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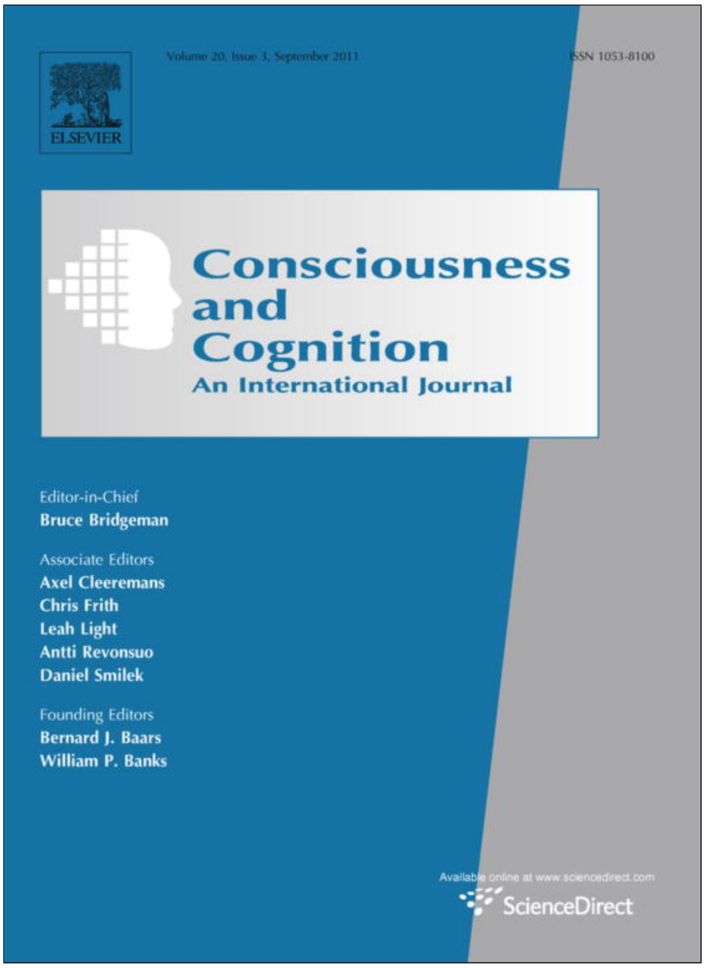

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Dreaming and waking: Similarities and differences revisited

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ABSTRACT

Dreaming is often characterized as lacking high-order cognitive (HOC) skills. In two studies, we test the alternative hypothesis that the dreaming mind is highly similar to the waking mind. Multiple experience samples were obtained from late-night REM sleep and waking, following a systematic protocol described in Kahan (2001). Results indicated that reported dreaming and waking experiences are surprisingly similar in their cognitive and sensory qualities. Concurrently, ratings of dreaming and waking experiences were markedly different on questions of general reality orientation and logical organization (e.g., the bizarreness or typicality of the events, actions, and locations). Consistent with other recent studies (e.g., Bulkeley & Kahan, 2008; Kozmová & Wolman, 2006), experiences sampled from dreaming and waking were more similar with respect to their process features than with respect to their structural features.

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1. Introduction

> "I am riding a white horse, bareback, and we are galloping along the shore of a pristine beach. The light of the setting sun reflects through ocean spray kicked up by breaking waves, creating a shower of tiny rainbow lights. I think to myself 'this is one of the most amazing experiences of my life!'" (Kahan, 2008)

In this excerpt, the individual adopts dual perspectives: a first-person, *participant* perspective (from which she reports the experience) and a third-person, *observer* perspective (from which she evaluates the experience). This ability to utilize multiple perspectives to monitor and evaluate one's ongoing experience is variously termed *reflective awareness* (James, 1890/1981), *reflective consciousness* (Farthing, 1992), or *self-reflection* (Rossi, 1972) (see Table 1 for formal definitions of these and related terms).[2]

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[2] In prior research (Kahan, 1994; Kahan & LaBerge, 1994, 1996, 2000), we employed the term *Reflective Awareness* (RA) as defined by William James and others (e.g., Globus, 1987; Weinstein, Schwartz, & Ellman, 1988): "awareness that is focused on subjective experience – awareness of ongoing thoughts, feelings, or actions" (Kahan & LaBerge, 1994, p. 248). Recently, Wolman and Kozmová (2007) extended the definition of RA to include a *verbalized* assessment of ongoing events and acknowledgment of the fact that RA may be directed to either internal experience (thoughts, memories, feelings) or external events. Although we endorse Kozmová and Woman's inclusion of a measurable index of RA (e.g., an individual's verbalization) in the operational definition, we stop short of including their requirement that the individual verbalize the potential *impact* of internal or external events "on an individual and his or her self-knowledge or memory of 'waking-life knowledge'" (p. 200). Thus, we have adopted Kozmová and Wolman's (2006, p. 200) operational definition of RA, excluding the phrase set apart by brackets: "Self-awareness in the mode of reflective awareness refers to instances in dreaming or waking in which an individual verbalizes [*assessive or evaluative thoughts about*] ongoing internal events (perceptions, feelings, memories, images, hallucinations, and such) and/or external events (actions, behaviors, situations, environments)".

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Table 1
Terminology.

Term	Definition
Self-consciousness	"the ability to become aware of one's own states, especially (but not only) mental states (e.g., perceptions, emotions, and attitudes), as one's own states" (Newen & Vogeley, 2003, p. 530).
Includes awareness of state (e.g. awareness that one is awake or dreaming):	
Self-reflective awareness	awareness of state, for example, awareness of dreaming while dreaming (Fosse, 2000, p. 492).
Lucidity	awareness in the dream state that one is dreaming (LaBerge, 1985; Van Eeden, 1913).
Does not (necessarily) include awareness of state:	
Reflective self-consciousness	"reports of having reflected, during the dream, on the plausibility of the events experienced" (Bradley, Hollifield, & Foulkes, 1992, p. 162).
Reflective consciousness	"simultaneously thinking about and commenting on the content of [one's] subjective experience" (Kozmová & Wolman, 2006, p. 199).
Reflective contemplation	"silent observation and detached musing about dream events external to the self" (Snyder, 1970, p. 149).
Self-reflectiveness	"self-organizing and self-regulating processes [that] occur within dreaming as well as waking" (Moffitt et al., 1988, p. 431).
Self-reflection	"an examination of one's thoughts, feelings or behavior" (Rossi, 1986, p. 153).
Self-awareness	awareness of being oneself (e.g., in a dream) (Bosinelli, 2001) "self-focused attention, selective processing of information about the self" (Carver & Scheier, 2003, cited by Kozmová & Wolman, 2006, p. 183).
Reflective awareness	"awareness that is focused on subjective experience – awareness of ongoing thoughts, feelings or actions(James, 1890; Globus, 1987, Chap. 2; Pollio, 1990)" (Kahan & LaBerge, 1994, p. 248). "underscores the way in which dreamers comment about ongoing experiences, situations, and environments in the dream" ..."is identical with the self-awareness mode of reflective consciousness and with 'reflected experience' (Kahan, 1994, p. 177)" (cited by Kozmová & Wolman, 2006, p. 200). "instances in dreaming or waking in which an individual verbalizes assessive or evaluative thoughts about ongoing internal events (perceptions, feelings, memories, images, hallucinations, and such) and/or external events (actions, behaviors, situations or environments)" (Kozmová & Wolman, 2006, p. 200).
Metacognition	The awareness, understanding, and control of one's cognitive processes (see Baars, 1988, pp. 302–303; Flavell, 1979; Nelson & Narens, 1990).
Analytical thought processes	"Comparing and contrasting, evaluating, reason, logic, reflection, contemplation" (Wolman & Kozmová, 2007).
Executive thought processes	"Higher order cognitive processes. Decision making, problem solving, planning, and agency" (Wolman & Kozmová, 2007).
Systemic reflection	"includes all processes involved in the mind–brain keeping track of itself for the purpose of successful functioning both organizationally and adaptively" (Purcell et al., 1993, p. 248).
Self-awareness	"self-focused attention, selective processing of information about the self" (Carver & Scheier, 2003, cited by Kozmová & Wolman, 2006, p. 183).
Reflective awareness	"awareness that is focused on subjective experience – awareness of ongoing thoughts, feelings or actions(James, 1890; Globus, 1987, Chap. 2; Pollio, 1990)" (Kahan & LaBerge, 1994, p. 248). "underscores the way in which dreamers comment about ongoing experiences, situations, and environments in the dream" ..."is identical with the self-awareness mode of reflective consciousness and with 'reflected experience' (Kahan, 1994, p. 177)" (cited by Kozmová and Wolman, 2006, p. 200). "instances in dreaming or waking in which an individual verbalizes assessive or evaluative thoughts about ongoing internal events (perceptions, feelings, memories, images, hallucinations, and such) and/or external events (actions, behaviors, situations or environments)" (Kozmová & Wolman, 2006, p. 200).
Metacognition	The awareness, understanding, and control of one's cognitive processes (see Baars, 1988, pp. 302–303; Flavell, 1979; Nelson & Narens, 1990).
Analytical thought processes	"Comparing and contrasting, evaluating, reason, logic, reflection, contemplation" (Wolman & Kozmová, 2007).
Executive thought processes	"Higher order cognitive processes. Decision making, problem solving, planning, and agency" (Wolman & Kozmová, 2007).
Systemic reflection	"includes all processes involved in the mind–brain keeping track of itself for the purpose of successful functioning both organizationally and adaptively" (Purcell et al., 1993, p. 248).

1.1. The question of high-order cognition in sleep

According to William James, *reflective awareness* is a hallmark of the waking adult mind and dreaming lacks this capacity (James, 1890/1981, p. 264). James' view is echoed in Freud's claim that dreaming returns us to an earlier developmental state, one dominated by *primary processes* such as magical thinking, irrationality, and loss of ego control (Freud, 1900/1953). James' and Freud's assertions regarding these deficiencies of the dreaming mind were assimilated into many influential dream theories (e.g., Hobson, 1988; Hobson & McCarley, 1977; Koukkou & Lehman, 1983; Rechtschaffen, 1978). For many years, few dream theorists questioned the claim that the mind operates differently in dreaming and waking (see Kahan (2001) and Moffitt et al. (1988), for reviews). Experimental investigations of the dreaming mind were rare; studies that compared cognitive skills across dreaming and waking were rarer still (see Cavallero & Foulkes, 1993, pp. 1–3; Haskell, 1986). Dreaming was generally seen as more relevant to understanding psychodynamic or personality processes than cognitive processes. Especially important to experimentalists, the study of sleep cognition typically does not permit the same systematic control of the stimulus conditions as is possible in studies of waking cognition. Nevertheless, some experimental psychologists argued persuasively that empirical investigations of the mind in sleep were necessary in order to understand human

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cognition (Cartwright, 1981; Cavallero & Foulkes, 1993; Hunt, 1982, 1989) and cognitive development (Foulkes, 1985, 1990; Foulkes, 1999).

