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When life is but a dream

Does transliminality predict continuity of thought across the sleep-wake cycle?

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Abstract
People with fantasy proneness and dispositions towards absorption and hypnotizability encounter waking thoughts that are particularly bizarre or dreamlike in nature. This suggests not only a continuity between dreaming and waking thoughts—what we refer to as *continuity of thought*—but perhaps stable individual differences in continuity of thought. The personality trait *transliminality*, which has been linked with increased awareness of subliminally-presented material, may underlie these dispositions and thus shows unique promise for predicting continuity of thought. In a sample of undergraduate students, we measured transliminality using the Revised Transliminality Scale (RTS) and then used experience sampling to capture the phenomenological qualities of dreaming and waking thoughts for one week. We examined evidence for continuity of thought across the sleep-wake cycle, examined the connection between transliminality and dreamlike thoughts in wakefulness, and assessed whether transliminality predicts greater overall continuity of thought. Results showed transliminality was unrelated to overall continuity of thought, however further exploratory analyses showed transliminality predicted greater continuity in *bizarreness of thought*—though this effect did not hold up after controlling for multiple comparisons. Moreover, transliminality was positively associated with waking thoughts that were more bizarre, interesting and novel. Overall, this work advances understanding on how personality may relate to phenomenology of thought, and opens the door for future research to assess how these personality-phenomenology relations may impact wellbeing, creativity, or behavior more generally.

Keywords
Bizarreness · Continuity · Continuity of thought · Experience sampling · Personality · Phenomenology of thought · Transliminality

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1 Introduction

The bizarre and dissociative qualities of dreams suggest they are distinct from everyday waking life. But is this true for everyone or is the line that separates dreaming from wakefulness especially fuzzy for some people? To tackle these questions, we examined individuals' thoughts in dreaming and wakefulness, and looked at similarities between these states as a function of *transliminality*—a personality characteristic which converging evidence suggests underlies anomalous or dream-like waking thoughts.

1.1 The continuity hypothesis

A long standing line of research has noted a crossover between the personal concerns present in individuals' waking life and their dreams, an idea formally expressed as the *continuity hypothesis* (Domhoff, 1996). Classic examples of continuity may be the appearance in one's dreams of a recent argument, an upcoming exam, or other distressing events from waking life. Key to the traditional notion of continuity is that it involves spill over of *specific* objects, people, events or activities—what might be called the contents of consciousness—from waking life into dreaming.

Differing subtly from the notion of continuity as concerning the contents of consciousness, other research focuses on continuity in terms of phenomenology of thought: how thoughts feel from a subjective or first-person perspective (Gross et al., 2021; Kahan & LaBerge, 1994; Kahn & Hobson, 2005). This work examines similarities between dreaming and wakefulness with respect to the experiential or phenomenological qualities of one's thoughts, such as how positive or bizarre thoughts feel (Perogamvros et al., 2017). Interestingly, continuity in phenomenology of thought is especially salient when comparing dreams with stimulus-independent thoughts: waking thoughts that occur when the mind turns inward and becomes decoupled from the external environment (Domhoff, 2018).

Yet another prominent area of research emphasizes continuity from the perspective of neurophysiology. Such work posits that localized 'sleep' in attentional networks combines with activation in the default mode network to trigger stimulus-independent thoughts (Andrillon et al., 2019)—a pattern of neurophysiology largely mirrored in dreaming (Fox et al., 2013). Similarities between dreaming and waking thoughts may therefore reflect not only a superficial correspondence, but rather common underlying neurophysiological processes (Andrillon et al., 2019).

Collectively, the above research suggests the traditional continuity hypothesis could be extended into a more comprehensive and inclusive model of continuity, in which crossover between dreaming and wakefulness is described in terms of contents, phenomenology of thought, and neurophysiology. In fact, this view is largely consistent with several existing frameworks concerning similarities between dreaming and waking states (Christoff et al., 2016; Domhoff, 2022; Kahan &

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LaBerge, 2011; Windt, 2020), although not all of these frameworks explicitly label such crossover as 'continuity'.

1.2 Continuity of thought

While the majority of past empirical work has examined continuity with respect to content or neurophysiology, only a handful of studies have looked at continuity in terms of phenomenology of thought—what we refer to as *continuity of thought*. As mentioned, this work typically compares the frequency or intensity of specific thought qualities across the sleep-wake cycle. However, these studies have so far found mixed support for the notion of continuity of thought. For example, one study found that thoughts during REM, when dreaming is most common, are similar to waking thoughts in terms of their temporal focus, emotional valence, and cognitive effort, but that differences in these states exist due to deficits in metacognitive thinking in dreaming (Perogamvros et al., 2017).[1] Further, another study showed that while certain thought qualities such as bizarreness, novelty, spontaneity, and fluidity occur significantly more often in dreaming compared to wakefulness, thoughts that are meaningful or goal-oriented are just as frequent in both states (Gross et al., 2021).

All in all, the limited work in this sphere indicates that while phenomenology of thought may remain largely stable across dreaming and wakefulness, differences may exist when it comes to particular thought qualities. Nevertheless, many open questions remain concerning how thoughts change across the sleep-wake cycle; one intriguing question is whether phenomenology of thought varies systematically across individuals in any consistent ways, such as in relation to certain personality attributes or other individual differences. Here we suggest that greater continuity between dreaming and waking thoughts may be tied to a personality attribute known as *transliminality*.

