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Exploring the range of reported dream lucidity

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Abstract

Dream lucidity, or being aware that one is dreaming while dreaming, is not an all-or-none phenomenon. Often, subjects report being some variant of "a little lucid" as opposed to completely or not at all. As recent neuroimaging work begins to elucidate the neural underpinnings of lucid experience, understanding subtle phenomenological variation within lucid dreams is essential. Here, we focus on the variability of lucid experience by asking participants to report their awareness of the dream on a 5-point Likert scale (from *not at all* to *very much*). Participants implemented a combination of mnemonic training lucid dream induction methods at home for one week and provided detailed reports about their dream experiences each morning. Consistent with previous research, cognitive induction methods led to about half of participants reporting at least one lucid dream and about half of all dreams including some level of lucidity. However, we also show that induction success rate varies significantly depending on the minimum criteria for lucidity. Participants also reported how much they adhered to specific components of each induction method, and the amount of mnemonic rehearsal during a brief early awake period was predictive of lucidity level. Furthermore, lucidity levels were positively correlated with dream control, dream bizarreness, and next-morning positive affect. Lastly, we asked participants open-ended questions about why they chose particular levels of lucidity. We focus a qualitative discussion on responses to those "semi-lucid" dreams (rated *just a little*, *moderately*, or *pretty much* lucid) to explore why participants rate their dreams as having intermediate levels of awareness. Together, the present study explores the frequency of semi-lucid dreams, what they are, why they might arise, their correlates, and how they impact methodological concerns in lucid dreaming research.

Keywords

Consciousness · Dreaming · Lucidity · Lucid dream induction · Phenomenology

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1 Introduction

In 1913, Dutch psychologist Frederik van Eeden coined the term "lucid dream" when he introduced the modern scientific community to the phenomenon of being aware of a dream in real-time:

> *[...] the type of dreams which I called "lucid dreams," seems to me the most interesting and worthy of the most careful observation and study[...] In these dreams the reintegration of the psychic functions is so complete that the sleeper remembers day-life and his own condition, reaches a state of perfect awareness, and is able to direct his attention, and to attempt different acts of free volition. Yet the sleep, as I am able to confidently state, is undisturbed, deep and refreshing.*
> (van Eeden, 1913, p. 446)

This general description of lucid dreaming has been consistent from the earliest objective verifications of lucid dreaming (Hearne, 1978; LaBerge et al., 1981) up to the widely-accepted modern definition of "becoming aware that one is dreaming while dreaming" (Baird et al., 2019, p. 305). While not explicitly stating so, this definition implies a binary nature of lucidity – either *to be or not to be* aware of the dream.

However, only pages after introducing the scientific definition that still holds today, van Eeden hints at the variability of lucid experience by observing in one instance that "[t]he lucidity had not been very intense, and I had some doubts about my real condition" (1913, p. 445). In this case, it seems that van Eeden expresses only a partial "level" of lucidity. Despite not having full realization of the dream, he was aware of his condition beyond the typical single-mindedness of non-lucid dreaming (Rechtschaffen, 1978).

Online surveys of lucid dream experiences suggest there is large variation in how individuals pursue, experience, and utilize lucid dreams (Lemyre et al., 2020; Mota-Rolim et al., 2013; Stumbrys, Erlacher, Johnson, et al., 2014). Being fully lucid and aware of the dream state implies that the dreamer can execute predetermined actions within the dream (Erlacher & Schredl, 2008), yet participants report often not being able to complete their intended actions due to "insufficient clarity" (Stumbrys, Erlacher, Johnson, et al., 2014). Others have reported incidences where lucidity wanes amidst lucid dream task completion, or even where lucid dream tasks are completed without specific dream awareness (Worsley, 1984). Moss (1986) proposed a "dream lucidity continuum" ranging from minor dream awareness to full-fledged lucidity and suggested that these lucidity levels are often traversed within a single dream. Similarly, Alan Worsley, one of the most studied and documented modern lucid dreamers, noted "rapid change in the level of lucidity" of his dreams and that "how well [he knows he is] dreaming varies from moment to moment within the same dream" (1988, p. 327). Brooks & Vogelsong (1999) provide a more direct example of how awareness of the dream can be present even without a complete grasp of the situation. In a lucid dream report, the dreamer "realized he had

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left his keys and wallet inside a dream house and made the keys appear in his hand so he could unlock the door to retrieve the wallet" (1999, p. 28). Of course, keys aren't strictly necessary to enter a dream house, which should be even more obvious to the dreamer since they recognized their ability to will the spontaneous presence of keys. Though the dreamer might have other motivation to follow the existing dream layout (e.g., dream stability), such contradictory logic is common even after achieving the analytical feat of dream awareness.

There are many early descriptive accounts of lucid dreaming variation (Gebremedhin, 1987; Gillespie, 1984; Kellog III, 1989; Moss, 1986; Tart, 1984, 1985; Worsley, 1984). Initial attempts to formalize the lucidity continuum proposed a single "pre-lucid" stage between non-lucid and lucid dreams (Green, 1968). In such pre-lucid dreams, the dreamer questions the nature of the dream, but might conclude (incorrectly) that they are not dreaming. Still others have argued for the necessity of a fourth "incipient/implicit pre-lucid" dream that captures cases where the dreamer observes bizarreness without asking the question of whether they are dreaming (Sparrow et al., 2013, 2018). Pre-lucidity was implemented as a level of awareness in subsequent scales (Leslie & Ogilvie, 1996; Ogilvie et al., 1982; Purcell et al., 1986; Stewart & Koulack, 1989). Some of these scales offered even more within-lucidity variation, based on length/stability of lucidity (Ogilvie et al., 1982) or the amount of control in the lucid dream (Stewart & Koulack, 1989).

