APPLYING A MODERN SITUATIONAL MEASURE TO IMPROVE THE RELIABILITY, VALIDITY, AND OUTCOME PREDICTABILITY OF DREAM ASSESSMENT

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

Dreams are hallucinatory activity occurring during sleep that nearly everyone experiences. To understand and research dreams, the field needs a reliable and valid dream assessment tool. The current, most used, measure (Hall and Van de Castle measure) has presented various reliability and validity issues since its development in 1966. I propose adapting the DIAMONDS taxonomy for situational characteristics to assess dream content. The validation process of this adapted measure has begun with foundational work informing the development of dream-specific subscales. In two preliminary studies I provide some evidence for substantive and structural validity of the adapted measure. Interim data analysis (n=53) in a larger study begins to establish its external validity as it relates to the measure's ability to predict next-day affect. The completion of this study should present some evidence of all phases of the validation process, therefore providing the field with a novel validated dream assessment tool

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HVDC .....Hall and Van de Castle

INTRODUCTION

Dreams do not have a single accepted definition; here I define them as the hallucinatory activity occurring during sleep that is often times bizarre or delusional but can also be quite ordinary (Pagel et al., 2001). Dreams are primarily recalled from the rapid eye movement (REM) sleep stage (Stickgold & Wamsley, 2017), which is characterized by a decrease in EEG amplitude power in lower-frequency components, ponto-geniculo-occipital spikes (which trigger rapid eye movements), and theta waves (Siegel, 2017). During REM sleep, there is activation in limbic and paralimbic brain areas that gives rise to detailed and vivid dreams. Motor cortices are also active and *inhibit* motor neurons to cause atonia, or the muscle paralysis during sleep that prevents us from acting out our dreams (Schwartz & Maquet, 2002). On the other hand, there is also the deactivation of other brain areas such as the frontal and parietal cortices (decreasing functions such as executive control and logical processing), which may facilitate the often-distorted perception and memory of dream mentation (Schwartz & Maquet, 2002). Although dreams can also occur during non-rapid eye movement (NREM) sleep, most people report those from REM sleep as they are more vivid, story-like, and bizarre, and they match what laypeople think of as a dream (Stickgold & Wamsley, 2017).

A majority of the population experiences dreams, presumably every night, and in some cases, people have reported remembering a dream from as early as one year of age (Stickgold, 2017; Nielsen, 2017). Dreams as a phenomenon do change across the lifespan. Dream studies in children have revealed that the rate of dream frequency recall during REM sleep increased from 20-30% in young children up to a median recall rate of 79% in older children and into adulthood (Domhoff, 2001). Dream content also develops over time in that young children under 5 often

report more static and bland images that eventually develop into sequences of events and finally into the developed narratives that adults report (Domhoff, 2001).

Dreams can also become negative and unsettling, which is when they may notably impact well-being. Nightmares, distressing and elaborate dream imagery resulting in sleep disturbances, affect 2-6% of the adolescents & adults on a weekly basis (Hasler & Germain, 2009). However, individuals with Post-Traumatic Stress Disorder (PTSD) are disproportionately impacted; dreams are a hallmark symptom of the disorder, with up to 90% of patients experiencing nightmares weekly (Hasler & Germain, 2009). In addition, even in non-clinical populations nightmares have been related to increased stress and poorer psychological well-being (Garcia et al., 2021; Zadra & Donderi, 2000).

Current dream theories

There are many theories in the field that attempt to answer the question of why we dream, especially considering the cases in which dreams become distressing. However, the purpose or function of dreams is still undetermined. Current theories in the field take social, biological, psychological, and evolutionary perspectives to try to answer this question. Though, there are also theories that suggest dreams are nothing more than the by-product of brain activity during sleep (J. A. Hobson & McCarley, 1977), or that they simply present a continuation of waking life experiences (Strauch & Meier, 1996).

There are theories that emphasize how dreams and, more specifically, their content influence waking life. Some theories posit an evolutionary purpose, such as the threat-simulation theory, which suggests we simulate threat during sleep to produce better survival rates in waking life. Another theory, social simulation theory, argues we simulate social interactions and skills during sleep to promote them during waking life (Revonsuo, 2000; Revonsuo et al., 2015). These

theories focus on an adaptive function in which dreams with threatening or distressing scenarios would be of particular utility.

Other cognitive theories suggest dreams help us process or cope with waking life experiences. There are several theories in this area. Dreams are inherently thought up as cognitive processes that occur during sleep and develop across the lifespan therefore strongly suggesting its cognitive influences (Domhoff, 2001). For example, one model of dreams derived from the cognitive neuroscience of memory suggests offline memory processing results in dreams as the brain works to process information during sleep (Wamsley & Stickgold, 2010); thus, is a part of cognitive processing. A similar theory, the NEXT-UP model, suggests dreams are a unique process for sleep-dependent memory function in which our past memories or current concerns are pulled in for new unexplored associations (Zadra & Stickgold, 2021). Overall these theories focus on the potential memory process dreams partake in, other theories take it a step further.

Emotion regulation and dreams

Emotion regulatory views of dreams suggests dreams serve a social cognition purpose where they diminish anxiety and negative affect. Many theories focus on nightmares. For example, the affective network dysfunction model suggests dreams, particularly nightmares, work to extinguish fear memories (Nielsen & Lara-Carrasco, 2007; Nielsen & Levin, 2007). This model considers neurophysiological processes, cognitive mechanisms, and clinical characteristics (e.g., anxiety disorders, post-traumatic stress disorder, etc.) to describe a process by which dreams extinguish fearful memories or associations. During dreams, the dreamer may connect ideas together, some which are fearful, and others which are not. Because of this, the original fearful memory becomes less distressing, though this happens gradually over time. This

process is especially evident (and in support of this view) by improvements in waking affect coincide with dreams becoming less distressing (Nielsen & Levin, 2007; Brown & Donderi, 1986; Pesant & Zadra, 2006).

On a shorter timescale, the emotional information processing hypothesis posits that dreams are necessary to cope with stressful life events because dreams are often tied to specific events or experiences (Cartwright, 1986), though later evaluations posit it also occurs in the presence of mild to moderate negative mood prior to sleep (Cartwright, 1998). Specifically, these changes in mood have been noted during the night (i.e., more positive and less negative dreams in later parts of the night) and post-sleep for both positive and negative emotions (Cartwright, 1998; Kramer, 1993).

Both the affective network dysfunction model and the emotional information processing theories pose similar functions, in that both suggest dreams are our way of working through high affective loads, but the emotional information processing hypothesis presents this a process that can be observable on a shorter scale and emphasizes its effects on negative *and* positive affect by reflecting waking life (Strauch & Meier, 1996). Overall, both theories suggest that dreams which impact emotion regulatory processes should evident in pre- and post-sleep affect changes. In order to evaluate the plausibility of these theories and advance the science of dreams, measurement tools for dream content are essential.

Current dream measurement

Unfortunately, given the nature of dreams, it is difficult to objectively study them and no system currently exists to do so. Very recent research has begun to look at polysomnography, specifically electrooculography (a measure for eye movements); lucid dreamers are asked to indicate if they are dreaming about something using specific eye movements (Konkoly et al.,

2021). However, this is in early stages with simple tasks (math, yes/no questions, etc.), and has been practiced only lucid dreamers rather than the general population. If we want to collect information on the narratives present in the typical dreamer, we must rely on their self-reports.

Although there have been many dream assessments, most of them assess dream recall frequency, beliefs about dream experiences, and types of dreams experienced (i.e., nightmares, recurrent, etc.), but not dream content (Zadra & Domhoff, 2017). Dream content analysis has mostly occurred in three kinds of scales: global self-rating scales, global rating scales by judges, and content analysis scales (Schredl, 2010). Global rating scales, administered by self-report or external judges, allow assessment of a dream in its entirety as well as the intensity of dream elements. Global rating scales like these can include open-ended, Likert-type, scales, or other questions that target specific dream characteristics. Global rating scales administered by self-report should provide the most valid assessment of a person's full dream experience compared to dream reports which may omit details. Content analytic scales differ from global rating scales in that content analytic scales are often nominal scales assessing the *occurrence* of certain objects or behaviors, while global rating scales assess the dream more holistically in terms of the dream experience and the overall extent or intensity (Schredl, 2010). The Hall and Van de Castle coding system is an example of a widely used content analytic scale.

Table 1. HVDC coding system

Eight Primary Categories	Secondary codes/subclasses	Tertiary codes/subclasses	Quaternary codes/subclasses
Characters	Number	Individual character	
		Group	
	Gender	Male	
		Female	
		Joint	
		Indefinite	
	Identity	Immediate Family Members	
		Relatives	
		Known characters	
		Prominent Persons	
		Occupational identification	
		Ethnic/nationality/regional identification	
		Strangers	
		Uncertain Identity	
	Age	Adult	
		Teenager	
		Child	
		Baby	
Social Interactions	Aggression	Non-physical	A1 Feelings of anger
			A2 Verbal or expressive anger
			A3 Negative or deceitful behavior
			A4 Accusations of verbal threats
		Physical	A5 Theft or destructions of someone's possessions
			A6 Aggressive behaviors towards a character
			A7 Attempt to physically harm someone
			A8 Aggression resulting in a death

Table 1. HVDC coding system (continued).

Eight Primary Categories	Secondary codes/subclasses	Tertiary codes/subclasses	Quaternary codes/subclasses
	Friendliness	F1 Feelings of friendliness	
		F2 Expressions of friendliness	
		F3 Friendliness expressed as gift-giving or loaning possessions	
		F4 Friendliness expressed as assisting/offering to	
		F5 Friendliness expressed as requesting to share a pleasant social activity	
		F6 Friendliness expressed with physical contact	
		F7 Friendliness resulting in long-term close relationship	
	Sexuality	S1 Sexual thoughts and fantasies	
		S2 Sexual propositions	
		S3 Kissing	
		S4 Non-intercourse sexual activities	
		S5 Sexual intercourse	
Activities	Physical		
	Movement		
	Location Change		
	Verbal		
	Expressive Communication		
	Visual		
	Auditory		
	Thinking		
Striving	Successes		
	Failures		

Table 1. HVDC coding system (continued).

Eight Primary Categories	Secondary codes/subclasses	Tertiary codes/subclasses	Quaternary codes/subclasses
Environmental Press	Good Fortune		
	Misfortune	M1 Barrier or obstacle	
		M2 Falling or in danger of falling	
		M3 Threaten by something in the environment	
		M4 Accidents with no injury or faulty/damaged possessions	
		M5 Injury or illness	
		M6 Death by accident or unknown cause	
Emotions	Anger		
	Apprehension		
	Sadness		
	Confusion		
	Happiness		
Physical Surroundings	Settings	Location	Indoor Settings
			Outdoor Settings
		Familiarity	Familiar Settings
			Distorted Settings
			Geographical Settings
			Unfamiliar Settings
			Questionable Settings
	Objects	Architecture	Residential
			Vocational
			Entertainment
			Institutional
			Details
			Building Materials
			Miscellaneous
		Household	
		Food	
		Implements	Tools

Table 1. HVDC coding system (continued).

Eight Primary Categories	Secondary codes/subclasses	Tertiary codes/subclasses	Quaternary codes/subclasses
			Weapons
			Recreation
		Travel	
		Streets	
		Regions	
		Nature	
		Body Parts	Head
			Extremities
			Torso
			Anatomy
			Sex
		Clothing	
		Communication	
		Money	
		Miscellaneous	
Descriptive Elements	Modifiers	Color	C+ (i.e., chromatic colors)
			C− (i.e., achromatic colors)
		Size	S+ (i.e., big, large)
			S− (i.e., small)
		Age	A+ (i.e., old)
			A− (i.e., young, new)
		Density	D+ (i.e., full, crowded)
			D− (i.e., empty)
		Thermal	T+ (i.e., warm, hot)
			T− (i.e., cool, cold)
		Velocity	V+ (i.e., fast)
			V− (i.e., slow)
		Linearity	L+ (i.e., straight, flat)
			L− (i.e., curved, crooked)
		Intensity	I+ (i.e., strong intensity)
			I− (i.e., weak intensity)

Table 1. HVDC coding system (continued).

Eight Primary Categories	Secondary codes/subclasses	Tertiary codes/subclasses	Quaternary codes/subclasses
		Evaluation	E+ (i.e., aesthetically pleasing or morally correct)
			E− (i.e., aesthetically unpleasant or morally incorrect)
	Temporal Scale		
	Negative Scale		

The Hall and Van de Castle coding system

Currently, there is no gold standard method of coding dream reports, and the field tends to rely on the Hall and Van de Castle (HVDC) coding system, which was initially developed by Hall in the 1940s, and then updated in collaboration with Van de Castle in the 1960s (Domhoff, 1999). The HDVC method had the best validity evidence, at least compared to other scales as of 1979, and at the time was the most widely used method of rating dreams (Winget & Kramer, 1979; Zadra & Domhoff, 2017). The field of dream content analysis has not advanced substantially since then. Use of a single dream content coding system is very beneficial as it allows for easier comparison across research studies, however the HVDC system has little validity evidence and is therefore not without flaws, as detailed below.

The Hall and Van de Castle coding system has extensive coding rules in an effort to increase interrater reliability. The HVDC system is made up of eight general categories which are characters, social interactions, activities, striving (i.e., success and failure), misfortunes & good fortunes, emotions, physical surroundings, and descriptive elements. These can then be broken down into additional subcategories, and even those are then divided into more subcategories (see Table 1). These codes can get increasingly complex. For example, when

coding characters, you first specify the number of characters, i.e., whether a single individual character is mentioned or if there is a group that you are counting as one character. You then specify gender of the character or character group: male, female, joint (for groups that include both men and women), and indefinite (when gender is not identifiable). Characters can also be identified by their familiarity to the dreamer, including immediate family members; relatives; known characters; prominent persons; occupational identification; ethnic, national, or regional identification; strangers; or uncertain identity. Finally, age of the characters is coded broadly: adult, teenager, child, and baby. As an example, you can see in Figure 1 that "the other customers" are coded as "2JSA" because they are a group (2) of presumably both male and females (J) that are strangers (S) presumed adults (A).

Figure 1. Example of coded dream using the HVDC system.

Series: NDSU National COVID Study – Wave 5 **Dream #:** 66 **Words:** 103

<table>
<tr><th>Characters</th><th>Aggression</th><th>Friendliness</th><th>Sexuality</th><th>Settings</th><th>Objects</th></tr>
<tr><td rowspan="2">2JSA</td><td>2JSA 6> D</td><td></td><td></td><td>IF</td><td rowspan="2">AV
FO</td></tr>
<tr><td colspan="3">Activities</td><td>Modifiers</td></tr>
<tr><td></td><td colspan="3">D P
2JSA M
D M</td><td rowspan="2"></td><td rowspan="2">Notes:</td></tr>
<tr><td>Failure</td><td>Success</td><td>Misfortune</td><td>Good Fortune</td><td>Emotions</td></tr>
<tr><td></td><td></td><td></td><td></td><td>CO, D
AN, D</td><td></td><td></td></tr>
</table>

#66

I went to a grocery store near my home in this dream. When I entered the store I picked up the usually things I would get from the store, like milk, bread and eggs. The dream was going fine until I noticed the other customers. They were all wearing masks and began to chase me. I was confused, so I ran out of the store. When I ran out of the door, I ended up back in the store and the sequence kept repeating itself. It did not stop until I woke up. It was a very weird dream and not very pleasant.

Note. An example of a coded dream from the NDSU National COVID Study at Wave 5, following the coding schematic used by Schneider & Domhoff (2022). Each color in the table represents a certain broad category, except for the purple color as it combines physical surroundings and objects.

The complexity continues as you move through the seven remaining categories. Social interaction gets coded into three main categories, which are then further broken down: aggression (with 8 subcategories), friendliness (with 7 subcategories), and sexuality (with 5 subcategories). Social Interactions also are coded in a way that distinguishes what character is involved, the recipient, or the provider of the coded interaction. For example, in Figure 1, the "2JSA 6> D" code indicates that the group of "other customers" (2JSA) chased (6, aggression subclass) the dreamer (>, points towards dreamer, D). Hall and Van de Castle report "perfect" (100%) agreement across two male raters in only 54-64% of these categories. For information on the reliability of all categories and subcategories across both reviewers from Hall and Van de Castle (1966), see Table 2. All additional categories are often subdivided and or indicate the interactions in a similar way, for continued information on the breakdown of the categories refer back to Table 1.

Table 2. Reliability percent agreement score and some correlation coefficients between two raters from Hall & Van de Castle (1966).

Main Category: (Dream Sample)	Reliability from percent agreement:	Reliability for two raters by correlation (if provided):
Characters (100 female dreams)	Perfect Agreement - 76% Presence of Character -93% Single v. Group – 92% Sex – 89% Identity – 81% Age – 92%	not provided

Table 2. Reliability percent agreement score and some correlation coefficients between two raters from Hall & Van de Castle (1966) (continued).

Main Category: (Dream Sample)	Reliability from percent agreement:	Reliability for two raters by correlation (if provided):
Social Interaction (50 dreams)	Aggressiveness: Perfect Agreement - 54% One detail wrong - 72% Friendliness: Perfect Agreement - 61% One detail wrong - 70% Sexuality: Perfect Agreement - 64% One detail wrong - 71%	r for # of social interactions scores Aggressiveness: r = .97 Friendliness: r = .91 Sexuality: not provided
Activities (50 dreams)	Perfect Agreement (all activites) – 85%	Total: r = 0.92 Physical: r = .92 Verbal: r = .98 Movement: r = .92 Only highest subcategories' correlations reported.
Successes & Failures (50 dreams)	Successes: Perfect Agreement – 56% Failures: Perfect Agreement – 100%	not provided
Environmental Press (50 dreams)	Misfortunes: Perfect Agreement – 71% Good Fortune: Perfect Agreement – 83%	not provided
Emotions (100 dreams)	Total Perfect Agreement – 63%	*r* = 0.76 (for groups of 10 dreams)
Physical Surroundings: Settings (100 dreams)	Total Perfect Agreement – 73%	Total Settings: *r* = .90 (for groups of 10 dreams) Location: *r* = .90 (range of subcategories: *r* = .85-.95) Familiarity: (range of subcategories: *r* = .80-.89) not all subcategory correlations provided.

Table 2. Reliability percent agreement score and some correlation coefficients between two raters from Hall & Van de Castle (1966) (continued).

