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University of Turku

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Doctoral Programme in Clinical Research

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I had a dream...

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Abstract

We experience affect—emotions and mood—not only when we are awake but also during dreaming. Despite considerable research, existing theories and empirical findings disagree about the frequency, nature, and correlates of dream affect. In this thesis, I discuss the conceptual and methodological issues that underlie these discrepancies. I present five empirical studies, the overall aim of which was to investigate the phenomenology and correlates of dream affect and how results regarding these are influenced by study methodology. Studies I–III focused specifically on methodological issues, by comparing self- and external ratings of dream affect (Studies I–II) or the affective content of home and laboratory dream reports (Study III). Studies IV and V investigated the waking well-being and neural correlates of dream affect, respectively. These studies show that results and conclusions regarding dream affect are very different, even contradictory, depending on whether dream reports have been collected using sleep laboratory awakenings or home dream diaries (Study III) or whether dream affect has been measured using self- or external ratings (Studies I–II). Self- and external ratings of dream affect are also differently correlated with waking well-being (Study IV). Together, these results caution against making broad generalizations about affective dream experiences from findings obtained with one type of methodology only. The studies also demonstrate that dream affect is related to aspects of waking well-being and ill-being (Study IV) and that certain affective states experienced in dreams, specifically anger, rely on similar neural processes as in wakefulness (Study V). These findings suggest that the phenomenology and neural correlates of affective experiences are, at least to some extent, continuous across sleep and wakefulness. Overall, this thesis shows how the conceptual and methodological issues in the study of dream affect may limit the validity, generalizability, and replicability of findings and, consequently, pose challenges to theory building and theory testing. It contributes to dream research by highlighting the need, and suggesting ways, to enhance the conceptual clarity and methodological rigour of research on dream affect. Due to the interdisciplinary nature of the thesis, the theoretical discussion and novel empirical findings also have implications for emotion research, sleep research, well-being research, consciousness research, and affective neuroscience.

KEYWORDS: dreaming, affect, emotions, self-ratings, external ratings, REM sleep, well-being, peace of mind, frontal alpha asymmetry

TURUN YLIOPISTO
Yhteiskuntatieteellinen tiedekunta
Psykologian ja logopedian laitos
Pilleriin Sikka: Tunnetilat unissa: käsitteelliset ja metodologiset haasteet unissa koettujen tunteiden ja mielialojen tutkimuksessa
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Tiivistelmä

Koemme tunnetiloja – tunteita ja mielialoja – sekä valvetilassa että unennäön aikana. Tämän väitöskirjan tavoitteena on selvittää, miksi unissa esiintyviä tunnetiloja koskevat teoriat ja aikaisemmat tutkimustulokset ovat ristiriitaisia. Väitöskirjan tutkimuksissa analysoidaan erityisesti erilaisten käsitteellisten määritelmien sekä erilaisten aineistonkeruu- ja analyysimenetelmien vaikutusta unennäön tunnetiloista saatuihin tuloksiin. Väitöskirja koostuu viidestä osatyöstä, joiden tarkoituksena oli selvittää unissa esiintyvien tunnetilojen yleisyyttä, luonnetta ja hermostollisia vastineita sekä tarkastella erilaisten tutkimusmenetelmävalintojen vaikutusta tuloksiin. Tutkimuksissa I–III keskityttiin menetelmävalintojen vaikutuksiin: Tutkimuksissa I–II vertailtiin itsearviointien ja ulkoisten arviointien vaikutusta unien tunnesisältötuloksiin, kun taas tutkimuksessa III tarkasteltiin tutkimusympäristön, jossa uniraportit kerättiin, vaikutusta unien tunnesisältötuloksiin. Tutkimuksessa IV keskityttiin unissa esiintyvien tunteiden ja hyvinvoinnin väliseen suhteeseen ja tutkimuksessa V unien tunnetilojen hermostollisiin korrelaatteihin. Tutkimukset I–III osoittavat, että tulokset ja johtopäätökset ovat huomattavan erilaisia, jopa ristiriitaisia, riippuen siitä, onko unien tunnetilat arvioinut unennäkijä itse vai ulkoinen arvioija (tutkimukset I–II) ja onko unet raportoitu kotona vai unilaboratoriossa (tutkimus III). Tutkimus IV paljasti unissa koettujen tunnetilojen olevan yhteydessä valveilla koettuun hyvinvointiin ja tutkimus V osoitti, että unissa ja valveilla koetut tunnetilat, erityisesti vihaisuuden tunne, perustuvat samanlaisiin hermostollisiin prosesseihin. Väitöskirjan tulokset osoittavat, että unissa esiintyviä tunnetiloja koskevat tutkimukset eivät ole aikaisemmin tuottaneet yhteneviä tuloksia ilmeisesti siksi, että eri tutkimuksissa on käytetty erilaisia käsitteellisiä määritelmiä sekä erilaisia aineistonkeruu- ja analyysimenetelmiä. Erilaiset määritelmät ja tutkimusmenetelmät väistämättä johtavat epäyhtenäisiin tutkimustuloksiin. Täten yksittäisten tutkimusten yleistettävyys ja toistettavuus on hyvin rajallista, eikä niiden perusteella ole mahdollista kehittää tai luotettavasti testata teorioita unennäön aikaisista tunnetiloista. Tämä väitöskirja edistää unennäön tunnetilojen tieteellistä tutkimusta osoittamalla, että tutkimusalueen käsitteellistä ja menetelmällistä perustaa on huomattavasti selkeytettävä, jotta tutkimukset tuottaisivat luotettavia, yleistettäviä ja yhteneviä tuloksia. Väitöskirjassa esitetään useita konkreettisia ehdotuksia, miten tutkimusaluetta olisi tähän suuntaan kehitettävä. Väitöskirjan tulokset ja johtopäätökset eivät rajoitu koskemaan pelkästään unennäön tutkimusta, vaan ovat merkityksellisiä myös laajemmin tajunnantutkimuksessa, subjektiivisen hyvinvoinnin tutkimuksessa ja tunnetilojen biologista perustaa tutkivassa neurotieteessä.

ASIASANAT: unennäkö, tunnetilat, tunteet, itsearvio, ulkoinen arvio, REM uni, hyvinvointi, mielenrauha, frontaalinen alfa-asymmetria

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To paraphrase the well-known saying, this PhD was only made possible by standing on the shoulders of giants. Here is my chance to shine the light onto them. Over the years I have crossed paths with so many of these giants, so I take the opportunity to apologize upfront to all of those who I might unintentionally leave in the shadows.

My heartfelt gratitude goes, first and foremost, to my supervisors Professor Antti Revonsuo and Docent Katja Valli. It is Antti who invited me to join his Consciousness Research Group at the University of Turku and who introduced me to the science of altered and higher states of consciousness—dreaming, hypnosis, and happiness research—well before I even contemplated doctoral studies. Our looooong discussion on life, the universe, and everything (about the brain) began in his office on a dark winter morning many, many years ago and has, over time, extended all the way to Sweden. Antti is an unlikely mix of Professor Dumbledore and Harry Potter: wise and (com)passionate, calm and collected, humble and humorous (I have laughed to the point of not being able to speak); and a visionary, with the magical ability to build bridges (across different fields) and untangle webs of knowledge. He asks exactly the right critical questions and comments on *that one thing* that one wishes one could ignore, but which, if left unaddressed, would prove to be the Achilles' heel. He has given me the time and space to explore my own interests, wander along the routes I have chosen and helped me get back on track when I have felt lost or stuck (and there have been quite a few of those occasions). Antti is the epitome of Stoic values, and I have learned (and am still learning) from him how to peacefully but persistently tread the academic path. Antti, you are a science wizard and a mentor in the best sense of the words—thank you for showing me what it means to be a Scientist and a Teacher!

Katja introduced me to the nuts and bolts of sleep and dream research: how to perform polysomnographic recordings, score sleep stages, collect and analyse dream reports. She leads by example; being hardworking and having incredible multi-tasking abilities, she is always everywhere and doing everything, yet ready to answer an email as soon as it pops into her mailbox or run to the lab as soon as she is called for. A true academic firefighter and paramedic in one, she has solved many emergencies. Katja has an eye for details and an answer to every question…at least to all of those involving sleep, dreaming, and evolutionary psychology. She makes the impossible possible—organizing our research group seminars and getting everyone into one room at the same time is a true feat (and her amazing coffee brewing ability forms only a small part of it). She has made the university a cosy place to be; seeing Katja in her woollen socks sliding along the floors and searching for her dog Amor (our past resident mood-booster) makes one feel immediately at home. Katja, thank you for all your time and energy, for being so responsive, for all the detailed comments on manuscripts and for the immensely encouraging words.

I am incredibly lucky to have had several mentors in my academic life who have shaped me both as a researcher and a person. Professor Talis Bachmann (University of Tartu, Estonia) was my first ever supervisor (when I was still an undergraduate) and it is he who helped kindle my love of research in general, and of consciousness research in particular. I am happy that he saw enough potential in a young and naïve student to take on the challenge of showing me what basic research is all about (it is quite likely I would have ended up as a sports psychologist otherwise). He took me under his protective wing from day one and has supported (and fought for me) ever since. He is also the reason why I ended up in Antti's research group in Turku, and as such, is directly responsible for me having done my PhD here. Talis, I am deeply grateful for everything you have done for me!

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Nils (our own resident photographer and gastronome) content analysed the hundreds of dream reports for Studies I and III and provided extremely useful comments and much-needed support to proceed with Study III when things seemed a little difficult. Nils has also been the brain, body, and soul behind the PhD Shadow Seminars that, every once in a while, brought together all the PhD students to discuss important (and less important) empirical and philosophical matters. Thank you for having organized all those seminars—I learned a lot during these occasions. He is passionate about not only doing sleep research, but about using his knowledge to make a difference in the real world—this is truly inspiring!

Jarno (a true Renaissance man) helped to content analyse the dream reports for Study III, though his role extends much further than that. He is a humble and bleeding-heart human(ist) with a constant hunger for new knowledge and skills (this must explain the reduced need for earthly food), an ability to look beyond borders and a need for combinatory play of ideas. Our intellectual (and non-intellectual) exchanges have given me new perspectives on science and life, adrenalin-rushes when conjuring up all-those-still-to-be-carried-out research ideas, the excitement of discovery (when entering his office and finding that new book to read), and a feeling of awe at the breadth and depth of his character. Jarno, thank you for the illumination!

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Turku, December 2019

Pilleriin Sikka

Table of contents

List of original publications

This thesis is based on the following publications, referred to in the text by their Roman numerals.

Empirical publications in peer-reviewed journals:

I. Sikka, P., Valli, K., Virta, T., & Revonsuo, A. (2014). I know how you felt last night, or do I? Self- and external ratings of emotions in REM sleep dreams. *Consciousness and Cognition, 25,* 51–66. https://doi.org/10.1016/j.concog.2014.01.011[1]

II. Sikka, P., Feilhauer, D., Valli, K., & Revonsuo, A. (2017). How you measure is what you get: Differences in self- and external ratings of emotional experiences in home dreams. *The American Journal of Psychology*, *130*, 367–384. https://doi.org/10.5406/amerjpsyc.130.3.0367[2]

III. Sikka, P., Revonsuo, A., Sandman, N., Tuominen, J., & Valli, K. (2018). Dream emotions: A comparison of home dream reports with laboratory early and late REM dream reports. *Journal of Sleep Research*, *27*, 206–214. https://doi.org/10.1111/jsr.12555[3]

IV. Sikka, P., Pesonen, H., & Revonsuo, A. (2018). Peace of mind and anxiety in the waking state are related to the affective content of dreams. *Scientific Reports*, *8*, 12762. https://doi.org/10.1038/s41598-018-30721-1[4]

V. Sikka, P., Revonsuo, A., Noreika, V., & Valli, K. (2019). EEG frontal alpha asymmetry and dream affect: Alpha oscillations over the right frontal cortex during REM sleep and presleep wakefulness predict anger in REM sleep dreams. *Journal of Neuroscience, 39*, 4774–4784. https://doi.org/10.1523/JNEUROSCI.2884-18.2019[4]

Theoretical publication as an invited book chapter:

Sikka, P. (2019). How to study dream experiences. In K. Valli & R. J. Hoss (Eds.), *Dreams: Understanding biology, psychology, and culture* (Vol. 1, pp. 153–165). Santa Barbara, CA: Greenwood, an Imprint of ABC-CLIO, LLC.[5]

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Abbreviations

EEG	Electroencephalography
EMG	Electromyography
EOG	Electrooculography
ER	External ratings
ER-CA	External ratings using content analysis
ER-CA-Dis	External ratings using content analysis of discrete affect
ER-GS	External ratings using global rating scales
ER-GS-Dim	External ratings using global rating scales of dimensional affect
ES	Effect size
EWB	Eudaimonic well-being
FAA	Frontal alpha asymmetry
HWB	Hedonic well-being
mDES	Modified Differential Emotions Scale
PA	Positive affect
PFC	Prefrontal cortex
NA	Negative affect
NREM	Non-rapid eye movement sleep
PSQI	Pittsburgh Sleep Quality Index
REM	Rapid eye movement sleep
SR	Self-ratings
SR-GS	Self-ratings using global rating scales
SR-GS-Dim	Self-ratings using global rating scales of dimensional affect
SR-GS-Dis	Self-ratings using global rating scales of discrete affect
WEIRD	Western, educated, industrialized, rich, and democratic

I was standing next to a small propeller airplane waiting for someone to arrive, a bit worried that the plane might take off without me. Suddenly, the plane started to move, and I yelled to the pilot that he should wait for me. I took my handbag and sat next to the pilot. The plane started to take off. Then, I realized that there were cracks in the window next to me, and I was worried that it might break and the air pressure could suck me out. Slimy mud was already squeezing inside through the cracks and staining my white bag and pants. At the same time, I was excited to fly. The pilot told me that there was nothing to worry about. The nose of the airplane turned upwards, and I was surprised at how strong the pressure felt on my face. Once we had gained altitude, we started flying around. At one moment, the plane did a few full loops, which was scary. I closed my eyes, but also couldn't resist looking, so I peeked and saw that everything was indeed upside down. Then, we flew around the world, and I could see all the oceans and landscapes below. Everything was very beautiful…blue transparent water…lush green plants…I even saw two small tiger cubs playing down in the grass. I observed and found them fascinating. At one point, I saw the world map and how the plane was moving from one continent to the next. Then, I was back on the plane again looking at the world below. It was amazing. I was so excited about this experience that I wanted to remember this dream. So, I thought I should tell it to someone in order to not forget it. Suddenly, I was in the university. A new research student from Estonia was on a research visit. She was sitting at a desk and I started to tell her my dream…how I was flying around. I had to hurry up. A machine behind her back was printing out some brain imaging results, and I knew that I had to finish telling the dream before the machine finished the analyses. Then, I asked the student what she is studying. And she said that she is doing research on the EEG of dream emotions. I got excited and said that this is what I am also interested in, that I am doing a Ph.D. on dream emotions, and that when she goes to the laboratory to collect data, I would come along.

(Author, 4th May 2019)

1. Introduction

Most of us know what it is like to dream. It is estimated that during our lifetimes, we spend at least six years dreaming, with most people having dreams every night. As in our waking lives, we experience a wide range of affective states—emotions and moods—in our dreams. We feel anxiety and fear, joy and excitement, anger and interest, even awe.

Why we have such experiences while sleeping is a mystery that has puzzled humans since ancient times. Although contemporary dream theories disagree about the possible functions of dreams, most acknowledge the importance and centrality of affect in our dreams. Some even go so far as to claim that affect drives the content of dreams (Hartmann, 1996; Hobson, Pace-Schott, & Stickgold, 2000).