Recent theoretical developments in cognitive neuroscience reinforce the importance of investigating cognitive processes across the sleep/wake cycle. Comprehensive models of consciousness have been developed to articulate how cognitive processes may covary with circadian (e.g., sleep and waking) and ultradian rhythms (e.g., REM and NREM sleep) (Domhoff, 2003; Fosse, Stickgold, & Hobson, 2004; Nielsen, 2003; Solms, 2003).

For example, J. Allan Hobson and his colleagues offered the Activation-Input Source-Modulation (AIM) model as a unifying neurocognitive model capable of accounting for variations in cognition across waking and sleep (Hobson & Stickgold, 1994a, 1994b; Kahn, Pace-Schott, & Hobson, 1997). AIM is the most recent version of the earlier Activation-Synthesis model of dreaming (Hobson, 1988; Hobson & McCarley, 1977). Hobson and his colleagues assert that particular phenomenological and cognitive features of dreams are the direct consequence of specific neurophysiological changes that occur during REM sleep (formal isomorphism) (Hobson, 1988; Hobson & McCarley, 1977; Mamelak & Hobson, 1989). According to the AIM model, high-order cognitive skills, including volition, logical reasoning, and reflective awareness, are suspended in dreaming, relative to waking (Hobson, Pace-Schott, & Stickgold, 2003a, p. 42; Hobson, Pace-Schott, & Stickgold, 2003b, p. 237). Hobson, Pace-Schott, and Stickgold (2003b) highlight neuroimaging studies which show reduced activation in the prefrontal cortex (pfc) in REM sleep, relative to waking (Braun et al., 1997; Maquet, 2000). The argument is that reduced activation of the dorsolateral prefrontal cortex (pfc) accounts for the (presumed) global reduction in high-order cognition in REM dreaming (Hobson et al., 2003a, 2003b; Kahn, Combs, & Krippner, 2002; Muzur, Pace-Schott, & Hobson, 2002). More specifically, Pace-Schott (2003) speculates that reduced activation of the dorsolateral pfc in REM promotes "illogical thought" and the "*characteristic features* of dreaming such as discontinuities, impaired attention, and amnesia [impaired working memory]" (p. 338) (emphasis added) (also see Fosse et al., 2004, p. 302; Kahn & Hobson, 2005).

But *is* the capacity for reflective awareness and other high-order cognition uniformly diminished in dreaming? In *lucid dreams*, for example, the dreamer is aware of dreaming while dreaming and often has the ability to direct aspects of the dream experience (volition) (LaBerge, 1985; Van Eeden, 1913). Lucid dreams involve both participant and observer levels of awareness as well as awareness that the experience is occurring during the dream state (Kahan & LaBerge, 1994). Here, in one of the many lucid dreams reported by Robert Waggoner (2009), we see these multiple levels of awareness as well as volition:

> "I seem to be walking through a small town. I enter a simple restaurant and walk through it inot a mechanic's garage. I see a door and decide to slip through it, even though it seems to have a string attached to an alarm. As I get out into the street, I look around and realize, 'This is a dream.' Lucidly aware now, I start flying up the street, looking at the people sitting in candle-lit cafes and walking down the street. The detail is incredibly vivid. I sing a funny rhyming song as I look at things. I keep flying farther and end up outside of town with a strong inclination to fly to the right. But then in a moment of conscious choice, I exercise my right to change the direction of the dream and decide, no, I'm going into the darkness, and I turn left" (p. 13).

Experimental studies of lucid dreamers in the laboratory provide incontrovertible evidence that lucid dreaming occurs during sleep, typically REM sleep, and that lucid dreamers are capable of using patterned eye movements to signal their realization of dreaming and/or the initiation and completion of a pre-agreed upon task such as counting, singing, or slow breathing (see, especially, LaBerge, 1985; LaBerge & Rheingold, 1990). Studies of lucid dreamers in the laboratory provide compelling evidence that dreaming consciousness can be as volitional and rational as waking consciousness (Holzinger, LaBerge, & Levitan, 2006; LaBerge, 1990). Further, lucid dreaming is a cognitive skill that may be developed (LaBerge, 1985; Paulsson & Parker, 2006; Purcell, Moffitt, & Hoffmann, 1993; Purcell, Mullington, Moffitt, Hoffmann, & Pigeau, 1986).

Numerous studies show that *non*-lucid dreaming often includes rational thinking and reflective awareness (e.g., Foulkes, Hollifield, Bradley, Terry, & Sullivan, 1991; Kahan, 1994; Kahan & LaBerge, 1996, 2000; Kahan, LaBerge, Levitan, & Zimbardo, 1997; Kahn & Hobson, 2005; Kerr, 1993; Purcell et al., 1986; Wolman & Kozmová, 2007). Further, high-order cognition is seen in both REM and NREM dreaming, including dreams sampled from slow wave sleep (Cavallero, Cicogna, Natale, Occhionero, & Zito, 1992; Cicogna & Bosinell, 2001; Cicogna, Cavallero, & Bosinelli, 1991; Cicogna, Natale, Occhionero, & Bosinelli, 1998; Mason et al., 1997).

Considerable evidence, then, supports the alternative view that dreaming is *continuous* with waking. Early proponents of the continuity theory focused on the *content* (the "what" of subjective experience); their central claim was that dreams reflect an individual's waking life experiences, concerns, and personality (e.g., Hall & Norby, 1972) (see Domhoff (2003), Schredl (2003), Schredl & Hoffman (2003), and Van de Castle (1994), for reviews). Other theorists proposed continuities across dreaming and waking with respect to their cognitive and perceptual *processes* (the "how" of subjective experience) (Cavallero & Foulkes, 1993; Domhoff, 2003; Kahan & LaBerge, 1994; Kerr, 1993). Cavallero and Foulkes (1993) elaborate:

> "Not only are the cognitive processes involved in dream production the same throughout the night, irrespective of the physiological characteristics of the various sleep stages, but they also seem to be the same as those operative in waking" (p. 133).

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The claim that dreaming cognition is continuous with waking cognition contrasts sharply with the historical- and still popular-view that the dreaming mind differs greatly from the waking mind (see Moffitt et al. (1988), for a review). Currently, there is no clear consensus on whether high-order cognitive skills similarly characterize both waking and dreaming experience.

1.2. Overview of the present research

The aim of Study 1 was to replicate and extend prior research on the similarities and differences in cognition sampled from dreaming and waking (Kahan & LaBerge, 1996, 2000; Kahan et al., 1997). The aim of Study 2 was to compare participants' ratings of the sensory and structural features of their dreaming and waking experiences. Ratings of the structural features targeted qualities such as: event location (e.g., familiar/unfamiliar, bizarre/realistic), event transitions (illogical/logical), actions (bizarre/realistic; atypical/typical), and "point-of-view" (participant, observer). Together, these studies permitted a test of which features of subjective experience are most likely to demonstrate continuities across dreaming and waking.

1.3. Methodological challenges in dream science

Any scientific study of dreaming includes inherent methodological challenges (for reviews, see Domhoff, 2003, Chap. 2; Hobson et al., 2003a, pp. 10–15; Kahan, 2001, pp. 352–353). Measures of dreaming are necessarily indirect and often rely heavily upon participants' subjective reports. Moreover, a dream report is always made from the waking (or awakening) state. The report of a dream experience is influenced by the constructive memory processes and individual difference factors that guide any episodic recollection (Conway, 2009; Johnson, 1992; Tulving, 2002). For example, an individual may selectively report only certain aspects of the experience, depending upon which phenomenological features are most easily recalled, how the individual understands the purpose of the study, and the situation in which the dream is reported. Further, an individual may embellish or elaborate the original experience in the course of recollection (Strauch & Meier, 1996).

In spite of their limitations, subjective reports offer the primary portal to the qualities of lived experience. With regard to the validity of dream narratives, in particular, Domhoff (2003) asserts "dream reports provide a sound basis for understanding both the formal structure and content of dreaming" (p. 40).[3]

For those interested in the cognitive processes that occur *during* the dream experience, there is yet another methodological challenge. Individuals are more likely to articulate the content of an experience (who, what, when, where) than the associated cognitive features (e.g., reasoning, evaluating, remembering) (Kahan, 1994). Also, most individuals are not practiced in discriminating the cognitive processes that occurred during the dream experience from those associated (only) with the recollective process (Foulkes, 1990; Foulkes et al., 1991).

However, as noted by Kahan et al. (1997):

> "...cognitive psychologists have argued persuasively that an individual's subjective reports and retrospective evaluations are valid indices of underlying cognitive processes (see, especially, Johnson, 1992; Johnson, Foley, Suengas, & Raye, 1988; Johnson, Kahan, & Raye, 1984; Suengas & Johnnson, 1988)" (p. 135)

Without question, there are persistent and substantial methodological concerns surrounding the use and interpretation of subjective reports, whether obtained from dreaming or waking. In spite of these issues, subjective reports not only illuminate more than they obscure—they are central to any experimental phenomenology. An ongoing methodological challenge is how *best* to sample subjective experience in the most reliable, valid manner possible (Hurlburt & Heavey, 2008).

1.4. Development of the metacognition, affect, cognitive experiences (MACE) questionnaire

When we (the authors) began our investigations into high-order cognition across dreaming and waking, the immediate challenges included how best to measure these cognitive processes (see, especially, Kahan, 1994; Kahan & LaBerge, 1994) and how best to obtain parallel measures of these cognitive processes in dreaming and waking. As noted by Kahan et al. (1997):

> "If dreaming experience is evaluated retrospectively, then, minimally, waking experience should also be evaluated retrospectively" (p. 135)

[3] The term "formal structure," as used by Domhoff (2003, pp. 40–42), refers to the narrative structure and other organizational features characteristic of dream reports. Formal structure is not to be confused with the terms "formal features" [of dreaming] or "formal approach" [to quantifying first-person data]. The term "formal features" is used by Hobson and his colleagues (Hobson, 1988; Hobson et al., 2003a) to refer to the purported defining psychological features of dreaming (e.g., loss of volition, logic, loss of orientational stability, heightened emotionality, sensorimotor hallucinosis) (see for example, Hobson et al., 2003a, p. 32). Hobson et al. (2003b) used the term "formal approach" to describe experimental-phenomenological approaches to quantifying first-person data.

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Spanning some years, now, we have collaborated on several studies comparing the cognitive skills reported from dreaming and waking (Kahan & LaBerge, 1996, 2000; Kahan et al., 1997, cited in Kahan, 2001). Our research aims have been, and are, twofold: first, to contribute to the development of valid and reliable measures of episodic recollections of both dreaming and waking experience; second, to delineate the extent of overlap between dreaming–waking cognition, especially in relation to the dominant claim that reflective awareness and other high-order skills are compromised or absent in dreaming (e.g., Hobson, 1988; Rechtschaffen, 1978; Weinstein et al., 1988).