Main Category: (Dream Sample)	Reliability from percent agreement:	Reliability for two raters by correlation (if provided):
Physical Surroundings: Objects (50 dreams)	Total Perfect Agreement – 83%	All object classes: $r = 0.99$
Descriptive Elements: Modifiers (50 dreams)	Total Perfect Agreement – 81% Range of perfect agreement among subcategories – 0%-100%	not provided
Descriptive Elements: Temporal & Negative Scale (50 dreams)	Temporal Scale: Perfect Agreement – 75% Negative Scale: Perfect Agreement – 96%	"generally in the nineties"

Methodological issues of HVDC

Agreement between judges

The HVDC system has often been reported as the most validated dream content assessment tool, however their original, reported reliability is actually poor. As listed in Table 2, measures in the HVDC system were validated using percentage agreement, and only a few with correlation coefficients. Interrater agreement, reported as percentage agreement, is ambiguous, misleading, and may not account for shared bias (Rosenthal & Rosnow, 1984). Two different raters can both agree, and they both can be wrong. In addition to the poor method of deriving interrater reliability, Hall & Van de Castle often grouped dream reports' codes (e.g., they grouped the analysis into chunks of 10 dreams, and reported agreement on the total number of codes across all ten dreams), which does not indicate agreement at the individual dream level. This might inflate their reliability data since this does not guarantee the codes match on the same dream report. Additionally, since the authors did not report their codes to the furthest or most

detailed level of coding at the level of individual dream reports, there is no way to derive their reliability with a more appropriate method such as a phi correlation which is more sensitive and can account for instances in which both raters may have been biased (Rosenthal & Rosnow, 1984). Thus, although the HVDC system did provide some reliability data (which was not always included during this time in other scales), the methods of reliability are not up to current standards.

Agreement with dreamers

Reliability and validity might also suffer because, while two judges may agree with each other, that does not mean they actually agree with the dreamer. One downside to the HVDC system is its reliance on external judges to rate dream reports. Although this coding system has explicit instructions and has demonstrated (according to Hall and Van de Castle) reasonable interrater reliability with external judges, a discrepancy can occur between external raters and the dreamers themselves. Schredl and Doll (1998) found that external raters underestimated positive emotions in dream reports compared to individual reports. The Hall & Van de Castle norms have concluded that negative emotions are predominant in dream reports, however this may be due to external raters not being able to adequately rate emotions in dream reports (Hall & Van de Castle, 1966). Intensity of emotions as well as been shown to be compromised with external raters and this can be especially problematic for its implications for the study of nightmares and research in samples with Post-Traumatic Stress Disorder (Röver & Schredl, 2017).

Overreliance on dream narratives and external coders

Additionally, the field has determined that written dream reports do not provide a complete picture of the original dream experience and its details (Hobson & Stickgold, 1994; Schredl & Erlacher, 2003). These methods typically first ask participants to describe their dream verbally or in written form. Next, judges (typically external raters, rather than the participants

themselves) code the dream in the categories mentioned in Table 1. These verbal and written reports often are missing details and may lack coverage of particular content, therefore limiting the information we can gather from dream reports. For example, if a participant does not explicitly mention if dream activity is something that happened in daily life (or not), we could not evaluate the continuity hypotheses from that dream report.

On a similar note, external judges are less likely to code bizarre (non-existing/impossible in waking life) events than are the dreamers (Schredl & Erlacher, 2003). It is also important to note external raters would not have the knowledge to identify scenarios that may appear normal but are very unlikely to occur in the participant's waking life. This information would become relevant when addressing to what extent elements from waking life are reflected in the participant's dream (e.g., when evaluating the continuity hypothesis). Hobson and Stickgold (1994) have suggested that in order to improve the validity of dream reports, researchers should use affirmative probes that ask about specific phenomena so that participants know what details of their dreams to specifically report. When implementing these methods, participants do report more bizarre and emotional characteristics in their dreams that would likely not otherwise be reported in a typical open-ended inquiry (Merritt et al., 1994; Resnick et al., 1994). Overall, this suggests that the HVDC may be more reliable when only considering external judges' interpretations of their dream reports, rather than the judges with the actual dreamer's experience. Since the HVDC system relies on written dream reports coded primarily by external judges, it may be missing details that are essential for evaluating the relevance of multiple theories simultaneously.

Theoretical validity

The HVDC system has its roots in psychoanalysis. Calvin Hall, the first developer of the scale, was heavily influenced by psychoanalysis and even wrote psychoanalytic texts, including

A Primer of Freudian Psychology (1954) and *A Primer of Jungian Psychology* (1973). Robert Van de Castle was mentored by Hall and thus likely shared similar views with regard to psychoanalytic perspectives in psychology (Bromley, 2014). The development and establishment of dream norms by this method of content analysis has provided the field with some important descriptive data of content in typical dreams (Hall & Van de Castle, 1966). This includes psychoanalytic content (no longer commonly reported) as well as other dream content (e.g., falling, negative emotions, etc.). However, since this system was developed, the field has moved away from psychoanalysis and moved toward evolutionary, cognitive, and other theoretical approaches to dreaming. Despite this shift, the poor reliability and validity of the HDVC system was not addressed; scientists either continued to use this scale, or ignored dream content altogether.

Because it was not updated, some of the categories from the HVDC system may no longer be relevant to the current theories in the field. Hall and Van de Castle describe developing their categories after having studied plenty of dream reports, which suggests some substantive foundation (Hall & Van de Castle, 1966). However, the development and deduction process leading to the final HVDC system are not described in-depth, therefore there is little documentation of their substantive validity process. Given the state of the field at the time, it is likely this measure will not assess the salient features of dreams which are consequential to modern theories. At the very least, additional validation evidence is needed to assess whether this tool is useful to gather empirical data that can be used to evaluate modern theories. This is crucial because the current categories (e.g., characters, objects, or descriptive elements) may not reflect current theories, unless researchers are looking for very specific experiences (see Table 1

for more examples). The HVDC system categories provide oddly specific descriptors of dreams that, in today's field, are no longer insightful.

The Hall and Van de Castle coding system at its conception included *additional* theoretical scales used on an ad-hoc basis, like castration anxiety and penis envy. Due to the state of dream theory at the time, the theoretical scales were developed under psychoanalytic theories meaning these ad hoc scales still do not cover content relevant to modern dream theories. Now, a majority of these subscale are no longer used as they are not inclusive of modern theory and frameworks (namely sociocultural concerns such as no code for non-binary interaction partners). This all speaks to the complexity in using this rating system (i.e., which categories matter, when, and for whom?), problems with reliability (different iterations of the same tool may produce different results), and poor substantive validity (item pools were not comprehensively developed and comprehensively evaluated). The scale has not seemed to stand in the face of time.

Limited quantitative and structural information

An additional major problem is the limited to no information on structural validity: to my knowledge there has been no evaluation of the factor structure of their codes. It's plausible that this type of analysis might have led to a phasing out of some of the codes inspired by psychoanalysis, or other codes that seem unrelated to either most of the content or salient features of dreams (e.g., thermal features). Additionally, this coding system is set up to provide more qualitative than quantitative data. The codes can be descriptive of dream and has been useful in providing some descriptive information of typical dream norms as seen in Hall & Van de Castle's (1966) norm reporting. However, there is little clarity as to how to quantitatively summarize these codes, which have multiple levels of depth which vary across subscales. Additionally, these codes are set up as dichotomous when continuous scores would be better to provide for statistical analyses of dream reports.

The need to modernize dream assessment

Dream science needs an updated measurement tool in order to advance the field. Additionally, most of the field has moved beyond psychoanalysis, therefore our tools should reflect the relevant perspectives in current theoretical work. Finally, due to the implications of dreams and nightmares research, our tools should be able to adequately assess both mundane and bizarre or emotional characteristics of dream experiences. Ideally, this tool would not have categories with many different coding options; rather, it should have pointed questions that are reliably answered by multiple raters (e.g., self-reports or trained coders) using continuous, Likert-based scales. Additionally, although alternative qualitative coding processes (e.g., identifying salient themes) may be useful, the science of dreams could benefit from a measure that broadly samples experiences relevant to multiple theories, thus facilitating comparison. Importantly, self-administered dream content analysis methods might improve the validity of dream science, as this methodology should more strongly capture the dreamer's experience. However, taking into consideration the current and historical uses of the HVDC system, ideally this new method could be self-reported, externally coded, or even administered via interview with the use of affirmative probes to improve its reliability. To summarize, we need a new, reliable and valid dream content measure of dream content that provides us with biopsychosocially relevant information, in order to evaluate current dream theories.

Table 3. Types of validity evidence.

Validity Phases	Defined	Forms of Validity
Substantive Validity (also known as content validity)	Does the measure represent the basic kinds of material they are supposed to represent?	Face Validity
Structural Validity	Does the scale's internal structure reflect the underlying trait variance of the target construct?	Item Analysis & Factor Analysis
External Validity (also known as criterion validity)	To what degree dos this measure correlate with other meaningful and relevant criteria?	Convergent and Discriminant Validity & Predictive Validity

Note. Information on types of validity based on the information of: Rosenthal & Rosnow (1984), Clark & Watson (1995), and Flake, Pek, and Hehman (2017).

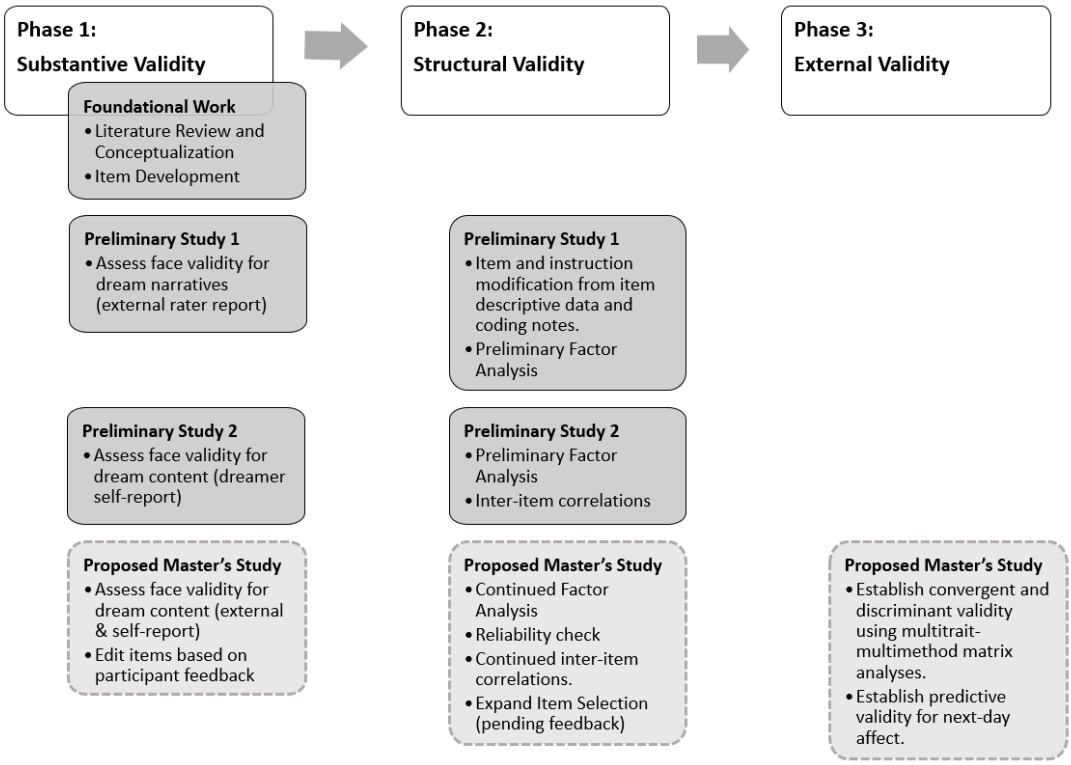
Proposed adaptation of DIAMONDS for dream content assessment

According to the continuity hypothesis, dreams reflect waking-life experiences and these experiences can affect the content of our dreams (Strauch & Meier, 1996). Therefore, I propose that the situational eight DIAMONDS taxonomy of major dimensions of situation characteristics, which has been developed and extensively validated to assess important situational perceptions, can also provide valuable information for dream content (Rauthmann et al., 2014). The dimensions are duty, intellect, adversity, mating, positivity, negativity, deception, and sociality; researchers landed on these eight major dimensions by following modern standards for developing and validating measurement tools. This included consideration of substantive validity using previous situational measures (e.g., the Riverside Situational Q-Sort), a working model of components of situation perception, and past literature on situation description and classification. Finally, there is strong evidence for structural validity of these subscales as assessed by a hierarchical analysis and bootstrapped factor analysis (Rauthmann et al., 2014). Further studies established that various situational cues (people/interactions, object, events, activities, and

places) and affordances relevant to waking experiences map onto the DIAMONDS dimensions, and that the DIAMONDS predict waking behaviors and affective experiences (Brown & Rauthmann, 2016; Rauthmann et al., 2014, 2015). Because this taxonomy was developed to capture psychologically-relevant and consequential features of situations, and dreams reflect to some extent waking experiences and affective states, using the DIAMONDS for dream content should help uncover their purpose, correlates, and sequelae of dream content. See Table 8 for detailed methodology on how the DIAMONDS is assessed.

In order to adapt the DIAMONDS measure for dream content, an extensive construct validation process is needed (see Fig. 2; Flake et al., 2017). Through the ongoing studies (Preliminary Study 1 and 2 described below) and the new proposed study, each phase of the construct validation process will be completed. Following the end of these research activities, I hope to have adapted and validated the DIAMONDS for dream content assessment. In adapting this measure for dreams, I hope to provide evidence for the DIAMONDS as a content analytic tool (via statements indicating occurrence of salient situational features likely present in dreams) as well as a rating scale (via responses on a scale indicating extent of situational features and overall dream experience), thus providing a better and more comprehensive dream report.

Figure 2. Construct validation process



In this project, I first describe the foundational work I completed, including the conceptualization and development of an initial item pool that addresses what the DIAMONDS would not capture about dreams or dream content based on a literature review (see the Conceptualization and Development of an Item Pool section). Two foundational mini-studies provide some evidence for substantive and structural validity, and serve as preliminary data for this project. Finally, in the proposed study herein I aim to establish external validity of these items while continuing to evaluate substantive and structural validity. Finally, evidence for external validity, specifically convergent and discriminant validity, will come from the proposed study, including a multitrait-multimethod matrix analysis. Evidence for predictive validity will come from regressions of dreams predicting next-day affect in the proposed study.

Conceptualization and developing an item pool

Despite the DIAMONDS being a well-developed measure for situational characteristics, dreams are not exactly the same as waking life. Therefore, the DIAMONDS measure needs to be adapted and validated to confirm it can adequately assess dream features. See Table 8 for a comparison between the original DIAMONDS and the adapted version for dreams. The development of the adaptation began with a literature search to identify relevant dream theories, a theoretical nomological net of dream correlates, and a review of existing scales to identify useful language for describing sleep experiences. This led to the development of five proposed factors to enhance the DIAMONDS for dream content: (1) continuity, (2) plausibility, (3) clarity, (4) memory, and (5) physiology. An additional change includes updates to the instructions. Participants are asked to describe a dream, rather than a situation, in their own words. Then, question stems ask them to reflect on their dream, rather than the situation (i.e., *The following question will ask you about your most recent dream*).

Once these sub-scales were decided, I developed an initial item pool that would capture what I believed was relevant in each subscale. I implemented some basic measurement principles to improve our items psychometric properties such as include reverse-scored items, avoid double-barreled items (i.e., items with a confusing or complex meaning), and duplicating items to assess item phrasing (Clark & Watson, 1995). Additionally, in order for the adapted portion of the DIAMONDS to match the original scale, the questions have the same response dimensions: a 7-point scale ranging from *Extremely uncharacteristic of your dream* to *Extremely characteristic of your dream* (differing from the original DIAMONDS scale in that it refers to *dreams* rather than *the situation*). The tentative final list of items amounted to 41 additional dream-specific items, of which we then moved on to preliminarily validate for its psychometric properties and

further inclusion in the proposed study. I expect these will follow a five-factor structure, but will conduct exploratory factor analyses and evaluate alternative conceptualizations in all studies.

Factor 1: Continuity

Although the continuity hypothesis does state that dreams reflect waking life experiences, it does not guarantee that dream experiences will be an exact replication or reflection of waking life experiences (Strauch & Meier, 1996). In order to assess the discrepancy between continuous and disconnected experiences in dream content I developed some items targeting the continuity or similarity between waking and dream experiences. Items assessed the origin of the dream content, whether it be from waking situations or cognitive-affective states. For example, participants report whether the events in their dream "have happened before in waking life" or "have no relation to events or preoccupations during my waking life." This factor resulted in 7 new items.

Factor 2: Plausibility

Relatedly, dream situations can often be fantastical or include impossible situations for waking life, such as flying, which would not be captured in the original DIAMONDS measure. Situations like these have been described as incongruent and discontinuous in past dream literature, and can be assessed with measures such as the Bizarreness Scale (Revonsuo & Salmivalli, 1995; Schredl & Erlacher, 2003). Incongruent dream features would include something that is inconsistent with waking life or typical laws of physics. Discontinuous features of dreams would include changes, transformation, or disappearances in dreams that would not occur in real life. Even though they are sometimes measured separately, both of these kinds of features describe experiences in dreams that differ from typical waking life experiences (Revonsuo & Salmivalli, 1995; Schredl & Erlacher, 2003). Therefore, I combined them and developed items which could tap whether dream content could be considered possible or

impossible in waking life. To assess this concept, I generated items that assess the plausibility of dream situations either by insinuating they are impossible (e.g., “The content of my dream could not realistically happen.”), improbable (e.g., “The abilities and behaviors of myself or others during my dream are unlikely but could happen.”), or possible (e.g., “My dream contained imaginable or possible situations.”). Nine plausibility items were developed.

Factor 3: Clarity

Another subscale that I considered relevant to include was ultimately labeled clarity, which assesses participants’ perceptions of their dreams or semi-lucidity in dreams. I considered labeling this factor Confusion, but felt Clarity was a more appropriate label because the items target the coherence and lucidity (or lack thereof) of their dream mentation, rather than confusing scenarios themselves. Semi-lucidity in dreams would likely present as some awareness of being in a dream but with confusion or skepticism (Mallett et al., 2021). Also, an additional feature in the Bizarreness Scale targets vague or uncertain scenarios (Revonsuo & Salmivalli, 1995; Schredl & Erlacher, 2003). Vague or uncertain scenarios can be the source of confusing narrative arcs or details of the dream experience because they are unidentifiable. Some items generated target the dreamer’s awareness of dream state (e.g., “At the time I was dreaming, I knew I was in a dream and that it wasn’t real life.”) while also targeting the clarity (or lack thereof) in the dream situations (e.g., “My dream is confusing because different events in the same dream do not seem to be connected.”). In total there are 7 clarity-related items.