Modern dream research dates back more than 160 years (Schwartz, 2000). Yet, many unresolved and contested questions remain regarding the affective nature of our dreams. Are dreams primarily affective, or are they mostly non-affective? Are dreams mostly negative or positive, or is the affective tone rather balanced? Do certain types of affective states, such as fear, dominate in dreams? Do the emotions and moods we experience in our dreams reflect our waking well-being? What are the neural correlates of dream affect? Do affective experiences in dreams and wakefulness rely on similar or different neural processes?

Empirical studies have produced inconsistent—and even outright controversial—results regarding the phenomenology of dream affect. At the heart of the inconsistencies lie conceptual and methodological issues. The phenomenon—dream affect—lacks clear and agreed-upon definitions, and there have been methodological discrepancies in how it has been measured: for example, whether self- or external ratings of affect have been used, and whether the data have been collected in the home or sleep laboratory environment. All of this has complicated the discovery of the waking and neural correlates of dream affect.

The various conceptual and methodological issues in the study of dream affect have received little attention. This is surprising, given that how we define and measure the phenomenon of interest determines the data we get. The fact that theories are built and tested based on these data places conceptualization and measurement at the centre of the scientific process. Put simply, to understand *why* we have (affective) dream experiences, we must know *what* these experiences are like, which in turn depends on *how* we study these. Thus, addressing conceptual and methodological issues is a crucial step towards resolving the controversies regarding the phenomenology and correlates of dream affect.

Therefore, in this thesis, my overarching theoretical aim is to address the questions above through a conceptual and methodological lens, that is, to discuss the conceptual and methodological issues underlying discrepant empirical findings and theoretical conclusions regarding the phenomenology and correlates of dream affect. To achieve this aim, I use an interdisciplinary framework integrating different scientific fields—such as psychology, philosophy, and (affective) neuroscience—and research areas, including dream research, sleep research, emotion research, consciousness research, and well-being research. The thesis builds on five empirical studies and one theoretical publication. The overall aim of the empirical studies was to investigate the phenomenology and correlates of dream affect and how results regarding these are influenced by study methodology. Studies I–III focused specifically on methodological issues, by comparing self- and external ratings of dream affect (Studies I and II) or by comparing the affective content of home and laboratory dream reports (Study III). Studies IV and V investigated the waking well-being and neural correlates of dream affect, respectively.

As such, this thesis, and the studies thereof, have important theoretical, empirical, methodological, and clinical implications. It not only helps to explain why such vast divides exist between various theories and empirical findings regarding dream affect but also provides crucial new insights regarding the phenomenology and correlates of dream affect. By highlighting the conceptual and methodological limitations in the scientific research on dream affect and proposing recommendations for how to tackle these, this thesis helps pave the way for more theoretically informed and methodologically rigorous research practices. The latter is particularly timely in light of the 'replication crisis' (Open Science Collaboration, 2015) and 'validation crisis' (Schimmack, 2019) and the ensuing focus on methodological issues in the field of psychology in general. Finally, a better understanding of the nature and correlates of dream affect may help in the development of diagnostic and prognostic markers, as well as interventions for enhancing the mental health of individuals.

2. Conceptual foundation

Any scientific endeavour begins with the identification of *what* it is that we wish to understand. Therefore, the first task is to define the phenomenon or construct under investigation. Definitions are important because they determine what is measured, how it is measured, and, ultimately, what kind of results are obtained. Definitions also enable communication and shared understanding among researchers: they help ensure that we are discussing and comparing the same phenomenon.

In this chapter, I define the phenomenon central to this thesis—dream affect. To do so, several other questions must be answered along the way: What is consciousness? What is a dream? What is affect?

2.1 What is consciousness?

In every moment of our lives, we experience something: we may perceive sights or sounds; feel emotions or physical sensations; remember, imagine, or think about something. This 'stream of consciousness', as William James (1890/1950) described it, is present not only when we are awake but also when we are asleep. We seem to be void of any experiences only under specific circumstances, such as during deep non-rapid eye movement (NREM) sleep, under anaesthesia[6], or as a result of certain physiological conditions (e.g., during epileptic seizures).

Our experiences have a particular phenomenal quality—it feels like something to have these experiences. This is why philosophers and consciousness researchers call the presence of subjective experiences *phenomenal consciousness*. At any given moment, we have a specific pattern of experiences, and this forms the *contents* of our phenomenal consciousness (Revonsuo, 2006). To be able to have any experiences at all, we must be in a *state* of consciousness—a state of certain

[6] However, evidence exists that subjective experiences can also occur during NREM sleep (e.g., Nielsen, 2000; Siclari, Bernardi, Cataldi, & Tononi, 2018) and anaesthesia (e.g., Noreika et al., 2011; Radek et al., 2018).

background mechanisms or conditions that allow phenomenal consciousness to appear (Revonsuo, 2010). In a non-conscious state, a person is unable to have any experiences whatsoever.

A state of consciousness should be distinguished from the behavioural state, characterized by the level of wakefulness and the level of responsiveness. Wakefulness refers to the level of neurophysiological arousal, ranging from being fully awake, to sleep, to coma (Blumenfeld, 2016; Laureys, 2005). Responsiveness refers to whether and how a person behaves in response to external stimulation (Mashour & LaRock, 2008). Although the presence of subjective experiences is typically associated with wakefulness and responsiveness, a person can have a high level of wakefulness without any experiences (as in the vegetative state, now termed the unresponsive wakefulness syndrome; Laureys et al., 2010) or have experiences without being awake and responsive (as when dreaming during sleep).

Our experiences are subjective—only we know 'what it is like' to have them (Nagel, 1974). The only way that other people can know if we are conscious—and what kind of conscious experiences we are having—is if we somehow communicate it to them. For this, we use *reflective consciousness*: we focus our spotlight of attention on some specific content of our phenomenal consciousness, reflect on it (e.g., by observing, labelling, categorizing), and then describe this experience to another using, for example, a verbal report (Revonsuo, 2006). Thus, we translate our actual raw experiences (phenomenal consciousness) into a self-report using higher-level cognitive processes (reflective consciousness) (see Figure 1). Although the report reflects our experiences, it should not be identified with the experiences.

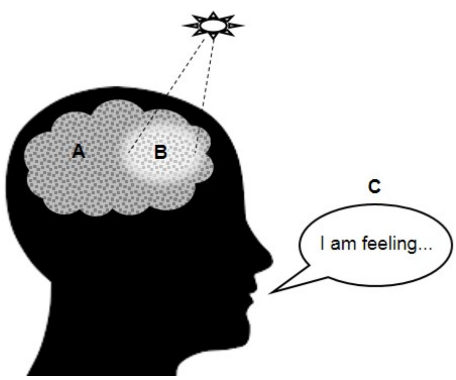

Figure 1. Relationship between phenomenal and reflective consciousness. Phenomenal consciousness (A) contains different kinds of contents of consciousness. Reflective consciousness (B) is needed to be able to communicate the contents to others: we focus our spotlight of attention on some specific content, reflect on it (i.e., observe, label, categorize), and then translate this into a (verbal) self-report (C).

2.2 What is a dream?

When asked “Did you have a dream last night?” or “What were you dreaming last night?”, people usually have no difficulties in understanding what is meant by the words *dream* and *dreaming* and, hence, answering those questions. However, it has proven a difficult endeavour to provide commonly accepted scientific definitions for these terms (Pagel et al., 2001).

From a philosophical perspective, dreaming refers to the process of having subjective experiences, and a dream is a particular pattern of subjective experience (Revonsuo, 2006; Sikka, Pesonen, & Revonsuo, 2018). Thus, dreaming is a form of phenomenal consciousness, and dream content forms the contents of our phenomenal consciousness. Different from waking experiences, which occur during wakefulness, dream experiences occur during sleep[7]. Also, unlike waking experiences, dream experiences are mostly disconnected from the surrounding external environment[8] and behavioural activity[9] (Revonsuo, 2006; Windt, 2010, 2015, 2017). During dreaming, we often experience a hallucinatory world, where various events happen in which we play an active role, while we are actually lying in bed, nearly motionless. Dream experiences misrepresent reality, because the neurocognitive mechanisms producing subjective experiences during dreaming are altered. Thus, the dreaming state constitutes an altered state of consciousness (Revonsuo, Kallio, & Sikka, 2009). Although dream experiences misrepresent reality at the time of occurrence, they are nevertheless considered to be realistic offline simulations of the waking world (Foulkes, 1985; Nielsen, 2010; Revonsuo, Tuominen, & Valli, 2016a; Snyder, 1970).

Whereas much of the philosophical and empirical literature converges in defining dreams as subjective experiences (Revonsuo, 2006; Windt, 2013, 2015; Windt & Metzinger, 2007), there is less consensus regarding what types of subjective experiences count as dreams—all, or only some, kinds of experiences (Zadra & Domhoff, 2017). The subjective experiences that occur during sleep are highly varied and can best be characterized as lying along a continuum: from simple and static experiences (fragmentary, unisensory percepts, such as images, sounds, bodily sensations, and thoughts) to complex and dynamic experiences (immersive,

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[7] Some researchers argue that dreams can also occur outside sleep, for example, during mind-wandering (Domhoff & Fox, 2015; Windt, 2010).

[8] Occasionally, experimental stimulation can influence the content of dreams (for a review, see Schredl, 2018).

[9] However, individuals with REM sleep behaviour disorder may ‘act out’ their dream experiences (e.g., Comella, Nardine, Diederich, & Stebbins, 1998; Oudiette et al., 2009).

multisensory, and story-like hallucinations) (Revonsuo, 2006, 2010; Windt, 2010, 2015). In broader and more inclusive conceptualizations, any subjective experiences occurring during sleep, be they simple or more complex, are considered dreams (see A in Figure 2; e.g., Flanagan, 2001). In narrower and more restrictive conceptualizations, only the more complex and dynamic experiences are considered dreams (see C in Figure 2; e.g., Hobson et al., 2000), whereas the simpler experiences are considered dreamless sleep experiences (e.g., Windt, Nielsen, & Thompson, 2016) or sleep mentation[10] (Revonsuo, 2006) (see B in Figure 2).

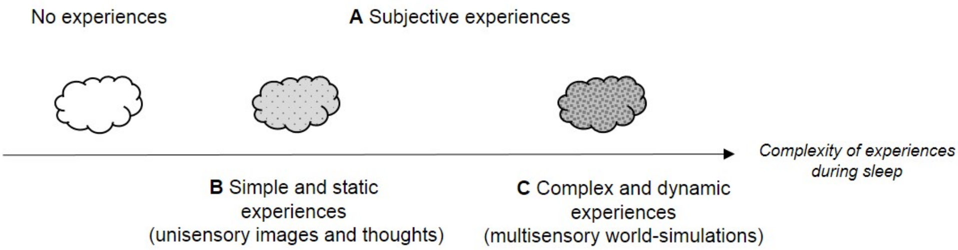

Figure 2. The continuum of subjective experiences during sleep and the broader (A) and narrower (C) definitions of dream and dreaming. Adapted from Sikka, 2019, p.154.

Regarding the narrower conceptualizations, dreaming has been defined as "…a multimodal, complex, dynamic world-simulation in consciousness during sleep" (Revonsuo et al., 2016a, p. 5). However, in such conceptualizations, it remains unclear exactly what demarcates dream experiences from dreamless experiences, or precisely where along the continuum we should draw a line between these different types of experiences. To address this problem, Windt (2010, 2015) has provided minimal requirements that an experience should include to be considered a dream: dreams are immersive spatiotemporal hallucinations occurring in sleep or sleep–wake transitions. Hence, what differentiates dreams from other types of subjective experiences during sleep is having the experience of being spatially and temporally present or immersed in the dream.

Despite progress in the development of a more precise conceptual definition of dreaming and dreams, a clear and agreed-upon operational definition distinguishing dreams from dreamless sleep experiences is lacking. Thus, even if conceptual differences between the different types of subjective experiences during sleep are

[10] Some researchers use the term *sleep mentation* to refer to all kinds of experiences occurring during sleep—subjective experiences in general (e.g., Stickgold, 2017).

theoretically recognized, they are rarely addressed empirically. In fact, it is not uncommon for empirical papers to define dreaming in the narrower sense but to operationally consider all reports of subjective experiences occurring during sleep as dreams. As a result, empirical literature typically follows the broader and more inclusive conceptualization of dreams and dreaming.

In the present thesis—and in the studies it consists of—I use the broader definition and thus consider all subjective experiences occurring during sleep as dreams and the process of having these experiences as dreaming.

2.3 What is affect?

In the title of a landmark article in 1884, William James famously asked, "What is an Emotion?" Fast forward a century, and emotion researchers confessed, "Everyone knows what an emotion is, until asked to give a definition. Then, it seems, no one knows" (Fehr & Russell, 1984, p. 464). Another three decades later, the situation can best be described as follows: everyone knows what an emotion is, but few agree. As with the concepts of dream and dreaming, the task of defining the concept of affect—and related concepts such as emotion and mood—is not an easy one, due to fervent conceptual and theoretical disagreements in the field of emotion research. Regardless, in what follows, I try to provide a concise synthesis of the relevant concepts and their interrelations.

2.3.1 Affect: A conceptual map

Affect is typically used as an umbrella term referring to various affective or valenced phenomena, such as emotions and moods (Juslin & Västfjäll, 2008; Scherer, 2005). It is important to distinguish affective states (i.e., state affect) from affective traits (i.e., trait affect). The latter are individual dispositions, or the tendency to experience some types of affective states more frequently or more likely than other types of affective states (Scherer, 2005). Thus, whereas affective states are relatively short-term and transient phenomena, affective traits are long-term and rather stable phenomena (Watson, 2000) (see Figure 3).

Different affective states—emotions and moods—are also distinguished based on their duration, although this is not the only differentiating feature. Despite the multitude of different conceptualizations (Kleinginna & Kleinginna, 1981), it is generally agreed that emotion is a short-lived and intense affective response to specific, important events or stimuli occurring in the external (i.e., outside the individual) or internal (i.e., inside the individual, such as thoughts) environment (Juslin & Västfjäll, 2008; Scherer, 2005). Mood lasts longer and is typically more diffuse, of low intensity, and often difficult to link to a specific event (Frijda, 2009; Gross, 1998, 2015; Scherer, 2005; see also Figure 5).

For example, a person with high trait anxiety (affective trait) may often experience anxiety without any apparent cause (affective state: mood), whereas a person with low trait anxiety (affective trait) is more likely to feel relatively calm most of the time (affective state: mood). In response to a challenging or potentially dangerous situation, both may experience fear (affective state: emotion) that subsides once the challenge is perceived to be over, although a person with high trait anxiety may be more likely to feel fear, experience it more intensely, and take longer to return to his or her baseline level of affectivity.

Affective states—emotions and moods—are subjective experiences; *it feels like something* for the person to experience anxiety or fear. Thus, affective states are particular contents of phenomenal consciousness, which are arguably different from non-affective states (Reisenzein & Döring, 2009). This special phenomenal quality was emphasized early on by William James (1890/1950) and the founder of experimental psychology, Wilhelm Wundt (1896/1897).

However, it is important to note that in addition to the conscious subjective experience (e.g., feeling afraid), emotion is considered to also consist of other components, including (1) the motor expression component (facial and vocal expression, e.g., looking scared); (2) the neurophysiological component (autonomic arousal, e.g., heart beating faster); (3) the motivational component (action tendency, e.g., wanting to escape); (4) the cognitive component (appraisal, e.g., evaluating how threatening the situation is); and (5) the regulation component (affect regulation, e.g., down-regulating the experience of fear or suppressing the urge to escape), although debate is ongoing regarding whether the latter two components should be considered part of emotion as such (Gross, 1998, 2015; Juslin & Västfjäll, 2008; Sander, 2013; Scherer, 2005). The subjective conscious experience of emotion integrates all of the other components and may reflect some or all of them (Scherer, 2005). Although the different components are generally discussed only with regard to emotion, moods arguably also consist of other, non-conscious components.