1.3 Transliminality and continuity of thought

Transliminality is a personality trait defined as the tendency for psychological material (e.g., perceptions, imagery, memory) to cross the boundary into or out of consciousness (Lange et al., 2000).[2] This conscious permeability is theorized to stem from a lower activation threshold guarding conscious awareness, resulting in direct phenomenological impacts such as more vivid imagery, perception, thought, and affect (Lange et al., 2019). To give an example with perception: although visual

[1] However, even sharp distinctions based on differences in metacognition are contested in light of the existence of *lucid dreaming*: dreams in which the dreamer becomes meta-aware of the fact that they are dreaming (Kahan & LaBerge, 1994).

[2] Although the definition of transliminality includes psychological material flowing *out of* awareness, (e.g., in the case of habituation to a repeated stimulus or the automatization of a learned behavior), it is worth emphasizing that transliminality is chiefly concerned with material flowing *into* awareness.

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stimuli will typically elude consciousness if presented for a short enough duration (and especially if masked), this is less likely for people higher in transliminality (Crawley et al., 2002). In other words, highly transliminal people are more likely to notice or be influenced by subliminally-flashed images compared to those lower in transliminality. However, because transliminality is theorized to raise sensitivity to not only perceptual stimuli but to imagery, thought, and affect as well, it follows that highly transliminal people should notice subtle images, thoughts or emotions that, for others, might only become conscious during sleep. In short, a greater awareness of mental phenomena during wakefulness (stemming from greater transliminality) should translate into greater continuity of thought.

Transliminality is typically assessed using the Revised Transliminality Scale (RTS), which consists of items taken from measures of magical thinking, absorption, fantasy proneness, manic experience, hyperaesthesia, mystical experience, and dream interpretation (Lange et al., 2000). It has been argued that the RTS may function as an umbrella measure for capturing traits related to transliminality: in a factor-analytic study examining the factor structure between the RTS and measures of schizotypy, boundary thinness, and temporal lobe lability, transliminality (as measured by the RTS) not only highly correlated with the other measures, but was also found to most closely represent the common underlying factor (Thalbourne & Maltby, 2008).[3] Yet despite being drawn from a seemingly disparate set of individual difference measures and correlating with a very wide range of trait measures, the RTS displays remarkable unidimensionality, suggesting it does indeed capture a single underlying factor, namely transliminality.

Although many experience continuity of thought at least to some degree (Gross et al., 2021), there is reason to believe continuity of thought may be heightened in individuals holding certain personality characteristics such as fantasy proneness, absorption, and magical ideation. Indeed, people high in these traits report more vivid and bizarre thoughts (Jamieson & Gruzelier, 2001), dissociative experiences (Koffel & Watson, 2009), anomalous perceptual experiences (Simmonds-Moore, 2009), and reduced reality testing (Dagnall et al., 2017; Mintz & Alpert, 1972)—all hallmark features of dreaming (Corlett et al., 2014; Simmonds-Moore, 2009). As noted, transliminality appears to underlie many of these personality characteristics and thus it is likely transliminality is tied to greater continuity of thought; yet, this possibility remains untested.

While a connection linking phenomenology of thought with transliminality has not been explicitly examined, some related traits have been explored. For example, Zedelius (2021) investigated the downstream impact of *fantastical daydreaming*—recall a major component of transliminality is fantasy proneness—and found that daily instances of fantastical daydreaming predicted both creative writing

[3] This determination was made because the RTS was the shortest, most psychometrically sophisticated measure, and that it was previously shown to correlate with presumed behavioral markers of transliminality such as access to subliminally-presented primes (Crawley et al., 2002) and vibro-tactile sensitivity (Houran et al., 2020).

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quality and creative behavior. Meanwhile, another study found that daily instances of *aberrant salience* were associated with an increased intensity of psychotic experiences (Reininghaus et al., 2016), wherein aberrant salience is defined as the misattribution of significance or *salience* to innocuous stimuli. Like fantastical daydreaming, individual differences in aberrant salience are highly correlated with transliminality (Ortega et al., 2023). Though indirect, these studies provide evidence that transliminality may be associated with greater creativity, in some cases, but also greater risk for pathology in other cases. In short, transliminality seems connected to several meaningful outcomes, though this evidence is indirect and fully correlational, and thus further research is warranted.

1.4 The current study

To recap, a wealth of research suggests thinking across dreaming and wakefulness is continuous, yet surprisingly few studies have considered whether continuity of thought relates to any individual differences in personality. Transliminality subsumes a host of interrelated personality measures that are themselves linked with anomalous waking phenomenology, and thus shows unique promise for explaining variation in continuity of thought. To investigate this possibility, we used the experience sampling method (ESM) in which participants are probed at random intervals and asked to report on their subjective experience. As such, the ESM allows for an ecologically rich examination of thought as it occurs in day-to-day life. Using the ESM, we probed participants for seven consecutive days and nights, and collected subjective reports of dream and waking thoughts. Specifically, participants rated their dream and waking thoughts across 10 dimensions: fluidity, novelty, vividness, topical shifts, meaningfulness, bizarreness, emotional valence, spontaneity, interestingness, and mood. We aimed to include a comprehensive set of qualities given the limited amount of work on continuity of thought, though ultimately we based the final set of qualities on previous work (Gross et al., 2021).