In addition to reflective awareness (monitoring or evaluation of internal or external conditions), we have investigated the occurrence of other high-order cognitive processes, including volition (e.g., choice) and control (e.g., focused attention) in participants' dreaming and waking experiences. The following dream narrative illustrates these component processes:

> "I look down the road and see the forest on fire. The fire is moving up the road and I begin to panic. I can feel the adrenaline rising in my body and my heart racing. My breathing is shallow (*monitoring of internal conditions*). An alarm goes off; it's an emergency warning system. Our group is told to drop everything and evacuate. I grab my notebook and run to the road, needing to cross to my car (*intention*). By now, there's a stream of cars heading away from the fire. There is a lot of traffic and I wonder to myself how I'll get across (*reflective awareness*). I decide to float over the road – I elevate myself and float over; I have to stir the air in a circle with my left hand to propel myself (*behavior regulation; control*)" (Kahan, 2008).

Our studies of the relationship between sleep cognition and waking cognition have thus focused on the set of cognitive skills subsumed under what Wolman and Kozmová (2007) recently termed "analytical processes" (e.g., comparing and contrasting, evaluating, reason, logic, reflection, contemplation) and "executive processes" (e.g., decision making, problem solving, planning, and agency) (p. 845). The *interaction* of reflective awareness (monitoring), volition, and control has also been discussed in the context of the metacognitive models proposed by Nelson and Narens (1990, 1994), and Flavell (1979) (see Kahan, 2001).

In the next section, we briefly summarize the sampling protocol we have developed and the pattern of findings that has recurred across previous studies.

1.5. Systematic sampling of dreaming and waking experiences

> "In an era of high-resolution brain imaging, similarly high-resolution reports of dream imagery may be needed. To achieve this, the method of self-observation preferred by Freud, William James and others may yet prove to be among the most productive – particularly in a domain for which the object of study remains directly observable only by dreamers themselves" (Nielsen & Stenstrom, 2005, p. 1289).

Our methodological goal has been to develop a protocol whereby experience samples obtained from dreaming and waking are, to the extent possible, parallel. Toward that end, our sampling protocol acquired increasing rigor over the course of the several studies we conducted (Kahan & LaBerge, 1996, 2000; Kahan et al., 1997). The sampling method used in the present study is most similar to that employed in our 2000 study (Kahan & LaBerge, 2000, described in Kahan, 2001). Therein, we used a home-based sleep monitoring system (the DreamLight®) to obtain two samples each of dreams in late-night REM and non-REM sleep and used a programmable beeper (the Programmable Electronic State Tester or P.E.S.T.®) to obtain multiple samples of participants' waking experiences. An experience sample included the participant's narrative report of the just-interrupted waking or dreaming experience and his or her responses on the Metacognitive, Affective, Cognitive Experiences (MACE) questionnaire (Kahan & LaBerge, 1996; Kahan et al., 1997). The MACE assesses the incidence of emotion and high-order cognitive (HOC) processes such as reflective awareness, choice, sudden attention, and focused attention (see Appendix A).[4] Across studies, participants have consistently reported a higher incidence of *Choice* and *Reflective Awareness of their own Thoughts, Feelings, or Behavior* in their waking experiences than in their dreaming experiences. This pattern was observed for practiced and novice dream recallers (Kahan et al., 1997), for dreams sampled from different sleep stages (Kahan & LaBerge, 2000) and from morning awakenings (Kahan & LaBerge, 1996; Kahan et al., 1997, 2007).

For the present studies, we further refined our sampling protocol and integrated recommendations for maximizing the validity of experience samples obtained from different target conditions. We used an experimental–phenomenological approach to quantifying first-person data, what Hobson et al. (2003b) termed the "formal approach." They reference a study

[4] *Sudden Attention*, as operationalized with the MACE, entails an explicit noticing of what captures one's attention, where the object of attention may be either an external or internal event. Examples of Sudden Attention from the MACE excerpts reported for waking include: "The "beep" on my computer indicating I got new e-mail captured my attention" and "My attention is captured by the pattern of light and shadow." Examples from the MACE excerpts reported for dreaming include: "All of a sudden I saw a shark" and "Suddenly I noticed a trumpet over S's eyes." *Sudden Attention* differs from the traditional concept of an "orienting response" – "the automatic shift of attention toward a new stimulus" (Feist & Rosenberg, 2010). *Sudden Attention* also differs from "attentional capture," which refers to factors, presumably involuntary, that influence or guide attentional selection in a visual search (Pan & Soto, 2010). These other two constructs emphasize unconscious, involuntary attentional selection in response to environmental events, whereas *Sudden Attention* emphasizes *conscious* awareness of where one's attention has been drawn. *Focused Attention*, as operationalized with the MACE, includes both attention and intention. An individual reports focusing on a particular task for a period of time; this sustained attention is in the service of a goal which may or be explicitly stated. Examples from the MACE excerpts for waking include: "I focused on trying to figure out a correct e-mail address" and "I tried not to be distracted." Examples from the MACE excerpts for dreaming include: "I focused on finding a Christmas present" and "I focused on filling and cleaning the tub."

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by Kahan (1994) which was an earlier attempt to quantify the incidence of high-order cognitive skills in dreaming. Participants used a precursor of the MACE, the Dream Rating Scale (DRS), to rate the incidence of particular cognitive and structural features of a just-recalled dream experience. Separately, trained raters applied the DRS to the participants' narrative reports. Participants' self-ratings yielded a higher incidence of high-order cognitive skills (e.g., volition and reflective awareness) than did the third-person ratings of dream narratives. Hobson et al. recommend the use of this type of experimental–phenomenological approach: "[I]n our view, scales based on affirmative probes (focused inquires about the presence of subtle psychological features) are most likely to have the requisite sensitivity to produce success" (p. 232). This is the approach we have taken in previous studies (Kahan, 1994; Kahan & LaBerge, 1996, 2000; Kahan et al., 1997) and is the approach we take in the studies reported here.

(1) *Increase the reliability of dream reports*: In order to elicit detailed subjective reports, we recruited participants with demonstrated skill in dream recall. Participants were pre-trained in the use of the equipment used to sample subjective experience and in the protocol used to report and evaluate those experiences (Hurlburt & Heavey, 2004, 2006; Pekala, 1991; Varela, Thompson, & Rosch, 1991, Chap. 1). We acknowledge the trade-off between training and the possibility of introducing demand characteristics or response bias. However, we believe the benefits of training out-weigh the risks of introducing demand characteristics, especially when assessing the process features of subjective experience (also see Fosse et al., 2004; Hobson et al., 2003b; Kerr, Foulkes, & Schmidt, 1982).
(2) *Sample dreaming and waking experiences systematically*: We obtained samples from dreaming and waking that were as comparable as possible by defining the times of the night or day during which experience samples were obtained (Cavallero & Foulkes, 1993; Hobson et al., 2003b, pp. 231–232; Montangero, Ivanyi, & de Saint-Hilaire, 2003). We obtained multiple experience samples from waking and sleep (four each) over the course of two weeks, and counterbalanced the sampling order.

We also took steps to maximize the reliability of participants' reports of the phenomenological features of their experience. Our questionnaires, refined in the course of several studies (Kahan, 1994; Kahan & LaBerge, 2000; Kahan et al., 1997) index specific cognitive, sensory, and structural qualities of the experience. Participants were instructed to report and rate their experiences immediately after receiving the signal. This minimized the time delay between the participants' experience and their ratings of that experience.

1.5.1. Summary of current method

Participants who reported regular dream recall and no clinical sleep disorders received training and practice in obtaining experience samples. We used the experience-sampling procedure developed and refined in the course of our prior studies. Multiple experience samples were obtained from sleep and from waking. A sample began with an experimental interruption during late-night REM sleep or waking. The participant wrote a narrative of the just-interrupted experience and then completed two questionnaires. The first assessed the incidence of particular high-order cognitive processes during the experience; the second assessed other cognitive, sensory, and structural qualities of the experience.

In Study 1, we used data from the first questionnaire to compare the reported incidence of particular cognitive processes in dreaming and waking. Based on consistent patterns observed in prior studies, we expected that *choice* and *reflective awareness of internal experiences (own thoughts, feelings, or behaviors)* would be reported less often for dreaming than for waking experiences; no differences across dreaming and waking were expected for *sudden attention, focused attention, or reflective awareness of external events*. Ratings from the Cognitive Processes section of the second questionnaire were used to assess participants' ratings of several additional cognitive processes across dreaming and waking (e.g., remembering, thinking, imagining). In Study 2, we compared participants' ratings of the sensory and structural features of their dreaming and waking experiences. The latter analyses broaden the data base and theoretical conversation concerning which aspects of phenomenological experience are most likely to vary across dreaming and waking.

The present investigation replicates previous research in that we again systematically sample the occurrence of targeted high-order cognitive events from dreaming and waking (Study 1). We also extend our methodology to a comparison of participants' ratings of their dreaming and waking experiences with respect to additional cognitive processes not investigated in our previous studies (e.g., remembering, imagining) (Study 1) and to other process features of dreaming and waking phenomenology (sensory and structural features) (Study 2). Our aims are twofold: first, to advance theoretical understanding of the relationship between dreaming and waking phenomenology; second, to continue to develop and refine experience-sampling procedures appropriate for these (and perhaps other) cross-state comparisons.

1.5.2. Predictions

Again, our predictions were derived from the "continuity theory" of dreaming—the claim that the generation of dreaming experience involves the same cognitive and perceptual systems operating during waking (Cavallero & Foulkes, 1993; Domhoff, 2003; Kahan & LaBerge, 1994; Kerr, 1993). Our approach adds nuance to continuity theory in that we predict both similarities and differences across dreaming and waking. In view of our previous findings, we expected experiences reported from dreaming and waking to be characterized by the same range of cognitive skills, although the reported frequency of some cognitive skills (e.g., choice or self-reflection on internal experiences) may be lower for dreaming experiences. We also

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investigated whether participants' ratings of other cognitive, sensory, and structural features of their dreaming and waking experiences would be similar, as would be predicted by continuity theory (Domhoff, 2003; Schredl, 2003).