Several different terms are used to refer to the subjective experience of emotion: emotion(al) experience (Lambie & Marcel, 2002; Scherer, 2005), emotional feeling (LeDoux & Brown, 2017; Panksepp, 1998), feeling of emotion (Damasio, 2000), or feeling (Sander, Grandjean, & Scherer, 2018). Although emotions and moods are considered conceptually distinct, operationally they are often confounded with each other. This means that in the empirical emotion literature, the various terms mentioned above pertain not only to the subjective experience of emotion but also to the subjective experience of mood. In fact, the term *feeling* is frequently defined as the subjective experience of emotion and/or mood (Juslin & Västfjäll, 2008). This is what is measured via self-reports, when we ask an individual, “how are you feeling?” However, *feeling* is also used to refer to the perception of physiological or bodily sensations (Pace-Schott et al., 2019). Therefore, given these inconsistencies and ambiguities, when the subjective experience of emotion and mood are not distinguished, I consider it more accurate to use the term *affective experience* (or affective feeling) (see Figure 3).

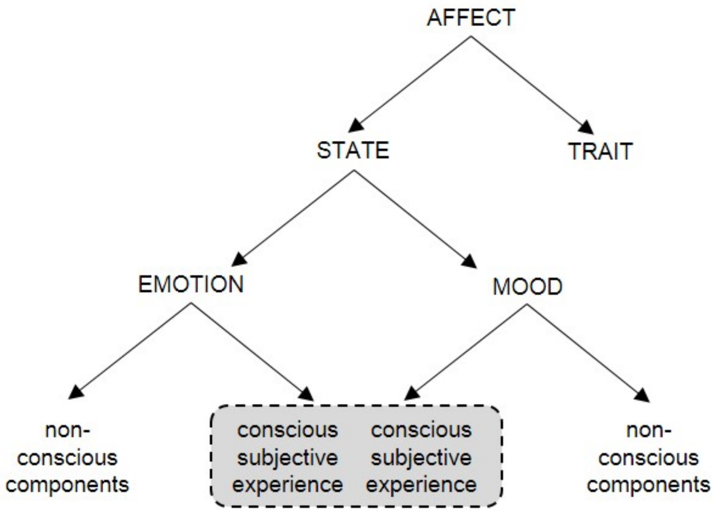

Figure 3. Conceptual map of affect. Shadowed area refers to affective experience (i.e., affective feeling)—the conscious subjective experience of affective states.

2.3.2 Models of affect

Another issue related to the conceptualization of affect pertains to the structure of affect, that is, what the basic building blocks of different affective states are and what distinguishes them from each other. Different models of affect have fundamentally different assumptions (see Sander et al., 2018 for a review; Siegel et al., 2018). Models of discrete affect, more commonly referred to as models of basic emotions (e.g., Ekman, 1970, 1972, 1992; Izard, 1971, 1992; Panksepp, 1998; Tomkins, 1962, 1984), originate from the observations of Charles Darwin (1872). According to these models, there is a limited number of discrete affects or discrete affect categories, such as anger, fear, sadness, disgust, and happiness, that are universal—shared in different cultures (Ekman, 1970, 1972, 1992) and mammals (Panksepp, 1998). How many and which categories exist is debated. However, each discrete affect category is considered to have a distinct psychological, behavioural, and neurobiological 'fingerprint' (in terms of autonomic or brain activity) that differentiates it from other affect categories (Siegel et al., 2018). Similarly, each discrete affect category *feels* different—for example, fear is experienced qualitatively differently from anger—and individuals use words such as "angry" or "afraid" to describe these subjective experiences.

In contrast, according to the dimensional models of affect, all affective states arise from combinations of more fundamental affective dimensions. This idea dates back to Spencer (1855) and Wundt (1896/1897). Again, there is some disagreement over how many and which dimensions exist, but the dimensions of valence (positive vs negative, pleasure vs displeasure), arousal (arousal vs non-arousal, activation vs deactivation), and motivational direction (approach vs avoidance/withdrawal) are among the most frequently used (e.g., Davidson, 1992; Lang, Bradley, & Cuthbert, 1990; Larsen & Diener, 1992; Russell, 1980). The dimensions can be bipolar (e.g., pleasant–unpleasant, activation–deactivation; Barrett & Russell, 1999) or unipolar (e.g., positive activation, negative activation; Watson & Tellegen, 1985), depending on whether the endpoints of dimensions are considered related or independent. According to dimensional models, common overlapping neurobiological systems reflecting these dimensions, such as valence and arousal, underlie all affective states (Posner, Russell, & Peterson, 2005).

Modern constructivist theories build on the dimensional models. Russell and Barrett (1999) call the subjective experience of bodily (neurophysiological) changes associated with fundamental affective dimensions *core affect*. According to Barrett (2006, 2017), we experience core affect—to what extent something feels pleasant versus unpleasant, activating versus deactivating—and use concepts to categorize our experiences into a particular emotion category (e.g., whether this particular experience is anger or fear) depending on the context or situation. In fact, Barrett reserves the term *emotion* for the subjective experience—"the experience of feeling an emotion"—which happens as a result of conceptual categorization (2006, p. 27). From this perspective, there is no unique physiological or neurobiological pattern characteristic to an emotion as such, only to core affect (Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012). Thus, core affect forms the basic building block of the subjective experience of emotion and mood.

Discrete and dimensional models of affect are not necessarily mutually exclusive. The circumplex models of affect combine affective dimensions with discrete affect categories: different discrete affective states arise as combinations of more fundamental affective dimensions (e.g., Yik, Russell, & Steiger, 2011). For example, fear is considered a combination of negative valence and high arousal.

As discussed below, which conceptual model of emotion is used has direct implications for the measurement of affective experiences and their neural correlates.

2.4 What is dream affect?

The preceding sections have revealed a conceptual and terminological tangle involving the concepts of dream and affect. It is not surprising, then, that there is no agreed-upon definition for dream affect. In empirical dream research, as in emotion research, conceptual distinctions between the different types of affective states are typically not acknowledged. As a result, the terms *affect*, *emotion*, *mood*, and *feeling* are used interchangeably, although the term *emotion* occurs most frequently. In fact, often the different types of affective phenomena—state affect (i.e., affect experienced in dreams) and trait affect (i.e., the general tendency to experience certain affective states in one's dreams)—are not distinguished, and one is used to draw conclusions about the other. Also, the reason for using a particular model of affect—discrete or dimensional—is seldom explained.

In this thesis, by bringing together the consciousness, dream, and emotion literatures—and following from the conceptual map laid out previously—I use the following working definition: *dream affect refers to affective experiences—the subjective experience of affective states, such as emotions and moods (i.e., affective feelings)—that occur during dreaming.* Hence, dream affect constitutes particular contents of phenomenal consciousness during sleep—the affective contents of dreams. When referring to affective dispositions, I use the term *affective trait* (or *trait affect*). Such a conceptualization was also used in the original Publications IV and V. It should be noted, however, that in the original Publications I–III and VI, the term *emotion* was used as a synonym for affective experiences.

Regarding the theoretical model of affect, I have not strongly committed to either the discrete or the dimensional approach. Due to the lack of consensus and clear empirical support in favour of one model over the other, an approach integrating both seems to be the most fruitful. When discrete affective states are measured, it is possible to categorize them into dimensions post hoc, whereas the opposite is not possible. For this reason, in the empirical studies conducted in the framework of this thesis, the model of discrete affect was used for the measurement of affect, which enabled the analysis of both discrete and dimensional affect.

3. Methodological foundation

Once the phenomenon of interest has been adequately defined, the next challenge is to determine how best to measure it. For our measurements to be useful, the methods for collecting and analysing data must be valid (i.e., they should measure what we intend to measure as accurately and precisely as possible) and reliable (i.e., they should produce consistent results). Reliability enables replicability (i.e., consistent results across different studies), but replicable results are only valuable if they are valid.

In this chapter, I focus on the methods used to study dream affect. First, I discuss issues related to the measurement of dream experiences in general: what kind of data we can access to study dream experiences, including dream affect. Next, I describe various methodological aspects and decisions involved when collecting and analysing such data. Finally, I describe the most common methods used to study dream affect and discuss their strengths and weaknesses.

3.1 How dream experiences are studied: From experiences to retrospective self-reports

As discussed in the previous chapter, dreams are *subjective* experiences. Hence, only the person experiencing dreams has direct access to them. We, as researchers, can observe and measure the behavioural state—sleep—but we have no objective or third-person methods to observe and measure dream experiences (or any other subjective experiences, for that matter) as they are happening[11]. Even the most

[11] Progress has been made in detecting signs of consciousness in patients diagnosed with various disorders of consciousness, such as the unresponsive wakefulness syndrome. However, despite promising developments, the methods are not based on detecting phenomenal experiences as such but rather rely on the preserved ability of the patients to intentionally and consistently engage in specific imagery and in measuring the corresponding brain activity (Gosseries, Laureys, & Schnakers, 2019).

modern brain imaging techniques, which measure brain activity while a person is dreaming, ultimately rely on subjective reports or self-reports given by the person upon awakening from sleep. These are used to confirm whether the person was, in fact, experiencing a dream, and what he or she was dreaming about (e.g., Horikawa, Tamaki, Miyawaki, & Kamitani, 2013; Siclari et al., 2017). Similarly, although lucid dreamers are often able to report aspects of their dream experiences to researchers while dreaming (for example, by signalling with their eyes according to a predetermined pattern; e.g., LaBerge, Baird, & Zimbardo, 2018), these experiences must be verified by self-reports provided upon awakening. Thus, self-reports are the only means, at least to date, to obtain information about dream experiences, including affective dream experiences.

However, important differences exist between dream experiences and self-reports regarding these experiences. Whereas dream experiences occur in phenomenal consciousness, self-reports depend on reflective consciousness (see Section 2.1). Moreover, self-reports of dream experiences rely on what the person remembers about the experience. Thus, to get information about the dream experience, we depend on the episodic memories of the dream experience and on the self-reports of these memories (Domhoff, 2018; Sikka, 2019; Snyder, 1970; Zadra & Domhoff, 2017). In essence, then, we have different conscious selves: the self who experiences the dream (the experiencing self), the self who remembers the dream experience (the remembering self), and the self who reports the dream experience (the reporting self) (see Figure 4)[12]. Importantly, the process of transforming the experience into a self-report entails several potential pitfalls. First, attention is selective—we can only access part(s) of the experience (what we pay attention to), whereas the rest fades away. Second, memory is biased; we remember certain experiences better than others (Kensinger, 2009), and memory fades over time—particularly when transitioning from one state to another (Goodenough, Witkin, Lewis, Koulack, & Cohen, 1974) or due to interference (Calkins, 1893; Cohen & Wolfe, 1973; Koulack & Goodenough, 1976; Parke & Horton, 2009)—and is influenced by whether we intend to remember something (Alger, Chen, & Payne, 2019). Third, the process of reporting may be biased (see Sections 3.2.2.1 and 3.2.2.2). Fourth, self-reports are provided in a different behavioural state (wakefulness) than that in which they were experienced (sleep). Fifth, self-reports

[12] The terms *the experiencing self* and *the remembering self* were introduced by Kahneman and Riis (2005) to refer to the momentary experience and evaluations based on the memories of those experiences, respectively. The term *the remembering self* has also been referred to as *the extended self* (Neisser, 1988) and *the continuing me* (Nelson, 2001).

(as well as our memories of our experiences) can be influenced by our waking beliefs or conceptual knowledge about ourselves (the believing self) (Conner & Barrett, 2012; Robinson & Clore, 2002). As a result, we have access to a rather limited, and possibly biased, account of the experience, rather than to the actual 'raw' experience per se.

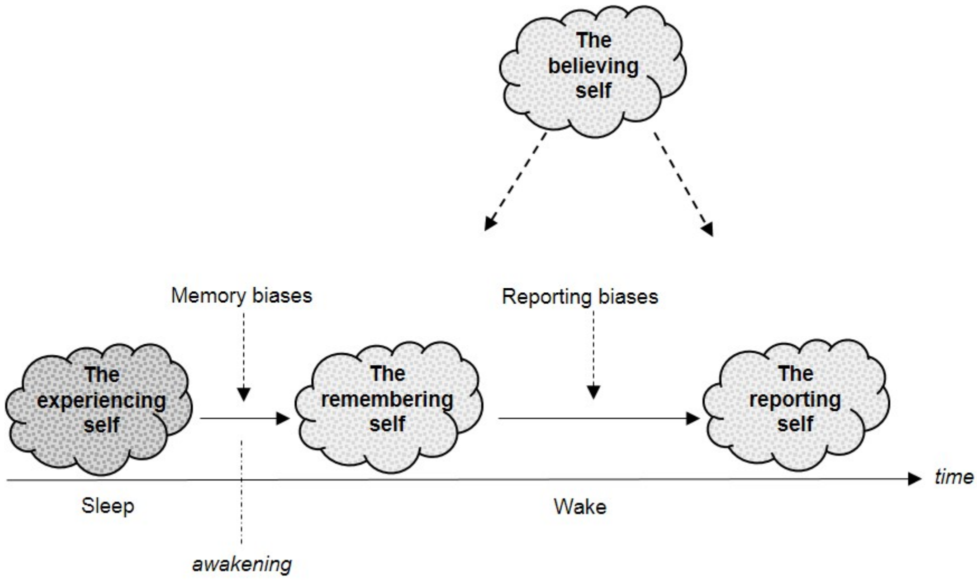

Figure 4. The relationship between the dream experience (the experiencing self), memories of the dream experience (the remembering self), and self-reports (of the memories) of the dream experience (the reporting self). Waking beliefs about one's dream experiences (the believing self) can influence both the remembering and reporting selves. Adapted from Sikka, 2019, p. 154.

In summary, to study the phenomenon of dream experience, data in the form of retrospective self-reports are collected. Empirical dream research is, hence, the study of remembered and reported dreams (Domhoff, 2018; Zadra & Domhoff, 2017), which are assumed to truthfully reflect the actual dream experiences, at least "when gathered under ideal reporting conditions" (Windt, 2015, p. 196; see Section 8.5.2).

3.2 Methods for studying dream affect

As in the study of other contents of dream experiences, dream affect is investigated by collecting and analysing retrospective self-reports. Self-reports of dream affect are thus indirect measures of, or proxies for, affective dream experiences. When talking about results and conclusions regarding dream affect (i.e., affective dream experiences), as done in the current thesis, it is important to keep in mind that these are all based on retrospective self-reports.

The assumption that retrospective self-reports reflect underlying affective dream experiences hinges on the rigour of study methodology. Studies vary widely in the methodology used for collecting and analysing data. Table 1 summarizes the various methodological aspects involved in the study of dream affect. Several aspects are common to the study of dream experiences in general (see Sections I and II in Table 1; see also Kahan & Horton, 2012; Sikka, 2019; Stickgold, 2017; Windt, 2015; Zadra & Domhoff, 2017). Other aspects pertain specifically to the study of affective experiences (see Section III in Table 1; see also Ekkekakis, 2013; Larsen & Fredrickson, 1999). Results regarding the phenomenology (i.e., the frequency and nature) of dream affect depend on the decisions made regarding each of those aspects.