More modern approaches to measuring lucidity include a variety of questionnaires based on indirect measures of dream awareness, such as levels of insight or self-reflectiveness (Dresler et al., 2014; Kahan & LaBerge, 2011; Kahan & Sullivan, 2012; Lee & Kuiken, 2015; Voss et al., 2013). To-date, the current focus of these scales has not been to quantify the variation *within* lucid dreams, but rather to strictly contrast lucid versus non-lucid dreams or waking. Voss et al. (2013) used a 6-point Likert scale ranging from *Strongly disagree* (0) to *Strongly agree* (5), with probes such as "While dreaming, I often asked myself whether I was dreaming." Factor analysis on these 28 probes revealed that lucid dreams contained more insight, control, thought, memory, dissociation, and positive emotion than non-lucid dreams. Additionally, some lucidity-related factors – control, thought, memory, and positive emotion – varied significantly depending on whether the dreams were reported from home or the laboratory. Notably, the scale's range between *Strongly disagree* and *Strongly agree* suggests a neutral point (at 2.5), and although some factors were higher in lucid dreams, they were still below neutral (e.g., control and dissociation). Therefore, it's unclear if they should be determined as characteristics of lucidity (Voss et al., 2018). Contrasting views have resulted in different lucid dreaming definitions across studies, for example some including control as a defining characteristic (Schädlich & Erlacher, 2012; see also Horton, 2020) and others dissociation (Voss et al., 2014). These results highlight the difficulty in measuring lucidity and the characteristics that may or may not encompass dream awareness (see also Windt & Voss, 2018), particularly through statements that do not directly probe dream awareness.

Only a few questionnaires designed to quantify dream lucidity ask the explicit question about how aware of the dream the participant was. Kahan (1994) asked participants to self-report their lucidity directly on a Likert scale (1-7 with N/A option as 0) by asking them "Were you *aware* of dreaming *while* in the dream?" using the Dream Rating Scale. Rather than most responses clustering at 1 (*Not at all*) or 7 (*Very much*), 33% of dreams included a middle level of lucidity (response options 2-6). She concluded that dreams contain a variety of lucidity levels as opposed to a distinct grouping. The Dream Lucidity Questionnaire (DLQ; Stumbrys et al., 2013) is a 12-item questionnaire that asks participants how much they agree with certain statements related to lucid dreaming (e.g., how much control they had over the dream, or how sure they were about being asleep). Responses are made on a 5-point Likert scale (0 = *not at all*, 1 = *just a little*, 2 = *moderately*, 3 = *pretty much*, 4 = *very much*), and the first question is a direct assessment of lucidity on a continuous scale (*I was aware that I was dreaming*). Dyck et al. (2017) administered the DLQ to investigate the efficacy of a variety of lucidity induction methods and found that while 10% of dreams were *pretty much* or *very much* lucid, still 33% of dreams were *just a little* or *moderately* lucid. The use of these continuous scales has provided critical insight into the non-binary nature of dream awareness, but the lack of dream reports in the previous studies prevents an understanding of the phenomenology that underlie such ratings.

The goal of the current study was to explore the frequency and phenomenology of semi-lucid dreams, or those that are within the extreme bounds of a Likert lucidity probe. Towards this aim, we took the simplest method of probing a lucidity continuum (*how aware of the dream were you*, 0-4) and investigated (1) how the full range of the scale was utilized, (2) how measures of induction success were impacted by varying the minimum Likert criterion for lucidity, (3) the relationship between the range of lucidity and other dreaming and waking characteristics, and (4) the phenomenology of semi-lucidity. The notion of lucid dream variability has important implications for how we measure lucidity, which is a crucial topic in this developing field of research (Baird et al., 2019).

2 Methods

2.1 Participants

Thirteen undergraduate psychology students from Swansea University participated in exchange for course credit. All participants were female within the age range of 18 and 20 years (M = 19.3, SD = 0.7). Participants responded to an advertisement for a study about lucid dreaming. Ethics were approved by Swansea University.

2.2 Procedure and lucid dream induction methods

Participants were emailed an information packet that included general information about lucid dreaming and specific lucid dream induction methods that they were to practice daily for the following week (modeled after Aspy et al., 2017). The email also included a link to a web-based survey that they were asked to complete each morning (see *Measures*). There is a large variety of existing induction methods (Price & Cohen, 1988; Stumbrys, Erlacher, Schädlich, et al., 2012), yet those that require only behavioral/cognitive training are the easiest to implement in field studies. Therefore, we asked participants to perform a combination of cognitive lucid dream induction methods: both the mnemonic induction of lucid dreams (MILD) and reality checking (RC). MILD – as implemented in the current study – is an induction method that consists of waking up early (after about five hours of sleep), staying awake for a short period of time (generally 5-60 minutes), and returning to bed while mentally rehearsing the intention of becoming lucid during the next dream (LaBerge, 1980). RC is an induction method that is based on brief but regular "reality checks" throughout the day, which are moments where one contemplates the question of whether they are currently dreaming or not (Tholey, 1983). Note that MILD and RC are complementary in that they operate at different timescales. While MILD is a specific practice that occurs during early morning hours and is expected to have more immediate consequences, RC occurs throughout the day and presumably has a more longitudinal impact. Participants were asked to complete both practices to the extent they were comfortable doing so.

2.3 Measures

Participants were asked to, on each morning, complete a web survey through PsyToolkit (Stoet, 2017, 2010). The survey consisted of a series of questionnaires and open-ended questions. It began with questions regarding their sleep (e.g., bedtime, sleep quality) and adherence to the induction methods for the previous twenty-four hours. Following an open dream report, participants completed a custom 8-item questionnaire regarding dream characteristics (e.g., bizarreness, sensory vividness, emotionality) and mood upon awakening. Questions were framed, for example, as *Please note the intensity of bizarreness in the dream.* Response options followed a 9-point Likert scale (1 = *very little*, 9 = *a lot*, with an additional option 0 = *no recall*). The next questionnaire was an extended (19-item) version of the Dream Lucidity Questionnaire (DLQ). The original DLQ (Stumbrys et al., 2013) is a 12-item questionnaire assessing dream awareness and various aspects that often coincide with lucidity (e.g., dream control and access to waking memories). Response options of the DLQ follow a 5-point Likert scale (0 = *not at all*, 1 = *just a little*, 2 = *moderately*, 3 = *pretty much*, 4 = *very much*). We extended the original DLQ to include additional probes that assess further aspects of lucidity and dream control (as in Dyck et al., 2017, 2018), the latter being modeled after the Lucid Dreaming Skills Questionnaire (LUSK; Schredl et al., 2018).

Though we administered the entire extended DLQ, our analyses focus on the first probe (DLQ-1), *I was aware that I was dreaming*, because this is the most straightforward and direct assessment of lucidity under the current literature definition. The only other DLQ responses used in the current study were those related to control (DLQ probes 4, 6, 8, and 10), which were averaged together for a single measure of dream control.