Factor 4: Memory degradation

Considering the nature of dream recall but mostly dream amnesia, I thought it was important to assess the state of the dreamer’s memory of the dream. Items assessing the memory of the dream might be especially important if the measure if implemented with the Most Recent Dream (MRD) method instead of a daily diary approach. Additionally, data on the status of the

dream's memory can speak to the distressing nature for nightmares. A defining feature of nightmares is that they are vivid and well-remembered dreams. Items addressing the memory of the dreams (e.g., "When I first woke up from this dream it was clear but now I have forgotten most of it." and "Even though time has passed, I have little to no problem remembering my dream.") were developed. Six memory-related items were evaluated.

Factor 5: Physiology

Finally, I included items addressing any physiological responses the dreamer may have noticed about their dream experience. Although this specific subscale does not speak to the dream content like most of the new adapted measure, it is important for assessing distress associated with the dream and might capture some elements of distressing dreams that do not necessarily fit the clinical nightmare classification which specifies sudden awakenings and becoming quickly oriented and alert (American Psychiatric Association, 2013). These symptoms can also be informative as to the autonomic activation involved in distressing dreams or nightmares that some theories suggest are an indication of a failed or overwhelmed emotional regulatory process (Nielsen & Levin, 2007). The items included in the adapted measure should cover hyperarousal symptoms often seen in nightmares that may indicate the elevated distress in dream processes such as the fear memory extinction function that suggests nightmares are the results of a dysfunction in extinguishing a condition response to fearful stimuli (Nielsen & Levin, 2007). I included 12 items to address various physiology-related responses to dream content (e.g., "As I woke up from my dream/sleep, I felt my heart would jump out of my chest." and "As I was dreaming/sleeping, I was sweating.").

PRELIMINARY STUDY 1

The purpose of this preliminary study was to primarily determine its suitability for assessing dream (non-waking) content. However, this study could also be used to evaluate the utility of the adapted DIAMONDS (preliminary labeled the DIAMONDS-CCoMPP, which stands for the Clarity, Continuity, Memory degradation, Plausibility, and Physiology) (v1) for narratives of dream reports. In this sample, I was able to assess the substantive or face validity of the measure for dream narratives rated by external raters. This preliminary study also helped me determine whether any additional items should be included in the measure. In other words, when rating dreams I assessed if there were elements of dream narratives which could not be evaluated, and therefore needed to develop new items. Finally, if this demonstrates validity as an external rating system, then this may allow for a recasting of previously collected data to this system. For example, of dream narratives can be reliably coded, then perhaps even archival dream narratives could be coded by external judges in this manner.

Study 1: Methods

I examined the suitability for the DIAMONDS-CCoMPP measure to assess dream content based on dream narratives from an ongoing nationally-representative longitudinal study (*N*=301) of psychosocial factors, sleep, and health during the pandemic which have been followed since April 2020. Participants were recruited on Prolific for the original study; data for this assessment comes from Wave 5 (Summer 2022) and includes 55 participants' dream narratives which were randomly selected from the Wave 5 cohort (*N*=143). The participants (*N* = 55, 58.2% female, 79.3% white) provided a dream narrative using the Most Recent Dream (MRD) method in which they were asked to describe with as much detail as possible their dream as well as when the dream occurred as well as when and where they were when they

remembered this dream. A subsample of 55 dream narratives were selected for coding using a random number generator, with the exception that dream narratives were selected only if they had at least 10 words. I then referred to these narratives when completing the 41-item DIAMONDS-CCoMPP as an external rater.

I also examined the additional items' response distributions, skewness, and kurtosis to identify poor items that may need to be edited. By examining items' response distributions, I was aiming to ensure items had a relatively normal distribution while flagging abnormal distributions such as bimodal and flat distributions. I flagged items with a skewness or kurtosis exceeding ±2. I also examined the original DIAMONDS items' skewness and kurtosis values to ensure the items behave normally.

In addition to looking at the additional items' descriptive statistics, I ran a preliminary exploratory factor analysis to explore whether there was any evidence for my proposed factor structure. After reverse-coding the necessary items, I begin with a principal factor analysis with oblique rotation; this technique initially begins with a principal component analysis (with the goal of retaining as much variance as possible among the factors), then rotated it using the ProMax rotation (allowing the items to correlate, since theoretically these dream features can often be related). I examined all hypothetical factors with Eigenvalues greater than one and then further determined which ones to retain based on meaningful change in Eigenvalues across factors, factor distributions. When assigning items to factors, I considered the rotated standardized regression coefficient factor loadings and interpretability.

Table 4. Preliminary studies' descriptives

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Instructions to DIAMONDS. The following questions will be asking you to rate how characteristic the statement is about your dream (or situations in your dream) ranging from extremely uncharacteristic of the situation to extremely characteristic of the situation.		"Please tell us how much each statement applies or does not apply to the dream you just reported. Consider your dream as a whole and do not focus on any one detail or situation in the dream, unless that is all you remember. If a statement is neither characteristic nor uncharacteristic of your dream, select 4."	
Response dimensions to DIAMONDS. Extremely uncharacteristic of your dream>> Extremely characteristic of your dream.		"Extremely uncharacteristic of the dream" >> "Extremely characteristic of the dream"	
Item 1. Situation is enjoyable.	4.22(2.04) -0.35, -1.21	"Dream is enjoyable."	3.73(2.16) 0.12, -1.40
Item 2. A job needs to be done.	4.42 (1.96) -0.39, -0.89	no Δ	3.12(2.00) 0.63, -0.83
Item 3. Being counted on to do something.	3.96(1.78) -0.33, -0.53	no Δ	3.05(1.97) 0.53, -0.99
Item 4. Minor details are important.	4.00(1.61) -0.11, -0.82	no Δ	3.97(1.94) -0.04, -1.21
Item 5. Situation evokes values concerning lifestyles or politics.	3.53(1.45) -0.62, -0.04	"Dream evokes values concerning lifestyles or politics."	2.91(1.87) 0.54, -0.94

Table 4. Preliminary studies' descriptives (continued).

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Item 6. Situation affords an opportunity to demonstrate intellectual capacity.	3.49 (1.50) -0.46, -0.31	"Dream affords an opportunity to demonstrate intellectual capacity."	2.61(1.97) 0.99, -0.33
Item 7. Being under threat.	3.73(2.03) -0.05, -1.19	no Δ	3.65(2.46) 0.12, -1.70
Item 8. Being criticized.	3.53(1.64) -0.23, -0.51	no Δ	2.32(1.95) 1.33, 0.41
Item 9. Being dominated or bossed around.	3.71(1.63) -0.50, -0.48	no Δ	2.38(1.79) 1.03, -0.29
Item 10. Situation is playful.	3.69(2.01) -0.01, -1.35	"Dream is playful."	3.09(2.32) 0.56, -1.28
Item 11. A reassuring other person is present.	4.58(1.76) -0.66, -0.51	no Δ	3.53(2.48) 0.28, -1.61
Item 12. Being blamed for something.	3.09(1.54) -0.28, -0.90	no Δ	2.05(1.86) 1.64, 1.41
Item 13. Task-oriented thinking is called for.	3.38(1.81) -0.15, -1.29	no Δ	3.05(2.20) 0.58, -1.17
Item 14. Situation entails frustration.	3.95(2.09) -0.13, -1.34	"Dream entails frustration."	3.61(2.24) 0.19, -1.48
Item 15. Physical attraction is relevant.	2.49(2.12) 1.08, -0.23	no Δ	2.14(2.02) 1.59, 0.93

Table 4. Preliminary studies' descriptives (continued).

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Item 16. Situation would make some people tense and upset.	4.33(2.03) -0.30, -1.19	"Dream would make some people tense and upset."	4.28(2.31) -0.27, -1.50
Item 17. A person or activity could be undermined or sabotaged.	4.20(1.60) -0.73, -0.19	no Δ	2.88(2.07) 0.66, -1.01
Item 18. It is possible to deceive someone.	3.89(1.40) -0.81, 0.87	no Δ	2.46(1.91) 1.08, -0.08
Item 19. Someone in this situation might be deceitful.	3.82(1.60) -0.45, -0.42	no Δ	2.61(2.05) 0.88, -0.72
Item 20. Situation may cause feelings of hostility.	3.49(2.05) 0.17, -1.18	no Δ	3.04(2.25) 0.52, -1.35
Item 21. Situation affords an opportunity to express unusual ideas or point of view.	3.29(1.34) -1.03, -0.65	"Dream affords an opportunity to express unusual ideas or point of view."	2.62(1.80) 0.78, -0.64
Item 22. Situation could entail stress or trauma.	3.91(2.04) -0.16, -1.30	"Dream could entail stress or trauma."	4.14(2.30) -0.20, -1.50
Item 23. Close personal relationships are present or could develop.	4.93(2.00) -0.82, -0.51	no Δ	4.09(2.36) -0.15, -1.58
Item 24. Situation includes intellectual or cognitive stimuli.	3.44(1.29) -1.10, -0.16	"Dream includes intellectual or cognitive stimuli."	3.18(2.16) 0.58, -1.03
Item 25. Social interaction is possible.	5.29 (2.07) -1.15, 0.13	no Δ	4.81(2.15) -0.66, -0.92

Table 4. Preliminary studies' descriptives (continued).

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Item 26. Situation is humorous.	3.35(1.77) 0.06, -1.04	"Dream is humorous."	2.68(1.99) 0.82, -0.66
Item 27. Behavior of others presents a wide range of interpersonal cues.	4.13(1.28) -0.63, 1.17	no Δ	3.32(1.83) 0.25, -1.05
Item 28. Situation is anxiety-inducing.	3.85(2.07) -0.06, -1.17	"Dream is anxiety-inducing."	4.46(2.34) -0.38, -1.40
Item 29. Situation includes stimuli that could be construed sexually.	2.03(1.73) 1.41, 0.88	"Dream includes stimuli that could be construed sexually."	2(1.84) 1.72, 1.63
Item 30. Situation is sexually charged.	2.00(1.67) 1.42, 1.06	"Dream is sexually charged."	1.82(1.75) 2.06, 2.93
Item 31. Potential sexual or romantic partners are present.	2.73(2.19) 0.80, -0.82	no Δ	2.55(2.41) 1.16, -0.46
Item 32. Situation is simple and clear-cut.	4.71(1.36) -0.18, -0.82	"Dream is simple and clear cut."	4.28(2.05) -0.13, -1.15

Table 4. Preliminary studies' descriptives (continued).

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Instructions to additional questions. The following questions will ask you about your most recent dream.		"Please tell us how much each statement applies or does not apply to the dream you just reported. Some questions will also ask about your experience while dreaming or when waking up from the dream. Consider your dream as a whole and do not focus on any one detail or situation in the dream, unless that is all you remember. If a statement is neither characteristic nor uncharacteristic of your dream, select 4."	
Response dimensions to additional questions. Extremely uncharacteristic of your dream>> Extremely characteristic of your dream.		"Extremely uncharacteristic of the dream" >> "Extremely characteristic of the dream"	
Item 1. "The events in my dream have happened before in waking life."	3.85(1.66) -0.11, -0.38	no Δ	2.64(2.00) 0.84, -0.61
Item 2. "The events in my dream have happened before in real life."	3.87(1.67) -0.19, -0.30	no Δ	2.80(2.13) 0.70, -0.97
Item 3. "The events in my dream are similar to something that has happened to me before."	4.49(1.76) -0.40, -0.39	no Δ	3.22(2.38) 0.41, -1.47

Table 4. Preliminary studies' descriptives (continued).

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Item 4. "The events in my dream contain something I am currently worried or preoccupied about when I am awake."	4.00(0.90) -1.10, 4.56	"The events in my dream are related to something I have recently been concerned about or dealing with while I'm awake"	3.15(2.30) 0.55, -1.28
Item 5. "The events in my dream have nothing to do with what I experience during waking life."	3.56(1.23) 0.16, 0.31	no Δ	3.97(2.53) 0.08, -1.73
Item 6. "The events in my dream have never happened before in real life."	3.49(1.27) 0.27, 1.13	no Δ	3.86(2.42) 0.17, -1.62
Item 7. "The events in my dream have no relation to events or preoccupations during my waking life."	4.38(1.88) -0.15, -0.71	no Δ	4.51(2.40) -0.31, -1.50
Item 8. "The events in my dreams are unlikely but could happen."	5.27(1.64) -1.45, 1.35	"The events in my dreams may be unlikely but could happen."	3.88(2.14) -0.04, -1.34
Item 9. "The abilities and behaviors of myself or others during my dream are unlikely but could happen."	4.82(1.71) -0.95, -0.06	"The abilities and behaviors of myself or others during my dream may be unlikely but could happen."	4.19(2.04) -0.21, -1.13
Item 10. "My behaviors, thoughts, or feelings during my dream are out of the ordinary compared to my real life."	3.44(1.58) -0.13, -0.93	no Δ	3.32(2.20) 0.47, -1.21
Item 11. "The content of my dream could not realistically happen."	2.76(2.10) 1.07, -0.41	"The events in my dream are not realistically possible."	3.66(2.39) 0.29, -1.54

Table 4. Preliminary studies' descriptives (continued).

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Item 12. "My dream contained fantastical or impossible situations."	2.31(2.18) 1.27, -0.16	no Δ	3.65(2.37) 0.20, -1.53
Item 13. "My dream contained unlikely or surprising situations."	4.87(1.69) -0.53, -0.58	no Δ	4.47(2.23) -0.32, -1.38
Item 14. "My dream contained imaginable or possible situations."	5.44(1.88) -1.24, 0.46	no Δ	4.36(2.00) -0.38, -0.94
Item 15. "My dream sequence followed linear time, like how events happen in real life.	4.11(0.92) -0.22, 1.83	no Δ	4.69(1.92) -0.65, -0.50
Item 16. My dream moved around in time in a way that would not be possible in real life.	3.78(0.79) -2.43, 7.04	no Δ	3.03(2.11) 0.73, -0.74
Item 17. At the time I was dreaming, I knew I was in a dream and that it wasn't real life.	3.98(0.30) -4.61, 36.95	"When I was dreaming, I was aware that I was in a dream and not awake."	2.47(1.92) 1.04, -0.21
Item 18. "My dream followed a timeline that made sense and seemed to follow a story."	4.42(0.83) -0.53, 5.49	no Δ	4.70(1.97) -0.59, -0.64
Item 19. "The events and experiences in my dream seemed connected to each other."	4.51(1.02) -0.96, 4.09	no Δ	4.55(2.03) -0.49, -0.92
Item 20. "The events and experiences in my dream were not connected to each other."	3.47(1.03) 0.91, 3.76	no Δ	2.54(1.78) 0.85, -0.48
Item 21. "My dream is confusing because different events in the same dream do not seem to be connected."	3.55(1.03) 0.61, 3.99	no Δ	2.64(1.96) 0.94, -0.36

Table 4. Preliminary studies' descriptives (continued).

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Item 22. "At the time I was dreaming, my dream was vivid or very detailed."	4.15(1.03) 0.98, 2.56	no Δ	5.72(1.40) -1.14, 0.95
Item 23. "At the time I was dreaming, my dream seemed real and I only realized I was dreaming when I woke up."	4.16(0.71) 3.55, 12.48	"At the time I was dreaming, my dream felt so real that I did not realize I was dreaming."	5.31(1.82) -0.81, -0.28
Item 24. "Even though time has passed, I can easily remember my dream."	3.64(1.14) -0.08, 2.33	no Δ	5.42(1.41) -0.70, 0.12
Item 25. "Even though time has passed, I have little to no problem remembering my dream."	3.60(1.03) -0.91, 1.45	no Δ	5.51(1.55) -0.78, -0.20
Item 26. "As time has passed, my dream makes less and less sense."	4.05(0.59) 0.55, 5.90	no Δ	2.68(1.73) 0.91, -0.10
Item 27. "As time has passed, the details of my dream have begun to fade."	4.16(1.03) -0.13, 3.95	no Δ	3.19(1.98) 0.63, -0.89
Item 28. "When I first woke up from this dream it was clear but now I have forgotten most of it."	4.07(0.66) -1.66, 10.41	no Δ	2.73(1.86) 0.81, -0.58
Item 29. "At first my dream seemed to make sense but looking back now, I am confused about it."	3.93(0.72) -2.09, 10.31	no Δ	2.34(1.64) 0.95, -0.48
Item 30. As I woke up from my dream/sleep, my heart was racing.	4(0) -, -	no Δ	3.27(2.35) 0.42, -1.42

Table 4. Preliminary studies' descriptives (continued).

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Item 31. As I woke up from my dream/sleep, I felt my heart would jump out of my chest.	4(0) -, -	no Δ	2.85(2.19) 0.79, -0.83
Item 32. As I woke up from my dream/sleep, I felt calm.	3.82(0.72) -2.77, 8.44	no Δ	3.84(2.14) -0.02, -1.27
Item 33. As I woke up from my dream/sleep, I felt relaxed.	3.80(0.70) -2.99, 9.17	no Δ	3.59(2.16) 0.22, -1.32
Item 34. As I woke up from my dream/sleep, I felt at ease.	3.85(0.83) -1.36, 5.82	no Δ	3.59(2.13) 0.19, -1.28
Item 35. As I woke up from my dream/sleep, I felt comfortable.	3.85(0.62) -3.75, 15.75	no Δ	3.73(2.16) 0.04, -1.38
Item 36. As I woke up from my dream/sleep, I noticed I was breathing rapidly.	4(0) -, -	no Δ	2.85(1.93) 0.65, -0.81
Item 37. As I woke up from my dream/sleep, I noticed I was breathing rapidly.	4(0) -, -	no Δ	2.64(1.80) 0.84, -0.59
Item 38. As I woke up from my dream/sleep, I felt as if I could not move.	4(0) -, -	no Δ	1.64(1.28) 2.22, 4.63
Item 39. As I was dreaming/sleeping, I was sweating.	4(0) -, -	no Δ	2.5(2.14) 1.03, -0.51
Item 40. The contents of my dream made me wake up suddenly.	4.07(0.42) 6.52, 44.31	no Δ	3.08(2.22) 0.47, -1.33

Table 4. Preliminary studies' descriptives (continued).

Original Version in Preliminary Study 1:	Study 1 Item Descriptives: *M* (*SD*) Skew, Kurtosis	Modified Version in Preliminary Study 2:	Study 2 Item Descriptives: *M* (SD) Skew, Kurtosis
Item 41. As I woke up from my dream/sleep, I felt confused.	4.15(0.52) 4.18, 18.71	no Δ	3.70(2.13) 0.02, -1.37

Study 1: Results

Performance of the adapted DIAMONDS

The items' mean, standard deviation, skewness, and kurtosis values are presented in Table 4. The DIAMONDS items' descriptive statistics were assessed mostly to ensure these items continued to behave normally. In terms of skew and kurtosis, all items were within our normal range indicating the items were neither skewed or kurtotic. This was expected since the DIAMONDS items have already been extensively validated. These statistics begin to indicate that the DIAMONDS can be used to assess dream content.