One general methodological aspect involved in the collection of self-reports of dream experiences concerns *who* is studied, or *whose* self-reports are collected. In addition to various demographic characteristics (e.g., gender and age), several other individual differences may influence the quality of the data collected and the results obtained. Given that the collected data are necessarily retrospective, results may reflect individual differences in dream recall or memory abilities in general, rather than differences in dream phenomenology (Kahan & Claudatos, 2016; Kahan & Horton, 2012). Further individual differences that may influence results include participants' introspection (or self-observation) and language skills, attention and metacognitive skills, motivation to take part in the study, beliefs about dreaming, interest in and attitudes towards dreams, and various personality traits (Kahan, 2012; Kahan & Horton, 2012; Schredl, 2018; Snyder, 1970). When studying dream affect, a number of affect-related abilities and traits—such as low affect differentiation or granularity (i.e., the inability to distinguish similar affective states from one another; Barrett, 2004; Erbas et al., 2019) and alexithymia (characterized by difficulty in identifying and describing affective states)—may compromise reports of affective experiences (Kashdan, Barrett, & McKnight, 2015).

Other aspects common to the study of the different contents of dream experiences involve decisions regarding *what* types of self-reports are collected (e.g., narrative reports or targeted probes), as well as *where* (e.g., in the sleep laboratory or home environment), *when* (i.e., what the sampling procedure is), and *how* (e.g., which method of awakening is used) they are collected. Different types of self-reports involve different reporting and response biases (see Sections 3.2.2.1 and

3.2.2.2). Depending on where, when, and how self-reports are collected, they may be more or less susceptible to memory biases and more or less generalizable across people, time, and settings.

If narrative reports are collected, they must be content analysed to obtain quantitative data regarding the experiences described in the reports. Content analysis of narrative dream reports involves decisions as to *who* rates the reports (i.e., external judges or dreamer), *how* (e.g., instructions to raters), and with *what* method (e.g., type of scale) they are analysed. Different choices regarding each of these aspects can lead to different results.

When specifically studying dream affect, a number of additional decisions must be made, such as what type of affective phenomenon (e.g., state or trait affect), affective experience (e.g., emotion or mood or affective states in general), and model of affect (e.g., discrete or dimensional or their combination) is investigated. A plethora of different affect rating scales and items can be used to collect (i.e., as targeted probes) and analyse (i.e., for content analysis of narrative reports) data, each with its own strengths and weaknesses (see e.g., Ekkekakis, 2013). When measuring discrete affect, one must choose whether to use standardized or unstandardized (i.e., ad hoc lists of items relevant for a particular study) scales, which particular affect items to measure, whether to include only high-arousal/activation states or also low-arousal/activation states, and whether the number of positive and negative affect items is balanced. When measuring dimensional affect, decisions involve whether to use unipolar or bipolar and unidimensional or multi-dimensional scales. In addition, the particular response format of the scale (i.e., how many scale points it includes) may exert influence (Schimmack, Böckenholt, & Reisenzein, 2002). Last but not least, results may differ depending on which aspect of affect is measured: presence (whether affect is experienced or not), intensity (the strength with which affect is experienced), frequency (the number of times affect is experienced), or duration (how long the affective state lasts) (Diener, Larsen, Levine, & Emmons, 1985; Schimmack, Oishi, Diener, & Suh, 2000). For example, in the situation depicted in Figure 5, the measurement of the intensity of emotion would indicate that the person is experiencing more negative than positive emotions, whereas the measurement of the frequency of emotion would show that positive emotions prevail.

Table 1. Methodological aspects and decisions involved in the collection and analysis of retrospective self-reports of dream affect

Methodological aspects		**Decisions to make**	**Questions to consider**
I GENERAL ASPECTS: COLLECTION OF SELF-REPORTS			
WHO	Sex/Gender	Male/man Female/woman Other	Are the data representative of the population or group of interest? Are the data influenced by other individual differences?
	Age group	Children Adolescents Adults	
	Culture	Western Eastern	
	Country/Society	WEIRD Developing Third World Traditional indigenous Hunter-gatherer tribal	
	Marital status	Single In a relationship Married Divorced Widowed	
	Occupational status	Student Employed Non-employed	
	Health status	Healthy Clinically diagnosed	
	Sample size	1 - …	
WHERE	Environmental setting	Sleep laboratory Home Other	Are the data ecologically valid?
WHAT	Type of self-report	Narrative report Targeted probes Questionnaire	Are the data influenced by reporting and response biases?
	Reporting modality	Written Oral Other	Are the data influenced by the reporting modality?
WHEN	Temporal lag	Immediately upon awakening After delay	Are the data influenced by memory biases?
	Time of night	Early Middle Late	Are the data representative of dream experiences across the whole night?
	Sleep stage	REM NREM (N1, N2, N3)	
	Time in sleep stage	Fixed (minutes) Unspecified	

HOW	Method of awakening	Induced Spontaneous	Are the data influenced by memory biases?
	Experimental situation	Participant monitored Participant not monitored	Are the data influenced by reporting biases?
	Number of nights	One Several	Are the data representative of dream experiences across different nights?
	Number of dream reports	One Several	Are the data representative of the whole dream life of a participant?
II GENERAL ASPECTS: CONTENT ANALYSIS OF NARRATIVE DREAM REPORTS			
WHO	Rater	External judges Dreamer	
WHAT	Type of scale	All vs specific contents Nominal vs ordinal	
	Unit of analysis	Dream report as a whole vs every event, episode, or time the specific contents occurred	Are the data influenced by aggregation biases or the repetitive reporting of the same experience?
HOW	Instructions to raters	Rating explicitly or implicitly expressed content	Are the ratings reliable and reproducible?
	Controlling for report length	Yes No	Does report length reflect an inability to describe existing content, the amount of content, or individual differences in language use?
III SPECIFIC ASPECTS: MEASUREMENT OF AFFECT			
WHAT	Type of affective phenomenon	State affect Trait affect	Which construct is targeted?
	Type of affective experience	Affect Emotion Mood Core affect	
	Model of affect	Discrete Dimensional Circumplex	Which model is best suited for measuring the intended construct?
	Type of affect rating scale	Discrete (e.g., fear, anger) Dimensional (e.g., positive affect, negative affect)	Is there an empirically validated instrument that can be used? Which is the psychometrically strongest instrument?
	Aspect of affect	Presence Frequency Intensity Duration	

Note. WEIRD = western, educated, industrialized, rich, and democratic; REM = rapid eye movement sleep; NREM = non-rapid eye movement sleep. Adapted from Sikka, 2019, pp. 155-156.

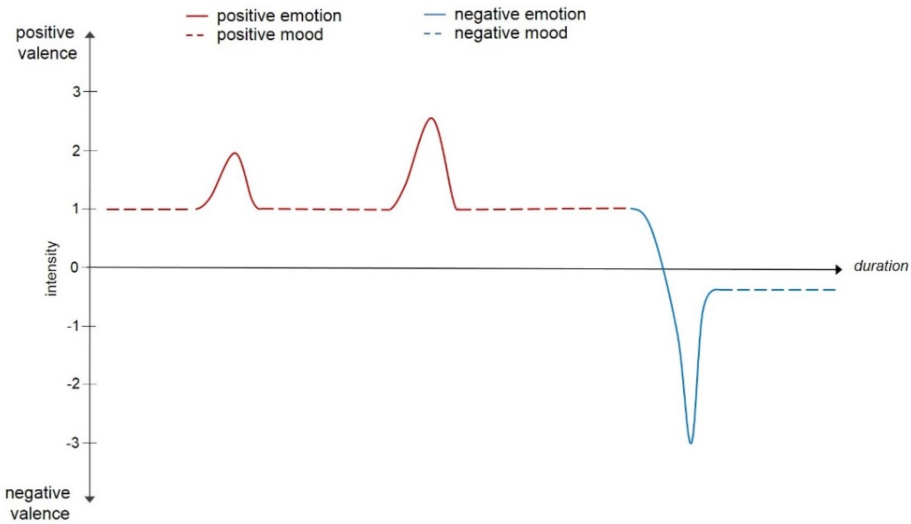

Figure 5. Example displaying different types and aspects of affective experiences. Emotions are relatively short-lived and intense, whereas moods are longer lasting and less intense. Measurement of different aspects of affect, such as the presence (e.g., whether the emotion is experienced), frequency (e.g., how often the emotion is experienced), intensity (e.g., how strongly the emotion is experienced), and duration (e.g., how long the emotion lasts), yield different results. In the situation depicted in the figure, measuring the presence of emotions would show that both positive and negative emotions occur. Measuring the (mean) intensity of emotions would indicate that negative emotions dominate, whereas measuring the frequency and duration of emotions would show that positive emotions prevail.

An important methodological aspect that applies to the study of dream experiences in general—and to the study of dream affect in particular—is the temporal lag between the experience and the self-report regarding that experience. Research on waking affect has demonstrated that our memories of affective experiences are distorted with respect to the actual experience, a phenomenon known as the memory–experience gap (Miron-Shatz, Stone, & Kahneman, 2009). Specifically, retrospective evaluations of affective experiences follow the peak-end rule—we remember the peak affective experience (e.g., the most positive or negative moment) and the end of the experience. This means that people select a representative moment (peak and/or end) and evaluate the whole experience based on it (Kahneman, 1999; Kahneman & Riis, 2005; cf. Miron-Shatz, 2009). Importantly, the longer the temporal delay from the experience (i.e., from the experiencing self), the more likely it is that the memories of our affective experiences (the remembering self) are biased (Kahneman & Riis, 2005; Robinson & Clore, 2002).

Different methods for collecting and analysing self-reports of dream affect involve a different combination of the methodological aspects described in Table 1. Below, the most typical methods are described and their main strengths and weaknesses discussed. Although these methods are described from the perspective of the study of dream affect, they can also be used to study other types of contents of dream experiences.

3.2.1 Typical methods for collecting retrospective self-reports of dream affect

3.2.1.1 Sleep laboratory awakenings

In the sleep laboratory, participants are monitored with polysomnography, which typically includes the measurement of brain electrical activity (electroencephaloraphy, EEG), eye movements (electrooculography, EOG), and muscle activity (electromyography, EMG). After participants have fallen asleep, researchers wake them up at a specific time of night, sleep stage, and time during sleep stage. The awakening schedule depends on the research question. Participants then provide a narrative (typically oral) dream report and/or rate the affect they experienced in the dream using targeted probes (e.g., affect rating scale). After this, participants are again allowed to fall asleep. Often, multiple awakenings are used in the laboratory, meaning that participants are awakened several times throughout the night (e.g., Foulkes, 1979). In other studies, participants can sleep through the night, and the reports and/or affect ratings are collected upon morning awakening (e.g., Weisz & Foulkes, 1970).

Collection of data in the sleep laboratory is considered the 'gold standard' of dream research, because it is possible to control exactly when and how data are acquired (Schredl, 2018; Windt, 2015). Dream reports and affect ratings can be obtained immediately upon awakening, reducing the possible effects of memory biases. Because it is possible to collect data from different times of night, sleep stages, and times spent in each sleep stage, a more representative sample of dream experiences across the night can be achieved (Zadra & Domhoff, 2017).

However, the laboratory setting and experimental situation—sleeping in a novel and atypical environment, being attached to equipment, and being closely monitored by the researchers—can influence dream content. In fact, as many as 20 % of dream reports collected in the laboratory have references to the laboratory environment (Schredl, 2008). If multiple awakenings are used, participants may get very tired due to interrupted sleep or suffer from sleep inertia, which may affect the quality of narrative reports and bias ratings of dream affect (Zadra & Domhoff, 2017). All of these possible influences call into question the ecological validity of dream reports and affect ratings collected in the sleep laboratory.

To reduce the possible effect of the novel and atypical sleeping environment, often, adaptation nights are performed or the first night removed from the analyses. Together with the fact that data collection in the sleep laboratory is a highly time- and resource-consuming endeavour, this means that laboratory studies usually involve only a few nights per participant. As a result, it is questionable whether the data collected in the laboratory are representative of the whole dream life of the participant (Sikka, 2019).

3.2.1.2 Home dream diary

The most widely used method for collecting data regarding dream experiences is the home dream diary. Participants sleep at home and are asked, immediately upon awakening, to write down (or audio record) their dream reports and/or rate the affect experienced in the preceding dream using targeted probes (e.g., affect rating scale). In the home environment sleep is typically not monitored, and therefore it is unclear when exactly the awakenings occur, although some studies have also used home-based sleep recording equipment (e.g., Fosse, Stickgold, & Hobson, 2001; Okuma, Fukuma, & Kobayashi, 1975).

Because participants sleep in a naturalistic environment, home dream diaries are ecologically valid. Assuming that participants diligently follow the instructions, it is possible to ensure a rather short temporal delay between a dream experience and its report/ratings. Because of the relative ease and low cost, home dream diaries can be obtained over a longer period. As a result, it is possible to collect more dream reports and affect ratings per person, which means that the data are more representative of the whole dream life of the participant. At the same time, longer data collection periods rely on participants' motivation, which may wane over time and influence the quality of dream reports (e.g., participants may not be very accurate and detailed when reporting their dreams; Zadra & Robert, 2012).

However, the main problem with home dream diaries is that because the sampling of the dream data is typically not controlled, the data reflect only a selective sample of the dream experiences. In fact, laboratory studies have shown that the most recent, affective, and longest dreams are remembered in the morning, with recency being the most crucial factor (Baekeland & Lasky, 1968; Meier, Ruef, Ziegler, &

Hall, 1968; Trinder & Kramer, 1971). Evidence also exists that dreams with more negative affect are more likely to be recalled in the morning (Goodenough et al., 1974). Thus, because in the home environment dream reports and ratings mostly derive from morning awakenings, they likely reflect the most recent and most affective dream experiences of the night.

3.2.1.3 Most recent dream

Using the Most Recent Dream method, participants are asked to write down the most recent dream they can recall, "whether it was last night, last week, or last month" (Domhoff, 1996). This dream report is either content analysed as other narrative reports, or it can be accompanied with targeted probes about the affect experienced in the dream. With this method, it is easy to collect dream reports from a large number of participants, in either a classroom, other group setting, or via the Internet. However, because there is often a rather long delay from the actual dream experience (i.e., hours, days, weeks), memories of these experiences are likely to be distorted and influenced by waking beliefs (Beaulieu-Prévost & Zadra, 2015; Johnson, Kahan, & Raye, 1984). Memory biases are especially likely because participants are not instructed or trained in how to recall and report dreams, and they have not originally intended to remember and report them. In fact, instead of the most recent dream, participants may report a recurrent dream or the first dream that comes to mind. Moreover, since every participant reports only one dream, and it is unknown exactly when (sleep stage, time of night, time in sleep stage) it was experienced, the representativeness of the collected data is questionable. Thus, the Most Recent Dream likely reflects a very selective sample—the most salient (e.g., the most affective)—of dreams. This makes the method more suitable for studying other phenomena (e.g., the most memorable dreams), rather than affective dream *experiences* as such (Sikka, 2019).

3.2.1.4 Dream questionnaire

Dream questionnaires or surveys ask questions about one's dream experiences in general, such as what the affective tone of one's dreams is on average (e.g., the Mannheim Dream Questionnaire; Schredl, Berres, Klingauf, Schellhaas, & Göritz, 2014). Questionnaires are easy to administer to large groups of participants, either in classroom settings or via the Internet. However, the longer the time delay from specific dream experiences and the more the respondents must aggregate their experiences over a long period (e.g., over a lifetime), the less likely it is that questionnaires reflect memories of actual experiences. Rather, such questionnaires reflect respondents' cognitive evaluations or beliefs about their dream lives (Sandman, 2017; Zadra & Domhoff, 2017), something that has been referred to as the 'believing self' (see Figure 4) in emotion research (Conner & Barrett, 2012). Asking people to provide general evaluations of their dream lives is particularly problematic when respondents' dream recall rates are low, meaning that they do not have access to memories of dream experiences (Beaulieu-Prévost & Zadra, 2005; Schredl, 2002). Because such general evaluations tap into trait affect (Conner & Barrett, 2012), it is not surprising that other trait measures (e.g., personality traits) are often better correlated with dream questionnaires than with the content of dream diaries (e.g., Bernstein & Belicki, 1995-1996).