Analyses were conducted with three primary aims. First, we aimed to replicate and extend research showing evidence of continuity of thought by comparing the prevalence of each thought quality in dreaming and wakefulness. Second, we sought to examine the relationship between transliminality and dreamlike thoughts during wakefulness. Here we hypothesized that transliminality would be positively associated with thought qualities previously found to be prevalent in dream states, in particular bizarreness, spontaneity, novelty, and fluidity (Gross et al., 2021). Third, we assessed whether transliminality was associated with greater continuity in terms of the *overall pattern* of thought qualities, and predicted that people high in transliminality would show greater overall continuity of thought. In addition to our primary aims, we also conducted several post-hoc exploratory analyses examining connections between transliminality and continuity in *specific* thought qualities.

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2 Methods

2.1 Participants

This study was approved by the Institutional Review Board of the University of California, Santa Barbara (UCSB). Participants were undergraduate students from UCSB and were compensated with course credit for their participation. A total of 127 participants were recruited; however, five of these did not pass an attentional check that was embedded in the training procedure. Of the 122 remaining, another six participants did not submit any thought reports thus bringing the final sample size to N = 116 participants (mean age = 18.8, SD = 1.3). Our desired sample size was 130 participants (similar to Zedelius et al., 2021, the sample size of which was based on several other experience sampling studies), though we fell short of this goal due to the amount of research credits at our disposal for compensation.

2.2 Procedure

Participants first came to the laboratory to complete a self-report measure of transliminality and undergo a training procedure for the experience sampling component of the study. For the experience sampling training, participants were given both verbal and written instructions about the study procedures and subsequently tested on this information via multiple-choice questions (e.g., "How many days will this study last?"). Feedback was provided after each question that evaluated participants' answers and reiterated the correct response (e.g., "Correct! This study will last seven days."). Next, participants were asked to download *ExpiWell* (https://www.expiwell.com), a smartphone application used to administer the experience sampling questionnaires (i.e., thought probes). Participants completed a demo thought probe in the ExpiWell app and were given the opportunity to clarify any confusion with the probe items. Finally, to ensure participants would wake up for the nighttime probes, they were instructed to set alarms on their phones for 3:00 a.m. and 5:30 a.m., repeating every day.

2.2.1 Probe delivery

In the week following the in person laboratory session, participants received eight thought probes per day sent from the Expiwell app—six during the day and two at night. The six daytime probes were sent pseudo-randomly between the hours of 9:00 a.m. and 9:00 p.m., such that one probe was delivered within each two-hour window of time (e.g., 9:00 a.m.-11:00 a.m., 11:00 a.m.-1:00 p.m., etc.). The two nighttime probes—intended to capture participants' dream thoughts—were sent at the fixed times of 3:00 a.m. and 5:30 a.m. each morning. These early morning times were chosen to maximize the chances of waking participants directly from a dream, as the proportion of time spent in REM sleep (when dreaming is most frequent) increases as the night goes on (Nielsen, 2000). The timing and frequency of both

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daytime and nighttime probes were based on Gross et al. (2021) which examined thought content across the sleep-wake cycle. Once a probe was sent, participants were given five minutes to begin responding to it— after five minutes the survey expired and they were unable to retake it. A total of 56 probes were sent to each participant.

2.2.2 Classifying dreaming and waking thoughts

Upon receiving a probe, participants were instructed to: "Please answer these next questions as they relate to the thoughts you were *just having* (roughly 5 seconds before you were prompted to respond)". Participants first reported if they were awake or asleep at the time of receiving the probe. If they indicated being awake, they reported whether their thoughts were focused internally, externally, or their thoughts were completely blank (no thoughts). Including these categories allowed us to identify genuine waking thoughts (i.e., thoughts related to *something*, whether internal or external stimuli) while filtering out instances of *mind-blanking*: moments of empty conscious awareness where our mind goes seemingly 'nowhere' and, as such, are void of any phenomenological qualities (Ward & Wegner, 2013). If participants reported being asleep at the time of probe delivery, they then indicated whether they had been dreaming or not. To ensure no waking thoughts were mistakenly classified as dream thoughts (or vice versa), all probes included the above items for distinguishing between mental states (for more details, see Supplementary Materials: Experience-Sampling Items).

There were two ways participants could report that they were not experiencing any thoughts whatsoever, in the case of mind-blanking while awake, or when they simply could not recall any dreams. In either of these cases, participants were asked to report on the last thought they remembered having. This guaranteed all probes contained roughly the same number of items, helping to ensure participants would not dishonestly report their mental state to avoid giving a full response. Nevertheless, reports in which participants indicated they were asleep but not dreaming, or mind-blanking, were ultimately dropped from analysis.

2.2.3 Thought qualities

After differentiating dreams and waking thoughts, each probe then queried the core phenomenological qualities of participants' stream of thought. Specifically, participants rated their thoughts in terms of: fluidity, novelty, vividness, topical shifts, meaningfulness, bizarreness, emotional valence, spontaneity, interestingness, and mood.[4] Participants rated their thoughts along each of these dimensions on a scale from one to five (see figure 1 for exact item wording and response choices).

[4] Although mood is not a quality of thought per se, we included it given the interrelatedness between cognition and mood (Killingsworth & Gilbert, 2010).