Performance of the novel dream content items

The items' mean, standard deviation, skewness, and kurtosis values are presented in Table 4. In terms of distribution, of the 41 items, 40 had approximately normal distributions. One (item 11) had a distribution that appeared bimodal; I suspect the wording might be too restrictive. In terms of skew and kurtosis, some items had normal skewness *and* normal kurtosis (n = 15), despite the relatively low number of dream narratives coded thus far. However, the results also identified items with abnormal kurtosis (n = 11), or both an abnormal skewness and kurtosis (n = 9). In general, these items had low variability (and were thus identified as having problematic distributions), with the majority of ratings clustering at 4 (i.e., that item was neither characteristic nor uncharacteristic of the dream).

Two factors in particular seemed problematic: items from proposed factor 5 (physiology) and proposed factor 4 (memory degradation). This could due to the dream narratives not being detailed enough to provide an external rater with the information to rate these items, or the items performing poorly; self-reports of dream narratives would be needed to evaluate both possibilities. Additionally, after reviewing my notes when rating the narratives, and combining

these with the information revealed from the descriptive statistics, some items in other sections could benefit from being reworded (n = 6). Finally, I decided to change the wording of the instructions. All changes from Preliminary Study 1 to Preliminary Study 2 are in Table 4.

At this time, even though the sample size was low, I conducted a preliminary exploratory factor analysis of items with sufficient variation (items 1-16 & 18-29, covering hypothetical factors continuity, plausibility, clarity, and memory degradation). A four-factor solution fit the data best. A large portion of items were encompassed in a continuity-like factor (n = 11), including all of the original continuity items and some items from other proposed factors. A second factor (n = 6) included items from the proposed clarity factor (n = 4) and a few from the proposed plausibility factor (n = 2). A third factor included items only found in the proposed plausibility factor (n = 5), though not all of the originally proposed plausibility items. Finally, the fourth factor (n = 6) to come through seemed to encompass memory-like characteristics and included a majority of the original memory degradation items (n = 5) and one original clarity item. See Table 5 for results of this preliminary factor analysis.

Table 5. Preliminary study 1 factor analysis results.

Item	Factor 1 (≈Co)	Factor 2 (≈Cl)	Factor 3 (≈Pl)	Factor 4 (≈MD)	Developed for
Internal consistency reliability (Cronbach's α)	0.90	0.92	0.94	0.85	-
The events in my dream have happened before in waking life.	**0.97**	0.02	0.01	-0.08	Co
The events in my dream have happened before in real life.	**0.94**	0.01	0.02	-0.07	Co
The events in my dream are similar to something that has happened to me before.	**0.89**	0.01	0.01	-0.00	Co
The events in my dream have no relation to events or preoccupations during my waking life.	**0.70**	-0.03	0.23	0.03	Co
My behaviors, thoughts, or feelings during my dream are out of the ordinary compared to my real life.	**0.66**	-0.05	-0.27	-0.02	Pl
The events in my dream have nothing to do with what I experience during waking life.	**0.61**	0.12	0.01	-0.04	Co
The events in my dream have never happened before in real life.	**0.61**	-0.05	0.04	0.09	Co
My dream contained unlikely or surprising situations.	**0.61**	-0.05	-0.11	0.14	Pl
The events in my dream contain something I am currently worried or preoccupied about when I am awake.	**0.29**	-0.13	0.20	0.28	Co
At the time I was dreaming, my dream seemed real and I only realized I was dreaming when I woke up.	**0.24**	-0.04	0.02	-0.02	Cl
My dream is confusing because different events in the same dream do not seem to be connected.	0.07	**0.97**	0.02	-0.00	Cl
The events and experiences in my dream seemed connected to each other.	-0.01	**0.97**	0.07	0.01	Cl
The events and experiences in my dream were not connected to each other.	-0.01	**0.95**	0.07	0.01	Cl
My dream followed a timeline that made sense and seemed to follow a story.	-0.03	**0.81**	-0.27	-0.03	Cl
My dream sequence followed linear time, like how events happen in real life.	-0.06	**0.63**	0.14	0.06	Pl

Table 5. Preliminary study 1 factor analysis results (continued)

Item	Factor 1 (≈Co)	Factor 2 (≈Cl)	Factor 3 (≈Pl)	Factor 4 (≈MD)	Developed for
My dream moved around in time in a way that would not be possible in real life.	-0.01	**0.55**	-0.32	-0.03	Pl
The content of my dream could not realistically happen.	-0.01	0.02	**0.93**	0.01	Pl
My dream contained fantastical or impossible situations.	0.01	0.02	**0.89**	-0.03	Pl
My dream contained imaginable or possible situations.	0.09	0.00	**0.89**	0.04	Pl
The abilities and behaviors of myself or others during my dream are unlikely but could happen.	-0.10	-0.08	**0.83**	-0.06	Pl
The events in my dreams are unlikely but could happen.	-0.05	0.02	**0.82**	0.00	Pl
Even though time has passed, I can easily remember my dream.	-0.02	0.02	-0.02	**0.91**	MD
As time has passed, the details of my dream have begun to fade.	-0.02	-0.07	-0.11	**0.80**	MD
Even though time has passed, I have little to no problem remembering my dream.	0.05	-0.02	0.02	**0.79**	MD
When I first woke up from this dream it was clear but now I have forgotten most of it.	-0.02	-0.08	-0.15	**0.71**	MD
At the time I was dreaming, my dream was vivid or very detailed.	0.03	0.25	0.17	**0.63**	Cl
As time has passed, my dream makes less and less sense.	0.02	-0.01	0.07	**0.59**	MD
At first my dream seemed to make sense but looking back now, I am confused about it.	0.37	0.04	-0.03	**0.30**	MD

Note. Original Factor Designations: Co = Continuity; Pl = Plausibility; Cl = Clarity; MD = Memory degradation.

Study 1: Conclusions

Our additional items showed reasonable descriptive statistics considering it is in early stages of development. At this stage, these results are very informative for the adaptation process before the proposed master's study. After incorporating my notes while rating and the descriptive

statistics, I amended the items and moved forward with 41 total for Preliminary Study 2. Given the low variance in proposed factor 5 and the abnormal skewness and kurtosis of our proposed factor 4, it may be possible that external raters may not be able to rate these scales without sacrificing their reliability and validity. It is important to determine how these items behave when dreamers are using them, both to evaluate the distributional properties in self-reports (and whether they vary from external raters' reports), as well as whether dreamers themselves feel the items are sufficient in capturing their dream experience. This led me to launch preliminary study 2 in an online sample to evaluate the items' behavior when rated using self-reports.

PRELIMINARY STUDY 2

The purpose of this preliminary study was to evaluate the modified DIAMONDS-CCoMPP to determine its suitability for assessing dream (non-waking) content for self-reports. In this sample, we can again assess the substantive validity (refer back to Table 3) of the modified and additional items as a self-report measure for dream content (i.e., face validity). Additionally, this study aids in the identification and possible elimination of poor items before the proposed study based on the data's distributions as a self-report measure.

Study 2: Methods

We examined the suitability of the newly developed items in an online Prolific sample. The participants (N = 74; 50% female; 58.11% White, non-Hispanic) took the adapted measure in a 25-minute study online. Participants were asked to first report their dream using the Most Recent Dream (MRD) method to prime them to remember their dream. Once they completed the dream narrative, they were expected to rate their dreams on the modified DIAMONDS items and the modified additional items. Participants also answered a few dream frequency, sleep quality, and demographic questions at the end. We examined the items' response distributions to determine if any items should be eliminated or updated based on non-normal distributions or low variability. We decided to evaluate the items in 75 participants, considering it took 55 narrative ratings to see adequate response distributions in Preliminary Study 1 and we wanted to account for missing data. One participant's response was removed prior to analysis due to poor data quality.

Similar to the previous study, I examined the items' response distributions, skewness, and kurtosis to identify poor items that may need to be edited and to confirm the original DIAMONDS items are behaving normally. By examining items' response distributions, I was

aiming to ensure items had a relatively normal distribution while flagging abnormal distributions such as bimodal and flat distributions. I flagged items with a skewness or kurtosis exceeding ±2.

I also ran another preliminary exploratory factor analysis to explore whether there was any evidence for my proposed factor structure will all of the novel dream items. After reverse-coding the necessary items, I begin with a principal factor analysis with an oblique rotation; this technique initially begins with a principal component analysis (with the goal of retaining as much variance as possible among the factors), then rotated it using the ProMax rotation (allowing the items to correlate, since theoretically these dream features can often be related). I examined all hypothetical factors with Eigenvalues greater than one and then further determined which ones to retain based on meaningful change in Eigenvalues across factors and item loadings. When assigning items to factors, I considered the rotated standardized regression coefficient factor loadings, interpretability, and alpha reliability. In particular, factor loadings where one or more values were within 0.1 units where further examined to determine which factor fit best.

Study 2: Results

Performance of adapted DIAMONDS

The items' mean, standard deviation, skewness, and kurtosis values are presented in Table 4. These item descriptive statistics were assessed in order to corroborate that they continued to behave normally. All but one item of were within normal range of skew and kurtosis indicating that for the most part these items continue to behave normally. The item (i.e., Item 30 - "Dream is sexually charged") that was beyond the normal range of skew and kurtosis is a part of the Sexuality subscale of the DIAMONDS. However, I would note these values are within 1 unit of the normal range (i.e., the values did not exceed 3).

Performance of novel dream items

The items' mean, standard deviation, skewness, and kurtosis values are presented in Table 4. In terms of distribution, approximately 8 had a bimodal distribution. Of these seemingly bimodally distributed items three came from the proposed continuity factor, two from the proposed plausibility factor, two from the proposed memory degradation faction, and one from the proposed physiology factor. I suspect this is the case because the words of these items may seem restrictive which may lead the ratings towards the scale's anchors. In terms of skew and kurtosis, only one item had an abnormal skew and kurtosis (see Table 4 for values). The item (i.e., "As I woke up from my dream/sleep, I felt as if I could not move.") that presented an abnormal skew and kurtosis is a part of the physiology subscale of the novel dream items. Overall, most items seem to present a decent variability.

Although our sample size is still too low to conduct a well-powered factor analysis, I proceeded to conduct a factor analysis for informative purposes. The factor analysis seems to provide some support for the proposed factor structure. The first factor that arose was comprised of all the proposed physiology items (n = 12). The second factor that arose was comprised of all continuity items (n = 7), some plausibility items (n = 2), and one clarity item. The third factor that arose was comprised of primarily memory degradation items (n = 6), but also included one clarity item. The fourth factor that arose was comprised of primarily of plausibility items (n = 7), but also included one clarity item. Finally, the fifth factor that arose was comprised of the remaining clarity items (n = 4). Notably, the proposed clarity factor seems problematic (see Factor 5 in Table 6). The items in this proposed factor seem ambiguous as some loaded similarly on multiple factors and some items completely loaded on a different factor.

Table 6. Preliminary study 2 factor analysis results.

Item	Factor 1 (≈Ph)	Factor 2 (≈Co)	Factor 3 (≈MD)	Factor 4 (≈Pl)	Factor 5 (≈Cl)	Developed for	PS1 Loading	Current (PS2) Loading
Internal consistency reliability (Cronbach's α)	0.93	0.90	0.90	0.77	0.61	-	-	-
As I woke up from my dream/sleep, I felt calm.	**0.91**	-0.06	-0.04	0.02	0.28	Ph	-	≈Ph
As I woke up from my dream/sleep, I felt at ease.	**0.90**	-0.07	-0.09	-0.06	0.25	Ph	-	≈Ph
As I woke up from my dream/sleep, I felt comfortable.	**0.89**	-0.08	-0.04	-0.08	0.29	Ph	-	≈Ph
As I woke up from my dream/sleep, I felt relaxed.	**0.87**	-0.11	-0.05	-0.02	0.26	Ph	-	≈Ph
As I woke up from my dream/sleep, my heart was racing.	**0.81**	0.15	0.12	0.11	-0.31	Ph	-	≈Ph
As I woke up from my dream/sleep, I felt my hear would jump out of my chest.	**0.78**	0.17	0.15	0.15	-0.40	Ph	-	≈Ph
As I woke up from my dream/sleep, I noticed I was breathing rapidly.	**0.73**	0.06	0.12	0.08	-0.46	Ph	-	≈Ph
As I was dreaming/sleeping, I was sweating.	**0.69**	-0.01	0.05	-0.02	-0.19	Ph	-	≈Ph
As I woke up from my dream/sleep, I noticed I was moving around a lot and restless in bed.	**0.67**	0.14	0.02	-0.21	-0.19	Ph	-	≈Ph
The contents of my dream made me wake up suddenly.	**0.65**	0.03	0.01	0.06	-0.13	Ph	-	≈Ph

Table 6. Preliminary study 2 factor analysis results (continued).

Item	Factor 1 (≈Ph)	Factor 2 (≈Co)	Factor 3 (≈MD)	Factor 4 (≈Pl)	Factor 5 (≈Cl)	Developed for	PS1 Loading	Current (PS2) Loading
As I woke up from my dream/sleep, I felt confused.	**0.45**	-0.04	-0.23	-0.06	-0.17	Ph	-	≈Ph
As I woke up from my dream/sleep, I felt as if I could not move.	**0.43**	-0.16	-0.08	0.25	-0.41	Ph	-	≈Ph
When I was dreaming, I was aware that I was in a dream and not awake.	0.14	-0.10	0.04	0.09	**0.12**	Cl	-	≈Cl
The events in my dream are similar to something that has happened to me before.	-0.00	**0.93**	-0.06	-0.09	0.06	Co	≈Co	≈Co
The events in my dream have happened before in real life.	0.04	**0.92**	0.04	-0.11	-0.08	Co	≈Co	≈Co
The events in my dream have happened before in waking life.	0.05	**0.89**	0.08	-0.08	-0.05	Co	≈Co	≈Co
The events in my dream are related to something I have recently been concerned about or dealing with while I'm awake	0.11	**0.82**	-0.18	0.01	0.17	Co	≈Co	≈Co
The events in my dream have nothing to do with what I experience during waking life.	0.01	**0.80**	-0.11	-0.06	0.16	Co	≈Co	≈Co
The events in my dream have no relation to events or preoccupations during my waking life.	-0.04	**0.76**	0.14	0.17	0.07	Co	≈Co	≈Co
The events in my dream have never happened before in real life.	0.04	**0.74**	-0.01	-0.03	0.16	Co	≈Co	≈Co

Table 6. Preliminary study 2 factor analysis results (continued).

Item	Factor 1 (≈Ph)	Factor 2 (≈Co)	Factor 3 (≈MD)	Factor 4 (≈Pl)	Factor 5 (≈Cl)	Developed for	PS1 Loading	Current (PS2) Loading
My dream contained unlikely or surprising situations.	-0.28	**0.47**	-0.04	0.11	0.11	Pl	≈Co	≈Co
My behaviors, thoughts, or feelings during my dream are out of the ordinary compared to my real life	-0.01	**0.45**	0.04	0.21	0.09	Pl	≈Co	≈Co
Even though time has passed, I can easily remember my dream.	-0.00	-0.12	**0.85**	-0.08	0.13	MD	≈MD	≈MD
Even though time has passed, I have little to no problem remembering my dream.	0.04	-0.16	**0.84**	0.06	0.09	MD	≈MD	≈MD
When I first woke up from this dream it was clear but now I have forgotten most of it.	0.04	-0.01	**0.79**	-0.10	0.10	MD	≈MD	≈MD
As time has passed, the details of my dream have begun to fade.	-0.01	-0.07	**0.76**	-0.14	0.10	MD	≈MD	≈MD
At the time I was dreaming, my dream was vivid or very detailed.	0.04	0.11	**0.64**	-0.09	-0.07	Cl	≈MD	≈MD
As time has passed, my dream makes less and less sense.	-0.03	0.04	**0.62**	0.32	0.22	MD	≈MD	≈MD
At the time I was dreaming, my dream felt so real that I did not realize I was dreaming.	0.10	**0.22**	0.32	0.08	-0.17	Cl	≈Co	≈Co
My dream followed a timeline that made sense and seemed to follow a story.	0.06	-0.07	0.15	**0.72**	0.24	Cl	≈Cl	≈Pl

Table 6. Preliminary study 2 factor analysis results (continued).

Item	Factor 1 (≈Ph)	Factor 2 (≈Co)	Factor 3 (≈MD)	Factor 4 (≈Pl)	Factor 5 (≈Cl)	Developed for	PS1 Loading	Current (PS2) Loading
My dream contained fantastical or impossible situations.	-0.09	0.26	-0.13	**0.62**	0.18	Pl	≈Pl	≈Pl
The events in my dream are not realistically possible.	0.00	0.25	-0.22	**0.61**	-0.10	Pl	≈Pl	≈Pl
The events in my dreams may be unlikely but could happen.	0.12	-0.27	-0.31	**0.57**	0.01	Pl	≈Pl	≈Pl
My dream sequence followed linear time, like how events happen in real life.	-0.01	-0.02	0.16	**0.51**	0.06	Pl	≈Cl	≈Pl
My dream contained imaginable or possible situations.	-0.16	0.14	-0.03	**0.50**	-0.11	Pl	≈Pl	≈Pl
My dream moved around in time in a way that would not be possible in real life.	-0.05	-0.15	0.27	**0.43**	0.17	Pl	≈Cl	≈Pl
The abilities and behaviors of myself or others during my dream may be unlikely but could happen.	0.12	-0.04	-0.15	**0.42**	-0.00	Pl	≈Pl	≈Pl
My dream is confusing because different events in the same dream do not seem to be connected.	-0.07	0.14	0.19	0.09	**0.72**	Cl	≈Cl	≈Cl
The events and experiences in my dream were not connected to each other.	-0.11	0.23	0.11	0.18	**0.60**	Cl	≈Cl	≈Cl

Table 6. Preliminary study 2 factor analysis results (continued).

Item	Factor 1 (≈Ph)	Factor 2 (≈Co)	Factor 3 (≈MD)	Factor 4 (≈Pl)	Factor 5 (≈Cl)	Developed for	PS1 Loading	Current (PS2) Loading
At first my dream seemed to make sense but looking back now, I am confused about it.	-0.04	0.16	**0.40**	0.04	0.51	MD	≈MD	≈MD
The events and experiences in my dream seemed connected to each other.	-0.00	0.07	0.08	0.39	**0.40**	Cl	≈Cl	≈Cl

Note. Original Factor Designations: Ph = Physiology; Cl = Clarity; Co = Continuity; Pl = Plausibility; MD = Memory degradation.