The extended DLQ was followed by the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), which was administered to assess the impact of lucidity on morning affect. The PANAS consists of 20 probes about present moment feeling, equally split across positive and negative affect (e.g., how *enthusiastic* or *scared* one feels). PANAS response options follow a 5-point Likert scale (0 = *not at all*, 4 = *very much*), and each of the positive and negative affect probes were summed for individual measures of positive and negative morning affect.

Finally, participants completed a series of open-ended questions designed specifically to probe *why* a lucidity level (i.e., DLQ-1 response) was selected. Participants were asked (1) *Why did you rate your awareness at the value you did* (2) *What kind of experience(s) gave you an impression of your selected level of awareness*, and (3) *What prevented you from attributing full awareness to your dream*. We found the first question to ultimately be the most useful for interpreting why participants chose different levels of lucidity, and thus focused our results on responses to only that question.

2.4 Analyses

2.4.1 Lucidity induction

First, we simply counted the frequency of each level of lucidity (DLQ-1 response) reported by participants for each night of their diary. Second, we combined all participants to get frequency counts for each lucidity level aggregated across all nights in the sample. Third, we calculated induction success rates at the group level according to different lucid dream cutoffs. There are many ways to measure lucidity, as well as many ways to measure lucid dream induction success. To highlight this, we report lucid dream frequency (i.e., induction success) in three different ways. Each participant's lucid dreaming frequency was calculated as the fraction of nights that include a lucid dream according to each cutoff point (from a minimal cutoff of *just a little* lucidity up to a strict cutoff of *very much*). We averaged this lucid dreaming frequency across all participants to calculate induction success rate of the sample at each cutoff point. We repeated this process first using all diary nights, then using only those nights with dream recall. To compare the effects of varying the lucidity cutoff and changing the inclusion of nights without recall, we ran a 2-way repeated measures ANOVA using the Python package *Pingouin* (Vallat, 2018), with one factor as 'nights included' (all vs. only those with dream recall) and the other factor as 'lucidity cutoff' (*just a little*, *moderately*, *pretty much*, *very much*). Lastly, we also report a binarized measure of lucid dream frequency that

represents the fraction of participants that became lucid at least one night, again at each lucidity cutoff.

To investigate how adherence to the prescribed induction methods influenced lucidity level, we ran a mixed effects ordinal regression model using the R package *ordinal* (Christensen, 2019) with MILD rehearsal length, MILD awake time, and the number of reality checks performed the previous day as predictors of DLQ-1 response. Thus, each model predictor was evaluated for its independent contribution to variation in lucidity level. This analysis was first run including all nights regardless of whether a dream was recalled. We also report the same analysis after dropping nights without recall.

2.4.2 Semi-lucid interrogation

A main goal of the current study was to qualitatively assess the reasons for denoting a dream as semi-lucid. We interpreted responses 1-3 (*just a little*, *moderately*, and *pretty much*) to the DLQ-1 as being semi-lucid, or semi-aware of the dream as it was occurring. To interrogate participants' reason for a semi-lucid response selection, we focused on the open-ended question: *Why did you rate your awareness the way you did?* Answers were grouped according to DLQ-1 response and evaluated qualitatively.

2.4.3 Correlates of lucidity

With a continuous measure of lucidity, we were able to investigate its relationship with other dream characteristics and morning affect. All correlations were run using Kendall's tau correlation measure, preferred for ordinal data (Somers, 1962). Because each participant reported a unique amount of dreams, we ran a resampling method where a random night with recall was sampled from each participant and then a single tau value was computed. This process was repeated 1000 times, and then all tau values were Fisher z scored. For two-tailed significance tests, the smaller of the two proportions of z scored values above and below zero was doubled.

3 Results

3.1 Lucidity induction

Though all participants were asked to report their dream each morning for one week, participants contributed varying amounts of morning reports (Figure 1A). When aggregating across all participants, each of the four nonzero lucidity options appears to be chosen roughly equally (Figure 1B). The frequency of dreams reported as having nonzero lucidity (i.e., at least *just a little*) appear similar to the aggregate frequency of those with no lucidity (Figure 1B, inner panel). Across a variety of cutoffs used to measure lucid dream frequency, induction success varied

from 5% to 69% (Figure 1C). Unsurprisingly, reporting lucid dream frequency as a function of all nights rather than only nights with dream recall resulted in lower frequencies (F = 8.2, p = .014), and implementing a more stringent criterion for a lucid dream resulted in lower frequencies (F = 10.0, p < .001). There was also an interaction, such that a more stringent lucidity criterion was less impacted by the choice of restricting to nights with dream recall (F = 5.0, p = .006). It's clear visually in Figure 1C that the rate of participants who became lucid at least once according to each cutoff is higher than the induction rates across all nights in a sample. These results suggest that how lucid dream frequency is measured has significant impacts on how induction method results are reported and interpreted.

MILD rehearsal length was a significant predictor of lucidity level (odds ratio = 1.2, odds ratio CI = [1.0, 1.4], p = .027; Figure 2), but this was not the case for MILD awake time (p = .133) nor the number of reality checks performed (p = .713). The effect of MILD rehearsal length was consistent when we only included nights with dream recall (p = .062). These results suggest that the mental exercises involved in MILD have a strong influence on lucidity level, even after controlling for the length of the MILD waking period and recent reality check frequency.

3.2 Interrogation of semi-lucidity

Participants reported dreams across all semi-lucid levels of DLQ-1 (Figure 1), and thus it seems the whole range of lucidity offered to participants was utilized. Our qualitative assessment of the open question *Why did you rate your awareness the way you did?* supports this notion as well (Figure 3). Participants tended to defend their selection of *just a little* lucidity with comments that suggested they were not lucid by the strict definition (e.g., "I only knew the situation was odd"; "I had no idea I was asleep"). The selection of *moderately* lucid seemed to consist of dreams in which there was a tendency towards observing non-realness but without explicit dream awareness, perhaps in line with notions of implicit pre-lucidity (e.g., "The dream at moments felt real"; "[…] the things occurring in my dream were too bizarre to be real life"). Dreams reported as *pretty much* lucid start to include responses that appear to fit the modern criterion for lucidity (e.g., "Because I realized I was dreaming"), but with deficits in features of lucidity such as dream length (e.g., "[…] it took me a while to realize I was asleep"), stability (e.g., "I was mostly aware that I was dreaming but at times things felt more real"), or control (e.g., "[…] I was able to partially control it").