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Thought Quality	Item	Response Options
Valence	*The content of my thoughts was…*	1 (Very negative) to 5 (Very positive)
Mood	*How were you feeling emotionally?*	1 (Very bad) to 5 (Very good)
Fluidity	*My thoughts were moving freely (i.e., I wasn't guiding them)*	1 (Strongly disagree) to 5 (Strongly agree)
Novelty	*My thoughts were novel (i.e., I've never experienced or thought them before).*	
Vividness	*My thoughts were clear and vivid.*	
Topical Shifts	*My thoughts were jumping from topic to topic.*	
Meaningfulness	*My thoughts felt important and meaningful to me.*	
Bizarreness	*My thoughts were bizarre and unusual.*	
Spontaneity	*My thoughts came to mind spontaneously/out of nowhere.*	
Interestingness	*My thoughts were interesting to me.*	

Figure 1: Experience sampling items and response options.

2.2.4 Compensation

Participants received SONA credits based on the percentage of probes they completed by the end of the seven day experience sampling period. All participants were given one credit for attending the initial lab session and completing the training procedure. After the sampling period, participants who completed 80% or more of the thought probes earned two additional SONA credits (for a total of three credits), while those who completed 50–80% earned one additional SONA credit (for a total of two credits).

2.3 Measures

2.3.1 Transliminality

Transliminality was measured with the Revised Transliminality Scale (RTS), a 17-item true/false questionnaire developed by Lange (2000). As described in the introduction, the RTS is the prevailing measure of transliminality and demonstrates strong psychometric properties. Sample items include, "I have felt that I had received special wisdom, to be communicated to the rest of humanity" and "I have sometimes sensed an evil presence around me, although I could not see it". Transliminality is calculated as the sum of all 'true' responses, with possible scores ranging from 0 to 17.

2.3.2 Overall continuity of thought

Although thoughts were assessed across multiple qualities, one aim of this study was concerned with *overall* continuity of thought and its relationship with transliminality. Thus, to create a measure of overall thought continuity, each participant's experience sampling data were transformed into a single variable

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quantifying the overlap between dreaming and waking thought reports. This variable, *Cohen's coefficient of overlap* (OVL_2), is a multi-dimensional measure of effect size defined as the statistical overlap between two distributions. As such, OVL_2 gives a standardized measure of the similarity between two groups (Del Giudice, 2013)—or in the context of this study, between two mental states. Importantly, OVL_2 accounts for covariation between dimensions, ensuring that any dream-wake similarity that is due to a correlation between any two thought qualities (e.g., *interesting* and *meaningful*) is partialed out.

We used an R function (Del Giudice, 2019) to compute OVL_2 for each participant. The input for this function included two data matrices (one per mental state) containing the raw scores of all probes per participant across all 10 thought qualities. Typically, this function uses the two matrices provided to it to calculate covariance between dimensions (used to partial out shared variance). However, since calculating covariance for each participant separately would have inflated variability (due to being based on a small sample of reports), we instead calculated covariance using the entire sample of waking and dream reports. Consequently, the covariance matrix used in computing OVL_2 was held constant across participants. Finally, we employed a log transformation of OVL_2 since preliminary analyses showed these data were positively-skewed. Thus, to sum up, overall continuity of thought was operationalized as the log-transformed, multi-dimensional overlap between each participant's dreaming and waking thought distributions.

2.4 Data exclusions

A total of 4095 experience sampling reports were collected from the final sample (N = 116). However, 567 reports were dropped because participants indicated they were either mind-blanking (241 reports) or asleep but not dreaming (326 reports). Of the remaining 3528 reports, 3168 were classified as waking reports and 360 were classified as dreams.

Twenty-nine participants did not submit any dream reports and so were excluded from the analysis predicting overall continuity of thought from transliminality (since their OVL_2 could not be computed). This particular analysis therefore used data from the 87 participants who submitted at least one dream and one waking report; this data set contained 360 dream reports and 2565 waking reports.

2.5 Data analysis

The hierarchical nature of experience sampling data necessitates using multilevel models to account for missing data across participants as well as within-person variability across sampling events. We therefore used linear mixed-effects models to examine the prevalence of different thought qualities in dreaming and wakefulness, the relationship between transliminality and waking phenomenology of thought, and in our post-hoc analyses examining the link between transliminality and continuity in specific thought qualities.

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When examining the relationship between transliminality and overall continuity of thought, the data were no longer hierarchical (due to collapsing all sampling events per participant into a single observation) and thus a mixed-effect model was inappropriate. However, since overall continuity of thought was derived from a different number of thought reports per participant, it is likely participants with fewer reports (and likely more variance in their reports) would have been overrepresented in a simple linear regression model. Accordingly, we used a weighted linear regression model wherein the weights for each observation were based on the relative proportion of dream and waking reports (calculated separately then added together) per participant.

All statistical analyses were performed using R Statistical Software (v4.2.1 R Core Team, 2017) and all multilevel models were fit using restricted maximum likelihood with the *lme4* package (Bates et al., 2015). Statistical tests for fixed effects were conducted using *t*-tests with Satterthwaite degrees of freedom approximations using the *lmerTest* package (Kuznetsova et al., 2020). To determine statistical significance, the standard alpha criterion of $p < 0.05$ was adopted and corrected for multiple comparisons using the Holm-Bonferroni method (Holm, 1979). Specifically, a separate Holm-Bonferroni correction was applied to each set of analyses (i.e., one per aim including the exploratory analyses). Moreover, to maximize the transparency of our analyses, we discuss significance in terms of both unadjusted and adjusted alpha levels and report exact *p*-values from all statistical tests (except in cases when $p < .001$).

