The key objective of the current work was to clarify the complex interrelationships between awareness ability in lucid dreams, cognitive flexibility, and attentional control. Under the theoretical explanation of lucid dreaming as a mixed state of awareness carrying extraordinary cognitive resources, the work assumed attentional control would play a mediatory role, identifying the mechanism whereby awareness ability within a dream generalizes into enhanced cognitive flexibility during waking life. Contrary, however, to initial expectations, the research yielded a more complex picture of associations. While a direct relationship between lucid dreams and cognitive flexibility was strongly confirmed, the posited mediatory role of attentional control, in turn, measured under the Attentional Blink (AB) paradigm, failed to gain confirmation. Interpretation of these data in detail fills the subsequent chapter, methodically contrasting the statistics of each table and expounding upon their conceptual implication.

It's worth keeping in mind the characteristics of the distribution and sample of data before examining the major hypotheses, since these provide a valuable background against which the results may be interpreted. Participants (N = 165) were female overwhelmingly (72.1%) and sampled only from a single faculty of science and the arts, and most of these participants were at postgraduate level (30.9% in their last year of study at university). Age distribution was in early twenties, the typical age of a university population. Its demographic profile then suggests a sample likely to be relatively educated and arguably more self-aware than the general population, and these may influence self-report measures of dream experience and of cognitive traits.

Tests of normality (Table 4.2) offered a significant finding which presaged the future method of statistics. Whilst the distribution of scores on cognitive flexibility and lucid dreaming was normally distributed ($p > .05$), the extracted variable of attentional control, derived from the attentional blink task, significantly differed from normality ($p = .005$). Such a non-normal distribution of attentional performance is indicative of there potentially having been ceiling or floor effects operating at the task level, or there potentially having been a subset of participants behaving in an exceptionally different manner than the mean. Such a statistical fact meant the use of non-parametric correlations (Spearman's ρ) was required in order to possess a more resilient analysis alongside the parametric Pearson's r, and was in favour of the selection of bootstrapping for the mediational analysis, since this method does not posit an assumption of normally distributed data.

Table 4.3 presents the matrix of correlations underlying this research, which checks the required associations for the mediation model. The results offered both confirmation of existing theories and a significant, unforeseen challenge for the study's central hypothesis. The analysis revealed a statistically significant, positive correlation between cognitive flexibility and ability at lucid dreaming ($r = .243$, $p < .01$; $\rho = .248$, $p < .01$). Our result strongly supports the second hypothesis (H_{12}) and aligns with growing volumes of work on the proposition that the cognitive skills exercised during lucid dreaming are continuous with waking executive functioning. The very processes of achieving lucidity—of recognizing the bizarreness of the dream, referring oneself back to waking memories for verification, and shift one's mental set from passive consumer of phenomena to active self-creator—are exemplary of cognitive flexibility. Our result aligns, then, also with work by Baird et al. (2019), who insisted on metacognitive monitoring enhanced in the course of lucid dreams, and by Lee (2017), who found heightened reflective awareness and logicality of report in reports of lucid dreams. Our positive correlation thus implies, then, that individuals most at risk of exhibiting this sort of conscious self-monitoring at night may have a generalized, trait-like facility for adaptive and flexible thinking in the waking state. On the other hand, the correlation tests failed to find any significant correlation between attentional control and ability at lucid dreaming, as measured by the AB task ($\rho = -.017$, $p > .05$). This refutes directly the third hypothesis (H_{13}) and raises the largest puzzle of this research study. Theory lending support to a posited relationship was strong; maintaining the state of lucidity requires sustained attention to the mental state, and achieving it frequently involves the selective attention utilized for identification of dream anomalies (Solomonova & Carr, 2022). Lack of correlation forces a critical reappraisal of operationalizing attentional control. The Attentional Blink paradigm accesses a very narrow, low-level attention function: the temporal constraints of conscious awareness and the processing bottleneck of the mind in switching between and off fast stimuli. It is a temporal selective attention measurement. It is very likely this narrow facet of attention is not the relevant one for lucid dreaming. Lucidity might require attentional skills at a broader level, e.g., executive attention (resolution of conflicts and allocation of resources toward a goal) or sustained attention (vigilance). Research finding correlations between attention and lucidity used alternate measures; e.g., Blagrove et al. (2010) used the Stroop task, measuring conflict monitoring, and Loo and Cheng (2021) used the Attentional Network Task (ANT) - and, hence, might tap other aspects of attention or attention-related processes. Conclusion of the current study does not necessarily reflect superior attentional control deficiency among lucid dreamers; rather, it strongly suggests superior control does not manifest as a miniature "Attentional Blink."

Moreover, no strong correlation was present between attentional control and cognitive flexibility ($\rho = -.035$, $p > .05$). We find this surprising, given that attentional control is widely accepted as a central aspect of executive functions (Diamond, 2013). Such dissociation is perhaps a consequence of differing types of measures: the AB task is an objective, direct performance measure, but the Cognitive Flexibility Inventory (CFI) is a self-rating scale of one's perceived ability to think of alternatives and view situations as controllable. One's millisecond-level processing ability may not necessarily reflect their self-report, higher-level strategies for managing challenges of life.