In summary, when asked about their motivation for selecting semi-lucid levels, low-end semi-lucid dreams (i.e., *just a little*) tended to not include any level of "awareness" but rather just skepticism (similar to the existing definition of pre-lucid or implicit pre-lucid dreams). In contrast, high-end semi-lucid dreams (i.e., *pretty much*) tended to include awareness but not control. These results are important given the current lack of agreement over methods of measuring lucidity (Baird et al., 2019). With a formal definition of just awareness and not specifically

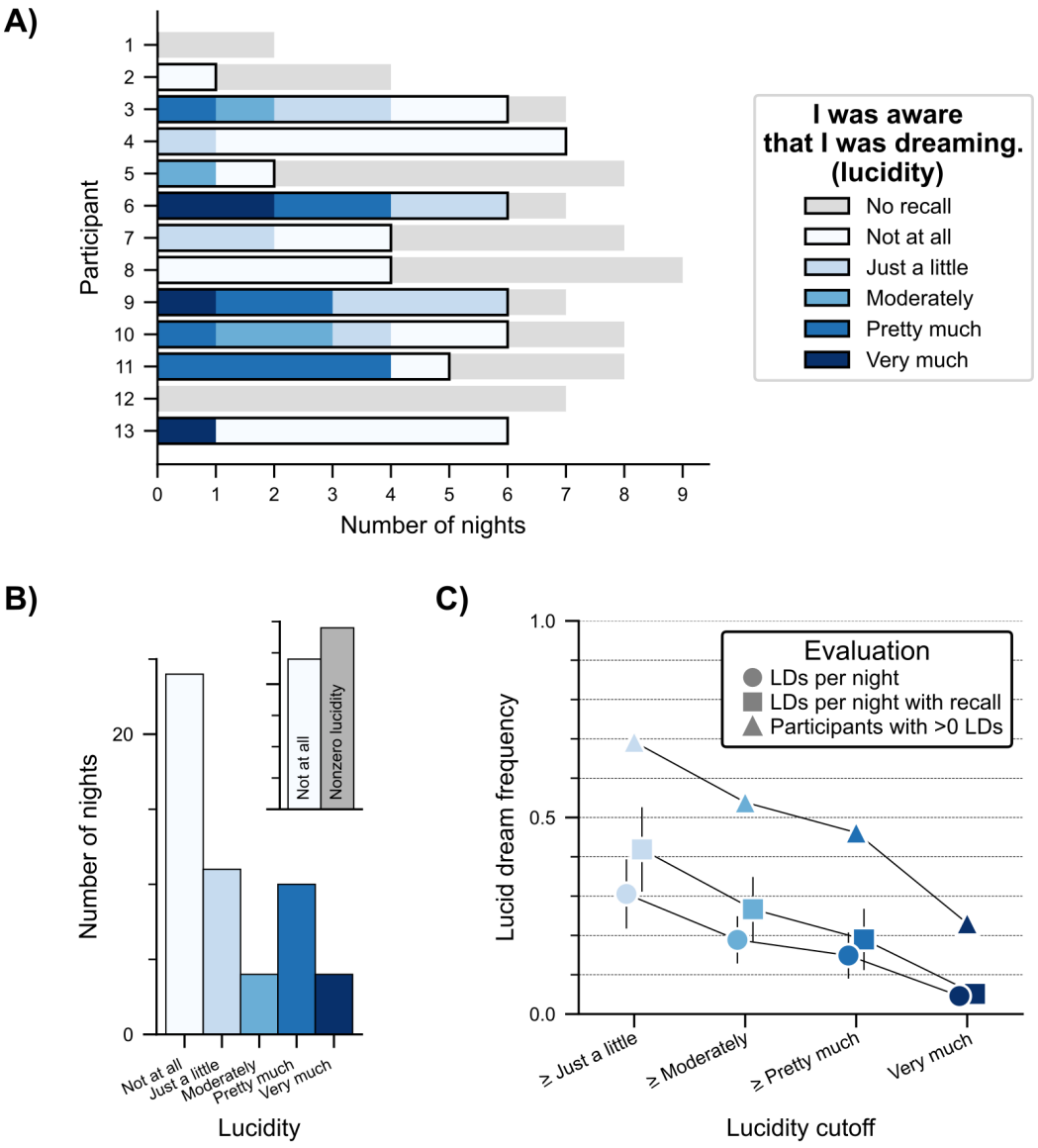

Figure 1: **Lucidity induction.** **A)** Display of individual differences of DLQ-1 range utilization. **B)** Roughly half of nights with dream recall included nonzero lucidity, and all nonzero scale options were utilized similarly. Upper right inset aggregates all the nonzero lucidity response options together, shown on the same scale. **C)** Lucidity induction success varies across a variety of measurement approaches. Evaluations include the frequency of lucid dreams across all nights (circles), across only nights with recall (squares), and the frequency of participants that had 1 or more lucid dreams (triangles). Error bars represent SEM.

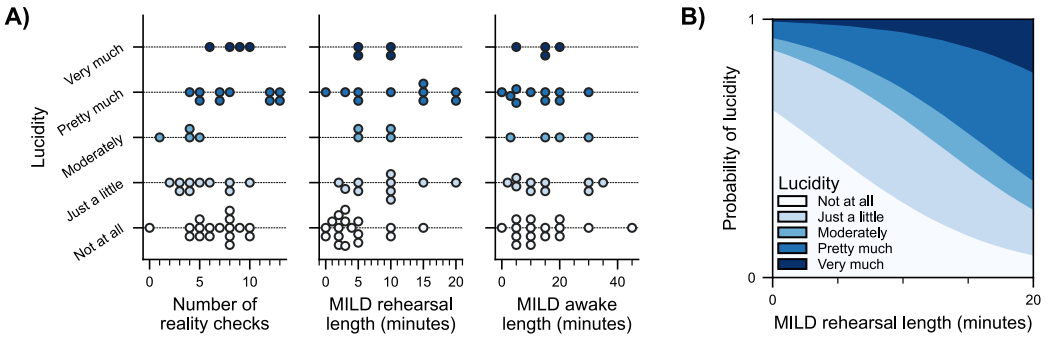

Figure 2: **Induction method adherence and lucidity level. A)** Only MILD rehearsal length was significantly predictive of attained lucidity level. Note that slight variation around each lucidity level (y-axis gridlines) is to show all data points and does not represent variation in values, and participants might contribute multiple datapoints to each plot. **B)** The significant effect of MILD rehearsal length plotted differently, as continuous model predictions after being fit with empirical data.