Study 2: Conclusions

This second preliminary study demonstrates improved descriptive statistics from the first study. This supports the conclusion from preliminary study 1 that some items may not be apt for external raters but better for self-reporting. Additionally, participants did not report aspects of their dream as missing from the current version. The descriptive statistics and preliminary factor analysis are informative to continue the adaptation process. Primarily, to move forward I will modify items in the clarity factor to determine if they improve in the proposed study or if they should be removed.

Table 7. The current items of the DIAMONDS+ were modified based on the results of preliminary studies 1 & 2.

Item 1. The events in my dream have happened before in waking life.
Item 2. The events in my dream have happened before in real life.
Item 3. The events in my dream are similar to something that has happened to me before.
Item 4. The events in my dream are related to something I have recently been concerned about or dealing with while I'm awake.
Item 5. The events in my dream have nothing to do with what I experience during waking life.
Item 6. The events in my dream have no relation to events or preoccupations during my waking life.
Item 7. The events in my dream have never happened before in real life.
Item 9. The events in my dreams may be unlikely but could happen.
Item 10. The abilities and behaviors of myself or others during my dream may be unlikely but could happen.
Item 11. My behaviors, thoughts, or feelings during my dream are out of the ordinary compared to my real life.
Item 12. The events in my dream are not realistically possible.
Item 13. My dream contained fantastical or impossible situations.
Item 14. My dream contained unlikely or surprising situations.
Item 15. My dream contained unlikely or unrealistic.
Item 16. My dream contained imaginable or possible situations.
Item 17. My dream sequence followed linear time, like how events happen in real life.
Item 18. My dream moved around in time in a way that would not be possible in real life.
Item 19. When I was dreaming, I was aware that I was dreaming and not awake.
Item 20. My dream followed a timeline that made sense and seemed to follow a story.

Table 7. The current items of the DIAMONDS+ were modified based on the results of preliminary studies 1 & 2 (continued).

Item 21. My dream followed a timeline that was clear and coherent.
Item 22. The events and experiences in my dream seemed connected to each other.
Item 23. The events and experiences in my dream were not connected to each other.
Item 24. My dream is confusing because different events in the same dream do not seem to be connected.
Item 25. At the time I was dreaming, my dream was vivid or very detailed.
Item 26. At the time I was dreaming, my dream was clear and elaborate.
Item 27. At the time I was dreaming, my dream felt so real that I did not realize I was dreaming.
Item 28. At the time I was dreaming, my dream was so vivid and felt realistic.
Item 29. Even though time has passed, I can easily remember my dream.
Item 30. Even though time has passed, I have little to no problem remembering my dream.
Item 31. As time has passed, my dream makes less and less sense.
Item 32. As time has passed, the details of my dream have begun to fade.
Item 33. When I first woke up from this dream it was clear but now I have forgotten most of it.
Item 34. At first my dream seemed to make sense but now I don't remember many details.
Item 35. As I woke up from my dream/sleep, my heat was racing.
Item 36. As I woke up from my dream/sleep, I felt my heart would jump out of my chest.
Item 37. As I woke up from my dream/sleep, I felt calm.
Item 38. As I woke up from my dream/sleep, I felt relaxed.
Item 39. As I woke up from my dream/sleep, I felt at ease.
Item 40. As I woke up from my dream/sleep, I felt comfortable.
Item 41. As I woke up from my dream/sleep, I noticed I was breathing rapidly.
Item 42. As I woke up from my dream/sleep, I was moving around a lot and restless in bed.
Item 43. As I woke up from my dream/sleep, I felt pressure on my body or an inability to move.
Item 44. As I was dreaming/sleeping, I was sweating.
Item 45. The contents of my dream made me wake up suddenly.
Item 46. As I woke up from my dream/sleep, I felt confused.

Note. The item numbers here do not apply to the prior studies. The item numbers here reflect the items in the following study.

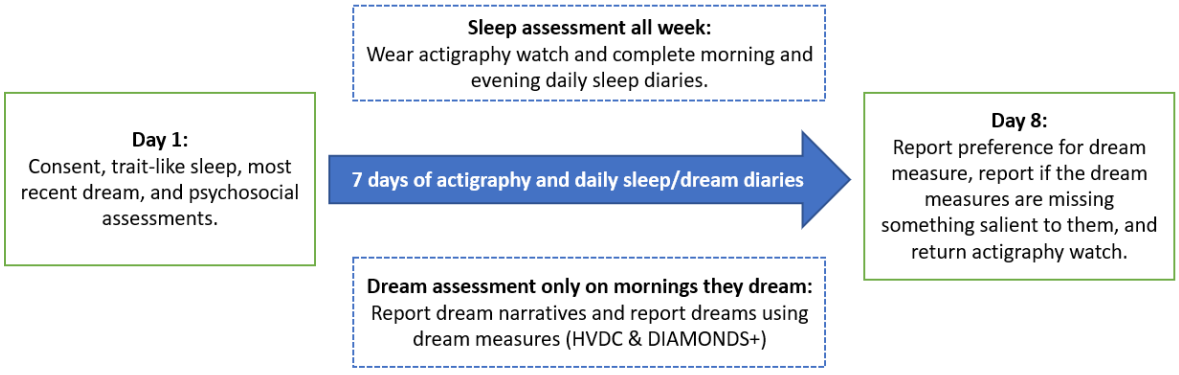
METHODS

My foundational work and the preliminary studies have established some evidence for substantive and structural validity. The next step was to establish external validity of the adapted DIAMONDS+ measure. This study's aims were to establish both content and criterion validity. Content validity was assessed by evaluating the convergent and discriminant validity of strongly related variables and those it should not be related to. The study's primary aim was to evaluate the DIAMONDS+'s utility for future empirical work by assessing its criterion validity, specifically predictive validity, of the measure for next-day affect.

Participants

For this next step of the construct validation process I utilized a larger convenience sample. An *a priori* power analysis in G*Power considering an $\alpha = .05$ and $ß = .80$ reveals I must recruit at least 309 participants to detect small-to-medium differences in overall adjusted variance explained in a linear multiple regression in order to assess the measure's predictive value of next day affect. In order to account for attrition, I aim to recruit 350 participants. The current preliminary results for disquisition purposes utilize the data of 53 participants.

Figure 3. Study 3 procedure timeline



Procedure

I launched a week-long study to answer my research questions. Participants come into the lab for their first visit in which they will first consent to participate in the study. During this lab session participants complete a Qualtrics questionnaire which includes measures on dreams, sleep, and other psychosocial measures (see Measures section). Since I aim to compare our dream measures, we randomized the order of which measure appears first in order to avoid any order effects. Participants are prompted to get the research assistant for further instructions when completing the dream and sleep questions to ensure their understanding. After they have completed the dream reports and all other questionnaires, participants take some brief computer tasks as well as Ishihara's Color Deficiency Test. The computer tasks include a self-referent encoding task (SRET), Operation Span (OSPAN) task, and the Stroop task. Additionally, health measures such as neck circumference, height, weight, and blood pressure are taken in the lab.

Participants are given instructions for the actigraphy, Qualtrics daily diaries, and dream reporting they will be completing through the week. Participants are expected to wear the actigraphy watch for one week and complete the evening and morning sleep diaries. During the morning diaries they will also be asked if they had a dream last night, if they did, they will be redirected to an additional survey. The additional survey will include the current version of the DIAMONDS+ (described in Table 7), the Hall and Van de Castle system, as well as other dream, sleep, and affect questions. In total we expect to collect 1-2 dream reports from participants by the end of the week (Schredl, 2004). After reporting their dreams on both scales, we will request participant feedback on the measure (i.e., Is it missing something? Do you think it assessed your dreams adequately? Which method did you prefer? etc.). Once the week is done participants will return to the lab to return their actigraphy watch and to answer some more questions. At this visit

we will conduct a short interview in which we probe for participant's feedback on the measure to assess if any further changes are needed to the measure.

Measures

Dream assessment

DIAMONDS+

Informed by my literature review and the results of preliminary studies 1 and 2, I will use the adapted DIAMONDS (v3) to measure dream (non-waking) content. Changes to this measure, considering Preliminary Studies 1 and 2, are summarized below. The current version is included in Table 8.

Table 8. Comparison table for the original DIAMONDS measure and the newly adapted DIAMONDS+.

	DIAMONDS	**DIAMONDS+**
Number of items	32-item	45-item
Subscales	8 Duty, Intellect, Adversity, Mating, Positivity, Negativity, Deception, Sociality	13 Duty, Intellect, Adversity, Mating, Positivity, Negativity, Deception, Sociality, Continuity, Plausibility, Clarity, Memory Degradation, Physiology
Response dimensions	7-point or 9-point scale; "Extremely characteristic/uncharacteristic of the situation"	7-point scale; "Extremely characteristic/uncharacteristic of the dream"

Hall and Van de Castle Coding System

The HVDC coding system has been extensively described above, however in order to include in this portion of the study, I have converted the codes into question form in order to be administered by self-report. It is possible that in translating the HVDC system into a survey format it may perform differently than the original coding system (preliminary study data may

reveal the comparison) and if so this may provide some evidence for only modifying our current dream content assessment and not switching to another.

Other dream measures

The Most Recent Dream Method is a popular method of gathering dream narratives and has been typically used in groups setting such as this proposed study (Domhoff, 1996). This method asks participants to report the date their dream occurred as well as when and where they recalled it. They are asked to describe their dream as detailed as possible. The original version will be presented in the laboratory visit so that we can walk-through how to complete this portion of the study in the following week of actigraphy and daily diaries. During the week, participants will report if they had a dream last night during their morning diary. If so, they will be presented with this prompt, but it will be slightly modified as it will simply prompt them to think about a dream they had last night instead of recalling another.

The Dream Recall Frequency Scale was developed by Schredl as a single-item for a larger survey study (Schredl, 2004). This is a 7-point scale ranging from never, less than once a month, about once a week, several times a week, and almost every morning. I included this scale in order to determine if the adapted DIAMONDS scale provides us with more information than someone's dream recall frequency.

The Dream Intensity Inventory developed by Yu (2008) is 20-item tool that targets dream recall frequency, frequencies of intense dream episodes, and experiences during dreaming. This measure was also included to determine if the adapted DIAMONDS scale provides us with more information than the frequencies of different dreams and the experiences they evoke.

Sleep assessment

Sleep measures

Various dimensions of sleep will be assessed with different sleep measures. First, participants will provide some information on their typical sleep schedule on scheduled and unscheduled days. In addition to those questions participants will be responding to the RU-SATED scale (Buysse, 2014), the Pittsburgh Sleep Quality Index (Buysse et al., 1988), the PROMIS Sleep Disturbance Scale (Short Form 8b; Yu et al., 2012), the PROMIS Sleep Related Impairment (Short Form 8a; Yu et al., 2012), Insomnia Severity Index (Morin et al., 2011), Sleep Hygiene Index (Mastin et al., 2006), Bedtime Procrastination Scale (Kroese et al., 2014), Epworth Sleepiness Scale (Johns, 1991), Nightmare Disorder Index (Dietch et al., 2021), and the Horne-Ostberg Morningness Eveningness Scale (Horne & Östberg, 1976). These tools will help us learn more about our participant's sleep and sleep-related factors.

Actigraphy

In addition to the sleep measures, sleep will be assessed behaviorally through actigraphy. Participants will be expected to wear the actigraphy watch for one-week and complete the accompanying sleep diaries. Data from actigraphy and the sleep diaries should provide us with behaviorally-assessed time in bed, total sleep time, sleep onset latency, sleep efficiency, and wake after sleep onset.

Affect

Positive and Negative Affect Scale

We will include the Positive and Negative Affect Scale (PANAS) to assess our primary outcome of next day affect. In the laboratory visit we include the PANAS-X which is the expanded 60-item version which has reported a high reliability between sample for positive (α =

0.83-0.90) and negative (α = 0.79-0.93) affect (Watson & Clark, 1994). Additionally, we included the Positive and Negative Affect Scale Short Form (PANAS-SF) for the daily diaries which has this measure has reported a high reliability for both momentary and daily affect for positive (α = 0.89-0.90) and negative (α = 0.85-0.87) affect (Watson et al., 1988).

Other self-reported measures

In addition to the dream, sleep, and affect measures which comprise a main portion of the study, I have included additional measures that may become important to evaluate the emotion regulatory function of dreams. The added measure includes the Big Five Inventory 2 (Soto & John, 2017), Center for Epidemiological Studies Depression Scale (Radloff, 1977), Perceived Stress Scale (Cohen et al., 1983), PTSD Checklist for DSM-5 (Blevins et al., 2015), Impact of Event Scale-Revised (Weiss & Marmar, 1997), Posttraumatic Growth Inventory (Tedeschi & Calhoun, 1996), and the PROMIS Anxiety (Short Form 6a; Pilkonis et al., 2011) as well as some basic demographic questions. Some of these measures inform the convergent and discriminant validity but they may also inform the overall results as they relate to dream function.

Table 9. Study aims measures and their data source.

Aim	Data Source	Data
Substantive Validity	V2 Interview Feedback	Overall thoughts
		Experiences and perceptions of the methods
		Suggested improvements
		Preferred method
Structural Validity	V1 Survey	DIAMONDS+ Dream Report
	Daily Diaries	DIAMONDS+ Dream Report
Criterion Validity	V1 Survey	Perceived Stress
		Depression
		Executive Function
		Colorblindness
		Habitual Sleep
		DIAMONDS+ Dream Report
	Computer Tasks & Other	Depression
		Executive Function: Inhibitory Control (Stroop)
		Executive Function: Working Memory (OSPAN)
		Ishihara's Test for Color Deficiency
	Actigraphy	Time in Bed
		Total Sleep Time
		Wake After Sleep Onset
		Sleep Onset Latency
		Sleep Efficiency
	Daily Diaries	Time in Bed
		Total Sleep Time
		Wake After Sleep Onset
		Sleep Onset Latency
		Sleep Efficiency
		DIAMONDS+ Dream Report
Predictive Validity	Daily Diaries	Hall & Van de Castle Dream Report
		DIAMONDS+ Dream Report
		Positive & Negative Affect

Other measures

In order to establish convergent and discriminant validity while accounting for shared method variance, I also included some task-based measures. The Stroop task and OSPAN task are utilized as additional task-based measures of executive function, more specifically inhibitory control and working memory respectively (Psychology Software Tools Inc., 2020; 2022; Stroop, 1935; Turner & Engle, 1989). The self-referent encoding task (SRET) is utilized as an additional behavioral measure of depression-like cognitions (Dainer-Best et al., 2018; Liu & Tan, 2014). In addition to these computer tasks, participants took a brief version of the Ishihara Test for Color Blindness to have an additional measure of colorblindness.

Analysis plan

Substantive validity

Substantive validity will be assessed via descriptive statistics of participants' feedback throughout the study of the newly adapted dream measure. At the baseline survey, after reporting the most recent dream they can recall, participants are asked to rate both the HVDC and the newly adapted measure based on how frustrating, mentally-taxing, simple, and reasonable the measure is on a 4-point scale (1 = Not at all, 4 = Very much). Similarly, throughout the week, after reporting their dream, participants are asked to both the HVDC and the newly adapted measure based on how frustrating, mentally-taxing, simple, and satisfying the measure is on a 4-point scale (1 = Not at all, 4 = Very much). In addition to those items, participants are asked what percentage of the questions they were able to confidently answer based on their memory of the dream. Finally, at the end of the study participants provided their thoughts and feedback on both measures in a semi-structured interview.

Structural validity

Structural validity will be assessed by examining inter-item correlations of the proposed five factor that I have laid out in the Conceptualization and Item Development Section. I roughly expect those factors cover the continuity of their dreams to waking life, the plausibility of the experiences in their dreams, the clarity of their dream and their dream state, the condition of their memory of the dream, and some physiological responses to their dream. These items were developed based on the literature and past measure so they are meant to tap into those specific themes. I expect to see items developed under one factor to be highly correlated with each other and less so to the items corresponding to the other factors. I have chosen to assess the structural validity with inter-item correlations because this analysis can identify items that are unrelated or redundant in order to reduce the scale and increase its efficiency. For inter-item correlation analyses, I will use the latest dream report collected during the week of sleep and dream assessment in order to get the most accurate dream report (as compared to the report collected during Day 1's laboratory visit). The items will be evaluated using the field's benchmarks for inter-item correlations of $.15 \leq r \leq .50$ (Clark & Watson, 2019). These benchmarks should account for the inclusion of items that may not be extremely correlated with one another (at the lower end) but still represent a similar factor without sacrificing the unidimensionality of the subscale. At the higher end, correlations that are too high indicate items are so highly correlated that they may not be assessing sufficient variance in the construct. There may be room for improvement in the items included; I expect there will be changes based on the inter-item correlations and feedback from participants might inform additional items to existing factors or additional factors overall.

Additionally, I plan to preliminarily assess the factor structure of the additional DIAMONDS items by conducting an exploratory factor analysis. I hypothesize that the preliminary five factors I have laid out will come through in an exploratory factor analysis. In addition, to examining the factor structure I will examine the internal consistency reliability of the subscale. However, I acknowledge this is exploratory and thus a preliminary factor structure. This proposed study does not include the sufficient sample size needed to factor analyze this measure (at least 10 participants are needed per item). Thus, I anticipate completing an additional study in the future with sufficient power for a confirmatory factor analysis (perhaps in a sample with clinical characteristics).

Criterion validity

Criterion validity will be assessed by establishing convergent and discriminant validity. Convergent and discriminant validity will be derived from multitrait-multimethod matrix analysis to establish a nomological net. The criterion validity will be examined with multitrait-multimethod matrix because this analysis assesses whether the measure can provide information that defines dream experiences, distinguishes irrelevant characteristics, and can account for some of the shared methods variance. The goal will be to establish a range of relationships of the new measure to other constructs. Some dream, sleep, stress, and psychosocial measures will be assessed by typical self-report (during their laboratory visit) and through daily diaries. To assess criterion validity, I will be using the dream report, trait-like sleep, and psychosocial measures from the day one laboratory visit. The only exception will be the inclusion of actigraphy-assessed sleep variables to include an additional method of measuring sleep.

Hypothetically, the new measure should be most highly correlated with other measures of dreams, since they are all measuring constructs in the same domain consistent with measurement

principles (Clark & Watson, 1995). I expect this new measure to be related most closely to dream and sleep measures and less so to stress and psychosocial measures, establishing its convergent validity. I anticipate the new measure will have moderate correlations with other sleep measures (i.e., lower correlations with sleep measures than with dream measures) considering the evidence pointing towards differences in dream characteristics like dream recall, dream content, arousal or emotionality levels in samples that experience sleep disorders as well as considering they both concern non-waking behaviors (Schredl, 2009). These anticipated correlations are in line with prior research of more objectively assessed sleep and some self-reported sleep correlations which range between approximate average correlations of r = .12-.32 (Nielsen et al., 2017; Brand et al., 2011).