3 Results

3.1 Continuity of thought by quality

Which thought qualities were more prevalent in dreams? Which were more prevalent in wakefulness? Were there any qualities that showed no difference between waking and dreaming? To examine these questions, we ran 10 separate multilevel models (one per thought quality) with mental state (i.e., dreaming vs. wakefulness) as a fixed effect and thought quality as the dependent variable. Participant was included as a random effect for all models.

Results showed dream thoughts were rated as significantly more fluid, novel, bizarre, spontaneous and interesting than waking thoughts (all *p*s < .001). Participants also reported better mood in dreams compared to waking ($p = .019$), however this effect was not significant after a Holm-Bonferroni correction. Conversely, waking thoughts were reported as more vivid than dreams ($p < .001$). Meanwhile, no difference was found between waking and dreaming thoughts in terms of their meaningfulness, emotional valence, or the amount of topical shifts (all *p*s > .05). Figure 2 shows the mean values for each thought quality split across waking and dreaming, while table 1 reports standardized beta coefficients (with 95% confidence intervals) and significance values for each of these tests.

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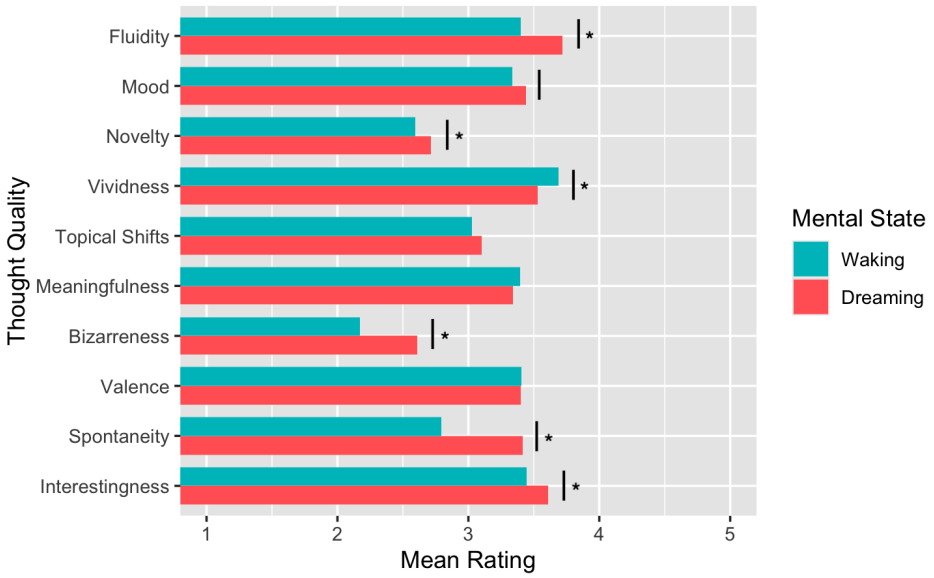

Figure 2: Bar plot of mean response values by thought quality and mental state. Each quality was rated on a scale from 1 to 5. Statistical significance was based on multilevel models with thought quality as the dependent variable, mental state as the independent variable, and participant as a random effect. Vertical black bars indicate significance at $p < .05$ level. Asterisk indicates significance after Holm-Bonferroni adjustment.

Comparing Dreams and Waking Thoughts			
Thought Quality	*β*	*[95% CI]*	*p*
Fluidity	**-.38**	**[-.48, -.28]**	**< .001***
Mood	**-.12**	**[-.23, -.02]**	**.019**
Novelty	**-.15**	**[-.25, -.05]**	**.002***
Vividness	**.28**	**[.18, .38]**	**< .001***
Topical Shifts	-.08	[-.18, .02]	.136
Meaningfulness	.09	[-.01, .18]	.072
Bizarreness	**-.55**	**[-.64, -.45]**	**<.001***
Valence	.01	[-.09, .12]	.780
Spontaneity	**-.64**	**[-.74, -.54]**	**<.001***
Interestingness	**-.18**	**[-.28, -.08]**	**<.001***

Table 1: Separate multilevel models predicting each thought quality with mental state as a fixed effect and participant as a random effect. Mental state was coded as (0) for dreaming and (1) for wakefulness. Bolded items indicate significance at p <.05 level. Asterisk indicates significance after Holm-Bonferroni adjustment. β = Standardized slope coefficient, CI = confidence interval.

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3.2 Transliminality and dreamlike waking thoughts

Does transliminality show any relevance for predicting anomalous or dreamlike thoughts during wakefulness? To test this, we ran separate multilevel models with thought quality as the dependent variable, transliminality as the predictor variable, and participant as a random effect. Since we were interested in the presence of dreamlike experiences occurring *during wakefulness*, only data from waking reports were included in these analyses.