3.2.2 Typical methods for measuring dream affect

3.2.2.1 External ratings of dream affect

In dream research, external ratings (ER)—or third-person ratings—have been the traditional method for measuring dream affect. With this method, narrative (written or oral) dream reports are collected and content analysed by 'blind' external judges, using a particular scale.

Typically, ER are conducted using a detailed content analytic scale: a nominal scale with which the judges identify and classify every occurrence (or presence) of an affective state (emotions and moods are not distinguished) explicitly mentioned in the dream report into one of the discrete affect categories. Among the existing scales, one of the most widely used is the Hall and Van de Castle (1966) Emotions scale, which consists of five categories of discrete affect: anger, apprehension (e.g., fear, anxiety), sadness, happiness, and confusion. Using this scale, Hall and Van de Castle collected 1,000 dream reports from students (five each from 100 women and 100 men) in the US between 1947 and 1950. Results based on these reports are often considered the 'norms' with which to compare findings from other studies. However, this scale is problematic because it has more negative affect (anger, apprehension, sadness) than positive affect (happiness) categories. Also, confusion has been classified as a negative affect category, which is questionable, since it contains affective states having both positive (e.g., amazed, awestruck) and undetermined (e.g., surprised) valence. As a result, with this scale ratings of dream affect may be biased towards a more negative valence.

In other studies, ER are conducted using global rating scales: ordinal (Likert) scales with which judges rate the whole dream report on some particular affective dimensions, such as the intensity of positive affect, the intensity of negative affect (Schredl & Doll, 1998), or overall affective intensity (e.g., De Gennaro et al., 2011). Whereas with detailed content analysis, only the presence of explicitly expressed affective states are coded, with global dimensional rating scales, the implicitly expressed affective states and their intensity are also rated. However, some researchers question the reliability and validity of intensity ratings performed by judges (Domhoff, 1996) and urge caution in inferring affective states from the reports (Windt, 2015).

ER are often considered 'objective' because the use of narrative reports makes it possible for other researchers to reproduce the results (Domhoff, 1996; Schredl, 2018). The use of at least two different judges enables the reduction of possible experimenter effects and the calculation of inter-rater reliability. However, even if high inter-rater reliability ratings are achieved, this does not necessarily mean that the ratings are also valid. For example, if no affective states are explicitly expressed in the dream report (e.g., "we played with the child"; "the beast was following me"), it is not possible to know whether this is because the dreamer did not experience any affective states in the dream or because the person simply failed to report these states.

In narrative dream reports people describe their dream experiences as they remember them happening, using freely chosen words that they naturally use, and they are not confined to the items preselected by the researcher. However, such reports depend on the reporting and language skills of the participants (Kahan, 2012). It can be challenging to express complex experiences in words. Moreover, narrative reports follow a story-schema: participants are more likely to report some features of the content (e.g., what happened, where, who was present) than others (e.g., how they felt) (Kahan, 1994; Kahan & Horton, 2012; Kahan & LaBerge, 1996, 2011; Merritt, Stickgold, Pace-Schott, Williams, & Hobson, 1994). This means that narrative reports may specifically underrepresent affective dream experiences (Kahan & Claudatos, 2016; Kahn & Hobson, 2002; Strauch & Meier, 1996). Even if participants are explicitly instructed to describe their affective experiences, they may have difficulty labelling them.

3.2.2.2 Self-ratings of dream affect

Self-ratings (SR)—or first-person ratings—involve the collection of targeted (or affirmative) probes (Hobson & Stickgold, 1994; Nielsen, 2010). Targeted probes can take the form of affect items, affect rating scales, or specific questions about dream affect, which the participants (i.e., the dreamers) are asked to rate or answer. Typically, participants are asked to provide global ratings of the preceding dream experience—the extent to which they experienced certain affective states in the dream as a whole (e.g., Blagrove, Farmer, & Williams, 2004; Schredl & Reinhard, 2009-2010). Less frequently, they are asked to rate each line (e.g., Fosse et al., 2001; Merritt et al., 1994) or scene (Nielsen, Deslauriers, & Baylor, 1991) in the corresponding narrative dream report.

A wide variety of rating scales are used for global SR. Discrete affect scales include lists of different affect items, and the participants are asked to rate the presence and intensity of each item in the preceding dream (e.g., Fosse et al., 2001; Kahn & Hobson, 2002; Kahn, Pace-Schott, & Hobson, 2002; Merritt et al., 1994; Nielsen et al., 1991). Dimensional scales range from those encompassing a single bipolar scale, with which participants must rate the overall affective tone or valence of the dream (e.g., Blagrove et al., 2004), to those including several unipolar scales that separately assess the intensity of positive affect and negative affect (e.g., (Schredl, 2018; Schredl & Reinhard, 2009-2010).

The wide variety of scales used for SR makes it difficult to compare results from different studies. For example, some discrete affective states (e.g., awe) may appear relatively infrequently across different studies not because they are seldom experienced, but because they are seldom measured. Also, the choice of a particular scale is rarely justified. Surprisingly, empirically validated affect rating scales, such as those used in emotion research, have seldom been used (e.g., Stairs & Blick, 1979). Instead, studies use different lists of ad hoc affect items, which poses a threat to validity. As with ER, the scales often consist of an unequal number of positive and negative affect items—with the number of negative affect items typically exceeding the number of positive affect items—which may inadvertently bias the results towards increased negativity by way of participants rating the items simply because they are presented.

On the one hand, the use of targeted probes ensures that participants report experiences that may otherwise be left out of the narrative report, particularly affect experienced in the dream. On the other hand, the particular questions or affect items used may bias the results. For example, participants may choose an item they originally might have not chosen, they might want to choose an item that cannot be found on the list/scale, or the label used by the researcher and how the participant understands it may differ (Scherer, 2005). Furthermore, the ratings may be influenced by waking cognition at the time of rating—participants may incorrectly assume that they felt a certain way based on the dream content (Domhoff, 2005; Foulkes, Sullivan, Kerr, & Brown, 1988; Kahn & Hobson, 2002; Zadra & Domhoff, 2017). When Likert-type scales are used, systematic response biases, such as the tendency to only select extreme endpoints of the scale or to agree with all items, can influence the results (Baumgartner & Steenkamp, 2001; Paulhus, 1991; Paulhus & Vazire, 2007).

4. Theoretical and empirical foundation

Scientific research does not arise from a vacuum but builds on past work. Theories are based on existing empirical data and are either supported or challenged by new data. If new data support the predictions drawn from the theory, we can have confidence in the theory. If the data do not support the predictions, we may need to modify the theory. Thus, theories and data form a continuous research cycle through which theories are developed and adapted (Popper, 1959).

In this chapter, I provide an overview of the theories and empirical research findings that the current thesis builds on. Although the studies conducted in the framework of this thesis did not directly test any particular dream theory, they do have implications for dream theories in general. Therefore, it is important to get an idea of what the different theories say about dream affect. Then, I review the empirical research literature that forms the foundation for the studies of the current thesis. Because this thesis focuses on affective dream *experiences*, the emphasis is on findings obtained with methods that come closest to investigating them—narrative dream reports and ratings of affect collected upon awakening, either in the sleep laboratory or in the home environment.

4.1 Theories of dreaming: How and why we experience affect in dreams

A host of different theories of dreaming have been put forward. Most of these theories focus on dream experiences in general, not specifically on affective dream experiences. My purpose here is not to provide an exhaustive review of the various theories but to outline the central tenets of those theories that shed light on how or why we experience affect in dreams and that make either explicit or implicit predictions regarding the affective nature of dreams.

In general, we can divide modern dream theories into two groups: theories that consider dream experiences to be a mere epiphenomenon (i.e., a by-product of neurobiological processes occurring in the brain during sleep), and those that attribute a specific function to dream experiences.

4.1.1 Non-functional dream theories

According to the so-called non-functional theories, dreaming reflects important processes occurring in the brain during sleep but is not in itself functional.

Random activation theories [13] (e.g., Flanagan, 1995; Hobson, 1988, 2009; Hobson & McCarley, 1977; Hobson et al., 2000) argue that dreaming results from the random activation of the forebrain—including memory and affect networks—by the brainstem mechanisms during rapid eye movement (REM) sleep. This activation leads to affective and perceptual dream experiences that are synthesized into a more or less coherent dream 'story' as the forebrain tries to make sense of these experiences. Affect is generated first and considered the primary driver of dream content. Because the activated affect-related networks and brain areas (e.g., amygdala) are thought to be preferentially involved in the processing of negative affect, dream experiences are assumed to be dominated by negative affect (e.g., fear or anxiety), although positive affect (e.g., joy or elation) is also considered relatively common (Flanagan, 2000; Hobson et al., 2000). Thus, dream experiences are considered inherently affective and often negatively valenced. Due to the activation of memory networks, dream experiences may reflect (i.e., be continuous with) our waking experiences, but they are nevertheless auto-created by the brain and, as a result, often unrelated (i.e., discontinuous with) to our waking life (see discussion on continuity and discontinuity in Hobson & Schredl, 2011 and Voss, Tuin, Schermelleh-Engel, & Hobson, 2011).

Memory consolidation theories of dreaming (e.g., Payne, 2010; Stickgold, Hobson, Fosse, & Fosse 2001; Stickgold & Wamsley, 2017; Wamsley & Stickgold, 2011) rely on a large body of evidence demonstrating that sleep plays a role in offline learning and the consolidation of memories (Alger et al., 2019; Payne & Kensinger, 2018). These theories posit that dreaming reflects the memory consolidation process—the reactivation, reprocessing, and recombination of episodic memory elements from previous waking experiences with semantic information and affect. Because sleep, especially REM sleep, is involved in the consolidation of affective memories, the processing of affect is reflected in the affective content of dreams. Dreams contain both positive and negative affect and are not necessarily dominated by either. However, it is an open question whether dreams only reflect—or also

[13] The term *random activation theory* is adopted from Revonsuo (2000a) and Valli (2008).

actively contribute to—memory consolidation and learning (e.g., Wamsley & Stickgold, 2019).

The cognitive (Foulkes, 1985, 1990) and neurocognitive (Domhoff, 2003, 2018) theories assert that dreaming is a form of 'default' activity that occurs spontaneously when the mind is not being constrained by external stimulation or task-related activity. As the names of the theories imply, dreaming is a form of internally generated cognition or thought and is considered akin to imagination (Foulkes & Domhoff, 2014), mind-wandering or daydreaming (Domhoff, 2018). Dreaming is supported by the activation of portions of the default mode network—a large-scale network of functionally connected brain areas, including areas related to the processing of affect (e.g., anterior cingulate cortex, medial prefrontal cortex) (Domhoff, 2018). Brain structures often associated with negative affectivity, such as the amygdala, can be—but do not have to be—activated (Domhoff, 2018). Dream content is thus formed by spontaneously activated semantic and episodic memory fragments, which are combined into a plausible simulation of the waking experience (Foulkes, 1990). However, dream experiences are mostly cognitive in nature, and affect can be present or absent from dream experiences.

The continuity hypotheses[14] (e.g., Bell & Hall, 1971; Domhoff, 1996, 2017; Hall & Nordby, 1972; Schredl, 2003; Schredl & Hofmann, 2003) assume that there is continuity between waking and dream experiences, that is, dream experiences reflect (the memory fragments of) waking experiences. Different formulations of the hypotheses conceptualize continuity differently. Dream experiences may be continuous with waking thoughts and affects, such as personal concerns and conceptions (Domhoff, 2017, 2018), or with waking behaviours, activities, and events (Schredl & Hofmann, 2003). Waking life experiences with higher affective intensity are assumed more likely to be incorporated into dream experiences (Schredl, 2003; Schredl, 2018). Also, these theories posit affective continuity between dream and waking experiences—pre- and post-sleep waking affect is considered to be associated with (or continuous with) dream affect (Schredl & Reinhard, 2009-2010).

Based on a large body of neuropsychological data, Solms (1997, 2000, 2011) argues that dreaming is generated by the dopaminergic mesolimbic-mesocortical system, also known as the 'reward', 'wanting', or 'SEEKING'[15] system (Berridge,

[14] The term is used in plural because different versions of the continuity hypothesis exist (Tuominen, Stenberg, Revonsuo, & Valli, 2019).

[15] Panksepp (1998) uses uppercase letters to refer to a specific brain system underlying appetitive motivation, or curiosity/interest/foraging/anticipation/craving/expectancy.

1996; Panksepp, 1998; Rolls, 2000). Accordingly, dreaming reflects the SEEKING activity during sleep and is, therefore, particularly characterized by approach-related affect (e.g., curiosity and interest) and behaviours (e.g., exploration and novelty seeking) (Malcolm-Smith, Koopowitz, Pantelis, & Solms, 2012). The activation of medial and anterior temporal cortical areas further contributes to the affective quality of dreams (Solms, 2000).

4.1.2 Functional dream theories

Among the theories that attribute a specialized function to dream experiences, it is possible to distinguish between evolutionary and psychological theories of dream function.

Evolutionary theories argue that dreaming is evolutionarily adaptive: during dreaming important skills are practised, because this was beneficial to the survival and reproduction of an organism in our evolutionary past (Revonsuo, 2000b; Revonsuo et al., 2016a). A prominent example is the threat simulation theory (Revonsuo, 2000b; Valli & Revonsuo, 2009), according to which the function of dreams is to selectively simulate threatening events (e.g., being chased or attacked) to rehearse threat-avoidance responses and behaviours. This would have been adaptive for ancestral humans, as it would have helped them to better deal with real threats during wakefulness. Threatening events during wakefulness trigger the activation of the threat simulation system, and during sleep memory traces with the highest negative affectivity are selected for simulation. At the neurobiological level, the threat simulation system is reflected in the activation of affect-related brain areas, such as the amygdala. According to this theory, dreams display a negativity bias: they include predominantly negative content (e.g., threats) and negative affect (e.g., fear). Bad dreams and nightmares are examples of a well-functioning threat simulation system.

The social simulation theory (Revonsuo et al., 2016a) proposes that dreams selectively simulate social perception, social interaction, and social behaviours, and this rehearsal helps maintain and strengthen social bonds in wakefulness. As a result, dreams are biased towards social contents. Although the theory does not explicitly address dream affect, it assumes that dreams include more positive than negative social interactions, which implies that dreams may involve more positive than negative affect.

Psychological theories of dream function argue that dreaming is psychologically adaptive: dreaming helps individuals cope better with waking life and hence influences their mental health and well-being. Several different emotion processing and emotion regulation theories have been put forward (Cartwright, 1991, 2010; Hartmann, 1996, 2011; Kramer, 1991, 1993, 2007; Levin & Nielsen, 2007; Malinowski & Horton, 2015; Nielsen & Levin, 2007; Perogamvros & Schwartz, 2012). As the name implies, these theories assign a central role to affect in the function of dreaming. According to these theories, dreams incorporate or reflect the dominant affect, affective concerns, or affective experiences of waking life. The function of dreams is to reprocess these memory elements, integrate them with existing memory traces so as to ultimately downregulate their intensity and thus help us cope better with these experiences during wakefulness. The activation of affect-related brain areas (amygdala, medial prefrontal cortex) during sleep, particularly during REM sleep, is argued to provide a suitable condition for these processes and is taken to explain the highly affective nature of dream experiences.