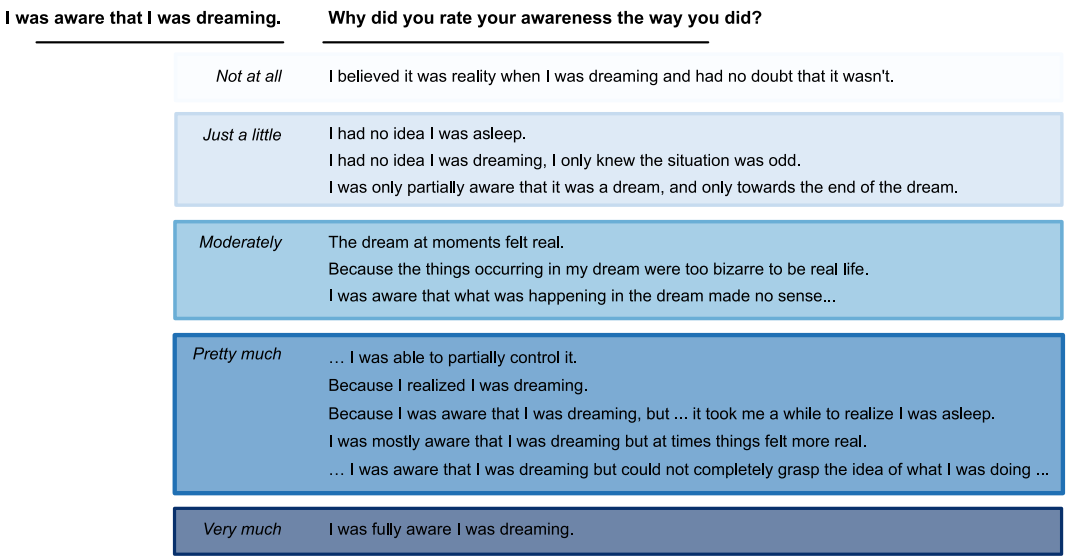

Figure 3: **Semi-lucidity interrogation.** Representative defenses of why participants picked each DLQ-1 response (i.e., lucidity level).

control, it seems our low-end semi-lucid dreams do not meet this definition, but our high-end semi-lucid dreams do. These results might be interpreted as lucidity levels binning into "low" and "high" lucidity, yet this brief assessment seems consistent with the use of a 5-point Likert scale to assess lucidity, as each response level reveals a unique pattern of response profiles.

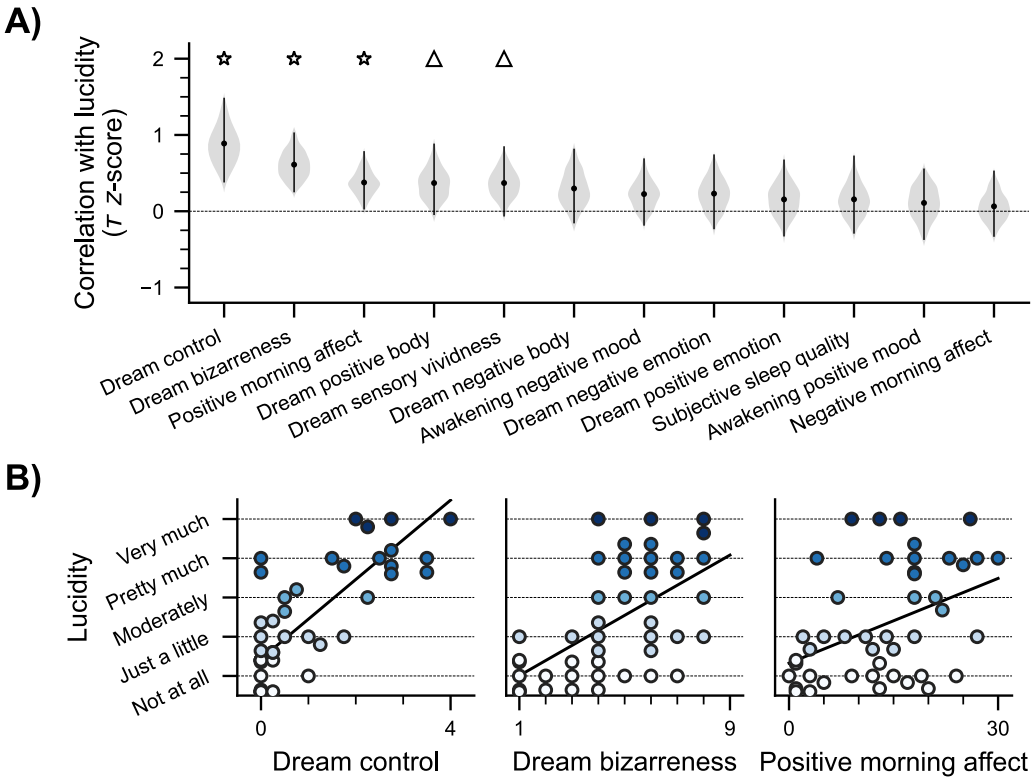

Figure 4: **Lucidity level correlates. A)** Dream control and dream bizarreness were the strongest dream characteristic predictors of lucidity level. Positive, but not negative, morning affect increased along with lucidity. Violin shadings represent the full distribution of resampled z values, with error bars highlighting the 95% confidence intervals. Stars indicate $p < .05$, triangles indicate $p < .10$. **B)** The strongest relationships with lucidity plotted with full dataset. Note that slight variation around each lucidity level (y-axis gridlines) is to show all data points and does not represent variation in values, and participants might contribute multiple datapoints to each plot. Slope lines are averaged across all resampled correlations.

3.3 Correlates of lucidity

Participants reported dream characteristics and morning affect upon awakening, all of which were tested for correlations with reported lucidity (Figure 4). Lucidity level was correlated with dream control (mean $z = .89$, $p < .001$) and dream bizarreness (mean $z = .61$, $p = .002$). There was a positive trending relationship between lucidity and dream sensory vividness (mean $z = .37$, $p = .084$), as well as positive dream body sensations (mean $z = .37$, $p = .080$). We were also interested in how dream lucidity was related to affect upon awakening. We found that lucidity level was positively correlated with positive morning affect (mean $z = .38$, $p = .032$), but showed no relationship with negative morning affect (mean $z = .06$, $p = .754$).