The regression analyses (Table 4.4) offered additional explanation of the interrelationships between variables discovered through the correlation matrix. There was a statistically significant regression equation for forecasting cognitive flexibility from lucid dreaming ($F(1,163) = 10.201$, $p = .002$), and there was about 6% of variance explained by lucid dreaming ($R^2 = .059$) in the equation. Although this is a relatively small effect size, it is statistically significant and goes toward supporting the argument that lucid dreaming is an important, but not complete, predictor of an individual's potential for flexible thinking. The other regression models, however, were not significant. Lucid dreaming was not a predictor of attentional control ($p = .764$), and attentional control was not a predictor of cognitive flexibility ($p = .359$). These results were expected given the lack of correlations and served to formally confirm that the needed paths for a mediation model were not in the data. They essentially showed that the "a" path (predictor to mediator) and the "b" path (mediator to outcome) of the conceptual mediation model were not present, and thus, paved the way for the formal mediation test.

Mediation analysis (Table 4.5), conducted via Hayes' PROCESS macro, provided the ultimate solution for the study's key research question. There was no room for ambiguity in the results: attentional control, assessed via the AB task, was not a mediator of the relationship between ability in lucid dreams and cognitive flexibility. Most important statistic here is the indirect effect. Calculated indirect effect was zero (0.037), and, more significant, the 95% bootstrapped confidence interval was broad and uncontested (- [.362, .465]) and included zero. It thus points, at high confidence, towards the absence of a statistically significant data explaining pathway through the chain of lucid dream through attention control to cognitive flexibility. It thus points towards the dismissal of the principal hypothesis (H_{11}). Nevertheless, the mediation analysis yielded a significant positive finding: the direct effect of dream lucidness on cognitive flexibility was once again significant at the statistical level ($B = 5.764$, $p = .024$), and the 95 % confidence interval [.751, 10.778] excluded zero. That's a good finding. It reveals that the correlation between dream lucidness and cognitive flexibility is not a spurious consequence of some joint variance between temporal attention and dream lucidness; it is a direct correlation standing on its own merits. Even after controlling for the (non-significant) effect of attentional blink performance, independent ability to be lucid in dreams predicts superior cognitive flexibility. Synthesis of Findings In combination, then, the results of this experiment draw a clear picture: while the "what" of the first hypothesis was correct (lucid dreamers were more flexible cognitively), the "how" was not. It does not turn out, then, that heightened temporal attentional processing is the correct mechanism underlying this correlation. The data deny a unitary explanation of "attentional control," instead underwriting the possibility of dissociations between the low-level, specific processing reflected in the Attentional Blink task and the higher-order, more generalizable cognitive ability posited underlying both lucidity and waking flexibility. Verification of a direct relationship between lucidity and cognitive flexibility, dissociated from this attentional tap, underwrites a metacognitive explanation of the lucid dream, since it is the higher-level processes of self-insight, reality monitoring, and self-reflexivity, rather than a fast attentional refresh rate, which we instead discover linked to it. Knowing, stand-up and, in a sense, cognitively, "I am a dreamer" may be the underlying ability sponsoring, through and through, a more universally flexible and self-insightful kind of cognition.

VI Limitations & Implications

6.1 Limitations

- Measurement of Attentional Control: We mentioned that reliance on the use of the Attentional Blink task alone as a predictor of attentional control is a major drawback. Its requirement for temporal attention may not have been sensitive enough to the skills of executive attention involved in lucid dreaming.
- Research Design: We adopted a cross-sectional, correlational design. It cannot on its own establish causality. We cannot be sure if dream lucidity promotes cognitive flexibility, if individuals predisposed towards cognitive flexibility tend to have more lucid dreams, or if there is an unseen, third variable (e.g., personality traits of openness to experience) operating on both.
- Sample Characteristics: Participants included students from a private Coimbatore college, and female respondents dominated the population. This limits generalizability of data to other age groups, educational levels, and cultures. It is further documented that young adults exhibit a higher prevalence of lucid dreams, and this may have impacted the data.
- Relying on Self-Report Measures: Lucid dream ability and cognitive flexibility were assessed by self-report questionnaires (LuCiD and CFI). Even though both are standardized instruments, self-report data can be at risk for response bias, e.g., social desirability or faulty recall.
- Data Distribution: None of the attentional control data were normally distributed. Although robust statistical procedures (Spearman's correlation and bootstrapping) were used to accommodate this, this remains a statistical weakness.

6.2 Implications

- Adopt a Wider Set of Measures of Attention: Prospective research ought to investigate the function of attention in mediation through the application of a wide array of tests of varying elements of attentional control, such as the ANT, paradigms of switching, and the Stroop task. This would facilitate a more nuanced description of the specific attentional mechanisms underlying the relation between flexibility and clear-sightedness.
- Incorporate Longitudinal and Experiment Designs: To account for the issue of causality, longitudinal studies would be able to track participants over time and determine if pre-existing differences in the rate of lucid dreaming foreshadow future gains in cognitive flexibility. Better still, experimental studies would randomly train a group of participants in the production of lucid dreams and determine if gains in attention control and cognitive flexibility happen differently than in a control group.
- Replicate with Varied Samples: Replication of the study with more varied samples on the age, cultural, and educational dimensions is necessary to find the generalizability of findings.
- Incorporation of Neuroimaging: Neuroimaging methods like fMRI or EEG can further help elucidate the convergent neural basis of lucid dreaming and cognitive flexibility and provide biological validation of the behavioural correlation identified.
- Explore Other Potential Mediators: Because attentional control (operationalized here) was not a mediator, future research may explore other potential mediators, for instance, metacognitive awareness, working memory capacity, or personality traits.

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