2. Method

2.1. Sample and participant selection

Sixteen participants (6 men and 10 women, age range 20–47 years) completed the study. Eight participants (*M* age = 36) were members of a research group associated with the Lucidity Institute, an organization that provides information, equipment, and services related to the development of lucid dreaming skills. These individuals received no compensation for their participation. Eight participants (*M* age = 23) were undergraduates at a small, liberal arts university in Northern California. The students received partial credit in an introductory psychology course or $20.[5] We excluded data from two students and one Lucidity Institute participant due to subject error in following the research protocol. The experimental protocol was approved by the Santa Clara University *IRB*. Participants' reported dream recall frequency (DRF) did not differ for males ($M = 5.43$/wk) and females ($M = 4.27$/wk), $F(1, 15) = .93$, $MSE = 8.07$, $p > .05$; neither did DRF differ for Lucidity Institute members ($M = 3.87$) and college students ($M = 4.63$), $MSE = 2.25$, $p > .05$. On average, participants recorded 5–6 dreams per week, slept 7.25 h per night, and maintained relatively stable bedtime and awakening time (±1 h).[6]

2.2. Materials

Participants received written instructions for the operation of the Dreamlight® and P.E.S.T.® (see Section 2.3), experience logs to record details of the sampling nights, a sampling order for waking and sleep experiences, and a trouble-shooting guide.

Participants used two questionnaires to rate the cognitive process and other phenomenological features of their recollected dreaming and waking experiences. For each experience sample, participants completed the Metacognitive, Affective, and Cognitive Experiences Questionnaire (MACE) (Appendix A). Participants assessed the *pervasiveness* of seven metacognitive activities by responding to the question: "During how much of the time did you:" (engage in each activity). The response options were 0 through 4, with anchor points for 0 ("none"), 2 ("some"), and 4 ("all"). In previous studies, we used a similar measure to assess the incidence of metacognitive activities using a "Yes"/"No" format (dichotomous variable) (Kahan & LaBerge, 1996; Kahan et al., 1997). For the present study, we changed to a continuous scale (time) to obtain a possibly more sensitive measure of metacognitive processes. For answers other than "0" (none), the participant briefly described the relevant experience. For example, for the question "*During how much of the time did you think about your own thoughts or feelings?*" a participant who gave a rating of "3" might write: "I thought about the intensity of the jealousy I was feeling."[7]

Participants used a second questionnaire, the Subjective Experiences Rating Scale (SERS) to assess the pervasiveness ("none of the time" to "all of the time") of nine cognitive activities and the *prevalence* ("none" to "a lot") of eleven sensory qualities. The SERS, presented in Appendix B, also was used to assess structural features of the experience (e.g., logical organization, point-of-view). The structure of the SERS was derived from the Memory Characteristics Questionnaire (MCQ), used

[5] The college student participants were selected from a larger pool of 46 participants who first completed a week of dream journaling. Instructions were to describe any experiences, thoughts, or feelings that occurred immediately before awakening (Foulkes, 1962). This exercise was designed to increase the level of dream recall and stabilize sleep patterns (Langens, 2006; Schredl & Montasser, 1997). Students were advised to: (1) maintain a stable sleep schedule (e.g., a minimum of 6–8 h per night, with consistent sleep and wake times); (2) awaken 15 min earlier than their normal wake time; (3) write about experiences that occurred during the (approximately) 15 min prior to waking; and (4) avoid interpretation or analysis of the meaning of the dream experiences. Two research assistants not otherwise involved in the study reviewed the sleep and dream journals independently. The number of mornings with dream recall was determined for each participant. "Dream recall" was defined as a narrative report of a pre-awakening experience with a word count over 30 words. Research assistants also made a holistic assessment of the journal based on the number and completeness of dream narratives and the stability of the participant's sleep/wake times. The ten students whose journals received the highest ratings were invited to participate in the experience-sampling study. Participants who were not invited to continue were contacted, thanked, and credited for their participation.

[6] The heterogeneity of our sample, which includes both novice and practiced dreamers, may be of concern to some. In Kahan et al. (1997), "no systematic differences between practiced [$n = 38$] and novice [$n = 50$] dreamers were observed" (p. 142). Given the selection criteria in the present study regarding DRF and motivation to recall dreams, the novice group's two weeks of preparatory dream journaling, and the pre-training of all participants in the sampling procedure (including in the use of the equipment), we felt we had taken appropriate steps to minimize group differences. As indicated in the participants' section, DRF did not differ for the novice and practiced dreamers (or for males and females). The only group difference observed on our measures was that, *for both waking and dreaming experiences*, practiced dreamers more often reported having made a choice (Question 1 on the MACE questionnaire) [*Ms* (*SDs*) = .84 (.19), .61 (.18), respectively] in comparison with novice dreamers [*Ms* (*SDs*) = .63 (.35), .38 (.21), respectively], $F(1, 14) = 5.83$, $MSE = .08$, $p = .03$, $\eta^2 = .29$. Admittedly, group by state interactions may not have emerged because of our small sample sizes. However, the current findings replicate those of our prior studies, thus reinforcing the robustness of the pattern of results on the MACE, including across different samples (Kahan & LaBerge, 1996, 2000; Kahan et al., 1997).

[7] We omitted two questions from the previous version of the metacognition questionnaire (see Kahan et al., 1997). "*Did you feel any emotions during the experience?*" was removed because the incidence (and intensity) of particular emotions were assessed with the second questionnaire. We also omitted the question: "*Did you comment to yourself about any person or event?*" because we believed it was redundant with the question: "*Did you think about or evaluate what was going on around you)*". In a recent study, Kahan et al., (2007) demonstrated that these two questions are not redundant; hence, they have been reinstated in subsequent studies (also see Kahan & Sullivan, 2010).

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by Marcia Johnson and her colleagues to investigate the phenomenal qualities of episodic memories (Johnson et al., 1984, 1988; Mather, Henkel, & Johnson, 1997).

2.3. Apparatus

Participants were supplied with a Dreamlight® and P.E.S.T. (Programmable Electronic State Tester)®. The Dreamlight is a digital device that receives information from sensors in a mask worn by the dreamer. The mask relays information about eye movements and head movements to the device, which applies an algorithm to this information to predict REM sleep, NREM sleep, or Waking (LaBerge & Levitan, 1995). The Dreamlight is similar to the Nightcap® developed and employed by J. Allan Hobson and his colleagues (Ajilore, Stickgold, Rittenhouse, & Hobson, 1995; Fosse, Fosse, Hobson, & Stickgold, 2003; Mamelak & Hobson, 1989; Rowley, Stickgold, & Hobson, 1998; Stickgold, Pace-Schott, & Hobson, 1994). The P.E.S.T. (LaBerge & Levitan, 1994) is a programmable pager used for signaling participants to report on their waking experience.

2.4. Design and procedure

A within-participants, repeated-measures design was used to obtain four experience samples each from REM sleep and waking. Participants' responses on the MACE and SERS were the dependent variables.

All participants attended an orientation session. For participants recruited through the Lucidity Institute, orientation sessions were conducted by the first author at regularly scheduled research meetings of Lucidity Institute members. For participants recruited through the Santa Clara University research participant pool, orientation sessions were conducted by research assistants trained by the first author.

All orientation sessions were conducted similarly. A researcher introduced the study as an exploration of the relationship between dreaming and waking experience, provided an overview of the study, and had participants complete a questionnaire concerning their typical sleep and dreaming experiences. Research assistants who conducted orientation sessions were blind to the specific hypotheses of the study. Participants met individually with one of the two authors, or with a senior research assistant for a procedural orientation. Regarding the Dreamlight®, participants not already familiar with the device and sleeping mask received instruction in their use (LaBerge & Levitan, 1991, 1995). Participants practiced using the Dreamlight® for two nights before starting the experiment. Data from practice nights were excluded. For each sampling night, the participant entered start and end times into the Dreamlight® to define a 4-h interval in the latter half of the night during which the device would search for REM sleep and deliver a sound alarm after 3–5 min of continuous REM. We elected to sample the participant's experience in this time frame because eye movement density within REM normally fluctuates between phasic (clear eye movements) and tonic (relatively few eye movements). We wanted to maximize the likelihood we were sampling from phasic REM.[8]

Participants defined this 4-h window for sampling to allow for variation in bedtime. We sampled from REM periods (REMPs) in the second half of the night when it is typical for healthy young adults to experience little slow wave sleep and longer REMPs which alternate with Stage 2 sleep (e.g., Keenan, 1999; Lavie, 1996). This sampling strategy thus minimized confounding the NREM sleep stages characterized by slow, synchronized delta waves (Stages 3 and 4) and NREM Stage 2 sleep, which is characterized by K-complexes, sleep spindles, and a generally higher frequency EEG pattern (Rechtschaffen & Kales, 1968).

When signaled, the participant pressed the "Reality Test" button located on the mask, thereby marking the Dreamlight® record. He or she then removed the mask, recorded a narrative of his/her experiences of the (approx) 5 min prior to the alarm, and completed the MACE and SERS questionnaires. After noting the total time to complete these measures, the participant turned off the Dreamlight and returned to sleep. The use of the Reality Test button permitted us to confirm that an awakening had occurred during REM sleep. The Dreamlight®, like the Nightcap (Ajilore et al., 1995), detects phasic REM using an algorithm that seeks a conjunction of eye movements and no head movements. With either of these devices, a signal could be delivered during a period of relaxed wakefulness that included eye movements and no head movements. We therefore reviewed the narrative reports associated with Dreamlight® awakenings to confirm that the participant was reporting (and rating) a sleep experience. Four of the 72 sleep experience samples were eliminated from the subsequent analyses because the narrative report clearly indicated the signal occurred during relaxed wakefulness (e.g., "I was lying awake and thinking about...").[9]

The P.E.S.T. was used to obtain samples of waking experiences during a time window of 2–8 h after morning awakening, as defined by the participant. The participant wore the P.E.S.T. in a pocket or on the waistband. When signaled, the participant turned off the P.E.S.T., recorded her/his experiences from the 5 min period prior to the signal, and completed

[8] Neither the Dreamlight® nor the Nightcap algorithms discriminate tonic REM (no eye movements and no head movements) from other sleep stages. For this, one would need standard polysomnography (Butkov, 1996). For information on the development of the Nightcap technology, see Ajilore et al., 1995; Mamelak & Hobson, 1989; for presentation of results from an oft-cited longitudinal study involving the Nightcap see, especially, Fosse et al., 2004; Stickgold, Malia, Fosse, & Hobson, 2001.

[9] We could have asked the three participants who submitted dream samples that were later eliminated to provide additional samples. Procedurally, this would have been unwieldy; several of the participants would have participated for a longer time in an already time and labor-intensive study. Also, our counterbalancing of sampling order would have been compromised. On balance, we felt it more important to apply our sampling protocol consistently than to obtain additional samples these participants.

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the questionnaires. Our protocol is consonant with previous experience-sampling procedures (Hurlburt & Heavey, 2004; Kerr et al., 1982), and parallels the approach taken in the Nightcap studies (also see Stickgold et al., 2001).

Special circumstances were covered by a trouble-shooting guide. For example, if the participant missed a night (e.g., mask taken off during the night, participant slept through the alarm), he was to disregard that night and repeat the procedure the following night. If the participant was awakened by the alarm and had no dream to report, he was to treat the sample as valid and fill out the report forms as usual; if the participant had to remove the P.E.S.T. (e.g., to exercise or take a shower), he was to leave the P.E.S.T. on and simply wait for the next signal.