4 Discussion

Now that there is little debate about the existence of lucid dreaming as a real phenomenon (Baird et al., 2019), the field's focus has moved from the goal of verifying lucid dreams (LaBerge et al., 1981) to their neural correlates (Dresler et al., 2012; Voss et al., 2009), how to induce them (Blanchette-Carrière et al., 2020; Carr et al., 2020; LaBerge et al., 2018; Stumbrys, Erlacher, Schädlich, et al., 2012; Voss et al., 2014), what sleep stages they occur in (Stumbrys & Erlacher, 2012), and how they can be used for therapeutic purposes (Ellis et al., 2020; Macêdo et al., 2019; Spoormaker & van den Bout, 2006). With the current study, we propose that an additional line of investigation should be into the non-binary expression of dream awareness within lucid dreams (see also Mota-Rolim et al., 2010; Noreika et al., 2010; Stumbrys & Erlacher, 2014). Though several existing questionnaires use a continuous scale in measuring lucidity (e.g., Stumbrys et al., 2013; Voss et al., 2013), they are almost exclusively used to bin dreams into a dichotomous lucid or non-lucid categorization. Emphasizing the full distribution of scores on these or novel scales might provide more sensitive insight into what induces lucidity and how lucidity impacts waking life. By focusing on a 5-point Likert scale of specific awareness of the dream, we were able to observe a variety of novel features of the proposed lucidity continuum (Moss, 1986).

4.1 Semi-lucid dreams

All nonzero lucidity levels (anything above *not at all* aware of the dream) were utilized equally across our sample. This finding suggests that lucidity follows a natural continuum. Further, when we interrogated participants' reasons for selecting semi-lucidity (*just a little*, *moderately*, or *pretty much*), responses were consistent with this notion. Participants reported *just a little* lucidity as most frequently containing only skepticism about the dream or observations of bizarreness, consistent with the previous categorization of pre-lucid dreams (Green, 1968), or more specifically, implicit pre-lucid dreams (Sparrow et al., 2013, 2018). Some such dreams were by all definitive criteria non-lucid, as participants were not aware of dreaming. *Moderately* lucid dreams were similarly full of skepticism, albeit to a stronger degree and still fitting some criteria for implicit pre-lucidity. It was not until the *pretty much* lucid dreams that participants began to report explicit awareness of the dream. Why then were these dreams not reported as *very much* lucid? Most responses included certain limitations of lucidity, such as a lack of control, or a fleeting moment of lucidity that appeared only at the beginning or end of the dream. The current definition of lucid dreaming does not include dream control (Baird et al., 2019), although dream control is typically higher in lucid than non-lucid dreams (LaBerge et al., 2018; Voss et al., 2013). Also note that van Eeden's (1913) original description of lucid dreams included dream control elements. Our results warrant future discussion about how control fits into the strict definition of lucid dreaming (see also Horton, 2020; Windt & Voss, 2018).

Viewing only the Likert responses to *I was aware that I was dreaming* suggests that lucidity falls along a true continuum, and that further variation in response options might capture more of its variability. While our results suggest a lucidity continuum, they also do not refute a lucidity *spectrum* containing clear boundaries or quantized sections on a subscale. It is also possible to interpret the open-ended responses as evidence for a binary nature of lucidity. That is, under a strict definition of being fully aware of the dream as it is occurring, our results suggest that only *pretty much* and *very much* lucid dreams are truly lucid, while *just a little* and *moderately* lucid dreams might actually be pre- or non-lucid. The criterion of being fully lucid is not included in the current literature definition of a lucid dream, and so future consideration of this is important. Others have argued that a good criterion of gauging lucidity is to simply ask the participant if they were lucid, offering just *yes* and *no* as response options (Baird et al., 2019). While on the surface this seems the most straight-forward way of determining lucidity, it is possible that forcing participants into a binary categorization of something that might be non-binary could result in false positives and misses.

Another approach to lucidity variation, not exclusive to the above-mentioned, is that even within fully lucid dreams lies a variety of cognitive profiles (Barrett, 1992; LaBerge & DeGracia, 2000; Lee, 2018; Sparrow, 2019). Interesting new studies have investigated the degree to which self-reflectiveness relates to within-dream memory (e.g., *During my dream, I remembered what happened earlier in the dream*; Lee, 2017, 2018). Future work might investigate whether such high-level cognitive processes such as access to long-term memory vary as a function of reported lucidity. Given the unique neural profile of lucid dreaming (Baird et al., 2019), teasing apart the specific cognitive components of lucid dreaming can make broader contributions to how the waking brain effectively implements higher-order cognition.

Our interrogation of semi-lucid dreams also suggests that there are individual differences in what one qualifies as lucidity. How someone chooses to report their lucidity on a continuous scale is likely to be dependent on their previous lucid dreaming experience. If a participant's first experience with lucidity is momentary and without dream control, they might rate it as *very much* lucid. But then after a subsequent lucid dream that includes dream control, the same participant might reevaluate their use of the lucidity response options and drop the same experience to *pretty much* lucid. A longitudinal dataset collected with a methodology similar to that presented here might be able to address how the use of the reported lucidity range changes as a function of experience with lucid dreams. In a similar vein, it seems clear that lucid dreaming can be learned (LaBerge, 1980; Price & Cohen, 1988; Stumbrys, Erlacher, Schädlich, et al., 2012), yet whether it is a proper skill (i.e., stable after learning) or an ability (i.e., decreases after training) is still undetermined (Schredl et al., 2018; Stumbrys & Erlacher, 2014). Collecting continuous lucidity reports before, during, and after lucid dream training might help to answer this and related questions.