Results showed transliminality significantly predicted waking thoughts that were more bizarre (p < .001) and interesting (p = .003). Transliminality also predicted better mood (p = .013), more novel thoughts (p = .033), more meaningful thoughts (p = .009), and more positively-valenced thoughts (p = .023)—importantly however these effects were no longer significant after correcting for multiple comparisons. Recall the previous analysis showed that levels of novelty, bizarreness, and interestingness were all heightened in dreams relative to waking thoughts; hence, as expected, we find evidence that transliminality is associated with experiences in waking life that are dreamlike in character. See table 2 for estimates of standardized slope coefficients (with 95% confidence intervals) and significance values for each of the multilevel models.

Transliminality and Waking Thoughts			
Thought Quality	*β*	*95% CI*	*p*
Fluidity	.07	[-.03, .16]	.155
Mood	**.10**	**[.02, .18]**	**.013**
Novelty	**.10**	**[.01, .19]**	**.033**
Vividness	.10	[.00, .20]	.06
Topical Shifts	.07	[-.02, .16]	.132
Meaningfulness	**.14**	**[.04, .24]**	**.009**
Bizarreness	**.18**	**[.09, .27]**	**<.001***
Valence	**.10**	**[.01, .18]**	**.023**
Spontaneity	.06	[-.03, .16]	.165
Interestingness	**.14**	**[.05, .24]**	**.003***

Table 2: Separate multilevel models predicting each thought quality with transliminality as a fixed effect and participant as a random effect, using data only from waking reports. Bolded items indicate significance at p <.05 level. Asterisk indicates significance after Holm-Bonferroni adjustment. β = Standardized slope coefficient, CI = confidence interval.

3.3 Transliminality and overall continuity of thought

Does transliminality predict greater continuity of thought after aggregating across all thought qualities? To test this, we ran a weighted linear regression model with

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transliminality as the predictor variable and overall continuity of thought as the outcome variable. Recall overall continuity of thought was operationalized by log-transforming the statistical overlap (OVL_2) between each participant's dreams and waking reports (see Methods). Contrary to our hypothesis, transliminality did not predict overall continuity of thought ($\beta = 0.028$, $t(85) = 1.039$, $p = .302$). These results suggest that individuals both low and high in transliminality show no difference in continuity of thought, at least when all thought qualities are considered at the same time.

3.4 Exploratory analyses: Transliminality and continuity in specific thought qualities

Given the null finding relating transliminality with overall continuity of thought, we explored the possibility that transliminality was associated with continuity in *particular* thought qualities. To test this, multilevel models were run with each thought quality as the dependent variable, predicted by mental state, transliminality, and the interaction of mental state with transliminality. For each thought quality, a significant interaction would imply a differential relationship between transliminality and that quality in dreaming compared to wakefulness. Depending on the direction of that interaction, as well as the direction of the main effect of transliminality, this would correspond to either more (or less) continuity in that particular dimension of thought.

Results showed a significant interaction between mental state and transliminality while predicting levels of bizarreness (β = 0.12 [95% CI = (.03, .21)], $p = .011$), but only *before* adjusting for multiple comparisons. We therefore interpret this effect as a "trending" or "marginal" interaction, and take it to suggest that transliminality may moderate the effect of mental state on reported levels of bizarre thoughts, such that higher transliminality is associated with increased similarity between dreaming and waking thoughts in terms of bizarreness. In other words, when it comes to the bizarre features of one's thoughts, individuals higher in transliminality seem to show greater continuity of thought.

In addition, we see a significant main effect of mental state (β = -.55 [95% CI = (-.64, -.45)], $p < 0.001$), but not transliminality (β = 0.01 [95% CI = (-.06, .18)], $p = .723$) when predicting bizarreness of thought. A significant main effect of mental state indicates dream thoughts were reported as more bizarre than waking thoughts, even while controlling for trait-level differences in transliminality. Parameter estimates of the interaction terms for each multilevel model are displayed in table 3. For the full set of parameter estimates (including main effects) across all interaction models, see the Supplementary Materials.

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Interaction of Mental State and Transliminality			
Thought Quality	*β*	*95% CI*	*p*
Fluidity	.04	[-.05, .13]	.390
Mood	.07	[-.02, .17]	.147
Novelty	.09	[-.01, .18]	.064
Vividness	.00	[.19, .09]	.960
Topical Shifts	-.02	[-.11, .08]	.737
Meaningfulness	-0.01	[-.10, .07]	.752
Bizarreness	**.12**	**[.03, .21]**	**.011**
Valence	.01	[-.08, .11]	.794
Spontaneity	.03	[-.06, .13]	.473
Interestingness	.00	[-.08, .10]	.855

Table 3: Separate multilevel models for each thought quality, predicted by mental state, transliminality, and the interaction of mental state with transliminality. Only the interaction effects are included here (main effects can be found in the Supplementary Materials). Bolded items indicate significance at p < .05 level. Asterisk indicates significance after Holm-Bonferroni adjustment. β = Standardized slope coefficient, CI = confidence interval.

4 Discussion

In this study, we aimed to replicate and extend past evidence of continuity of thought, confirm whether individual differences in transliminality predict dream-like thoughts in wakefulness, and determine whether transliminality predicts greater overall continuity of thought.