The sampling phase lasted two weeks. Each week, participants obtained two experience samples from waking and two from sleep, for a total of eight samples. The order for obtaining experience samples was counterbalanced across participants. Participants were contacted each week to confirm that experience samples were obtained. After two weeks, participants returned the study materials and equipment and were debriefed. Student participants were thanked and awarded either research participation units or payment. Research group members were thanked profusely.

2.5. Scoring and preparation for analysis

Participants' written narratives were transcribed verbatim by two research assistants not otherwise involved with the study. Before computing word count, irrelevant comments were deleted (e.g., "I was dreaming about..." "that's all I remember") (after Antrobus, 1983).

Had each participant recalled 4 dreams, there would be 64 dreams (16 participants × 4 dream samples). However, not all participants recalled four dreams. Four dreams were eliminated from analysis because the narrative report indicated the sample described was of an awakening episode, not a dream, thus reducing the number of potential dream samples to 60. Three other dream samples were eliminated because they did not meet the word count criterion of (>30 words). Thus, the total number of dream samples was 57 (of a possible 64), or 84% of the sleep samples. This percentage is consistent with the 83–85% dream recall frequency typically observed in experimental awakenings from REM sleep (see Nielsen (2003), for a review). For each participant, summary statistics were based on the number of dreams recalled; eleven participants recalled four dreams (44 dreams); three participants recalled three dreams (nine dreams), and two participants recalled two dreams (four dreams).

2.6. Analysis of word counts

Overall, word counts were higher for dreaming (*M* = 163, *SE* = 21.9, *range* = 31–494) than waking (*M* = 115.5, *SE* = 59.7, *range* = 36–281) reports, $t(15) = 2.75, p = .02, \eta_p^2 = .35$; this pattern was consistent for both novice and practiced dreamers. Average word counts did not differ for male (*M* = 122.4, *SE* = 24.6, *range* = 46–342) and female (*M* = 155.9, *SE* = 21.7, *range* = 84–338) participants, $t(15) = 2.45, p > .05, \eta_p^2 = .07$; neither was the interaction between sex and word count significant, $F(1,14) = .26, p > .05, \eta_p^2 = .02$. Word counts for participants' dreaming and waking reports were highly correlated, $r(16) = .61$, $p \leqslant .01$. Thus, the *number* of words used to narrate dreaming versus waking experiences would not account for differences observed in the qualities of a given participant's dreaming and waking experiences (Antrobus, 1983). Because our predictions derive from the "continuity hypothesis"—specifically, that the same cognitive processes operate in dreaming as in waking (Cavallero & Foulkes, 1993)—we chose not to control for word count in the statistical comparisons so as not to artificially minimize potential differences (Hobson et al., 2003a, p. 9; Hunt, Ruzycki-Hunt, Pariak, & Belicki, 1993).

3. Study 1: results

The purpose of Study 1 was to replicate and extend our past studies of the relationship between dreaming and waking metacognition and cognition (Kahan & LaBerge, 1996, 2000; Kahan et al., 1997). In previous studies, participants responded to the MACE questions in a "Yes"/"No" format (dichotomous variable). For the present study, we changed to a continuous scale (time) to obtain a possibly more sensitive measure of metacognitive processes.

3.1. Metacognitive activities: pervasiveness

Table 2 presents mean pervasiveness and associated statistics for metacognitive activities sampled from REM sleep and waking. Analysis of variance (ANOVA) for repeated measures was used to determine whether the mean pervasiveness of targeted metacognitive events differed for dreaming and waking experiences. Observed *p*-values and effect sizes (η_p^2) are reported.[10]

[10] Responses to the seven questions are not independent because the referent is the same target event, either a dreaming or waking experience. Because we conducted pair-wise comparisons (Dreaming vs. Waking) for each question, one could argue that we need to correct for the increased likelihood of Type I errors associated with the family-wise (*fw*) error rate (Howell, 2002). However, in view of the small sample size, we chose to maximize the power of our analysis by adopting a more liberal criterion for alpha (probability of a Type I error). Ultimately, effect sizes (indexed by η_p^2 [i.e., partial eta squared]) may prove more revealing of actual differences (Wright, 2003).

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Table 2
Mean Pervasiveness Ratings (and SD) for Metacognitive and Cognitive Activities in REM Sleep (REM) and Waking ($N = 16$).

	REM	(*SD*)	Waking	(*SD*)	Mean paired differences	95% CI of difference between means		*SE diff*	*t*	*p*	η^2
						Lower	Upper				
Choice**	0.9	0.59	1.89	0.7	−0.99	−1.71	−0.53	0.28	−3.66	0.002	0.52
Attention captured suddenly	1.7	0.84	1.66	1	0.04	−0.48	0.6	0.25	0.168	0.869	0.001
Focused attention[a]	1.85	1.06	2.67	1	−0.82	−1.66	−0.15	0.35	−2.07	0.06	0.3
Public self-consciousness	0.74	0.94	0.89	0.7	−0.14	−0.78	−0.04	0.17	−0.546	0.59	0.019
Reflective awareness											
Own thoughts, feelings	1.2	0.96	1.63	1	−0.42	−1	0.19	0.28	−1.48	0.16	0.12
Own behavior**	1.26	1.02	1.92	1.1	−0.67	−1.03	−0.18	0.2	−3.41	0.004	0.38
External events	1.6	0.9	1.39	1	0.21	−0.2	0.65	0.2	1.04	0.32	0.08

Note. Scale anchor points were 9 ("none of the time") to 4 ("all of the time").
* $p < .05$.
** $p < .01$.
[a] Strong trend ($p < .10$).

As seen in Table 2, participants gave higher pervasiveness ratings to their waking experiences than their REM dreaming experiences on two questions: *Choice* [Q1], and *Reflective Awareness (of own behavior)* [Q6]. Mean pervasiveness ratings for REM sleep and waking experience samples did not differ for the other five questions: *Attention Captured Suddenly* [Q2], *Focused Attention* [Q3], *Public Self-Consciousness* [Q4], *Reflective Awareness: Own Thoughts or Feelings* [Q5], and *Reflective Awareness: External Events* [Q7].

3.2. Metacognitive activities: incidence

Rating the pervasiveness of a particular cognitive activity likely require two judgments. First, a participant must decide whether a given cognitive activity occurred (e.g., "*Did you focus your attention for a period of time on accomplishing a particular task*"). If she decides "yes," she must also assess how much that activity pervaded the experience. In essence, a pervasiveness rating other than "0" also represents a "Yes" answer. Therefore, to determine whether the pattern of results in the present study conforms to that of our previous studies, we converted the pervasiveness ratings to occurrence ratings. Pervasiveness ratings of 1–4 ("some of the time" to "all of the time") were redefined as "yes" (and coded 1); pervasiveness ratings of 0 ("none of the time") were redefined as "no" (and coded 0). For each participant, the number of "yes" responses to each question was tallied separately for dreaming and waking experiences. Sums were divided by the number of samples obtained from that participant from dreaming and waking, respectively. This calculation yielded two proportions for each question, one for dreaming and one for waking experiences. Repeated measures ANOVAs were conducted to determine whether the mean proportion of "yes" responses differed for dreaming and waking samples. Table 3 (rows "a") shows the mean proportions and the associated statistics. Table 3 (rows "b") presents the same proportions (and associated statistics) from a related study (Kahan & LaBerge, 2000, described in Kahan, 2001). In that study, the Dreamlight® and P.E.S.T. were used to obtain two samples of REM dreaming, two samples of NREM dreaming, and two samples of waking experience, respectively, from each of 26 participants. The sampling procedure was comparable to that used in the present study; the same seven metacognitive activities were assessed in both studies.

Re-coding the pervasiveness ratings into occurrence ratings permitted a comparison with results obtained by Kahan and LaBerge (2000) for samples obtained from REM sleep and waking. The current findings were similar to the previous findings for five of the seven questions: *Choice* (W > D); *Sudden Attention* (W = D); *Focused Attention* (W = D); *RA: Own Behavior* (W > D), and *RA: External Events* (W = D). Although the pattern for *RA: Own Thoughts or Feelings* (W > D) was consistent with previous research, the difference between dreaming and waking experiences did not reach statistical significance in the present study. With data combined from the two studies, repeated measures ANOVA (for a mixed design) confirmed a higher incidence of *RA: Own Thoughts or Feelings* in waking experiences (52%) than in dreaming experiences (35%), $F(1,42) = 8.83, MSE = .10, p < .01, \eta_p^2 = .18$. Similar analyses of *Choice* and *SR: Own Behavior* were also statistically significant ($p = .006$, .008 and $\eta_p^2 = .18, .17$, respectively). The combined data set yielded no other statistically significant comparisons.

We also compared the ratings of pervasiveness and occurrence (Table 2 vs. Table 3, rows "a"). Whether presented as pervasiveness ratings or as occurrence ratings, the same pattern emerged for: *Choice* (W > D), *RA: Own Behavior* (W > D), *Sudden Attention* (W = D); *Public Self-Consciousness* (W = D); *RA: Own Thoughts, Feelings* (W = D); and *RA: External Events* (W = D). The only difference across dreaming and waking experiences was for *Focused Attention*; pervasiveness ratings showed a strong trend toward greater focused attention in waking experiences ($p < .06$), whereas no difference in focused attention was observed when participants' pervasiveness ratings were re-coded as occurrence ("Yes"/"No").

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Table 3
Mean proportion "Yes" responses (and SD) to questions of metacognition in REM sleep (REM) and waking experiences in the present study ($N = 16$) [a] and in a companion study ($N = 26$) (Kahan & LaBerge, 2000, described in Kahan, 2001)[b].