Most of the emotion regulation theories attribute a special role to negative affect: dreams specifically incorporate negative affective experiences (e.g., fear) and the processing of negative affect in dreams helps to downregulate it (Cartwright, 1991, 2010; Hartmann, 1996, 2011; Levin & Nielsen, 2007; Nielsen & Levin, 2007). Other theories propose that affective intensity, rather than affective valence, determines what is incorporated into dreams and that dreams downregulate affective intensity in general (irrespective of positive or negative valence) (Kramer, 1991, 1993, 2007; Malinowski & Horton, 2015). Regardless, dreaming is seen as an "emotional thermostat" (Kramer, 1991, 1993) or "overnight therapy" (Hartmann, 1995; Walker & van der Helm, 2009) that helps affective adaptation in wakefulness. Bad dreams and nightmares are a failure of this process (Cartwright, 2010; Kramer, 1991, 1993, 2019; Levin & Nielsen, 2009). The degree and effectiveness of emotion regulation during dreaming is influenced by both state and trait factors: waking affect load (i.e., elevated levels of life stress and negative events) and affect distress (i.e., disposition to experience stress and negative affect), respectively (Levin & Nielsen, 2009).

The reward activation model (Perogamvros & Schwartz, 2012) combines the neuropsychological findings of Solms (1997, 2000) with the emotion regulation and memory consolidation theories. Dreaming and dream content are proposed to be generated by the activation of the reward-related mesolimbic dopaminergic, or the 'SEEKING', system (Panksepp, 1998). The function of dreams is to expose the dreamer to affectively and motivationally relevant stimuli (i.e., appetitive and aversive) to aid in the offline consolidation of memories with high affective and motivational value, improve future performance during wakefulness, and aid in affect regulation. Dreams are thus characterized by both approach- and avoidance-related behaviours (e.g., exploration or novelty seeking vs avoiding a threat by fleeing) and affective states (e.g., interest vs fear) (Schwartz & Perogamvros, 2017).

In summary, all of the theories reviewed above agree that dream experiences involve the activation of episodic memory elements that can be combined with affect. All of the theories also seem to assume that affective dream experiences occur due to the activation of the same brain areas that underlie affect in wakefulness. However, the theories disagree about the nature and function of dream affectivity. Whereas several theories argue that dreams are inherently affective, others consider dreams to be mostly cognitive in nature. Also, while many theories consider dreams to be negatively biased, others are more ambivalent regarding the prevailing valence of dreams. Finally, whereas some theories consider dream phenomenology, including affective experiences, to be unrelated to (or discontinuous with) waking phenomenology, according to others, dream affect is related to (or continuous with)—either simply reflecting or also contributing to—waking well-being.

4.2 Empirical literature on methodological issues

Theoretical disagreements about the phenomenology of dream affect (e.g., whether dreams are mostly affective or non-affective, negatively biased or not) are upheld by the empirical literature, which provides support for opposing views. The question arises as to what extent the study methodology—how dream affect has been measured (i.e., SR vs ER), and where and how the data have been collected (i.e., laboratory vs home environment)—can explain such controversies. Below, I review existing studies on these methodological issues.

4.2.1 Self- versus external ratings of dream affect

Studies using ER in the form of the detailed content analysis of dream reports have shown that most dream reports are non-affective (e.g., Domhoff, 2018; Hsu & Yu, 2016; Snyder, 1970), with less than one affective state per report (e.g., Hall & Van de Castle, 1966; Hsu & Yu, 2016). Also, such studies have demonstrated that dream reports contain more negative than positive affect (e.g., Brown & Donderi, 1986; Domhoff, 2018; Hall & Van de Castle, 1966; Hsu & Yu, 2016; Snyder, 1970), with anxiety and/or fear being the most prevalent discrete affective states (Hall & Van de Castle, 1966; Hsu & Yu, 2016; McCarley & Hoffman, 1981; Snyder, 1970).

In contrast, studies using SR have found the majority of dreams to be affective (Fosse et al., 2001; Foulkes et al., 1988; St-Onge, Lortie-Lussier, Mercier, Grenier, & De Koninck, 2005; Strauch & Meier, 1996; Yu, 2007), with several affective states per dream (Blick & Howe, 1984; Howe & Blick, 1983; Kahn & Hobson, 2002; Merritt et al., 1994; Nielsen et al., 1991). Results regarding affective valence are mixed: from the dominance of negative affect (Blick & Howe, 1984; Kahan & Claudatos, 2016; Merritt et al., 1994; Nielsen et al., 1991), to a balanced amount of positive and negative affect (Fosse et al., 2001; Kahn & Hobson, 2002; Yu, 2007) or affective tone (Blagrove et al., 2004; Strauch & Meier, 1996), to the dominance of positive affect (St-Onge et al., 2005). These inconsistencies arguably depend on additional methodological differences between the studies, such as the data collection environment and procedure (St-Onge et al., 2005), the number and type of discrete affect items included (Kahan & Claudatos, 2016; St-Onge et al., 2005), and individual differences such as age (Blick & Howe, 1984; St-Onge et al., 2005) and mental health status (Cartwright, Young, Mercer, & Bears, 1998). Which discrete affect is the most prevalent depends on which particular items have been measured. Joy and interest are typically the most frequent among the positive affective states, while anxiety, fear, and anger are the most prevalent among the negative affective states.

The findings reviewed above suggest that differences in the method of measurement—whether ER or SR has been used—may underlie (at least some) discrepancies in results. However, to determine whether this is indeed the case, systematic comparisons of SR and ER in the same sample are needed. In 1951, the eminent dream researcher Calvin S. Hall reported, albeit in a popular science journal, that dream reports content analysed by external judges contained more negative than positive affects, whereas the dreamers rated the same dreams to be more pleasant than unpleasant (Hall, 1951)[16]. More than two decades later, Stairs and Blick (1979) demonstrated that the participants' own and judges' ratings of dream affect had poor agreement. Another two decades later, Kahan and LaBerge (1996), who compared ER and SR of cognitive and metacognitive processes in dreams, reported a higher prevalence of dream affect with SR (93 %) than with ER (38 %).

Besides these early reports, prior to the studies conducted in this thesis, only one study had directly compared SR and ER of dream affect in the same participants. In

[16] Specifically, Hall (1951) reported that, when written dream reports were content analysed, 64 % of all dream affects (what he termed *emotions*) were negative and only 18 % positive. But participants themselves rated the same dreams more often pleasant (41 %) than unpleasant (25 %), with 11 % having mixed affective tone, and 23 % having no affect.

this previous study, Schredl and Doll (1998) measured dream affect in 133 home dream reports using three different rating methods: (1) SR using two dimensional, unipolar (four-point Likert) scales, one measuring the intensity of positive affect and the other the intensity of negative affect in the dream as a whole; (2) ER based on the detailed content analysis of dream reports (ER-CA) using the Emotions scale from the Hall and Van de Castle (1966) content analysis system; and (3) ER based on the global ratings of the dream report as a whole (ER-GS) using the same two dimensional rating scales as for SR. The results showed that whereas with SR almost all of the dreams (99.2 %), with ER-CA less than half of the dream reports (42.1 %), were rated to contain affect. With ER-GS, however, more than two-thirds of the dream reports (86.5 %) were rated to contain affect. Thus, when judges could infer affective states from dream action and rate affect in the dream report as a whole, differences in the degree of dream affectivity between SR and ER were smaller, as opposed to when judges were instructed to rate only explicitly expressed affect. Nevertheless, ER (irrespective of whether content analysis or global rating scales were used) yielded more than twice as many negative than positive dream reports. With SR, the percentage of negatively and positively valenced dreams was more balanced, although negatively rated dreams still prevailed. Moreover, with SR, as compared with ER-GS, the intensities of both positive and negative affect were higher, but the differences were larger for positive affect. Although women expressed more affect in dream reports (i.e., with ER), their SR of affect did not differ from those of men. Also, there were no gender differences in the valence of dream affect.

Recently, Röver and Schredl (2017) replicated Schredl and Doll's (1998) findings using SR and ER-GS. In addition, they found that longer dream reports and higher levels of extraversion were related to smaller differences between SR and ER-GS with respect to negative affect ratings. According to the authors, this suggests that a more detailed description of the dream enables external judges to more accurately rate dream affect. Extraverts are more likely to express affect, and therefore external raters may find it easier to detect affect in their reports. However, in the study, this only explained ratings of negative affect, whereas differences with regard to positive affect remained unexplained. Gender did not explain differences in the results obtained with the two measures.

In summary, ER and SR yield different results regarding the phenomenology of dream affect. This raises questions about the validity of the measures and calls for more systematic research on this methodological aspect. In particular, it is important to determine whether similar discrepancies are obtained when discrete affect is measured with both ER and SR and when the number of positive and negative affect items is balanced, and whether these differences are specific to the data collection environment (i.e., home) or also emerge in other settings (i.e., in the sleep laboratory). To address these questions, Studies I and II were conducted.

4.2.2 Home versus laboratory studies of dream affect

Dream researchers have long debated whether and to what extent dream content differs depending on whether the data are collected in the home or in a sleep laboratory environment. Studies comparing home and laboratory dream reports from the same participants have demonstrated that home dream reports contain more aggression than laboratory dream reports (e.g., Domhoff & Kamiya, 1964; Domhoff & Schneider, 1999; Hall, 1966). However, aggressive content does not directly translate into affective content.

Only a few studies have directly compared the affective content of dreams in the two settings. Table 2 gives an overview of the main features and results of existing studies. As shown, studies vary widely in the sample composition, dream sampling and reporting procedures, affect rating scales, and units of analysis used. Taken together, the findings of existing studies indicate that when the same dream sampling (morning awakenings) and reporting (oral or written) procedures are used in the home and laboratory setting, no differences exist in the ER of the affective content of dream reports (Foulkes, 1979, Study 3; Weisz & Foulkes, 1970). When different dream sampling (morning awakenings at home, but multiple REM awakenings in the laboratory) and reporting (written reports at home, but oral reports in the laboratory) procedures are used, home dreams are rated (with both ER and SR) to contain more affect, especially negative affect (Foulkes, 1979, Study 4; Okuma et al., 1975; St-Onge et al., 2005). This pattern of findings suggests that differences in the two settings are less due to *where* (home vs lab) than *how* the data have been collected.

At least three methodological aspects may help explain the differences observed in these studies. First, the reporting modality: at home dream reports are written down, whereas they are reported orally in the laboratory. Reporting modality has been shown to lead to different results regarding at least some aspects of dream content (Casagrande & Cortini, 2008), although due to the lack of research, it is not known whether and how this influences the affective content of dreams. However, Foulkes (1979, Study 4) and Okuma et al. (1975), who used the same reporting procedure at home and in the lab, still found more affective content in home dream reports. This suggests that reporting modality alone cannot explain the differences.

Second, dream reports in the two settings derive from different sleep stages. Laboratory dream reports have been collected upon awakening from REM, whereas home dream reports possibly derive from different—REM and NREM—sleep stages. Although differences in the affective content of REM and NREM dream reports are recognized (Foulkes, 1962; Smith et al., 2004; Wamsley, Hirota, Tucker, Smith, & Antrobus, 2007), these differences seem to disappear when the reports are obtained upon morning awakening (Cicogna, Natale, Occhionero, & Bosinelli, 1998; McNamara, McLaren, & Durso, 2007). This indicates that differences between home and laboratory REM dream reports arising due to differences in sleep stages should be minimal, because home dream reports derive from morning awakenings.

This brings us to the third explanation. Dream reports collected at home and in the laboratory derive from different times of night. Reports collected at home upon morning awakenings mostly represent late-night/early-morning dreams (Hall, 1966), whereas reports collected in the laboratory upon REM awakenings represent dreams from different times of night—from both early-night and late-night/early-morning periods. Late-REM dreams have been shown to be longer and contain more affect than early-REM dreams (Agargun & Cartwright, 2003; Verdone, 1965; cf. Fosse et al., 2001). Thus, home dream reports collected in the typical manner (i.e., upon morning awakening) may contain more affect, because they represent a selective sample of late-night (REM or NREM) dreams, whereas sleep laboratory dream reports collected in the typical manner (i.e., upon multiple REM awakenings) represent both early- and late-night REM dreams. Because a direct comparison of home dream reports with early- and late-REM laboratory dream reports can help to shed light on this issue, Study III was conducted.

Table 2. Overview of studies comparing the affective content of home and laboratory dreams

Study	Sample	Sampling procedure		Reporting procedure		Affect rating scale	Self-ratings (SR) or external ratings (ER)	Unit of analysis: whole dream (D) or every occurrence of affect (E) within dream	Findings regarding the differences between home (H) and laboratory (L) dreams
		Home	Laboratory	Home	Laboratory				
Weisz and Foulkes (1970)	12 young males (19-28y)	Morning awakenings (2 non-consecutive nights)	Morning awakenings (2 non-consecutive nights)	Oral	Oral	2 dimensions from Hauri, Sawyer, & Rechtschaffen (1967): "Vivid Fantasy"[a] and "Hedonic Tone"	ER	D	NS
Okuma et al. (1975)	5 male psychiatrists (25-47y)	1. Morning awakenings (2 weeks; during 1967-1968) 2. REM awakenings using the "Dream Detector" (during 1972-1973)	Multiple REM awakenings (during 1967-1968)	1. Written 2. Oral	Oral	Hall & Van de Castle (1966) content analysis system: all five categories (anger; apprehension; happiness; sadness; confusion) evaluated as one "emotional elements" category	ER	E	Dreams containing "emotional elements": 1. H > L 2. H > L
Foulkes, (1979, Study 3)	14 children (8 girls, 6 boys; 10-11y)	Morning awakenings (3 consecutive nights)	Morning awakenings (3 consecutive nights)	Written	Written	8 categories from the Scoring System for Children's dreams (Foulkes & Shepherd, 1970): afraid; angry; sad; happy; surprised; excited; confused; any. Overall hedonic tone	1. ER 2. SR	1. E + D 2. D	1. NS 2. Fear: H > L Pleasant hedonic tone: H > L

Table 2 continues…

Foulkes, (1979, Study 4)	18 children (7 girls, 11 boys; 12-13 y)	Morning awakenings (6 consecutive mornings)	Multiple REM awakenings (2 non-consecutive nights)	Written	1. Oral	Scoring System for Children's dreams (Foulkes & Shepherd,1970)	ER	E + D	1. Affect: H > L Afraid: H > L Angry: H > L Excited: H > L Unpleasant hedonic tone: H > L Length: H < L
					2. Written (morning reports of recalled dreams)				2. Affect: H > L
St-Onge et al. (2005)	28 younger (20-33 y) vs 30 older (60-77 y) women	Morning awakenings (7 consecutive days)	Multiple REM awakenings (1 night)	Written	Oral	8 items; 4 positive: happiness, contentment, quietness, cheerfulness; 4 negative: anger, sadness, uncertainty, anxiety	SR (upon morning awake-ning)	D	Presence and intensity of affect: H > L Presence and intensity of negative affect: H > L Most frequent affect items: H: anxiety (57.5%), uncertainty (56.7%), quietness (52.6%), contentment (51%). L: quietness (57%), happiness (46.3%), cheerfulness (46.3%)

Note. [a]Includes also other variables not measuring affective states. NS = no significant differences. Adapted from Sikka, Revonsuo, Sandman, Tuominen, and Valli, 2018, pp. 2-3.

4.3 Empirical literature on the correlates of dream affect

Wakefulness and sleep are two distinct behavioural and neurophysiological states. This raises the question as to whether and to what extent the experiences we have in these states are similar or different, related or unrelated to each other. Specifically, is dream affect continuous or discontinuous with our waking experiences? And do affective experiences in these two states rely on shared neural substrates, as predicted by dream theories? Research on the waking well-being and neural correlates of dream affect can help answer these questions.