When comparing phenomenology of thought across dreaming and wakefulness, we find suggestive, though mixed, support for an extended continuity model. Emotional valence of thoughts, meaningfulness, and degree of topical shifts remained similar across the sleep-wake cycle. Indeed, we found no statistical difference in the intensity of these features between waking and dreaming states. On other dimensions of thought however, disparities between dreams and wakefulness were observed; dream states comprised relatively more bizarre, fluid, spontaneous, interesting, and novel thoughts, whereas waking thoughts were more vivid.[5] Collectively, these findings provide evidence for continuity in some thought

[5] It should be noted that even substantial disparities in qualities could be seen as evidence for continuity, as such disparities often can, and in this case do, reflect only differences in degree rather than kind. Admittedly, the current data do not allow for a fair comparison of these accounts however, since participants were not able to indicate when a particular quality was completely absent from their experience.

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qualities, while also indicating that other qualities may in fact differ between waking and dreaming—a general pattern that mirrors past work (Gross et al., 2021; Kahan & LaBerge, 2011; Perogamvros et al., 2017), and which illustrates the benefits of investigating continuity of thought at a more fine-grained level.

Focusing on the more granular differences between waking and dream mentation, we find several intuitive distinctions. First and foremost, we find evidence that thoughts during dreaming are substantially more bizarre in comparison to waking thoughts—a result consistent with large volumes of work positing bizarreness as a key feature of dream mentation (Hobson et al., 1987; Scarone et al., 2008; Schredl, 2010; Williams et al., 1992). Indeed, it is likely the reader has personally experienced the often incoherent and illogical nature of dreams. However, there is some disagreement concerning how bizarre dreams really are, with evidence suggesting some elements of dreams, such as emotions and actions, are no more bizarre than in normal waking life, whereas other elements, such as cognition, do show greater bizarreness—as was found in the present study (Revonsuo & Salmivalli, 1995). Moreover, one way bizarreness can often manifest in dreaming is 'discontinuity' in thought, which closely resembles the notion of topical shifts (i.e., "My thoughts were jumping from topic to topic")—a thought quality that did not differ between dreaming and waking in our sample. Overall, the evidence that bizarreness is a key feature of dream mentation is promising, though not entirely convincing. Secondly, and also in line with past work, we found evidence that dream thoughts are experienced as more novel, spontaneous, and fluid than waking thoughts (Fox & Christoff, 2018; Gross et al., 2021). But what might these differences in thought qualities actually *mean* in terms of subjective experience? It could be speculated that greater fluidity in dreaming, for example, may manifest as a sense of passivity, wherein one feels they are simply watching the dream unfold before them, rather than exerting any direction or control over it. All in all, many of the findings revealed here show medium-to-large effect sizes, corroborate past work, and mirror our intuitive understanding of the differences between dreaming and wakefulness. This work therefore likely provides a trustworthy descriptive account of phenomenology of thought as it changes across the sleep-wake cycle.

Next, we examined the prediction that individuals higher in transliminality encounter an increased prevalence of dreamlike features in their waking thoughts. In line with this prediction, we found that transliminality was positively associated with waking thoughts that were more novel, bizarre, and interesting—qualities that were also found to be elevated in dreaming across the sample as a whole. It is perhaps unsurprising that qualities such as *novelty* and *bizarreness* were associated with greater transliminality, given the earlier discussion of the possible link between transliminality and creativity, coupled with the fact that creativity is commonly defined as the ability to generate *new* and *unusual* ideas (Guilford, 1967). It may be especially important to replicate this link between novelty and transliminality given that it did not withstand the statistical correction. We also found that transliminality predicted features that were not characteristic of dreaming such as

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increased meaningfulness and more positive emotional valence, though it is possible these effects were simply due to chance. Furthermore, several other features of dream thoughts, including increased spontaneity and fluidity, were not predicted by transliminality. Taken together, these findings suggest that transliminality is relevant for explaining some, but not all, dreamlike aspects of waking thoughts.

We now turn to the final aim of this study, concerning the relationship between overall continuity of thought and transliminality. Contrary to our hypothesis, transliminality did not predict greater continuity of thought in terms of the aggregate pattern of thought qualities. However, this may have been partially due to the coarseness of the continuity measure which, by design, included a wide range of thought qualities. As such, it is plausible that the relation between transliminality and overall continuity of thought was diluted by certain thought qualities that simply did not vary across mental states. For example, a stable emotional tone across all thought reports (as was observed) may have masked variability in other qualities or added too much statistical noise to detect an association between overall continuity and transliminality.

Conversely, it could be the case that transliminality predicts continuity of thought for qualities that differ more substantially across dreaming and wakefulness. To test this, we assessed whether transliminality interacted with mental state to predict particular qualities of thought. Bizarreness was the only thought quality for which we found suggestive evidence of such a relationship. Specifically, we found that the disparity between dreaming and waking thoughts, in terms of bizarreness, was marginally less pronounced for individuals higher in transliminality compared to those lower in transliminality (i.e., transliminality was associated with greater continuity in bizarreness of thought across dreaming and waking). This trend roughly mirrors a recent clinical study in which researchers found heightened continuity in cognitive bizarreness across dream and waking reports for in-patients suffering from psychotic major depression (PMD), relative to a group of healthy controls (Cavallotti et al., 2014). Although transliminality and PMD are conceptualized as vastly different constructs, their purportedly shared role in predicting greater correspondence in bizarreness between waking and dreaming thoughts hints at underlying similarities. This finding, along with the previously discussed connection between transliminality, aberrant salience, and psychotic experiences (Reininghaus et al., 2016), provides further evidence that transliminality may have implications for certain kinds of psychopathology.