		REM	(*SD*)	Waking	(*SD*)	Mean paired differences	95% CI of difference between means		*SE diff*	*t*	*p*	η^2
							Lower	Upper				
Choice**	[a]	0.51	0.23	0.73	0.29	0.239	−0.43	−0.02	0.09	2.5	0.03	0.28
	[b]	0.52	0.41	0.71	0.4	−0.19	−0.39	0.006	0.1	−2	0.05	0.14
Attention captured suddenly	[a][3]	0.67	0.27	0.63	0.29	−0.04	−0.12	0.24	0.08	0.52	0.61	0.03
	[b]	0.33	0.34	0.38	0.36	−0.06	−0.23	0.2	0.09	−0.68	0.50	0.02
Focused attention	[a]	0.69	0.29	0.83	0.25	0.14	−0.37	0.1	0.11	1.24	0.24	0.09
	[b]	0.63	0.41	0.77	0.35	−0.13	−0.35	0.08	0.11	−1.27	0.22	0.06
Public self-consciousness	[a][2]	0.27	0.3	0.41	0.3	0.135	−0.32	0.02	0.08	1.72	0.11	0.17
	[b]	0.4	0.35	0.29	0.32	0.12	−0.04	0.27	0.07	1.54	0.14	0.09
Reflective awareness												
Own thoughts, feelings	[a][3]	0.5	0.33	0.67	0.31	0.17	−0.37	0.07	0.1	1.65	0.12	0.13
	[b]	0.25	0.32	0.42	0.37	−0.17	−0.33	−0.01	0.08	−2.21	0.04	0.16
Own behavior**	[a]	0.54	0.31	0.72	0.3	0.18	−0.32	−0.02	0.07	2.75	0.02	0.27
	[b]	0.44	0.43	0.63	0.36	−0.19	−0.38	−0.002	0.09	−2.08	0.05	0.15
External events	[3][a]	0.66	0.25	0.64	0.36	−0.02	−0.16	0.22	0.09	−0.18	0.86	0.01
	[b]	0.52	0.41	0.42	0.37	0.1	−0.12	0.31	0.1	0.93	0.36	0.03

Note. Duration responses of "0" in the present study were defined as "No;" duration responses of "1–4" were defined as "Yes."
The same pattern of significant and non-significant comparisons was observed when data from the two studies were combined, excluding
Group differences significant, $p \leqslant .05$.
* $p \leqslant .05$.
** $p \leqslant .01$.
[2] *Private self-consciousness* due to the interaction between group and state.
[3] State × Group interaction significant, $p \leqslant .05$.

3.3. Summary

Across studies, participants have consistently reported a higher incidence of *Choice* and *Reflective Awareness of their own Thoughts, Feelings, or Behavior* in their waking experiences than in their dreaming experiences. This pattern was observed for practiced and novice dream recallers (Kahan et al., 1997), for dreams sampled from different sleep stages (Kahan & LaBerge, 2000) and from morning awakenings (Kahan & LaBerge, 1996; Kahan et al., 1997, Kahan et al., 2007). The present study shows that this pattern also extends to participants' estimates of the pervasiveness of particular cognitive activities wherein a greater range of response options was available (0 "none of the time" to 4 "all of the time") than in our prior studies of occurrence using dichotomous measures ("Yes"/"No").

In prior studies, the reported incidence of *Focused Attention* did not differ for dreaming and waking experiences. The present study shows the same pattern. However, results for pervasiveness (vs. mere occurrence) suggest that *Focused Attention* may be somewhat more pervasive in waking experiences (Table 2 vs. Table 3). In general, the incidence (and pervasiveness) of focused attention reported for REM dreams is higher than we would expect if the ability to focus one's attention during dreaming is compromised or otherwise reduced, as some theorists have suggested (e.g., Braun et al., 1997; Fosse et al., 2004; Hobson et al., 2003b).

Also across studies, dreaming and waking experiences did not differ in the reported incidence of *Sudden Attention* and *Reflective Awareness of External Events.* This is rather surprising given that one might expect waking experiences, especially, to vary in the extent to which attention is captured by what is going on in the external world.

Results for *Public Self-Consciousness* (PSC) (concern for how one looks or appears to others) have been inconsistent between studies. In the present study, the trend was towards a higher incidence and greater pervasiveness of PSC for waking experiences than for dreaming experiences. In our other DreamLight® study (Kahan & LaBerge, 2000, reported in Kahan, 2001), the trend was towards a higher incidence of PSC in dreaming than in waking experiences. In neither study was the dreaming/waking comparison statistically significant. When data from the two studies were combined, only the interaction between group and state was significant, $F(1,41) = 5.49, MSE = .06, p = .02, \eta_p^2 = .12$ (see Table 3).

3.4. Cognitive activities: pervasiveness

Table 4 presents mean pervasiveness and associated statistics for the nine cognitive activities rated by participants on the second questionnaire, the Subjective Experiences Rating Scale. Analysis of variance (ANOVA) for repeated measures was used to determine whether the average pervasiveness of particular cognitive events differed for dreaming and waking experiences. In comparison with participants' waking experiences, average pervasiveness ratings were lower for: *thinking, planning, imagining,* and *remembering*. Mean pervasiveness ratings of dreaming and waking experiences did not differ for: *evaluating, talking, listening,* or *attending (to external events; to internal events).*

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Table 4
Mean pervasiveness ratings (and SD) for cognition in REM sleep (REM) and waking experiences.

	REM	(SD)	Waking	(SD)	Mean paired differences	95% CI of difference between means		SE diff	t	p	η^2
						Lower	Upper				
Thinking**	2.23	0.67	2.98	0.63	−0.73	−1.07	0.4	0.16	−4.62	0.001	0.59
Planning**	1.11	0.63	2.31	0.8	−1.2	−1.59	0.82	0.18	−6.64	0.001	0.75
Imagining*	1.46	0.94	2.23	1.02	−0.79	−1.44	−0.14	0.31	−2.58	0.02	0.31
Evaluating	1.84	0.84	2.23	0.75	−0.39	−0.86	0.08	0.22	−1.78	0.10	0.17
Remembering*	0.93	0.7	1.91	1	−0.98	−1.7	−0.26	0.34	−2.9	0.01	0.36
Talking	1.3	1	1.53	1.01	−0.23	−1.13	0.68	0.43	−0.539	0.60	0.02
Listening	1.9	0.79	1.9	0.91	0.005	−0.63	0.64	0.3	0.017	0.99	0
Attending to											
External events	2.58	0.98	2.53	0.84	0.046	−0.65	0.75	0.33	0.142	0.89	0.01
Internal events	2.00	0.87	2.51	0.65	−0.515	−1.24	0.21	0.34	−1.52	0.15	0.13

Note. Scale anchor points were 0 (“none of the time”) to 4 (“all of the time”).
* $p \leqslant .05$.
** $p \leqslant .01$.

When pervasiveness ratings were re-coded as occurrence (yes/no) (Table 5), a similar pattern emerged, with two exceptions. First, the comparison of dreaming and waking experiences for reported *thinking* was not statistically significant (this comparison was statistically significant for reported pervasiveness). Second, *attending to internal events* was more often reported for waking than for dreaming experiences (this comparison was not statistically significant for reported pervasiveness).

4. Study 1: discussion

The results of Study 1 replicate the basic pattern of our previous studies in two important ways. First, participants reported the same range of cognitive skills for their dreaming and waking experiences, including the high-order skills of choice, planning, and focused attention. This recurring pattern reinforces the claim the same cognitive system operates in both dreaming and waking and challenges claims regarding the presumed suspension of executive processes in REM dreaming (e.g., Braun et al., 1997; Hobson, 2009; Hobson et al., 2003b; Maquet et al., 1996).

Second, across studies, including the present study, participants have consistently rated their waking experiences as including a higher incidence of choice and reflective awareness (of their own thoughts, feelings, or behaviors). The present study extends this pattern to include participants' ratings of the *pervasiveness* of these cognitive activities. These results reinforce the claim that, although the same cognitive system is operating in both dreaming and waking, certain thought processes may be less pervasive in dreaming than in waking. With respect to the typology of thought processes described by Wolman and Kozmová (2007, p. 845), our research indicates that dreaming and waking experiences are more likely to vary in the utilization of executive thought processes (decision making, problem solving, planning, agency) than in the utilization of analytical thought processes (comparing and contrasting, evaluating, reason, logic, reflection, contemplation) (also see Walker, Liston, Hobson, & Stickgold, 2002).

For other cognitive activities (e.g. sudden attention, public self-consciousness, reflective awareness of external events), our studies show less consistency in the patterns across waking and dreaming. It is possible that, for certain cognitive events, variations across waking and sleep are more closely tied to sampling technique (e.g., home vs. lab dreams, first vs. third-per-

Table 5
Mean incidence (proportion “Yes” ratings)[a] (and SD) of cognitive activities in REM Sleep (REM) and waking experiences.

	REM	(SD)	Waking	(SD)	Mean paired differences	95% CI of difference between means		SE diff	t	p	η^2
						Lower	Upper				
Thinking	0.97	0.09	0.95	0.1	0.02	−0.06	0.09	0.04	0.436	0.670	0.013
Planning	0.57	0.25	0.84	0.15	−0.27	−0.37	−0.17	0.05	−5.59	0.000	0.68
Imagining	0.61	0.33	0.83	0.22	−0.22	−0.38	−0.06	0.08	−2.91	0.01	0.36
Evaluating	0.79	0.15	0.84	0.26	0.05	−0.21	0.11	0.07	0.7	0.49	0.03
Remembering	0.45	0.27	0.78	0.33	−0.33	−0.59	−0.07	0.12	−2.72	0.02	0.33
Talking	0.62	0.29	0.63	0.32	−0.005	−0.29	0.3	0.14	−0.038	0.97	0
Listening	0.83	0.23	0.78	0.27	0.05	−0.17	0.26	0.1	0.463	0.65	0.014
Attending to											
External events	0.83	0.21	0.91	0.22	−0.08	−0.24	0.09	0.08	−1.02	0.33	0.06
Internal events	0.89	0.16	0.98	0.06	−0.09	−0.19	0.002	0.04	−2.09	0.05	0.23

* $p \leqslant .05$.
** $p \leqslant .01$.
[a] Prevalence ratings of “0” (none) were re-coded as “No”; ratings of 1 (some) – 4 (a lot) were re-coded as “Yes”.

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Table 6
Mean prevalence ratings for sensations in REM sleep (REM) and waking experiences.

	REM	Waking	*Diff* [R]-[W]	95% CI of diff. between means		*SE M diff*	*F*	*p*	η^2
				Lower	Upper				
Smell	0.47	1.3	−0.83	−1.54	−0.12	0.33	6.23	0.03	0.29
Touch	1.34	2.55	−1.21	−1.95	−0.46	0.35	11.87	0.004	0.44
Taste	0.26	1.16	−0.9	−1.45	−0.35	0.26	12.33	0.003	0.45
Sounds	2.17	2.63	−0.46	−1.27	0.35	0.38	1.49	0.24	0.09
Voices	2.49	2.56	−0.07	−0.79	0.64	0.33	0.05	0.83	0.01
Visual Detail	2.59	3.19	−0.6	−1.22	0.02	0.29	4.23	0.06	0.22
Visual complexity	2.52	2.73	−0.21	−0.87	0.44	0.31	0.48	0.50	0.03
Brightness	2.21	2.8	−0.59	−1.36	0.18	0.36	2.66	0.12	0.15
Colors	2.26	2.69	−0.43	−1.26	0.41	0.39	1.18	0.29	0.07
Movement: self	2.13	2.25	−0.12	−0.83	0.59	0.33	0.13	0.72	0.01
Movement: others	2.36	2.2	0.16	−0.59	0.91	0.35	0.2	0.66	0.01

Note: scale anchor points were 0 (“none”) to 4 (“a lot”).

son ratings), circadian factors, or other individual difference factors not yet formally considered in this line of research (e.g., waking imagery ability, mindfulness skills, need for cognition).