4.3.1 Dream affect and waking well-being

Clinical practitioners have long assumed that the content of dreams provides a window into the mental health of individuals (Pesant & Zadra, 2004). This idea dates back to the work of Freud (1900/1955) and Jung (1945/1974), who emphasized the importance of understanding dreams and considered dream work to have therapeutic value. Empirical research in clinical populations has indeed shown that people with various mental health and sleep disorders report frequent nightmares (i.e., dreams with extremely negative content that may awaken the dreamer) and negatively toned dreams (for reviews, see Levin & Nielsen, 2007, 2009; Nielsen & Carr, 2017; Nielsen & Levin, 2007; Skancke, Holsen, & Schredl, 2014). However, many studies have used dream questionnaires—rather than sleep laboratory awakenings or home dream diaries—which, as discussed previously, are methodologically problematic for drawing inferences about affective dream *experiences*.

Studies based on nonclinical samples and home dream diaries are limited and findings mixed. People who experience more anxious and depressive affective states in wakefulness are more likely to rate their dreams as negative (Blagrove et al., 2004) and to express negative affect in dream reports (King & DeCicco, 2007). Also, individuals with more symptoms of general psychopathology and higher trait anxiety express more negative affect in dream reports (Pesant & Zadra, 2006). Yet, other studies do not provide support for the relationship between general psychopathology, trait anxiety, depression, and dream affect (Beaulieu-Prévost & Zadra, 2005; Demacheva & Zadra, 2019; Schredl & Engelhardt, 2001; Zadra & Donderi, 2000).

In addition to inconsistent findings, research on the relationship between dream affect and waking well-being suffers from a conceptual problem: most studies have actually investigated only waking ill-being (i.e., symptoms of, or traits related to, psychopathology). Because well-being (and mental health in general) is not simply the absence of ill-being (Keyes, 2005; Seligman, 1999; World Health Organization, 2018), we must also investigate how waking well-being as such is associated with dream affect.

But what is well-being? Well-being is a heterogeneous concept. Here, I limit the discussion to mental (as opposed to physical) well-being. In well-being research, it is generally agreed that at least two different types of well-being exist—hedonic and eudaimonic (Ryan & Deci, 2001; cf. Kashdan, Biswas-Diener, & King, 2008; Ward & King, 2016). Hedonic well-being (HWB) refers to how people feel and think about their lives—how happy they consider themselves to be. It is operationalized as subjective well-being (Diener, 1984, 2013), consisting of two affective (positive and negative affect) and two cognitive or evaluative (life satisfaction and domain satisfaction) components (Diener, Scollon, & Lucas, 2009; Pavot & Diener, 2013). Eudaimonic well-being (EWB) refers to how virtuously people live their lives—whether they are flourishing (Huta & Waterman, 2014). Despite slightly different conceptualizations and operationalizations, most EWB measures emphasize the sense of meaning and purpose in life (Huta & Waterman, 2014; Vittersø, 2016). Although they are conceptually distinct, HWB and EWB are empirically related (Waterman, 2008). In addition to HWB and EWB, arguably a distinct aspect of well-being—a state of inner peace and harmony—exists that is largely neglected in the current framework of well-being. Lee and colleagues (Lee, Lin, Huang, & Fredrickson, 2013) developed the peace of mind construct and the Peace of Mind Scale to measure this type of well-being in the Chinese cultural context. Although peace of mind is especially valued in Eastern cultures, people in Western countries also associate well-being (or happiness) with inner peace and harmony (Delle Fave, Brdar, Freire, Vella-Brodrick, & Wissing, 2011; Delle Fave et al., 2016; Synard & Gazzola, 2017). However, in Western cultures this aspect of well-being has not yet been explored. In summary, there are several different types (and components) of well-being that are distinct from ill-being.

Because dream research and well-being research have developed relatively independently, the different aspects of well-being have been rarely addressed in dream studies. The handful of studies that do exist have measured HWB, or some of its components, and produced discrepant findings. For example, whereas Gilchrist, Davidson, and Shakespeare-Finch (2007) found a weak negative correlation between life satisfaction and negative dream affect, St-Onge et al. (2005) failed to observe any significant relationships between life satisfaction and (positive or negative) dream affect. Whereas state affect in wakefulness has been found to be positively correlated with respective dream affect (Gilchrist et al., 2007; Schredl & Reinhard, 2009-2010; Yu, 2007), trait affect in wakefulness has not been associated with dream affect (Gilchrist et al., 2007).

Thus, there is scarcity of research not only on the relationship between dream affect and waking ill-being but even more so on the relationship between dream affect and waking well-being. The mixed findings likely arise from methodological differences between the studies. Specifically, whereas some studies have used SR of dream affect, others have used ER of dream affect. If SR and ER yield different results regarding dream affect, the two measures may be differently associated with ill-being and well-being. Also, results may differ depending on whether waking states (e.g., state anxiety, state affect) or waking traits (e.g., trait anxiety, trait affect) have been measured. All of this underscores the need for more research informed by the science of well-being and by the methodological considerations discussed in previous chapters. To address this need, Study IV was carried out.

4.3.2 Neural correlates of dream affect

Since the discovery of REM sleep and its association with dreaming in the 1950s (Aserinsky & Kleitman, 1953, 1955; Dement & Kleitman, 1957), researchers have studied the neurobiology of REM sleep in the hope of shedding light on the neural processes underlying dream experiences. However, this approach was increasingly questioned with the accumulation of findings showing that dream experiences can also occur outside of REM sleep (e.g., Foulkes, 1962) and that abolishing REM does not abolish dreaming (Solms, 2000). It is now well recognized that REM sleep and dreaming are doubly dissociable states (Nir & Tononi, 2010; Solms, 2000), which means that brain activity during REM sleep does not necessarily translate into the neural correlates of dream experiences.

Recently, considerable progress has been made in elucidating the neural correlates of dreaming in general (Siclari et al., 2017; Siclari, Bernardi, Cataldi, & Tononi, 2018; for a review, see Cipolli, Ferrara, De Gennaro, & Plazzi, 2017) and of the specific contents of dream experiences in particular. Specifically, it has been shown that different contents of dream experiences—visual perception, thoughts, movement, and speech—involve the same brain areas as in wakefulness (Dresler et al., 2011; Hong et al., 1996; Horikawa et al., 2013; Perogamvros et al., 2017; Siclari et al., 2017). Because studies on non-affective experiences suggest continuity in the underlying neural mechanisms across wakefulness and sleep (see also De Gennaro, Marzano, Cipolli, & Ferrara, 2012; Domhoff & Fox, 2015; Fox, Nijeboer, Solomonova, Domhoff, & Christoff, 2013; Wamsley, 2013), it is reasonable to assume that affective experiences also share neural processes across the two behavioural states.

Indeed, neuroimaging studies have consistently demonstrated increased activation of affect-related brain areas (e.g., amygdala, anterior cingulate cortex) during REM sleep, as compared with wakefulness and NREM sleep (Braun et al., 1998; Maquet et al., 1996; Nofzinger, Mintun, Wiseman, Kupfer, & Moore, 1997). This is often assumed to reflect the intensely affective nature of REM dreams. However, to understand the neural correlates of affective experiences—while dreaming or awake—we cannot measure brain activity alone, but we must obtain self-reports of experiences and map them onto concurrent neural activity. The latter is especially challenging when investigating dream affect due to the retrospective nature of the self-reports of dream experiences. Nevertheless, “if we don't keep our attention on the psychology of the dream, we might find out a lot of biology without knowing what it is the biology of” (Rechtschaffen, as cited in Kramer, 1970, p. 149).

Studies relating the affective content of dream reports to structural differences in affect-related brain areas (e.g., amygdala) have yielded ambiguous results (Blake, Terburg, Balchin, van Honk, & Solms, 2019; De Gennaro et al., 2011). Importantly, only a few studies have investigated how self-reports of dream affect, obtained immediately upon awakening, are associated with neural activity occurring during pre-awakening sleep (Daoust, Lusignan, Braun, Mottron, & Godbout, 2008; Nielsen & Chénier, 1999; Sterpenich, Perogamvros, Tononi, & Schwartz, 2019). Consequently, we know very little about the neural correlates of dream affect.

The search for the neural correlates of affective dream experiences is best informed by knowledge about the neural correlates of affective experiences in wakefulness. Research on the neural basis of affect in wakefulness has flourished since the emergence of the field of affective neuroscience in the 1990s (Davidson & Sutton, 1995; Panksepp, 1991, 1998). However, stemming from conceptual disagreements, the field is fraught with heated debates regarding the appropriate level of analysis of affect (i.e., whether affect is represented in the brain in the form of discrete affective states or affective dimensions). What does emerge from existing studies, however, is that no specific brain structures are specialized for affect in general or for some discrete affective states in particular. Rather, there seems to be a distributed network of functionally integrated subcortical and cortical brain areas, which are assumed to underlie either discrete affect (Kragel & LaBar, 2016; Nummenmaa & Saarimäki, 2017; Pessoa, 2017; Saarimäki et al., 2016), affective dimensions (Lindquist et al., 2012), or other basic affect-related processes (Wager et al., 2015).

The prefrontal cortex (PFC) is an important hub (i.e., highly interconnected region) in this network. Several lesion, neuroimaging, neurophysiological, and brain stimulation studies have provided evidence for the lateralization of affective processing within the PFC (for reviews, see Harmon-Jones & Gable, 2018; Kelley, Hortensius, Schutter, & Harmon-Jones, 2017; Miller, Crocker, Spielberg, Infantolino, & Heller, 2013). In particular, four decades of research have shown that EEG frontal alpha asymmetry (FAA)—a relative difference in alpha power between the right and left frontal cortical regions—is associated with state and trait affect, as well as with the regulation of affect in wakefulness (see Reznik & Allen, 2018 for a review). FAA is typically calculated by subtracting (the natural log of) alpha power (8–13 Hz) in the left hemisphere from the homologous region in the right hemisphere (i.e., ln[F4]–ln[F3]). Because alpha power is inversely related to cortical activity (Jensen & Mazaheri, 2010; Klimesch, 2012; Klimesch, Sauseng, & Hanslmayr, 2007), higher FAA scores are assumed to reflect relatively greater left frontal activity (i.e., more right-frontal alpha power).

Numerous studies conducted in wakefulness have shown that resting FAA is related to certain affective dimensions. According to the affective valence model of FAA, positive affect is related to relatively greater left-sided—and negative affect to greater right-sided—activity (Davidson, Schwartz, Saron, Bennett, & Goleman, 1979; Tomarken, Davidson, Wheeler, & Doss, 1992). However, in earlier studies, valence was often confounded with motivational direction (i.e., positive affect is typically associated with approach tendencies, whereas negative affect is typically associated with withdrawal tendencies). Subsequent research provided evidence for the approach–withdrawal model of FAA: motivational approach-related affect, independent of valence (e.g., interest, anger), is related to relatively greater left-sided—but withdrawal-related affect (e.g., fear, anxiety) to relatively greater right-sided—activity (see Harmon-Jones & Gable, 2018 for review). However, whereas the relationship between FAA and approach-related affect has gained considerable support, the relationship between FAA and withdrawal-related affect is less consistent (Coan & Allen, 2004). As a result, it was recently proposed that FAA reflects supervisory or regulatory control: enhanced regulation of affect and behaviour is associated with greater right-sided frontal activity (Gable, Mechin, Hicks, & Adams, 2015; Gable, Neal, & Threadgill, 2018).

Not only is FAA responsive to situation-specific fluctuations in affect, but it has also been shown to be stable over time (Allen, Coan, & Nazarian, 2004; Hagemann, Naumann, Thayer, & Bartussek, 2002; Tomarken et al., 1992). Studies have demonstrated that FAA is stable across wakefulness and sleep, with the strongest correlations occurring between pre-sleep wakefulness and REM sleep (Benca et al., 1999; Schmidt, Cote, Santesso, & Milner, 2003). Thus, FAA has trait-like features. In fact, about 60 % of the variance in resting FAA is attributed to trait-like factors, whereas about 40 % to state-specific effects (Hagemann et al., 2002). As a result, it has been suggested that FAA may reflect trait affect, or a person's affective style—the propensity to react a certain way to affective stimuli (Davidson, 1998). Indeed, several studies in wakefulness have found that FAA predicts subsequent affective responses (Coan & Allen, 2004) and correlates with trait affect measures, such as trait anger (e.g., Harmon-Jones & Allen, 1998).

Despite considerable research on the relationship between FAA and affect in wakefulness, prior to the study carried out in this thesis, only one published study had investigated the relationship between FAA during REM sleep and corresponding dream affect[17]. Daoust et al. (2008) analysed the affective content of laboratory dream reports collected upon REM awakenings from 12 individuals diagnosed with autistic spectrum disorder and 11 healthy controls. No significant correlations were found between FAA and dream affect. However, in the analysis, the authors pooled together all of the affective states (regardless of valence, motivational direction or discrete affect) and participants (autistic spectrum and control) and collected a small number of dream reports ($N = 23$) that contained less than one affective state per report. All of this may have resulted in null findings. Also, because the authors used only ER of dream affect, it is unclear whether the results may have been influenced by the method of measurement.

If the neural processes underlying affective experiences are shared across wakefulness and sleep, as predicted by dream theories and supported by existing empirical findings, FAA during sleep should also be related to affective experiences in dreams. Moreover, if FAA has trait-like properties, it should not only be stable across wakefulness and sleep but also predict affective dream experiences from waking pre-sleep FAA. Study V was conducted to test these predictions.

[17] Several papers also refer to a conference abstract (Donzella, Davidson, Stickgold, & Hobson, 1994) that purportedly reports to have found an association between waking FAA and dream affect during subsequent sleep. However, this abstract is not available (personal communication with the first author), and the study was never published.

5. Aims of empirical studies

As described in the previous chapter, existing theories and empirical research findings paint a confusing, and rather incompatible, picture of the affective nature of dreams. This arguably results from methodological differences between studies, specifically, whether SR or ER of dream affect have been used and whether data have been collected at home or in the sleep laboratory. Resulting from these and other methodological and conceptual issues, findings regarding the correlates of dream affect are inconsistent and inconclusive.

To be able to draw any firm conclusions about the affective nature of dreams and its correlates, we must ensure that we have valid and reliable measures for studying dream affect. It is important to conduct systematic studies that directly compare different data collection and analysis methods to gain a better understanding of how the various methodological issues influence findings regarding dream affect. Therefore, the overall aim of the empirical studies conducted in the framework of this thesis was to investigate the phenomenology and correlates of dream affect, as well as how results regarding these are influenced by study methodology. Studies I–III focused specifically on methodological issues: the comparison of SR and ER of dream affect (Studies I–II) and the comparison of affect in home versus laboratory dream reports (Study III). Studies IV and V investigated the correlates of dream affect: waking well-being (Study IV) and neural (Study V) correlates. The specific aims of the individual studies were as follows:

Study I: to compare SR and ER of dream affect in the same set of dreams collected in the sleep laboratory.

Study II: to compare SR and ER of dream affect in the same set of dreams collected in the home environment.

Study III: to compare the affective content of dream reports collected at home upon morning awakenings with those collected in the sleep laboratory upon early- and late-REM sleep awakenings.

Study IV: to investigate the relationship between dream affect and waking well-being in a comprehensive framework, including measures of both waking ill-being and waking well-being.

Study V: to investigate the EEG correlates of affect in REM sleep dreams, specifically the relationship between FAA (during REM sleep and evening wakefulness) and dream affect (specifically, dream anger and dream interest).

6. Methods

6.1 Participants

Data were collected as part of two larger independent data collection efforts. Data collection I—Studies I, III, and V—was conducted at the University of Turku, Finland. After several screening rounds, of the 159 volunteers, 21 were invited to, and 19 participated in, the sleep laboratory experiment. Due to technical problems or missing data, data from 17 (Studies I and V) or 18 (Study III) healthy, right-handed, native Finnish speaking participants with good sleep quality (score ≤ 5 on the Pittsburgh Sleep Quality Index; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) were included in the analyses. Data collection II—Studies II and IV—was conducted at the University of Skövde, Sweden. Forty-seven healthy, native Swedish speakers were recruited and provided data. However, the final sample included 44 participants, since three participants (one man, two women) did not provide enough data (i.e., at least five dream reports) and were excluded. See Table 3 for details of the final samples.