Zooming out, we see that while transliminality was not associated with general continuity of thought, it may be associated with continuity in bizarreness of thought. But does this suggest that the line between dreaming and waking is fuzzier for people high in transliminality? On the one hand, bizarreness is just one of many components of thought, and thus continuity in bizarreness may account for a relatively small part of experience. On the other hand, bizarreness has been proposed as a critical distinguishing factor between waking and dreaming mentation (Schredl, 2010), and so having more bizarre thoughts may mark a meaningful

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difference in the waking lives of these individuals, ultimately leading to a generally dreamlike experience.

4.1 Limitations and future directions

This study had several limitations worth nothing. First, although great care was taken to minimize spurious effects (e.g., by correcting for multiple comparisons), some of the effects—especially those linking transliminality with waking thought qualities—showed relatively small effect sizes and should therefore be replicated in future studies. Second, as is often the case with experience sampling paradigms, our study had a high degree of missing data. This was especially the case for dream data, in which nearly 30% of participants failed to submit a single dreaming report. If there was a systematic relationship between the tendency to respond to the thought probes and any other variables, this may pose problems for the robustness of the observed findings. Encouragingly, no relationship was found between transliminality and the number of submitted dream reports. Third, the generalizability of our findings are rather limited given the relatively specific subject population (i.e., undergraduate students). Future work should evaluate whether similar patterns of phenomenology of thought, and their associations with transliminality, can be replicated in populations that are more diverse in terms of other demographics, such as age and education level.

Aside from the methodological limitations, there are some conceptual limitations that warrant discussion. The transliminality account offers a compelling framework for understanding the correspondence between dreaming and wakefulness. This framework parsimoniously unites research on several higher-order characteristics (e.g., absorption, fantasy proneness) and their lower-level cognitive or perceptual correlates (e.g, dissociation). However, it is important to note the limits of the transliminality account, including its relative infancy and hence limited integration with empirical work. Future research on transliminality should therefore include measures from alternative frameworks (e.g., aberrant salience, boundary thinness), so that these accounts can be compared or possibly integrated with one another.

Further, the transliminality account may be especially limited by its dearth of measurement tools. Indeed, the strongest validity evidence for the RTS (by far the most prominent measure of transliminality) comes from psychometric analyses indicating strong unidimensionality and relations with other validated measures (Lange et al., 2000, 2019). Yet studies showing convergence between the RTS and more objective markers of transliminality are scarce, save for a few exceptions (Crawley et al., 2002; Houran et al., 2020). In many ways, the present study was an attempt to explore continuity of thought as a possible objective marker of transliminality; hence, the null finding that the RTS failed to predict continuity of thought could be seen as evidence against the convergent validity of the RTS, as much as it is evidence against a genuine link between transliminality and continu-

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ity of thought. Thus, future work should explore additional objective measures of transliminality, or at least seek evidence that the RTS predicts behavior that more closely matches the theoretical definition of transliminality.

Future research should also explore other thought qualities that may have relevance to transliminal experiences. In the present study, we sought to include a set of qualities that account for the major phenomenological aspects of everyday thought; however, it is possible that there are other qualities for which transliminals display greater continuity. For example, schizotypes report experiences of thought insertion, i.e., the felt sense that a thought arising in their minds is not their own (Ratcliffe & Wilkinson, 2015). This experience may be explainable under a transliminality account; specifically, thoughts arising suddenly and spontaneously from an individual's own unconscious may be experienced as coming from an external source. Hence, measuring qualities such as feelings of agency and control in future studies may reveal additional links between transliminality and continuity of thought.

Lastly, there is developing interest in capturing the phenomenological markers of personality, i.e. what personality *feels* like from the inside, in contrast to the outwardly-focused descriptions of personality rooted in affective, cognitive, or behavioral observations. Such research shows that personality plays an important role in predicting key qualities of thought (Gross, 2022; Zeitlen et al., 2022). Yet, given the relative dearth of research examining phenomenological correlates of personality, the potential implications of these individual differences remain unclear. It is plausible that phenomenological correlates of personality are merely a reflection of underlying processes. However, and perhaps more interestingly, it is also possible that phenomenological experiences may *cause* further differences in phenomenology, affect, and behavior. In support of this latter possibility is the finding that creative individuals not only experience certain phenomenological qualities of thought, but that these thought qualities also predict greater day-to-day creative behavior (Zedelius et al., 2021; Zeitlen et al., 2022). Hence, future work should investigate the impact these phenomenological markers of personality have on downstream aspects of peoples' experiences and behavior.

4.2 Concluding remarks

So, are there aspects of personality that blur the line between dreams and waking life? In this study, we examined how transliminality, in particular, and personality, more generally, map onto the experience of one's thoughts across dreaming and wakefulness. Although transliminality was not related to overall continuity of thought between waking and dream states, our findings indicate these states may be more alike for highly transliminal individuals in terms of *bizarreness of thought*. Under a transliminality account, the increased frequency of bizarre thoughts for these individuals can be explained by greater permeability between conscious and unconscious processes. Such a leaky boundary may allow the bizarreness of the

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dream world to enter waking life, potentially fueling greater creativity (Zedelius et al., 2021), pathology (Cavallotti et al., 2014), or perhaps both. In any case, the current study opens the door for further research into the phenomenological markers of personality and their downstream impact on wellbeing, creativity, and behavior more generally.

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