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4.2 Methodological decisions in reporting induction success

Entangled with the issue of measuring lucidity is the question of how to measure lucid dream induction success (Stumbrys & Erlacher, 2014). The immense promise of lucid dreaming is limited by the capacity to experimentally induce lucidity (Appel et al., 2018), and thus a leading goal of the field is to develop reliable lucid dream induction methods. The method of quantifying induction success rate is often inconsistent across experiments, and might be one of the contributing factors to literature discrepancies (Stumbrys, Erlacher, Schädlich, et al., 2012). Induction success is often reported as a proportion of dreams that are lucid, but this might be a proportion of all attempts, a proportion of all reported dreams (i.e., excluding attempts without dream recall), or a proportion of participants that became lucid (i.e., not accounting for multiple attempts within each participant). Our results suggest that the success rate varies significantly depending on this selection. Unsurprisingly, our results also show that the success rate is further dependent on the operational definition of dream lucidity; success rate decreases as the criterion for what constitutes a lucid dream becomes increasingly stringent along the range of reported lucidity. Importantly, these success rates differ dramatically and have a significant impact on the interpretation of a given induction method.

While we show that the choice of induction success measure matters, it is difficult to advise one over another. The optimal metric to use for success rate should differ across study motivations. On the one hand, a therapeutic approach might be more concerned with only how many participants become lucid, since the primary motivation is to increase lucidity *at some point* across repeated attempts. On the other hand, laboratory investigations, due to time and effort, might be more concerned with how effective an induction method is at inducing lucid dreams on a single attempt. Similarly, despite the common practice of removing nights without dream recall (since it is possible a lucid dream was forgotten), knowing induction success across *all* attempts would be critical to how effective an induction method is. Thus, a best-practices approach might be to include all success rates to aid in cross-study comparisons.

Another possible reason for discrepancies in induction success across studies and induction methods is that they might induce different profiles of lucidity (LaBerge & DeGracia, 2000; Mota-Rolim et al., 2010). As we highlight here, lucidity lies along a continuum, and different induction methods might induce different but predictable levels of lucidity. Despite the combination of MILD and reality checking inducing varying levels of lucidity in the current study, it's possible that a given induction method might be effective in so far as it induces strictly low or strictly high levels of lucidity. Often the goal of inducing lucid dreams is to induce fully lucid dreams – even dream control specifically – for experimental control over dream actions or for nightmare sufferers to overcome negative dream content (Gieselmann et al., 2019; Macêdo et al., 2019; Zadra & Pihl, 1997). Thus, it will be crucial for future research to clarify the level of lucidity induced with a given induction method.

4.3 Adherence to lucidity induction protocols

The mnemonic induction of lucid dreams method (MILD), as implemented in the current study, involves waking up in the middle of the night and staying awake for a brief period of time while performing a mental rehearsal task (LaBerge, 1980). The mental rehearsal task to be performed during this brief awake period involves setting an intention to remember to become aware during the next dream and imagining the moment of lucidity. A related lucid dream induction method is known as wake-back-to-bed (WBTB), which entails waking up for a period of time during the night and then returning to sleep (Stumbrys, Erlacher, Schädlich, et al., 2012; Stumbrys & Erlacher, 2014). Because WBTB is primarily a behavioral technique and does not specify what action is performed while awake (e.g., Appel et al., 2020; Erlacher & Stumbrys, 2020), it is often used in conjunction with cognitive techniques such as MILD. To simplify instructions for our participants, we used the term "MILD" in its originally proposed implementation (LaBerge, 1980), a combination of WBTB's behavioral aspect and MILD's cognitive aspect. While both methods are effective at inducing lucidity, the mechanism behind their efficacy is unclear. WBTB is presumed to aid in "catching" a REM cycle, where lucid dreams are more likely to occur (LaBerge, 1988; LaBerge et al., 1981), a hypothesis that has recently received preliminary support (Gott et al., 2020). Another contributor to WBTB's efficacy, not mutually exclusive from such REM re-entry, is the cognitive activity of the brief awake period (Erlacher & Stumbrys, 2020). MILD was originally devised based on the notion of prospective memory, or setting an intention during waking to remember one is dreaming during the next dream (LaBerge, 1980; Tholey, 1983), and our data suggest that the mental rehearsal component of MILD also serves as a primary catalyst for inducing lucidity. Aspy et al. (2017) found contrasting results in that longer MILD practice led to a decreased chance of achieving lucidity, although they note that this effect was likely a result of MILD practice impacting sleep habits. It is possible that our approach of relating induction method adherence to the degree of lucidity, rather than strictly lucid or not, can help to uniquely reveal the efficacy of certain lucid dream induction methods.

Length of time awake during MILD (a.k.a. WBTB duration) is presumably an important factor in induction success, yet the existing literature is mixed. When looking at longer intervals, 30-60 minutes of awake time during the morning is optimal for inducing lucidity compared to shorter intervals of approximately 10 minutes (LaBerge et al., 1994), but a comparison within shorter intervals showed ~5 minutes awake time to be more effective than ~10 minutes (Aspy et al., 2017). We found no effect of awake time on lucidity level, leaving this still an open question.

Another popular method of inducing lucidity is reality checks (Stumbrys, Erlacher, Schädlich, et al., 2012; Tholey, 1983). The likely reason for this method's broad popularity and appeal is that it doesn't incur any modification to typical sleep habits, which is a concern for other induction methods (Soffer-Dudek, 2020; Vallat & Ruby, 2019). The proposal behind the efficacy of reality checks is rooted in the continuity hypothesis of dreams, which states that we dream about themes from our waking life (Schredl & Hofmann, 2003), even if not specific episodic re-

play (Fosse et al., 2003; Malinowski & Horton, 2014; Mallett, 2020). If one asks oneself if one is dreaming throughout the day, then the theory of reality checks proposes that one will also ask oneself while one is dreaming, and ideally come to the correct conclusion that indeed, one is. Notably, it is also possible to ask oneself if one is dreaming during a dream and incorrectly resolve that one is not. The efficacy of reality checks alone as an induction method is contentious (Stumbrys, Erlacher, Schädlich, et al., 2012) and has recently shown no singular effect at increasing lucidity (Aspy et al., 2017; Dyck et al., 2017), however seems to work when used in combination with other induction methods (Aspy et al., 2017; Stumbrys, Erlacher, Schädlich, et al., 2012). In the current study, we found no relationship between the amount of reality checks performed in a single day and the amount of lucidity in the subsequent night, which is consistent with recent work (Aspy et al., 2017). However, waking memories are frequently incorporated into dream content after a few days rather than on the subsequent night (Blagrove et al., 2011; van Rijn et al., 2015). Future work might account for this "dream-lag effect" with the specific prediction that the number of reality checks performed a few days before might be more predictive of dream lucidity.