The current findings, like those of our prior studies, challenge the general claim that high-order cognition is suspended in REM sleep (e.g., Braun et al., 1997; Fosse, Stickgold, & Hobson, 2001; Hobson et al., 2003a, 2003b; Occhionero & Esposito, 2003). The present findings also challenge the specific claim that the cognitive functions most likely to be attenuated in sleep are those relying upon focused attention and cognitive monitoring (see Fosse et al., 2004, p. 302). Individuals regularly report evaluating, planning, making decisions, and focusing their attention during dreaming; this recurrent pattern shows volitional activity is often present in dreaming (also see Nielsen, McGregor, Zadra, Ilnicki, & Ouellet, 1993, p. 497).

The second study tested the hypothesis that participants would show greater variation in their ratings of the structural features than in the process features of their reported dreaming and waking experiences.

5. Study 2: results

As described in the Method section and in the results of Study 1, participants used the Subjective Experiences Rating Scale (SERS) to evaluate nine cognitive processes associated with their dreaming and waking experiences (Table 4). Participants also used the SERS to assess the sensory and structural features of their dreaming and waking experiences. These ratings permitted a test of the hypothesis that dreaming and waking experiences are more similar with respect to their process features (cognitive, sensory) than their structural features (e.g., logical organization, event transitions, familiarity of location, actions) (see Table 5).

5.1. Sensory qualities

Participants’ dream experiences were rated, on average, as including less *smell, touch, taste*, and *visual detail* than their waking experiences (Table 6). Participants’ ratings of their dreaming and waking experiences did not differ for other visual qualities (visual complexity, brightness, colors), auditory qualities (sounds, voices), or movement (of self; of others, objects, or the environment). The same pattern was observed when prevalence ratings were re-coded as frequencies.

The present findings also suggest that vision is less dominant in dreaming than in waking. A rank ordering of the sensory qualities by *prevalence* reveals the expected dominance of vision for waking, with the four visual qualities in the top four positions (visual detail, brightness, colors, visual complexity), followed by auditory qualities (sounds, voices), touch, movement (self, others, etc.), smell, and taste. In contrast, the rank ordering for dreaming experiences is: vision (visual detail, visual complexity), audition (voices), movement of others or the environment, vision (colors, brightness), audition (sounds), self-movement, touch, smell, and taste. Although these rankings suggest that movement in the environment is more salient in dreaming than in waking experiences, participants’ ratings of the prevalence of movement (whether movement of the self or movement of others, objects, or the environment) did not differ for experiences sampled from waking and REM sleep.

5.2. Structural features

As seen in Table 7, robust differences were observed on questions concerning general reality orientation in dreaming and waking experiences.[11] *Locations* in waking experiences were rated as more distinct, familiar, and realistic than were locations in

[11] We purposely avoided using the term “dream bizarreness” in our discussion of the structural features of dreaming and waking experiences because this blanket term has often proven more confusing than clarifying (see Revonsuo and Salmivalli (1995), for a review). Investigations of dream bizarreness have employed myriad definitions. Thus, there is a need for clear operational definitions and reliable/valid measurement tools (also see Hobson et al., 2003b, p. 246; Wolman & Kozmová, 2007). A full discussion of issues surrounding the measurement and interpretation of dream bizarreness is beyond the scope of this paper.

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Table 7
Mean ratings of structural features of experiences sampled from REM sleep (REM) and waking.

	REM	Waking	*Diff* [R]-[W]	Between means 95% CI of difference		*SE diff*	*F*	*p*	η^2
				Lower	Upper				
Location									
Vague/distinct	2.62	3.92	−1.3	−1.79	−0.83	0.22	34.19	0.001	0.7
Unfam/familiar	1.29	3.82	−2.53	−3.2	−1.87	0.31	66.18	0.001	0.82
Bizarre/realistic	2.51	3.94	−1.43	−1.9	−0.96	0.22	41.6	0.001	0.74
Events									
Bizarre/realistic	2.03	3.89	−1.86	−2.34	−1.39	0.22	69.7	0.001	0.82
Event transitions									
Illog/logical	2.16	3.75	−1.59	−2.23	−0.96	0.3	28.39	0.001	0.65
My actions									
Bizarre/realistic	2.61	3.92	−1.31	−1.75	−0.87	0.21	40.03	0.001	0.73
Atypical/typical	2.64	3.8	−1.16	−1.58	−0.74	0.2	34.38	0.001	0.7
Others' actions									
Bizarre/realistic	2.28	3.72	−1.44	-2.01	−0.87	0.27	28.87	0.001	0.66
Atypical/typical	2.51	3.68	−1.17	−1.77	−0.57	0.28	17.48	0.001	0.54
Point of view									
Active participant	2.78	3.45	−0.67	−1.20	−0.14	0.25	7.34	0.02	0.33
Detached observer	1.48	1.20	0.28	−0.28	−0.85	0.26	1.17	0.300	0.07

Note. Scale anchor labels for low ratings ("0") to high ratings ("4") are indicated for each question.

dreaming experiences. Similarly, *events* were considered to be more realistic and *event transitions* more logical in waking experiences than in dreaming experiences. *Actions* (whether one's own or the actions of others) were rated as more realistic and typical in waking experiences than in dreaming experiences, and participants considered themselves more likely to be an active participant in their waking experiences. Only ratings of being a "detached observer" showed no differences for dreaming and waking experiences.

6. Study 2: discussion

The results of Study 2 for reported sensory qualities are consistent with previous studies of dream phenomenology in which smell, touch, and taste were under-represented in dreaming (McCarley & Hoffman, 1981; Okada, Matsuoka, & Hatekayama, 2005; Snyder, 1970; Zadra, Nielsen, & Donderi, 1998). Our results also confirm previous findings that REM dreams and waking experiences typically do not differ in brightness and clarity (e.g., Antrobus, Hartwig, Rosa, Reinsel, & Fein, 1987; Rechtschaffen & Buchignani, 1992).

The finding that the intensity of color in dream experiences did not differ from that of waking experiences is of particular interest. In several previous studies, the most common difference between perception in dreaming and in waking was the low incidence of color reported for dreaming (e.g., Kahn et al., 1962 – cited by Rechtschaffen & Buchignani, 1992). More recently, however, Okada et al. surveyed 531 Japanese undergraduates on general qualities of their dreams; 72% reported seeing color in their dreams. Given the dominance of the visual modality in waking, it is perhaps surprising that only 85.2% of participants in the Okada et al. study reported "seeing things" (vision) in their dreams. However, we know from studies of waking episodic memory that, as the delay is increased between the original experience and the recall of that experience, information about the particular qualitative characteristics of the experience declines (Johnson, Kounios, & Reeder, 1994); memory for the qualitative characteristics of dream experiences also declines with time (Bottman & Crovitz, 1989–1990; Strauch & Meier, 1996). One advantage of our protocol is that participants assess the qualitative characteristics of a just-interrupted experience (whether dreaming or waking), thus minimizing—but not necessarily eliminating—memory effects (Conway, 2009; Johnson, 1992).

The present findings also are consistent with prior research showing differences in the structural features and reality orientation for episodic recollections of dreaming and waking experiences (see, especially, Hobson et al., 2003a; Kahn & Hobson, 2005; Mamelak & Hobson, 1989; Merritt, Stickgold, Pace-Schott, Williams, & Hobson, 1994, p. 45). The participants in Kahn and Hobson's (2005) study, for example, reported they would have noticed the unusual events (anomalies) that occurred in their dreams had they happened during waking (also see Bradley, Hollifield, & Foulkes, 1992). However, their study does not provide a direct comparison of dreaming and waking cognition. Rather, it is more a study of 'theory of mind' (participants' assessment of what they believe they would have noticed during waking); there is no behavioral evidence of whether they typically *do* notice anomalous events during waking. People often miss anomalies in waking life, a point well documented in studies of change blindness (Simons & Levin, 1998) and inattentional blindness (Simons & Chabris, 1999) (see Rensink (2002), for a review). Thus, one's monitoring of current experience and one's recollection of experience, even recent

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experience, are subject to the limits of perception and memory (Roediger, 2008). This fact underscores the importance of including systematic comparisons of dreaming and waking in any study of dreaming that endeavors to test hypotheses concerning the relationship between dreaming and waking cognition and experience.

In the present study, the only structural quality for which participants' ratings did not differ for dreaming and waking experiences was that of being a "detached observer." This finding is notable because it suggests that "witnessing" one's ongoing experience as a detached observer (Gackenbach, Moorecraft, Alexander, & LaBerge, 1987) may be comparably infrequent for dreaming and waking experiences.

Taken together, the two studies reported here support the hypothesis that there is greater variation in the structural features than in the process features of experiences reported from dreaming and waking.

7. General discussion

The findings of Study 1 are consistent with the claim that the same cognitive system operates in dreaming and waking. None of the high-order cognitive skills that we assessed is absent in dreaming and individuals reported the same range of cognitive activities in their dreaming and waking experiences, including the high-order cognitive activities presumed by many theorists to be suspended in sleep (e.g., Hobson, 2009; Hobson et al., 2003a).

As predicted by continuity theory, the findings of Study 2 are consistent with the claim that there are stable similarities in the cognitive and sensory–perceptual processes across dreaming–waking. At the same time, our results show variation in the content and structure of reported dreaming and waking experiences. The latter findings suggest that episodic recollections of dreaming and waking experience are more similar in their process qualities (e.g., particular cognitive and sensory processes rated as having occurred during the experience) than in their structural or content qualities (e.g., locations, actions, reality orientation) (also see Bulkeley & Kahan, 2008; Kozmová & Wolman, 2006).

In the studies using our experience-sampling paradigm, participants have reliably reported a lower incidence of *choice/decision making* and *reflection on one's own thoughts or feelings* in their dreams than in their waking experiences. Why might this set of high-order skills be reported less often for dreaming than for waking experiences, where other high-order skills such as focused attention or reflective awareness of the external environment are reported with comparable frequency? One possibility is that the resource demands on the cognitive system, especially working memory, may be increased in dreaming. For example, the sensory inputs into the dream generation process, which are (largely) endogenous, are not entrained by the external environment in the same way they are during waking (e.g., Calkins, 1896; Kerr, 1993; LaBerge, 1998; Llinas & Pare, 1991). As such, the maintenance, stabilization, and manipulation of the various input sources (sensory, memorial, affective) may typically be more challenging during dream generation.

This account may help reconcile our recurrent findings of continuities in high-order cognition across waking and dreaming with the results of other research showing that experiences sampled from dreaming often show more discontinuities and anomalies than do experiences sampled from waking (e.g., Hobson, 1988; Kahn & Hobson, 2005; Stickgold, Sangodeyi, & Hobson, 1997).