Next, I expect the new measure to be somewhat related to psychosocial measures, because their ties to mental health disorders (Garcia, Menge, & Duggan, 2023), but less so than sleep measures given dreams and mental health symptoms occur at different levels of consciousness (i.e., wake versus non-wake; Palagini & Rosenlicht, 2011). Prior research supports correlations in the small-to-large effect size range (i.e., ρs = .09-.42) with an approximate average of ρ = .31 (Solomonova et al., 2021).

An important component of discriminant validity involves confirming the measure is *not* related to things it should not be related to. I will assess this component using colorblindness, because I can think of no *a priori* reason why colorblindness should strongly relate to dream content. Additionally, I added executive function measures as an additional measure for discriminant validity. However, here I expect a small correlation (as opposed to none, as with colorblindness) because of previous literature on dreams and executive function with average correlation of r = .17 (Sandor et al., 2016). I anticipate some, but ultimately low correlations with

inhibitory control and working memory considering the decreased brain activation occurring during sleep and oftentimes dream states that would be tied to these executive functions (Hobson et al., 2000). Finally, across all of our metrics I expect a similar range but lower correlations with constructs assessed with a method other than self-report due to shared method variance as presented by measurement principles (Campbell & Fiske, 1959).

In summary, in the multitrait-multimethod matrix, I expect dream recall frequency and dream intensity to be highly correlated to the adapted measure; I expect sleep quality, wake after sleep onset, and sleep duration to be moderately correlated; I expect perceived stress, depressive symptoms, and anxiety to be minimally correlated to the adapted measure; and finally, I expect colorblindness to not be correlated to the adapted measure. Additionally, some sleep variables will be assessed using actigraphy as well. Only colorblindness will be assessed by self-report and a brief task. Therefore, I expect self-reported methods to correlated higher than the alternative reporting methods (i.e., actigraphy-assessed sleep, colorblind test, etc.).

Predictive validity

Predictive validity will be assessed through the measure's predictive validity for next-day affect. Affect is the chosen outcome based on the emotional regulatory theories of dreams that suggest these processes can happen at the day-to-day scale. I will assess its predictive power using multiple regression analyses. In the multiple regression analyses, we will use a dream report collected though the week of sleep and dream assessment. If there are multiple dream reports from the sleep and dream assessment week, we will opt to use the most recent dream report.

Comparison of the original DIAMONDS and the DIAMONDS+

First, I will evaluate the DIAMONDS and its adapted scales for dream content. In Model 1a and 1b, I will evaluate the original DIAMONDS scales, and the new scales independently,

while considering overall model fit and variance explained for next-day affect. The predictors in Model 1a will be the DIAMONDS dimensions (i.e., Duty, Intellect, Adversity, Mating, pOsitivity, Negativity, Deception, and Sociality) while also controlling for sex and prior-day affect. Similarly, the predictors for Model 1b will be the newly developed items grouped under subscales informed by a factor analysis while controlling for sex and prior-day affect. Then in Model 2, I will simultaneously evaluate the original and adapted scales. In this case the predictors will be the DIAMONDS dimensions and the newly developed subscales, while continuing to control for prior-day affect and sex. I expect to validate the DIAMONDS for predicting next day affect, and that the new adapted scales will predict next day affect over and above the original scales.

Evaluating the adapted DIAMONDS and the HVDC

Next, in Model 3, I will look at the HVDC's overall model fit and variance explained for next-day affect. The predictors for Model 3 will include eight HVDC categories informed by previous use of HVDC scores as well as controlling for sex and prior-day affect. In comparing the adapted DIAMONDS measure and the HVDC, I expect to see the DIAMONDS to have a higher overall model fit and variance explained for predicting next-day affect after a dream report. Finally, in a 4th (final) additive model, I will include both the HVDC and the adapted DIAMONDS+ to predict next-day affect. In this model the predictors include the DIAMONDS dimensions, the newly developed subscales, and the HVDC categories while continuing to control for sex and prior-day affect. I expect the model statistics will not increase significantly and that the HVDC system will not be a statistically significant predictor of next-day affect. Overall, I expect the new DIAMONDS measure to explain next-day affect above and beyond the HVDC.

INTERIM RESULTS

The current data analysis occurs in 53 participants (M_{age}= 19; 62.3% female; 86.8% White, non-Hispanic). The participants were recruited and participated between November 2023 and March 2024 through the NDSU Psychology subject pool. Their data comes from the baseline visit, daily sleep diaries, dream reports assessed throughout the week, and the final laboratory visit feedback. Each participant reported 1 dream at baseline, and then had the opportunity to report up to 2 dreams in the following week. Thus, participants could report up to 3 dreams total during the protocol. A majority of participants reported at least one dream throughout the week (96%) and some report up to two dream throughout the week (57%). I opted to use the latest dream people reported throughout the week for analyses. Specifically, for the multiple regressions assessing predictive validity we only utilized nights where evening and morning diary were completed at least within 2 hours of the intended time and had complete data (n = 35).

Substantive validity

Participants find the methods reasonable to use

The face validity of the measure was briefly assessed following dream reports both at the baseline visit and throughout the week with a few items on a 4-point scale (1 = Not at all, 4 = Very much). Additionally, the final laboratory visit also assessed their overall thoughts, experiences and perceptions of the method, suggested improvement, and a forced choice preferred method. The only significant difference in participant ratings appeared during the weekly dream reports. No significant differences in frustration, mental taxation, simplicity, or reasonableness arose at the baseline visit (ps ≥ .16) where participants often rated towards the midpoint. During the first dream reported throughout the week, participants found the DIAMONDS+ method simpler to use (M = 2.96, SD = 0.85) than the HVDC method [M = 2.65,

SD = 0.87; t(50) = 3.05, p = .004]. However, this difference was not significant at baseline (p = .16) or for the second dream report of the week (p = .29). Aside from this, there were no other significant differences in how participants felt reporting the dreams throughout the week (ps > .20), including in frustration, mental taxation, or satisfaction.

On average, at the baseline survey, participants reported being able to confidently answer the newly adapted measure based on their memory of the dream 71.7% of the time compared to 63.8% for the HVDC method. This difference was statistically significant (t(50) = 4.31, p < .0001). Additionally, participants reported being able to confidently answer the newly adapted measure based on their memory of the dream 78.7% of the time compared to 73.8% for the HVDC method for the first dream report of the week. This difference was statistically significant (t(50) = 3.81, p = .0004). Only for the second dream report of the week was the difference not statistically significant (p = .07). These results suggest that based on participant's recollection of the dream the newly adapted measure has potential for increased validity and reliability of dream reports.

When forces to choose, participants prefer the new measure

At the end of the study, in a forced choice question asking participants about their preferred method of reporting their dreams, 83% have indicated they preferred the newly adapted measure over the self-reported HVDC method. Of those who preferred the newly adapted measure, they reported doing so because it was easier to complete (61%), it was quicker to complete (16%), seemed more accurate (16%), and it allowed them to report relevant or important aspects of their dreams (25%), among other reasons. Overall, it appears participants favored the newly adapted measure because it was easier to understand and quicker to complete without compromising important details of their dreams.

That being said, a minority (17%) of participants preferred the HVDC measure. Of those that reported preferring the HVDC reported doing so because it was easier to complete (33%), seemed more accurate (33%), and it allowed them to report relevant or important aspects of their dreams (22%), among other reasons. Future analysis into the specifics of what participants liked about the HVDC method may inform improvements to the scale prior to publication. Participants' affective experience while completing the measures can impact their reliability and validity of the dream reports as well as dream reporting compliance.

Structural validity

Distributional considerations

To assess if our items were normally distributed, I evaluated each item's mean, standard deviation, skew, and kurtosis. The DIAMONDS items modified to be applied to dreams behaved normally for the most part. In terms of skew and kurtosis, three items were outside of the normal range for skew and kurtosis: Item 9 (Skew = 2.02, Kurtosis = 3.59), Item 29 (Skew = 2.02, Kurtosis = 3.2), and Item 30 (Skew = 3.39, Kurtosis = 12.49). Of the additional items, three were flagged for having skew and kurtosis beyond the normal range: Item 36 (Skew = 2.49, Kurtosis = 5.33), 41 (Skew = 2.74, Kurtosis = 7.64), 43 (Skew = 4.71, Kurtosis = 24.62), & 45 (Skew = 2.69, Kurtosis = 6.55). All of these items were developed under the hypothesized physiology subscale. Additionally, of the newly adapted items, two items were flagged for a potentially bimodal distribution: Item 5 and 7. Both of these items come from the hypothesized continuity subscale. The items that were flagged as skewed, kurtotic or potentially bimodally distributed will be kept in mind for possible removal in future iterations of the scale.

Inter-item correlations

Based on the average inter-item correlations, our best hypothesized subscales include the plausibility (r = .16) and memory degradation (r = .49) subscales. The physiology (r = .55) and the continuity (r = .64) subscales had higher average inter-item correlations, suggesting there is some redundancy in the items in this subscale. This suggests there is opportunity to reduce these subscales without compromising the inter-item correlation of each subscale. On the other hand, the clarity subscale had a lower average inter-item correlation (r = .13) suggesting there could be some improvement in the subscale in future iterations of the scale. However, the average inter-item correlation is still near the suggested range for a subscale (i.e., r = .15; Clark & Watson, 1995). Overall, in line with my hypothesis, most of our hypothesized subscales are within or relatively close to the suggested range for valid unidimensional subscales.

Plausibility

Among the plausibility items, the inter-item correlations ranged from very minimal (r = -.007) to very large correlations (r = .84). Notably, one item ("My dream moved around in time in a way that would not be possible in real life.") was repeatably very minimally correlated with other items. This suggests this item might not be as related to plausibility as originally designed. Among our highly correlated item pairs are items that might not provide additional information for the subscale and therefore should be considered when limiting the subscale. Since the average intercorrelation is on the lower end of the suggested range, the priority would be to remove the minimally correlated item. At this stage, those items tentatively are Item 14 and Item 15, but I will re-evaluate these correlations when data collection is complete. If the items continue to perform poorly, I might either remove them at this stage, or edit them and evaluate

whether they need to be removed at a next stage of the validation process in a non-student sample.

Memory degradation

Among the memory degradation items, the inter-item correlations ranged from medium (r = .19) to very large correlations (r = .83). The items in this proposed subscale all seem to have similar ranges of correlations with each other. Since the average inter-item correlation is within the suggested range, it is likely this subscale does not need many modifications. However, future iterations of the scale might still consider reducing some of the high correlations to reduce the redundancy within the subscale. For example, Item 32 ("As time has passed, the details of my dream have begun to fade.") could possibly be eliminated due to redundancy, since it has large to very large correlations (rs = .33-.72) with other items. Most of the other individual inter-item correlations fell within the expected range. If item correlations remain high they will be considered in future iterations or modifications of the subscale.

Continuity

Among the continuity items, the inter-item correlations ranged from medium (r = .20) to very large correlations (r = .87). Among the highly correlated item pairs are items that were very closely worded for the purposes of item validation such as Item 1 ("The events in my dream have happened before in waking life.") and Item 2 ("The events in my dream have happened before in real life."; r = .86). The very large correlations between some item pairs suggests I can, and likely should, remove some of these items to reduce redundancy within the subscale and make it within the suggested average inter-correlation range. It is likely that after considering multiple iterations of the scale there is a version that reduces the redundancy while retaining the important information.

Physiology

Among the physiology items, the inter-item correlations ranged from very minimal (r = .02) to very large correlations (r = .93). The large range between correlations suggest this might be one of the more unstable proposed subscales. One item in particular ("As I woke up from my dream/sleep, I felt as if I could not move.") seemed to be minimally correlated with most items (rs = |.03-.29|). This suggests this item should be flagged as it might not be very related to the subscale as originally hypothesized. On the other hand, the very large correlations may, in part, be due to the large number of items currently in the subscale. No particular item appeared to be overly correlated with most items, but rather multiple items had high correlation ranges. This suggests the items should be limited to reduce the redundancy of the subscale.

Clarity

Among the clarity items, the inter-item correlations ranged from very minimal (r = .02) to very large correlations (r = .95). Two items seemed to be less correlated with the other items: Item 19 ("When I was dreaming, I was aware that I was dreaming and not awake."; rs = |.08-.61|) and Item 24 ("My dream is confusing because different events in the same dream do not seem to be connected."; rs = |.02-.32|). Since this proposed subscale's average inter-item correlation was lower than the expected range, the priority would be to limit the minimally correlated items as to ensure the subscale continues to assess the intended construct. Most of the other individual inter-item correlations fell within the expected range. It is possible some of the lesser correlated items will need to be removed or edited and re-evaluated in the next stage of the validation process.

Exploratory factor analysis

The results of this exploratory factor analysis should be taken with the consideration of the low sample size, meaning we are currently underpowered to definitively evaluate the latent structure of these constructs. In an early, interim check in the 53 participants reported here, the original DIAMONDS items were factor analyzed and the Eigenvalues confirm the items continue to reflect the original 8-factor structure proposed by Rauthmann and colleagues (2014; 2015; Brown & Rauthmann, 2016).

A second exploratory factor analysis in the newly developed (DIAMONDS+) items suggests there are a maximum of 12 factors (because 12 factors had Eigenvalues larger than 1). However, most methods recommend evaluation of the number of factors considering meaningful change in Eigenvalues. Following these recommendations, the newly-developed items continue to load on a 5-factor structure, consistent with my prior hypotheses and the work in Preliminary Studies 1 and 2.

Initial factor descriptions

Though I once again found a five-factor structure, the items did not necessarily ideally load on the factors they were developed for. It is unclear at this stage if this is because of low power, or because the latent structure is different than I originally expected. The first factor (E = 8.32) that arose is comprised of all the continuity-type items (*n* = 7; e.g., "The events in my dream have happened before in real life.") and some of the plausibility-type items (*n* = 5; e.g., "My dream contained unlikely or unrealistic situations."). The second factor (E = 6.59) that arose was comprised of all the physiological items (*n* = 11; e.g., "As I woke up from my dream/sleep, I noticed I was breathing rapidly."). The third factor (E = 5.27) that arose was comprised primarily of clarity-type items (n = 6; e.g., "My dream followed a timeline that was clear and coherent.")

and some plausibility-type items (*n* = 3; “My dream sequence followed linear time, like how events happen in real life.”). The fourth factor (E = 3.57) that arose was comprised of clarity items (*n* = 4; e.g., “At the time I was dreaming, my dream felt so real that I did not realize I was dreaming.”) and memory items (*n* = 2; e.g. “Even though time has passed, I can easily remember my dream.”). The final factor (E = 2.56) that arose was comprised of only memory degradation (*n* = 4; “As time has passed, the details of my dream have begun to fade.”). Two items did not clearly or differentially load onto any of the factors: Item 9 and Item 10. The internal reliability of these subscales (not including Items 9 and 10) ranged between good and excellent (α = 0.81-0.92). This primary factor analysis helped identify the suspected factor structure and individual items that may not be loading adequately, in addition to the previously identified Items 9 and 10 above. These items were then flagged and, with consideration of evidence from Studies 1 and 2, items were dropped one at a time from iterations of the factor analysis. Model fit statistics and loadings were re-examined each time. Ultimately, 11 items were dropped before a stable, well-fitting factor pattern was identified.

Final factor structure

The final stable factor pattern was comprised of 34 items (see Table 10). The first factor that arose was a clear physiology factor with only physiology items (*n* = 10) loading on this factor. The second factor that arose was a factor that was a mix of continuity (*n* = 6) and plausibility (*n* = 3) items. This factor seemingly represents continuity in a larger context than previously hypothesized, both continuity specific to the dreamer and continuity with real life. The third factor that arose was also clarity informed factor that seemed to instead assess dream vividness. This factor included clarity (*n* = 5) and memory (*n* = 2) items. The fourth factor that arose is what most clearly a clarity-informed factor focusing specifically on perceptions of the

dream coherence. It was comprised of clarity items (n = 3) and one plausibility item. The final factor that arose was a clear memory-informed items assessing dream amnesia. Only memory items (n = 4) clearly loaded onto this factor. The internal reliability for these subscales ranged between sufficient and excellent (α = 0.78-0.93). This final structure informed how the subscale scores were calculated for the nomological net and predictive analyses. Items for each subscale were summed and averaged.

Table 10. Interim exploratory factor loadings and groupings.

#	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Proposed Factor	Current Factor
Eigenvalues		7.87	5.70	4.88	3.12	1.93		
Internal Consistency Reliability (Cronbach's α)		0.92	0.90	0.93	0.78	0.82		
39	As I woke up from my dream/sleep, I felt at ease.	**0.87**	0.19	0.01	-0.16	-0.15	Ph	Ph
38	As I woke up from my dream/sleep, I felt relaxed.	**0.86**	0.07	-0.04	-0.18	-0.15	Ph	Ph
37	As I woke up from my dream/sleep, I felt calm.	**0.82**	0.09	0.01	-0.24	-0.10	Ph	Ph
40	As I woke up from my dream/sleep, I felt comfortable.	**0.80**	0.00	0.04	-0.10	0.02	Ph	Ph
35	As I woke up from my dream/sleep, my heart was racing.	**0.76**	0.02	0.06	0.08	0.27	Ph	Ph
36	As I woke up from my dream/sleep, I felt my heart would jump out of my chest.	**0.74**	-0.04	-0.08	0.06	0.34	Ph	Ph
41	As I woke up from my dream/sleep, I noticed I was breathing rapidly.	**0.73**	0.01	0.08	0.07	0.28	Ph	Ph

Table 10. Interim exploratory factor loadings and groupings (continued).

#	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Proposed Factor	Current Factor
46	As I woke up from my dream/sleep, I felt confused.	**0.65**	-0.20	0.01	0.15	-0.37	Ph	Ph
42	As I woke up from my dream/sleep, I noticed I was moving around a lot and restless in bed.	**0.61**	0.00	-0.12	0.23	0.19	Ph	Ph
45	The contents of my dream made me wake up suddenly.	**0.61**	-0.15	0.18	0.12	-0.01	Ph	Ph
7	The events in my dream have never happened before in real life.	-0.10	**0.82**	0.05	-0.17	0.04	Co	Co
14	My dream contained unlikely or surprising situations.	0.08	**0.77**	-0.48	0.18	0.05	Pl	Co
1	The events in my dream have happened before in waking life.	-0.17	**0.76**	0.14	0.11	0.00	Co	Co
6	The events in my dream have no relation to events or preoccupations during my waking life.	-0.06	**0.75**	0.14	-0.22	0.08	Co	Co
15	My dream contained unlikely or unrealistic situations.	0.35	**0.74**	-0.13	-0.04	0.08	Pl	Co
2	The events in my dream have happened before in real life.	-0.07	**0.72**	0.04	0.32	-0.04	Co	Co

Table 10. Interim exploratory factor loadings and groupings (continued).