4.4 Lucidity and bizarreness

Lucid and nonlucid dreams might be similar in bizarreness (Voss et al., 2013), yet when rated by external judges, non-lucid dreams show higher bizarreness (Yu & Shen, 2020). Our results suggest that increased dream bizarreness is related to increased dream lucidity. Another recent study found lucid dreams to be higher in bizarreness than non-lucid dreams (LaBerge et al., 2018), although these results are conflated with the ingestion of galantamine, which might have influenced dream bizarreness independently of lucidity (although see Sparrow et al., 2016). There is an intuitive notion that naturally occurring lucidity occurs as a result of a bizarre dream event (sparking the dreamer's realization "how strange, I must be dreaming"), but this is inconsistent with the high frequency of bizarre events that do not provoke lucidity. As with our finding of a positive relationship between lucidity and sensory vividness, we are unable to determine if bizarreness induced lucidity. Among other possibilities, perhaps increased lucidity allowed for a more direct/reflective evaluation of dream content, lucidity made dreams more bizarre, or a third variable (e.g., cortical arousal) induced both lucidity and bizarreness. A further consideration is that different levels of lucidity might be initiated by different dream characteristics.

4.5 Positive impact of lucidity

A promising benefit of lucid dreaming is its potential for nightmare therapy (Abramovitch, 1995; Aurora et al., 2010; Garfield et al., 1988; Gieselmann et al., 2019; Holzinger et al., 2015; Macêdo et al., 2019; Mota-Rolim & Araujo, 2013; Payne, 2014; Taitz, 2014; Zadra & Pihl, 1997). The initially proposed idea behind

lucid dreaming therapy is that lucid dreamers have control over their dream content, and thus can actively change the narrative of a dysphoric dream. However, recent studies have shown that lucid dreaming training sometimes improves nightmare symptomology despite a lack of induced lucidity (Spoormaker et al., 2003; Spoormaker & van den Bout, 2006), or might reduce only nightmare-related symptoms (Holzinger et al., 2020). Our results suggest the possibility that in such situations, lucid dreaming training might induce low levels of lucidity potentially undetectable using a binary lucidity outcome measure. Our semi-lucid interrogations are also in line with others suggesting that not all lucid dreams include dream control (Mota-Rolim et al., 2013; Schädlich et al., 2017; Schredl et al., 2018; Stumbrys, Erlacher, Johnson, et al., 2014; Windt & Voss, 2018). But without inducing dream control, how could lucid dreaming therapy be effective? One possibility is that the moment of lucidity brings with it a sense of relief, even if the content can't be changed. While this "just a dream" realization typically occurs when one awakens fully from a nightmare, there might be a particular impact of having this realization within the same environment of the nightmare event. For example, the emotional response to the ongoing nightmare might be different if the dreamer is aware of its non-reality. Another way to assess the clinical benefit of lucid dreaming is to quantify affect in the morning following a lucid dream (Konkoly & Burke, 2019; Stocks et al., 2020). Our results suggest that increased lucidity leads to increased morning affect, which might be another potential clinical benefit to lucid dreaming beyond the strict control of nightmares. Recent work suggests that characteristics of the dream state carry over into wakefulness (Lee & Kuiken, 2015; Sikka et al., 2018), and lucid dreams contain more positive emotions than non-lucid dreams (Mallett, 2020; Stocks et al., 2020; Voss et al., 2013). Thus, the positivity of lucid dreams carrying over into the waking state might offer a reason for why lucid dreams without control could benefit nightmare sufferers (see also Stocks et al., 2020). We found a clear positive relationship between lucidity and dream control, and so our results are unable to determine whether dream control was responsible for these positive waking impacts. Notably, lucid dreaming therapy has recently been scrutinized for its potential negative impact due to occasional sleep interruptions and/or reality-fantasy questioning (Soffer-Dudek, 2020; Vallat & Ruby, 2019). Our data shows no relationship between lucidity and negative affect or subjective sleep quality (as in Aspy, 2020; Ribeiro et al., 2020; Schadow et al., 2018; Schredl et al., 2020; Stocks et al., 2020), however we did not implement measures of psychosis, which will be important for future lucid dream induction studies.

While bodily sensations are under-appreciated within the discussion and description of lucid (Garrett, 2017; Kühle, 2015) and non-lucid (Windt, 2010) dreams, the same logic of carry-over effects might apply to the positive body sensations that increased with lucidity levels in the current study. Lucid dreamed actions share the neural substrate of waking actions (Dresler et al., 2011; Erlacher & Schredl, 2008) and might have the same carry-over effects from dream experience into waking (Stumbrys et al., 2016).

4.6 The continuity of consciousness

Not only dream awareness, but also waking self-reflection fluctuates amongst a continuum (Fazekas & Overgaard, 2018, 2016; Kahan & LaBerge, 2011; Kahan & Sullivan, 2012; Smallwood & Schooler, 2015). The unique state of non-lucid dreaming – and its variants (Nielsen, 2017, 2004; Windt et al., 2016) – can offer unique insight into the study of consciousness more broadly (Fazekas & Nemeth, 2018; Hunt, 1986; Revonsuo & Valli, 2010; Windt et al., 2016; Windt & Noreika, 2011). Lucid dreaming is often referred to as a point along a continuum (Fazekas & Nemeth, 2018; Hobson et al., 2000), and our results support other arguments that further studying variation within lucid dreams can offer further insight into studies of consciousness (Baird et al., 2019; Hobson, 2009). Future research into the neurophysiology of lucidity variation might aid in understanding the (waking) neural basis of cognitive components that are specific to lucid dream sub-types (Mota-Rolim et al., 2010). The characterization of the continuous nature of self-reflective awareness in waking has important implications for the diagnosis and treatment of clinical disorders of consciousness (Fernández-Espejo & Owen, 2013).

4.7 Conclusion

In summary, the current study was a largely exploratory investigation into the varieties of dream awareness. By focusing our analyses on a Likert-scale probe aimed directly at dream lucidity, we explored specific relationships between reported lucidity level and induction adherence, dream characteristics, morning affect, and phenomenology. Our goal was to contribute to the current methodological discussion of how lucidity should properly be measured and described in future research. In doing so, we showed that participants report dreams as existing along a continuum of lucidity, but how dream researchers interpret and apply the use of this continuum is still open for discussion.

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