Another possible explanation is that the executive functions of working memory are attenuated, but not suspended, during dream generation, possibly for purposes of learning and creativity (Pace-Schott, 2003; Stickgold, 2005). For example, a recent fMRI study (Limb & Braun, 2008) revealed reduced activation in the dorsolateral pfc when expert jazz musicians were engaged in the spontaneous creation of jazz compositions (during waking) compared with playing memorized compositions. The Clark and Braun findings are consistent with other fMRI studies that show variation in the activation of ventrolateral pfc (VLPFC) and the dorsolateral pfc (DLPFC) in working memory (WM) tasks, depending upon the extent to which the WM task draws on long-term memory (see Fletcher and Henson (2001), for a review).

7.1. Limitations of the current study

The limitations of the present investigation must be acknowledged. First, it is possible that subtle cross-state differences were not revealed due to the small sample size (16) and relatively few samples of dreaming and waking experiences obtained (4 each). Second, we cannot independently confirm that sleep samples were obtained from REM sleep. However, LaBerge and Levitan (1995) established the reliability of the Dreamlight in discriminating REM, NREM, and waking, and the reliability of the Dreamlight in this regard seems to be comparable to that of the Nightcap (Ajilore et al., 1995). We concur with the case made by Stickgold et al. (1994) for the use of a home-based sleep monitoring system (over the sleep laboratory), especially their point concerning the trade-off of precision in sleep staging for a more naturalistic sampling of nocturnal experience (also see Hobson et al., 2003a, pp. 11).

Third, our protocol involves demand characteristics in that the goal is to sample particular features of subjective experience. However, as noted earlier, a number of investigators have argued for using just such an approach in order to insure that the targeted qualities are, in fact, assessed (e.g., Hobson et al., 2003b; Kerr et al., 1982; Nielsen & Stenstrom, 2005).

Fourth, as discussed previously, our sample included both practiced and novice, albeit trained, dreamers. Our choice to include a heterogeneous sample was based largely on our prior research, in which we did not observe significant differences between practiced and novice dreamers (see Kahan (2001), for a review). In the present study, we did observe two group

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differences: for both dreaming and waking experiences, the practiced dreamers used more words to narrate their experiences and they reported more instances of choice in both their dreaming and waking experiences. Although neither group difference interacted with state, future comparisons of the process/content features of dreaming and waking experience should explicitly assess the degree to which individual difference factors (gender, cognitive style, motivation to recall dreams) account for variation in the process and/or content features of subjective experience (also see Bulkeley & Kahan, 2008; Schredl, 2006; Schredl & Reinhard, 2008; Schredl, Sahin, & Schafer, 1998).[12]

7.2. Suggestions for future research

Numerous challenges remain for future research. One is to articulate the interplay between *attention* and *intention* in shaping the content, structure, and even process of dreaming experience. Alan Moffitt, for example, posited that "[L]ucidity enables the further development of intentional action with the dream state. In effect, one can develop a new form of competence, a form of skill not available during the waking state" (Moffitt et al., 1988, p. 436). Further, numerous personal accounts of lucid dream development and exploration highlight the potential for carry-over into waking of the cognitive competencies cultivated through lucid dreaming, such as an increased capacity for reflective awareness, self-regulation of attention, and insight (e.g., Green, 1968; LaBerge, 1985; Tandan, 2009; Tart, 1979; Waggoner, 2009). Additional empirical research is needed to determine whether explicit awareness of state (lucidity) is, indeed, a prerequisite for these expanded cognitive skills.

Additional research also is necessary in order to characterize the qualities of ongoing experience that best predict reflective awareness and other high-order cognitive skills in dreaming. For example, Kozmová and Wolman (2006) hypothesize that intense emotion is one such trigger. Similarly, Nielsen et al. (1993) conjectured that intense sensation in dreams such as pain may initiate problem-solving sequences. Empirical studies are now needed of whether reflective awareness and other high-order cognitive skills are more likely to co-occur with intense emotion or other content-related qualities (also see Bulkeley & Kahan, 2008; Kuiken & Miall, 2001).

7.3. Conclusions

We began this paper with a review of the widespread view that dreaming is deficient in high-order cognition. We then described research that challenges this view, notably the claim that the capacity for reflective awareness is suspended in sleep. In two studies, we tested hypotheses derived from an alternative theoretical view, Continuity Theory, which proposes the same cognitive–perceptual system operates in the construction of dreaming and waking experience. In Study 1, we replicated prior research showing that dreams do exhibit executive and, especially, analytical features (after Wolman & Kozmová, 2007). Study 2 confirmed that experiences sampled from dreaming and waking show greater similarity in their cognitive and perceptual features than in their structural/organizational features.

From the standpoint of a cognitive neuroscience of conscious states, we agree with the observation made by Hobson and his colleagues that success in mapping the relationship between cognitive functioning and neural activity is contingent upon precision in the methodology used to sample subjective experience:

> "As we have emphasized in our writings on consciousness, we feel strongly that there is no way for cognitive neuroscience to sidestep first-person accounts of subjective experience (Hobson, 1999b). If the psychophysiology and neuropsychology of mental life are to advance, *we must develop the means of characterizing and quantifying the subjective experience of conscious states*. The recent spate of brain imaging articles makes it clear that no amount of technical sophistication can compensate for neglect of exactly what psychological features the neurobiological data are asked to explain" (Hobson et al., 2003b, p. 231) (emphasis added).

In sum:

- High-order cognition is much more common in dreams than has been assumed, so any theory of dreaming that does not take this into account is out-of-date.
- The continuity theory now has evidence for not only the similarities of mental content throughout states, but also similarities at the process levels of cognition. The present investigation adds nuance to continuity theory by demonstrating that experiences sampled from dreaming and waking were more similar with respect to their process features than with respect to their structural features.

[12] Of the individual difference factors that may impact dreaming, gender, for one, warrants further investigation. Women typically report generally higher DRF than men (e.g., Schredl & Reinhard, 2008), higher motivation to recall dreams (Schredl, Nürnberg, & Weiler, 1996), greater interest in dream interpretation (Schredl & Piel, 2008), and greater self-awareness in their dreams (Kozmová & Wolman, 2006). In the present study, there were not enough participants to formally compare males and females, beyond establishing comparability in initially stated DRF and in the word counts associated with the reported dreaming and waking experiences.

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- The similarity between the findings of this study and earlier studies also showcases the reliability of using home-dreamer methodologies like the DreamLight®, NightCap, or other ambulatory sleep-recording systems. These innovations are both convenient and cost-effective and represent valuable tools in studies of subjective experience across dreaming and waking.
- Advancing the art of first-person data is important, not only for qualitative researchers, but also for quantitative and interdisciplinary studies and those interested in the neuroscience of subjective experience.

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Results reported in Table 3, row b are from a related study conducted by Kahan and LaBerge; they were first presented at the conference: "Toward a Science of Consciousness 2000," in Tucson, AZ; the study and these results are described in Kahan (2001).

We are grateful to the research participants for their conscientious efforts. We thank the following Santa Clara University students for their assistance with data collection: Andrea Ancha, Jeri Chase, Maritez Garcia, Desmond Win, George Giacomini III, Marguerite Newton, David Tripaldi. We offer sincere thanks to Jonathan Schooler, two anonymous reviewers, and Ryan Hurd for their helpful comments on earlier versions of this paper.

Appendix A

A.1. Metacognitive, Affective, Cognitive Experiences (MACE) Questionnaire

The MACE.[a]

Instructions: For the following 7 questions, if you answer a question with other than "0," please describe a relevant example from the target experience.

During how much of the time did you:

a. Make a choice between two or more options? (e.g., I chose to finish my homework instead of going to the movies)

none		some		all
0	1	2	3	4

b. Find your attention suddenly captured by something? (e.g., I heard a scream behind me and I turned around to see what was happened)

none		some		all
0	1	2	3	4

c. Focus for a period of time on accomplishing a particular task? (e.g., I looked all over for my keys)

none		some		all
0	1	2	3	4

d. Feel concerned about the impression you made, how you looked, or how you appeared to others? (e.g., I was afraid I'd seem foolish if I asked a question)

none		some		all
0	1	2	3	4

e. *Think about* your own thoughts or feelings? (e.g., I thought about how irrationally jealous I was feeling)

none		some		all
0	1	2	3	4

f. *Think about* what you were doing? (e.g., I was thinking I need to be careful not to spill the boiling pot)

none		some		all
0	1	2	3	4

g. *Think about* what was happening around you? (e.g., I wondered why everyone seemed to be in such a hurry)

none		some		all
0	1	2	3	4

[a] ©Kahan & LaBerge, 1996. (For the most recent version of the MACE, contact the first author at tkahan@scu.edu)

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Appendix B

Subjective Experiences Rating Scale (SERS).[a]

Cognition					
During how much of the time were you engaged in:					
	None		Some		All
Thinking	0	1	2	3	4
Planning	0	1	2	3	4
Imagining	0	1	2	3	4
Evaluating	0	1	2	3	4
Remembering	0	1	2	3	4
Feeling	0	1	2	3	4
Talking	0	1	2	3	4
Listening	0	1	2	3	4
Attending to *outside world*	0	1	2	3	4
Attending to *inner world*[b]	0	1	2	3	4
Sensory qualities					
Please rate how *prevalent* each of the following qualities were *during* the dream experience. If you do not recollect a particular quality as having been present during the experience, circle 0 (none)					
	None				A lot
Smell	0	1	2	3	4
Touch	0	1	2	3	4
Taste	0	1	2	3	4
Sounds	0	1	2	3	4
Voices	0	1	2	3	4
Visual Detail	0	1	2	3	4
Visual Complexity	0	1	2	3	4
Brightness	0	1	2	3	4
Colors	0	1	2	3	4
Movement (self)	0	1	2	3	4
Movement (others, objects, the environment)	0	1	2	3	4
Structural features (General Reality Orientation)					
	Vague				Definite
Location was:	0	1	2	3	4
Location was:	Unfamiliar				Familiar
	0	1	2	3	4
	Bizarre				Realistic
Location was:	0	1	2	3	4
Events were:	0	1	2	3	4
My actions were:	0	1	2	3	4
Others' actions were:	0	1	2	3	4
	Atypical				Typical
My actions were:	0	1	2	3	4
Others' actions were:	0	1	2	3	4
	Illogical				Logical
Event transitions were:	0	1	2	3	4
Point of view: (During how much of the time were you)					
	None		Some		All
An active participant?	0	1	2	3	4
A detached observer?	0	1	2	3	4

[a] The SERS included here is for assessing a dreaming experience. A parallel form assessed waking experiences; the term ''waking'' was substituted for the term ''dreaming.''

[b] (Thoughts, feelings, memories, images, etc.).

[c] For permission to use the SERS or to receive the most recent version, please contact the first author at tkahan@scu.edu.

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