#	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Proposed Factor	Current Factor
5	The events in my dream have nothing to do with what I experience during waking life	0.03	**0.69**	0.24	-0.10	0.12	Co	Co
3	The events in my dream are similar to something that has happened to me before.	0.05	**0.58**	0.13	0.23	-0.35	Co	Co
13	My dream contained fantastical or impossible situations.	0.11	**0.52**	-0.20	0.12	-0.03	Pl	Co
28	At the time I was dreaming, my dream was so vivid and felt realistic.	0.03	0.13	**0.87**	0.11	-0.15	Cl	Cl
27	At the time I was dreaming, my dream seemed real and I only realized I was dreaming when I woke up	0.07	0.33	**0.68**	-0.14	-0.13	Cl	Cl
30	Even though time has passed, I have little to no problem remembering my dream.	-0.01	-0.11	**0.65**	0.06	0.27	MD	Cl
29	Even though time has passed, I can easily remember my dream.	0.11	-0.08	**0.64**	0.24	0.33	MD	Cl
23	The events and experiences in my dream were not connected to each other.	-0.14	0.08	**0.48**	-0.04	0.17	Cl	Cl

Table 10. Interim exploratory factor loadings and groupings (continued).

#	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Proposed Factor	Current Factor
25	Even though time has passed, I have little to no problem remembering my dream.	0.13	-0.12	**0.45**	0.23	-0.13	Cl	Cl
26	At the time I was dreaming, my dream was clear and elaborate.	0.00	-0.04	**0.43**	0.17	-0.02	Cl	Cl
21	My dream followed a timeline that was clear and coherent	-0.04	0.07	0.06	**0.92**	0.07	Cl	Coh
20	My dream followed a timeline that made sense and seemed to follow a story.	-0.01	0.04	0.00	**0.91**	0.02	Cl	Coh
22	At the time I was dreaming, my dream was vivid or very detailed.	0.14	-0.26	0.19	**0.77**	-0.19	Cl	Coh
17	My dream sequence followed linear time, like how events happen in real life.	-0.18	0.31	0.12	**0.69**	0.02	Pl	Coh
33	When I first woke up from this dream it was clear but now I have forgotten most of it.	0.00	-0.11	0.03	-0.11	**0.76**	MD	MD
32	As time has passed, the details of my dream have begun to fade.	0.09	-0.11	0.11	-0.11	**0.75**	MD	MD
31	As time has passed, my dream makes less and less sense.	-0.03	0.17	0.04	0.01	**0.70**	MD	MD

Table 10. Interim exploratory factor loadings and groupings (continued).

#	Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Proposed Factor	Current Factor
34	At first my dream seemed to make sense but looking back now, I am confused about it.	0.09	0.14	-0.04	0.10	**0.59**	MD	MD

Note. Factor Designations: Ph = Physiology; Cl = Clarity; Co = Continuity; Pl = Plausibility; MD = Memory degradation; Coh = Coherence

Criterion validity

Nomological network of the adapted dream-specific scales for dream experience

Correlations between the variables in the hypothesized nomological net are presented in Tables 11-14. At this stage, I interpreted the nomological network with consideration of effect sizes and not statistical significance.

Correlations of the DIAMONDS+ with other dream reporting scales

I originally hypothesized these DIAMONDS+ scales would have large correlations with other dream experience measures (e.g., approximately *r*s ≥ .40). The newly adapted subscales correlations ranged from very small to very large with the other dream constructs (see Table 11). The memory degradation scale was the most consistently related to these variables with small to very large correlations (*r*s = |.08-.39|). This was also the measure with the most seemingly statistically significant correlations. This subscale was significantly correlated with dream vividness ($r = .39$, $p = .008$) and dream cohesiveness ($r = .38$, $p = .009$). Followed by the clarity (*r*s = |.02-.31|) and physiology (*r*s = |.01-.31|) subscale whose correlations both ranged from very minimal to large correlations. The clarity subscale and dream recall frequency were also significantly correlated ($r = .30$, $p = .04$), as well as the physiology subscale and dream cohesiveness scale ($r = -.31$, $p = .03$). On the other hand, the current continuity (*r*s = |.007-.14|)

and coherence subscales (*r*s = |.03-.14|; i.e., renamed Factor 4 from Table 10) were less related to these variables with correlations only reaching small effect sizes at most. Generally, the results were varied but all significant correlations were in line with our hypothesis with correlations in the large to very large range.

Correlations of the DIAMONDS+ with other self-reported sleep variables

Trait-like self-reported sleep variables such as sleep quality, time in bed, total sleep time, wake after sleep onset, sleep onset latency, and sleep efficiency were originally hypothesized to be moderately correlated with our measure (i.e., approximately *r*s = |.20-.30|). The newly adapted subscales correlations ranged from small to very large with self-reported sleep constructs (see Table 12). Our most strongly related subscale with sleep variables was continuity with effects ranging between small and very large (*r*s = |.03-.52|). Both physiology (*r*s = |.03-.28|) and clarity (*r*s = |.002-.25|) subscales were somewhat related to sleep with correlations ranging between very small or minimal to medium correlations. The correlation between continuity and sleep quality was the only significant correlation in this grouping (r = -.52, p = .0002). Finally, both the memory (*r*s = |.02-.16|) and coherence (*r*s = |.002-.12|) subscales were less related to these variables with correlations only ranging up with small effect sizes. Generally, the correlations tended to range in the small to medium effect range which is less correlated than originally hypothesized.

Correlations of the DIAMONDS+ with other psychosocial variables

Other psychosocial variables such as perceived stress, anxiety, and depression were anticipated to have small correlations with our subscales (i.e., approximately *r*s = |.11-19|). Surprisingly, the psychosocial variables might have been the most consistently related to our subscales (see Table 13), perhaps moreso than sleep measures. The most strongly related

subscale with these psychosocial variables was our physiological subscale (*r*s = |.24-.30|) with medium to large effect sizes. This scale was significantly correlated with depression (*r* = .30, *p* = .04). Both the clarity (*r*s = |.13-.25|) and memory (*r*s = |.10-.22|) subscales had small and medium correlations with these variables. The coherence subscale had the largest range with correlations ranging from minimal to very large (*r*s = |.0004-.39|). It also had the most statistically significant correlations with perceived stress (*r* = -.31, *p* = .04) and depression (*r* = -.39, *p* = .008). Finally, the continuity subscale had correlations ranging between very small and medium effects (*r*s = |.04-.23|). Generally, the correlations were in the small to very large range which is more correlated than originally hypothesized.

Correlations of the DIAMONDS+ with hypothesized minimal or no relationship to dreams

Finally, I hypothesized variables like executive function would be unrelated to dream experience (i.e., approximately *r*s = |.00-10|). I specifically looked at working memory and inhibitory control both via self-report and task-based. Surprisingly, the dream experience subscales do seem to be related to working memory and inhibitory control (see Table 14). The coherence subscale was the most strongly related to these constructs with effects ranging from small to very large (*r*s = |.08-.42|). The clarity subscale followed with correlations ranging between very small and large (*r*s = |.04-.31|). The continuity scale was very minimally related to working memory (*r*s = |.006-.05|) but more so to inhibitory control (*r*s = |.12|). The memory (*r*s = |.05-.13|) and physiology (*r*s = |.07-.25|) subscales effects ranged from very small and reach up to small and medium effects respectively. Both the coherence (*r* = -.42, *p* = .003) and clarity subscales (*r* = -.31, *p* = .03) were significantly correlated with self-reported working memory but that was not the case for the task-based measure of working memory. Generally, the correlations

tended to be in the small effect range which is in line with our hypothesis. An apparent exception is the association with working memory.

Table 11. Correlations of the DIAMONDS+ with other dream reporting scales.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Duty	-																			
2. Intellect	**.25**	-																		
3. Adversity	.003	.15	-																	
4. Mating	.03	**.47**	.14	-																
5. Positivity	.23	.05	**-.43**	.14	-															
6. Negativity	.002	.21	**.62**	-.02	**-.77**	-														
7. Deception	.11	**.48**	**.63**	**.30**	**-.40**	**.64**	-													
8. Sociality	.12	**.46**	-.06	**.34**	**.33**	-.08	.25	-												
9. Physiology	-.15	.06	**.36**	-.15	**-.74**	**.69**	**.33**	**-.30**	-											
10. Continuity	.16	.14	**-.36**	.15	.23	-.27	-.26	.15	**-.30**	-										
11. Coherence	-.009	.14	.01	.01	.23	.03	.15	**.43**	-.19	.01	-									
12. Clarity	.005	.19	-.11	-.15	.19	-.12	-.04	**.38**	-.01	.09	**.54**	-								
13. Memory Degradation	.009	-.03	-.26	-.13	.15	-.01	-.14	.07	.05	.13	**.29**	.24	-							
14. Dream Recall	.01	.18	.25	.07	-.12	**.31**	.23	-.08	.19	.02	-.06	**-.31**	-.21	-						
15. Dream Quantity	-.06	-.24	-.16	-.02	-.05	-.11	-.15	.04	-.01	.10	-.14	-.06	.08	**-.60**	-					

Table 11. Correlations of the DIAMONDS+ with other dream reporting scales (continued).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
16. Dream Vividness	.15	.004	-.17	.10	.22	-.10	-.29	.13	.05	-.05	.12	.11	**.39**	**-.35**	.27	-				
17. Altered Dreams	-.05	-.21	-.23	.008	.17	**-.30**	**-.36**	.06	-.10	.08	-.07	-.15	.28	-.37	**.53**	**.39**	-			
18. Dream Pleasantness	.03	-.17	-.21	-.19	**.37**	**-.39**	**-.29**	.03	**-.31**	-.007	.05	.02	.15	-.27	.13	**.29**	.27	-		
19. Dream Cohesiveness	.10	.08	-.14	-.06	.04	-.01	-.05	.18	.18	-.06	.03	.22	**.38**	-.17	.29	**.46**	**.37**	.27	-	
20. Nightmare Disorder	-.11	-.06	-.14	.03	-.24	.17	-.001	.006	.26	.14	.05	.22	.22	-.04	.09	.02	-.09	**-.54**	.18	-

Note. Bolded correlations indicate significance where $p<.05$.

Table 12. Correlations of the DIAMONDS+ with self-reported sleep measures.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Duty	-																		
2. Intellect	**.25**	-																	
3. Adversity	.003	.15	-																
4. Mating	.03	**.47**	.14	-															
5. Positivity	.23	.05	**-.43**	.14	-														
6. Negativity	.002	.21	**.62**	-.02	**-.77**	-													
7. Deception	.11	**.48**	**.63**	**.30**	**-.40**	**.64**	-												
8. Sociality	.12	**.46**	-.06	**.34**	**.33**	-.08	.25	-											
9. Physiology	-.15	.06	**.36**	-.15	**-.74**	**.69**	**.33**	**-.30**	-										
10. Continuity	.16	.14	**-.36**	.15	.23	-.27	-.26	.15	**-.30**	-									
11. Coherence	-.009	.14	.01	.01	.23	.03	.15	**.43**	-.19	.01	-								
12. Clarity	.005	.19	-.11	-.15	.19	-.12	-.04	**.38**	-.01	.09	**.54**	-							
13. Memory Degradation	.009	-.03	-.26	-.13	.15	-.01	-.14	.07	.05	.13	**.29**	.24	-						
14. Sleep Quality	.02	-.23	.15	-.08	-.13	.14	-.02	-.15	.23	**-.52**	-.10	.002	.03	-					

Table 12. Correlations of the DIAMONDS+ with self-reported sleep measures (continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
15. Habitual Time in Bed	-.04	.01	-.27	.06	-.05	-.06	-.18	.08	-.03	.11	-.08	.17	-.03	-.01	-				
16. Habitual Total Sleep Time	.16	-.04	-.21	-.07	.17	-.23	-.15	-.03	-.20	.13	-.01	.04	-.02	-.17	**.62**	-			
17. Habitual Wake After Sleep Onset	-.10	.004	-.16	-.10	-.11	.04	-.02	.08	.13	.03	-.12	.25	.06	.10	.08	**-.37**	-		
18. Habitual Sleep Onset Latency	-.14	.12	.02	.18	**-.30**	.29	.13	.11	.28	-.08	.002	.13	.16	**.29**	**.41**	-.26	**.49**	-	
19. Habitual Sleep Efficiency	.21	-.08	.05	-.18	.20	-.13	.06	-.14	-.23	.05	.09	-.19	-.04	-.20	**-.33**	**.50**	**-.49**	**-.70**	-

Note. Bolded correlations indicate significance where $p<.05$.

Table 13. Correlations between the DIAMONDS+ with other psychosocial measures.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Duty	-																	
2. Intellect	**.25**	-																
3. Adversity	.003	.15	-															
4. Mating	.03	**.47**	.14	-														
5. Positivity	.23	.05	**-.43**	.14	-													
6. Negativity	.002	.21	**.62**	-.02	**-.77**	-												
7. Deception	.11	**.48**	**.63**	**.30**	**-.40**	**.64**	-											
8. Sociality	.12	**.46**	-.06	**.34**	**.33**	-.08	.25	-										
9. Physiology	-.15	.06	**.36**	-.15	**-.74**	**.69**	**.33**	**-.30**	-									
10. Continuity	.16	.14	**-.36**	.15	.23	-.27	-.26	.15	**-.30**	-								
11. Coherence	-.009	.14	.01	.01	.23	.03	.15	**.43**	-.19	.01	-							
12. Clarity	.005	.19	-.11	-.15	.19	-.12	-.04	**.38**	-.01	.09	**.54**	-						
13. Memory Degradation	.009	-.03	-.26	-.13	.15	-.01	-.14	.07	.05	.13	**.29**	.24	-					
14. Perceived Stress	-.03	-.06	.09	.09	-.09	.006	-.11	-.20	.28	-.17	**-.31**	-.13	-.10	-				

Table 13. Correlations between the DIAMONDS+ with other psychosocial measures (continued).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
15. Anxiety	-.005	-.03	.03	.02	-.05	-.01	-.004	-.27	.27	-.19	-.24	-.14	.15	**.75**	-			
16. Depression Symptoms	-.06	.002	.16	.13	-.17	.08	.06	-.19	**.30**	-.23	**-.39**	-.25	-.10	**.81**	**.75**	-		
17. Negative Self-Schema Endorsement	.04	.19	.24	**.29**	-.15	.24	.20	-.10	.24	-.04	-.21	-.25	-.22	**.35**	.14	**.43**	-	
18. Positive Self-Schema Endorsement	.18	-.003	-.13	-.07	.26	-.24	-.18	.17	-.28	.16	.004	.20	.13	**-.41**	**-.30**	**-.50**	**-.56**	-

Note. Bolded correlations indicate significance where $p<.05$.

Table 14. Correlations between the DIAMONDS+ with other psychosocial measures with hypothesized minimal or no relationship to dreams.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Duty	-																
2. Intellect	**.25**	-															
3. Adversity	.003	.15	-														
4. Mating	.03	**.47**	.14	-													
5. Positivity	.23	.05	**-.43**	.14	-												
6. Negativity	.002	.21	**.62**	-.02	**-.77**	-											
7. Deception	.11	**.48**	**.63**	**.30**	**-.40**	**.64**	-										
8. Sociality	.12	**.46**	-.06	**.34**	**.33**	-.08	.25	-									
9. Physiology	-.15	.06	**.36**	-.15	**-.74**	**.69**	**.33**	**-.30**	-								
10. Continuity	.16	.14	**-.36**	.15	.23	-.27	-.26	.15	**-.30**	-							
11. Coherence	-.009	.14	.01	.01	.23	.03	.15	**.43**	-.19	.01	-						
12. Clarity	.005	.19	-.11	-.15	.19	-.12	-.04	**.38**	-.01	.09	**.54**	-					
13. Memory Degradation	.009	-.03	-.26	-.13	.15	-.01	-.14	.07	.05	.13	**.29**	.24	-				

Table 14. Correlations between the DIAMONDS+ with other psychosocial measures with hypothesized minimal or no relationship to dreams (continued).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
14. Working Memory (Self-Report)	-.07	-.08	.19	.24	-.26	.17	.09	-.10	.25	-.05	**-.42**	**-.31**	-.05	-			
15. Working Memory (Behavioral)	.20	.22	.003	-.04	.02	.07	.19	.12	.07	-.006	.09	.09	-.09	-.13	-		
16. Inhibitory Control (Self-Reported)	-.27	-.009	-.14	.19	-.18	.11	-.10	.09	.19	.12	-.08	-.04	.13	**.60**	.05	-	
17. Inhibitory Control (Behavioral)	-.005	-.14	.18	.15	.03	-.04	.13	-.05	-.13	-.12	-.18	-.13	-.06	.05	**-.50**	**-.31**	-

Note. Bolded correlations indicate significance where $p<.05$.

Nomological network of the original DIAMONDS scale adapted for dream content

Correlations between the variables in the hypothesized nomological net are presented in Tables 11-14. At this stage, I interpreted the nomological network with consideration of effect sizes rather than statistical significance.

Correlations of the DIAMONDS with other dream reporting scales

I originally hypothesized these scales would have large correlations with the adapted dream content scale (e.g., approximately *r*s ≥ .40). The correlations between the adapted DIAMONDS subscales had similar ranges to those of the dream experience subscales when relating it to other dream constructs. Positivity (*r*s = |.04-.37|), negativity (*r*s = |.006-.39|), and deception (*r*s = |.0009-.36|) all had effects that ranged into very large correlations. Dream pleasantness and positivity were significantly correlated ($r = .37$, $p = .01$). Negativity was significantly correlated with dream recall ($r = 0.31$, $p = .03$), altered dream episodes ($r = -.30$, $p = .04$), and dream pleasantness ($r = -.39$, $p = .008$). Deception was significantly correlated with altered dream episodes ($r = -.36$, $p = .02$). Both intellect (*r*s = |.004-.24|) and adversity (*r*s = |.14-.25|) ranged into medium effects. Finally, duty (*r*s = |.01-.15|), mating (*r*s = |.008-.19|), and sociality (*r*s = |.006-.18|) had correlations ranging only into small effects. Generally, the results were varied but all significant correlations were in line with the original hypothesis with correlations in the large to very large range.

Correlations of the DIAMONDS with other self-reported sleep variables

Trait-like sleep variables such as sleep quality, time in bed, total sleep time, wake after sleep onset, sleep onset latency, and sleep efficiency were originally hypothesized to be moderately correlated with our measure (i.e., approximately *r*s = |.20-.30|). Trait-like sleep had correlations with dream content into the moderate effect range. Adversity (*r*s = |.02-.27|),

positivity (*r*s = |.05-.30|), and negativity (*r*s = |.04-.29|) were the most strongly correlated with sleep as they had effect sizes ranging to the medium-to-large effect range. The correlation between positivity and habitual sleep onset latency was the only statistically significant correlation (r = -.30, p = .04). Both duty (*r*s = |.02-.21|) and intellect (*r*s = |.004-.23|) had correlations suggest medium effects. Finally, mating (*r*s = |.06-.24|), deception (*r*s = |.02-.18|), and sociality (*r*s = |.03-.15|) had correlations ranging to the small-to-medium effects. Generally, the results were varied but most correlations were in the small-to-medium effect range which is somewhat in line with our hypotheses.

Correlations of the DIAMONDS with other psychosocial variables

Other psychosocial variables such as perceived stress, anxiety, and depression were anticipated to have small correlations with the adapted measure (i.e., approximately *r*s = |.11-19|). Other psychosocial constructs had correlations ranging into large effects, stronger than we had originally hypothesized. The most strongly correlated subscales included mating (*r*s = |.02-.29|), positivity (*r*s = |.05-.26|), and sociality (*r*s = |.10-.27|), their correlations suggested up to large effect sizes. The correlation between mating and a poor self-reference (i.e., the endorsement of negative descriptors in depressive cognition task) was the only statistically significant correlation (r = .29, p = .05). Adversity (*r*s = |.03-.24|), negativity (*r*s = |.006-.24|), and deception (*r*s = |.004-.20|) had correlations ranging into medium effect sizes. Finally, duty (*r*s = |.005-.18|) and intellect (*r*s = |.002-.19|) had effect sizes ranging only into the small-to-medium range. Generally, the correlations were in the small to large range, which is more correlated than I originally hypothesized.

Correlations of the DIAMONDS with hypothesized minimal or no relationship to dreams

Finally, I hypothesized variables like executive function would be unrelated to dream content (i.e., approximately *r*s = |.00-10|). The executive function constructs had correlations ranging between minimal to large effects. Duty (*r*s = |.005-.27|) and positivity (*r*s = |.02-.26|) were the most strongly correlated with these constructs with correlations ranging into large effect sizes. Intellect (*r*s = |.009-.22|), adversity (*r*s = |.003-.19|), mating (*r*s = |.04-.24|), and deception (*r*s = |.09-.19|) all had correlation suggesting up to medium effect sizes. Finally, both negativity (*r*s = |.04-.17|) and sociality (*r*s = |.05-.12|) had smaller correlations. None of these scales appeared to be significantly correlated with these variables. Generally, the correlations were larger than originally hypothesized, with most ranging between small and medium effects.

Predictive validity

In the multiple regression analyses, I utilized the most recent dream report collected though the week of sleep and dream assessment. Positive and negative affect were predicted separately utilizing only observations with complete data. Therefore, our analyses occur in 43 observations. Our models have multiple predictors and therefore will be underpowered at this stage.

Comparison of the original DIAMONDS and the DIAMONDS+

Both Model 1a (i.e., DIAMONDS only model; $F(10, 23) = 4.62$, $p = .001$) and Model 1b (i.e., DIAMONDS+ model; $F(7, 26) = 5.83$, $p = .0004$) were statistically significant in predicting positive affect. Both models explained very similar proportions of variance with the DIAMONDS model explaining only slightly more proportion of the variance (adj. $R^2 = 52.3\%$) over the additional subscales (adj. $R^2 = 50.59\%$). In both models the only significant predictor was prior night affect. Once the DIAMONDS and additional subscales were considered the

model remained significant ($F(15, 18) = 4.68$, $p = .001$). The variance explained increased somewhat from the previous models (adj. $R^2 = 62.56\%$). In this case, in addition to prior night affect being a significant predictor, so were deception ($p = .008$) and continuity ($p = .03$). This suggests there may be something important about considering both dream content and experience together to predict next day positive affect.

When predicting negative affect only the additional subscales model (i.e., Model 1b) was statistically significant in predicting next day negative affect ($F(7, 26) = 5.41$, p = .0006). In this model, prior-night negative affect ($p < .0001$) and the physiology subscales ($p = .007$) were the only statistically significant predictors. The DIAMONDS only model was not statistically significant ($F(10,23) = 1.76$, $p = .13$) and its only significant predictor was prior night affect. Additionally, when comparing the variance explained between the models, the additional subscales model explained more than twice the variance (adj. $R^2 = 48.35\%$) than that of Model 1a (adj. $R^2 = 18.65\%$). Once the DIAMONDS subscales and additional subscales are considered jointly the model remained statistically significant ($F(15, 18) = 3.16$, $p = .01$), but the variance explained did not increase substantially (adj. $R^2 = 49.49\%$). Similar to Model 1b, both prior night affect ($p = .002$) and the physiology subscale ($p = .005$) were significant predictors in the additional subscales model. These results suggest negative affect is best predicted by dream experience.

The HVDC model

The Hall and Van de Castle categories were determined from prior research, interpretability, and considering multiple versions of predictor that would give it the most predictive ability. In the end, the content indicators that were included were total number of characters in the dream, aggression index (i.e., frequency of aggression/total number of characters in the dream), friendliness index (i.e., frequency of friendliness/total number of

characters in the dream), sexuality index (i.e., frequency of sexuality/total number of characters in the dream), successes proportions (i.e., successes/ successes and failures in a dream), positive emotions, negative emotions, and proportion of familiar settings (i.e., familiar settings/ familiar and unfamiliar settings in the dream). This coding of the HDVC scale may have inflated the variance explained with affect, at least relative to some other methods of coding, such as the amount of colors or objects in dreams.

The HVDC model was statistically significant ($F(10, 23) = 6.07$, $p = .0002$) and explains slightly above half of the variance (adj. $R^2 = 60.55\%$) in next-day positive affect. However, the only significant predictor in the model was prior day positive affect ($p < .0001$). In predicting negative affect, the HVDC model was statistically significant ($F(10, 23) = 3.57$, $p = .006$) and explains slightly below half of the variance (adj. $R^2 = 43.82\%$) in next-day affect. In this model the significant predictors, in addition to prior-night negative affect ($p = .0006$), were total number of characters ($p < .0001$) and negative emotions ($p = .04$).

Comparison of the DIAMONDS+ and the HVDC

Finally, the full joint model considering the full DIAMONDS+ and the HVDC categories was statistically significant ($F(23, 10) = 5.62$, $p = .004$) and explains about two-thirds of the variance in next-day positive affect (adj. $R^2 = 76.3\%$). There was some improvement in the variance explained from Model 3 and Model 4. As before prior-night positive affect ($p = .0007$) was a significant predictor in this model. From the DIAMONDS scale, positivity ($p = .04$) and sociality ($p = .02$) were significant predictors along with the newly developed clarity ($p = .04$) and memory degradation ($p = .004$) scales. From the HVDC categories, the aggression index ($p = .03$) and proportion of familiar settings ($p = .01$) were significant predictors. These results

suggest there may be something important about increased details of the dream content along with clarity and memory of the dream.

However, the full joint model considering the DIAMONDS+ and the HVDC categories was *not* statistically significant ($F(23, 10) = 2.29$, $p = .09$) and the variance explained did not substantially increase (adj. $R^2 = 47.29\%$). The only significant predictor in this model was prior night negative affect ($p = .04$). The best model in this case was the DIAMONDS+ model suggesting that, in explaining negative affect, dream experience is important.

DISCUSSION

The current preliminary results begin to elucidate the performance of this novel dream measure that has the potential to improve data collection for dream research. At this stage I have the ability to assess all stages of the construct validation process (See Figure 2). In this study the primary aim was to establish external validity via convergent, discriminant, and predictive validity while providing continued evidence for substantive and structural validity in another sample. Here I present the interim results for all stages of the construct validation process in the present sample.

Substantive validity

Participants in this study provide feedback in various forms throughout this study. Overall, participants tended to view the dream reporting methods as favorable. There were not many differences when comparing their feedback between the newly adapted measure and the self-reported Hall and Van de Castle method. However, differences in the perceptions of the methods' simplicity did arise when completing dream assessments at home. Additionally, there were differences between the measures in the proportion of the time participants reported being able to confidently answer the items in the measures. This is a difference of note because of the necessity to rely on self-report for dream reporting given the inability to objectively study dreams and the dream amnesia typically tied to dreams. Some participants also reported preferring the newly adapted measure due to reasons that may also increase validity of dream reports such as participants perceiving the method to be more accurate and capture more relevant or important aspects of their dream. If participants perceive that they are able more confidently and more accurately report their dreams on the newly adapted measure this is evidence for some increased validity and reliability. Further investigations of the remaining feedback from

participants may present some suggested improvements that may increase participant satisfaction with the newly adapted measure.

Structural validity

The originally hypothesized factors for the developed items demonstrated structural validity in line with norms for scale development. At this stage, the original plausibility and memory degradation scales demonstrated inter-item correlations that suggests the scales appear to be sufficiently correlated. However, when looking at the individual inter-item correlations there seemed to be a large range of correlations across most hypothesized subscales. The memory degradation subscale seemed to possess the closest range in correlation but would still nonetheless benefit from reducing some of the items that are more highly correlated as would the other subscales. The high correlations are likely an effect of the multiple similarly worded items in the scale included to assess which wordings would be more beneficial to the subscales. Therefore, it is evident items will need to be limited to reduce the redundancy within the subscales (if retained as is) and achieve sufficient unidimensionality.

A preliminary, but underpowered, exploratory factor analysis began to present a factor structure that suggests the item pool developed does conform to a five-factor structure, at least considering meaningful change in Eigenvalues and interpretable factor loadings. Once establishing the factor structure and identifying problematic items (in this study and prior studies), multiple iterations of the item pool were included in a factor analysis removing items one at a time until arriving at a stable factor pattern. The stable factor pattern that emerged somewhat confirmed the hypothesized factors, however they were not identical to the ones I proposed. The hypothesized factors that remained were the memory degradation factor and the physiology factor. Interestingly enough, the hypothesized clarity factor seemed to better

represent two different factors: one that focused on perceptions of dream coherence and one that focused on dream vividness or detailedness. Additionally, it seems the items originally thought to represent two different subscales (continuity and plausibility) are better groupings of one factor representing a more global continuity. Although originally described as two different factors that assessed continuity with personally relevant waking life and plausibility of dream situations, the factor pattern suggests together they can describe a larger concept of continuity with waking life more generally. This suggests the original item pool had some overlap between the developed subscales, but they were still able to be grouped and distinguished in an interpretable way.

Criterion validity

The correlations between our newly adapted measure and the variables of the nomological net presented patterns I did not necessarily anticipate. Primarily, the correlations with other dream constructs were not as high as originally hypothesized. This suggests our scales may be capturing different aspects of dream experiences than those of prior scales. It is also likely that the associations were not as strong as originally anticipated because the newly adapted measures reference a specific dream while the other dream constructs reference more trait-like dream experiences. The measure may have higher correlations with psychosocial factors because it was adapted from a psychosocial scale of situation characteristics. Finally, it is also possible that dreams have more resemblance to waking experiences than they do to sleep and sleep constructs. These questions are interesting avenues for my future research program.

Similarly, the sleep variables were not as strongly correlated across the variables as originally anticipated. This may also be because dream characteristics of one specific dream may not be very related to more global habitual sleep overall. It may be worth in future analyses to

look at dream and sleep characteristics in reference to the same night. At this stage of the project the behavioral assessment of sleep (i.e., actigraphy assessed sleep through the week) was not included in the analyses, but the final data analyses should include this. Inclusion of a second method of sleep assessment may also encourage the use of dream and sleep data from the same night as opposed to the laboratory assessment.

Contrary to my original hypothesis, psychosocial variables such as perceived stress, anxiety symptoms, and depressive symptoms were actually more consistently strongly correlated with dream experience. The associations between dream experiences and depression are actually consistent with literature that suggests people who are depressed are likely to recall less dreams and report less details in those dreams (Palagini & Rosenlicht, 2011). The correlations of our dream measure and psychosocial variables, however, do speak to the associations between dream measures and psychological well-being that can and should continue to be investigated.

Future analyses of this study should pay attention to the discriminant validity of the scale. Originally, I planned to also establish discriminant validity via assessment of colorblindness, however our sample did not have anyone with colorblindness. Therefore, I did not have sufficient variability to assess this but hopefully in ongoing data collection we are able to assess this in the final data analysis. The associations between executive function and our dream experiences now seem in line with the theories of dreaming developing as a cognitive process and therefore may have not been the best choice to establish discriminant validity (Desseilles et al., 2011; Hobson & Stickgold, 1994; Wamsley & Stickgold, 2010), at least in comparison of self-reports versus task-based measures of a cognitive process. However, of note, the stronger associations tended to appear with the self-reported working memory as opposed to the task-based working memory tasks (or the inhibitory control measures) suggesting it may be, at least

partially, due to shared method variance. Ideally data from the completed study should elucidate this effect more. More in line with the original hypothesis, the dream content scales were less correlated with executive function though still larger than originally anticipated.

Predictive validity

The current regression analyses are underpowered, and given the large number of predictors, may not be stable. However, the results thus far seem to provide some support for the predictive validity of the newly adapted measure. In predicting negative affect, the full DIAMONDS+ model was the best fitting model explaining the largest portion of the variance. On the other hand, in predicting positive affect, the full joint model (considering both the DIAMONDS+ and HVDC categories) was the best fitting model explaining the largest portion of the variance. Looking more specifically at the significant predictors it appears as the content descriptors of the dream (i.e., the original DIAMONDS subscales) are more likely to be predictive of positive affect while descriptor of the overall dream experience (i.e., the novel, adapted DIAMONDS+ subscales) are more likely to be predictive of negative affect.

Despite my original hypothesis that the self-reported HVDC would not be very predictive of next-day affect, it appears that some HVDC indicators do remain important. Although, of note, some of the indicators that arose as predictive in the HVDC model included those that have analogous categories in the DIAMONDS+ method (e.g., negative emotions in HVDC and negativity in the DIAMONDS+). Additionally, because there is no standard use of the measure I included the indicators more likely to be important, such using aggression or sociality indexes over the counts of object or types of characters. In terms of measurement, this makes the HDVC approach similar to the DIAMONDS in that it is assessing some similar content (like overall affective perceptions and social situations). The face validity results, however, still suggest the

HVDC method is not ideal due to participant perceptions of the scale and participant (in)ability to report on their dream content using the HVDC scale.

The predictive validity results thus far support the contributions of dream content and experience for emotional regulatory processes, which is consistent with the dream literature (Cartwright et al., 1998; Nielsen & Levin, 2007). For negative affect it appears dream experience variables from the newly adapted subscales, especially physiological responses, are most predictive. This seems to support that dreams, or nightmares more specifically, that are physiologically arousing are impactful for emotional well-being and may help participants work towards the conditioning of fearful or distressing stimuli and therefore subsequent well-being (Nielsen & Levin, 2007; Tousignant et al., 2022). The current results are in line with theories that propose that dreams can be distressing in part because of visceral physical reactions to dream stimuli.

On the other hand, it appears that for positive affect it may be important to consider various aspects of dream content from the DIAMONDS measure as applied to dreams. This pattern is in line with prior research suggesting positive affect in dreams are usually a continuation of the prior day (Barnes et al., 2021; Strauch & Meier, 1996). These results expand on these theories and begin to suggest specific dream characteristics which are impactful to positive affect. Perhaps the most surprising or counter-intuitive significant predictor thus far has been that of increased aggression being predicting increases in next-day positive affect. These results might suggest there is some merit to dream theories such as the threat-simulation theory, in which enacting threatening simulations prepares us for these interactions in waking life (Revonsuo, 2000). Overall, the positive affect results are important and interesting. Dream science overwhelmingly focuses on nightmares because of their clinical and public health

implications (Hasler & Germain, 2009), but positive affect has not been as heavily researched. Disentangling the relationship of dreams to negative *and* positive affect is important because they represent different experiences, are predicted by constructs, and may reflect differences in they represent different experiences, are predicted by constructs, and may reflect differences in emotion regulatory functions of dreams and emotional processes more generally.

FUTURE DIRECTIONS

My current analyses are not to be taken as definitive, but they do begin elucidate patterns that may be emerging from the data. The current analyses already provide some evidence for the various forms of validity, including substantive, structural, and external validity, which are required for scale development. Data analysis of the full intended sample should provide additional, robust evidence of validity. Depending on the results of the full data, there may be a need for another step of the validation in a non-student sample. In the end, the aim would be to provide the field with a modern, reliable, and validated measure that comprehensively assesses dream content and experience.

Once the field can turn to a tool that provides meaningful and biopsychosocially relevant information about dreams, different dream theories can be evaluated. The adapted measure described herein includes constructs previously noted as important in the dream literature, such as dream content and continuity, as well as considering other constructs not previously robustly assessed such as the memory of the dream and the physiological responses to the dream. Notably, my results thus far support this given the different predictors that arose as important when predicting positive affect (i.e., dream content) and negative affect (i.e., dream experience). A combination of these in the newly adapted measure should open the possibilities of researching interdisciplinary sequelae or possible functions of dreams.

Applications of the newly adapted dream measure

The results thus far seem promising for the merit of this new measure. Considering the metrics in the measure it becomes important for empirical work based on dream theory in the field. Our results already present an example of our subscales pointing out important aspects of dreams in reference to the potential emotional regulation process. Further, some of the dream

content subscale from the DIAMONDS such as positivity and negativity can be informative about the dream more generally but also in relation to the affective tone of the dream, which would relate to future specialized probing of affective process in dreams. Additionally, subscales like mating, sociality, and perhaps adversity can be used to evaluate the evolutionary theories of dreams that suggest we are enacting scenarios (whether threatening or sociable) that prepare us for waking life. Empirical work on dreams would benefit from a stable tool to systematically test the theories and push the field forward.

Similarly, from the newly developed subscales, subscales such as clarity, memory, and physiology might speak to the intensity of the dream that becomes especially relevant for nightmares. Since nightmares are characterized as highly vivid, remembered, and arousing dreams, our subscale might be a useful tool to identifying particularly distressing dreams based on these metrics and identify new dream metrics that are tied to these as well. Additionally, given the connection between dreams and psychiatric disorders, our scale may be able to point dream metrics that are tied to dream experiences for those with mental illnesses. Some research has already identified some dream characteristics that can be predictive of worsening symptoms or distressing episodes in psychiatric disorders (Noreika et al., 2010; Skancke et al., 2014). Therefore, the more validated and consequential constructs of dreams we can assess can begin to identify more of these important experiences. In summary, more research is needed on clinical implications of dreams, and this scale can provide the foundation to test them more comprehensively.

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