6.2 Procedure

Data collection I (Studies I, III, and V) took place both in the participants' home environment and in the sleep laboratory. Before the sleep laboratory sessions, participants were asked to fill in home dream diaries (see Section 6.3.1) during a 7-day period, in which they provided written narrative dream reports. The laboratory procedure is described in Figure 6. Participants spent two non-consecutive nights in the sleep laboratory at the Department of Psychology, University of Turku. To ensure that the participants would not be sleep deprived, the two laboratory nights were separated by a week. Participants arrived at the laboratory in the evening, two hours before their typical bedtimes. After the EEG, EOG, and EMG electrodes had been attached, participants were asked to lie in bed while their waking resting state (evening baseline) EEG was recorded during eight one-minute sessions (four with eyes closed and four with eyes open, order counterbalanced). These recordings were performed between 10:30 and 12:00 p.m. Participants then rated their current waking affect using the Finnish version of the modified Differential Emotions Scale (mDES; see Section 6.3.2).

Subsequently, participants were allowed to fall asleep. Their sleep stages were scored visually (Iber, Ancoli-Israel, Chesson, & Quan, 2007; Rechtschaffen & Kales, 1968) by researchers who were monitoring the participants (via a camera and intercom system) throughout the night in a room adjacent to the laboratory bedroom. Multiple REM awakenings were performed: each and every time a REM sleep episode had continuously lasted for five minutes and was in a phasic stage, participants were awakened using a tone signal. Awakenings were performed in the phasic stage to ensure consistency and because tonic and phasic REM are known to differ in the underlying neurophysiology (e.g., Simor, Gombos, Szakadát, Sándor, & Bódizs, 2016; Wehrle et al., 2007) and dream content (Molinari & Foulkes, 1969). Participants were instructed to first report the last image they had had in mind right before awakening and then the whole dream, in as much detail as possible. These oral narrative reports were recorded using a microphone hanging above the bed. Then, participants rated their affective experiences in the preceding dream by filling in the mDES (as targeted probes) using a mouse and a computer screen placed above the bed. When participants did not recall a dream, researchers asked them to specify whether they had not had a dream or whether they felt like they had had a dream but were unable to recall any content (a so-called 'white dream'; Strauch & Meier, 1996). In such cases, however, mDES was not filled in. Participants then continued their sleep. The procedure was repeated throughout the night until the final morning awakening, between 5:30 and 8:30 a.m. After having reported and rated their last dream, participants were asked to lie awake in bed. As in the evening, participants' waking resting state (morning baseline) EEG was recorded (8 min) and their current waking affect measured (using mDES).

Following Casagrande, Violani, Lucidi, Buttinelli, and Bertini (1996), the first two REM episodes were defined as early REM, and all of the other REM episodes as late REM.

Data collection II (Studies II and IV) took place in the participants' home environment. First, participants were asked to fill in an online well-being questionnaire (see Section 6.3.3.). Then, they logged onto and filled in a written online home dream diary (see Section 6.3.1.) every morning upon awakening, during a 21-day period. In this diary, participants provided written narrative dream reports and rated the affect they experienced in their dreams using the mDES.

Table 3. Overview of the samples and methodology of empirical studies

		Study I	Study II	Study III	Study IV	Study V
RATIO-NALE		Comparison of SR and ER of dream affect in laboratory dreams	Comparison of SR and ER of dream affect in home dreams	Comparison of home and laboratory dream reports with respect to dream affect	Waking well-being correlates of SR and ER of dream affect	EEG correlates of SR (and ER) of dream affect
WHO	Gender	7M, 10F	16M, 28F	7M, 11F	16M, 28F	7M, 10F
	Age (M±SD)	25.76±4.93	26.9±5.1	25.89±4.85	26.9±5.1	25.76±4.93
	Culture	Western	Western	Western	Western	Western
	Society	WEIRD	WEIRD	WEIRD	WEIRD	WEIRD
	Country	Finland	Sweden	Finland	Sweden	Finland
	Health status	Healthy	Healthy	Healthy	Healthy	Healthy
	Other	PSQI ≤ 5		PSQI ≤ 5		PSQI ≤ 5
WHERE	Environ-ment	Lab	Home	Home vs lab	Home	Lab
WHAT	Type of self-report	Narrative reports + targeted probes	Narrative reports + targeted probes	Narrative reports	Narrative reports + targeted probes	Targeted probes (+ narrative reports)
	Reporting modality (narrative reports)	Oral	Written	Written (home) vs oral (lab)	Written	Oral
	Ratings	ER vs SR	ER vs SR	ER	ER vs SR	SR (+ ER)
	Affect rating scale	mDES	mDES	mDES	mDES	mDES
	Unit of analysis	Every occurrence of affect (ER) vs whole dream (SR)	Every occurrence of affect (ER) vs whole dream (SR)	Every occurrence of affect	Every occurrence of affect (ER) vs whole dream (SR)	Every occurrence of affect (ER) vs whole dream (SR)
WHEN	Temporal lag	Very short	Short	Short (home) vs very short (lab)	Short	Very short
	Time of night	Early/ middle/ late	Not controlled, but most likely late	Not controlled (home) vs early/ middle/ late (lab)	Not controlled, but most likely late	Early/ middle/ late

	Sleep stage	REM	Unspecified	Unspecified (home) vs REM (lab)	Unspecified	REM
	Time in sleep stage	5 min	Unspecified	Unspecified (home) vs 5 min (lab)	Unspecified	5 min
HOW	Method of awakening	Experi-menter-induced	Self-induced/ sponta-neous	Self-induced/ sponta-neous (home) vs experi-menter-induced (lab)	Self-induced/ sponta-neous	Experi-menter-induced
	Experi-mental situation	Participant closely monitored	Participant monitored from a distance[a]	Participant not monitored (home) vs participant closely monitored (lab)	Participant monitored from a distance[a]	Participant closely monitored
	Number of nights: data collection period	2	21	7 (home) vs 2 (lab)	21	2
	Total (and mean) number of dream reports	115 (6.76)	552 (12.55)	133 (7.39; lab) vs 151 (8.39; home)	552 (12.55)	115 (6.76)
	Model of affect: measured	Discrete	Discrete	Discrete	Discrete	Discrete
	Model of affect: analysed	Dimensional (PA, NA) + discrete	Dimensional (PA, NA) + discrete	Dimensional (PA, NA) + discrete	Dimensional (PA, NA)	Discrete
	Aspect of Affect: measured	ER: presence SR: presence + intensity	ER: presence SR: presence + intensity	presence	ER: presence SR: presence + intensity	ER: presence SR: presence + intensity
	Aspect of Affect: analysed	Presence	Presence	Presence	ER: presence SR: intensity	Intensity (for ER presence)

Note. SR = self-ratings; ER = external ratings; M = males; F = females; WEIRD = western, educated, industrialized, rich, and democratic; mDES = modified Differential Emotions Scale; REM = rapid eye movement sleep; PA = positive affect; NA = negative affect.
[a]Researchers can see whether (and when) participants have logged on to the online dream report.

All studies were carried out in accordance with the Declaration of Helsinki and were approved by the Ethical Board of the University of Turku, Finland (Studies I, III, V) or the Regional Ethical Review Board in Gothenburg, Sweden (Studies II, IV). Prior to data collection, participants signed an informed consent form. In Studies I, III, and V participants received monetary compensation of €100; in Studies II and IV participants did not receive any payment.

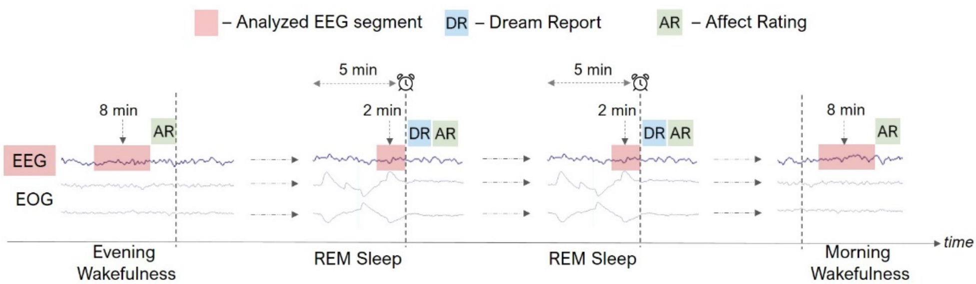

Figure 6. Description of the experimental procedure in the sleep laboratory. Reprinted from Sikka, Revonsuo, Noreika, and Valli, 2019, p. 4777.

6.3 Measurements

6.3.1 Home dream diary

Instructions for dream diaries were based on previous studies (e.g., Revonsuo & Salmivalli, 1995). Participants were asked to fill in the dream diary every morning immediately upon awakening. They were first asked whether they remembered having any dreams that night or whether they thought that they had had a dream but could not remember any contents (‘white dream’). If they remembered (any of the contents of) the dream experience, they were asked to “write down the dream in as much detail as you can remember”, which in Studies II and IV was followed by the following specification: “…(what happened, where, when, who was present, what you felt and thought)”. Such instructions were used to ensure a complete report of their experiences, while at the same time trying to avoid biasing the reports by drawing attention to only some contents of the experiences. Participants were asked to be as accurate, truthful, and detailed as possible, while at the same time restraining from changing, censoring, or interpreting the content. If participants wanted to comment on some aspects of the report, they were asked to do so by adding them in parentheses or at the end of the report so that they would be clearly separate from the reported dream experience.

Whereas Study III employed a pen and paper dream diary, in Studies II and IV an online dream diary was used instead. However, in the latter case, participants were asked to first make notes of their dream experiences using pen and paper while still lying in bed and, after having got up, to log onto the dream diary and fill it in. The online dream diary was used to ensure better quality reports and to monitor whether (and when) participants filled in the diary each day. If the participants did not log on to the online dream diary, an email reminder was sent. In case of several dreams per night, participants were instructed to report and rate them separately.

6.3.2 Measurement of dream affect

In all studies, the mDES (Fredrickson, 2013) was used for both ER (i.e., content analysis of narrative dream reports) and SR (i.e., as targeted probes) of dream affect. The same scale was used across different studies to ensure consistency and comparability of results.

The mDES is an expanded version of the original Differential Emotions Scale (Izard, 1977). It consists of 20 discrete affect categories or items (each described by three adjectives): 10 for positive affect (PA) and 10 for negative affect (NA). This scale was used because it (a) includes a balanced number of PA and NA categories/items; (b) includes a wider range of affective, particularly positive, states; (c) includes both high- and low-arousal affective states; (d) enables the measurement of not only discrete but also dimensional affect (by aggregating the 10 PA and 10 NA items into two separate subscales); and (e) has been used in emotion and well-being research. Despite its name, the scale does not specifically measure emotions, but affective states (emotions and moods) in general.

For Studies I, III, and V, a Finnish translation of the scale—and for Studies II and IV, a Swedish translation of the scale—was used. The scale was translated into Finnish and Swedish using the back-translation method (Brislin, 1970).

6.3.2.1 Self-ratings of dream affect

For SR, participants were asked to rate the extent to which they experienced each of the 20 mDES items on a scale from 0 (“I did not experience any of these feelings at all”) to 4 (“I experienced one or more of these feelings extremely much”).

Because Studies I and II compared SR with ER, the two rating methods had to be comparable. Therefore, for these studies, the presence (vs absence), but not intensity, of each affective state was analysed (i.e., score 0 denoted the absence, and scores 1–4 the presence, of affect). Because Studies IV and V did not focus on the comparison of the two rating methods per se but instead explored results obtained with the different methods as they are typically used, the intensity of affective states was analysed (which also included the score 0, denoting the absence of affect).

In addition to analysing discrete affective states as such, two different subscales were created—one for PA and the other for NA—by either summing (Study I, II) or calculating the mean of (Study IV) the respective items. For Study V, only discrete items were analysed. The subscales had good reliability as measured with Cronbach's alpha (see Table 4).

Table 4. Reliability of self- and external ratings of dream affect

	Study I	Study II	Study III
Self-ratings (SR)			
Cronbach's alpha PA	.85[a]	.93	N/A
Cronbach's alpha NA	.84[b]	.85	N/A
External ratings (ER)			
Inter-rater percent agreement (identification of affective states)	81.48	79.00	92.43 (home) 76.54 (lab)
Cohen's kappa (categorizing affective states)	.84	.92	.95 (home) .81 (lab)

Note. [a]Based on nine items ('Awe/Wonder/Amazement' excluded due to poor item-to-total correlations). [b]Based on nine items ('Embarrassed/Self-conscious/Blushing' excluded due to poor item-to-total correlations).

6.3.2.2 External ratings of dream affect

All narrative (written and transcribed oral) dream reports were content analysed by two judges. Content analysis occurred in two stages. In the first stage, the judges independently identified all of the occurrences of affective states according to the specified criteria (see Table 5). Identification percent agreement was calculated between the raters. The affective states that the judges agreed on were directly accepted to the second stage, whereas the states the judges disagreed on were discussed and either accepted (upon agreement) or discarded (upon disagreement) from further analysis. In the second stage, the judges independently coded all of the accepted affective states by categorizing each of them into one of the 20 categories of mDES. In Studies II, III, and IV, an additional category—"Other"—was used for affective states that the judges were not able to code into the existing 20 mDES categories. Coding inter-rater reliability was calculated using Cohen's Kappa coefficient. The affective states that the judges agreed on were accepted to final analysis, whereas the ones the judges disagreed about were discussed and then either unanimously accepted or discarded from further analysis. Inter-rater reliability of both the identification and categorization of affective states was adequate in all studies (see Table 4). Explicitly expressed affective states (Criteria 1 or 2 in Table 5) were distinguished from those inferred from behaviour (Criterion 3 in Table 5).

ER reflect only the presence, not the intensity, of affective states. The judges did not rate the intensity of discrete affective states, because the validity of such ratings has been questioned (Domhoff, 1996). As was the case with SR, subscales were created for PA and NA by summing the respective items.

For all dream reports, the length or word count of the reports was calculated by summing all dream-related words, while excluding repetition, utterances, fillers, waking correction, and commentaries (Antrobus, 1983).

Table 5. Criteria for the identification of affective states in the narrative dream report used for external ratings

Inclusion criteria: The affective state is identified when:
(1) An affective state is explicitly expressed as experienced by the dream self (e.g., "I noticed that there were two shockingly big dogs and *I was afraid* of what was going to happen");
(2) An affective state is explicitly expressed, and it cannot be attributed to any other character besides the dream self (e.g., "Three of the puppies jumped on me which was *terribly funny* as they began biting each other's tails");
(3) The dream self exhibits behaviour that clearly depicts an affective state, and the affective state is clearly inferable from the behaviour (or context) (i.e., only one prominent affective state can be interpreted from the outside as underlying the behaviour) (e.g., "He was quite a joker so *we were laughing*").
Exclusion criteria: The affective state is not identified:
(1) If the dream self exhibits behaviour obviously related to an affective state, but the exact affective state has not been explicitly expressed, and the underlying affective state is not clearly and directly inferable from the expression (i.e., several different affective states can underlie the behaviour) (e.g., "I started to cry", "I protested");
(2) If the affective state is mentioned twice within the same dream report as felt by the dream self and it obviously refers to the same target or situation, the affective state is coded only once (e.g., "the car was driving at a very high speed and this made me *worried*…I was *worried* because it was my father's car");
(3) A general compliment is in question (e.g., "I said how nice of him to come").

6.3.2.3 Dream affect variables

Table 6 summarizes how the different dream affect variables used in the analyses—and presented in the results section—were computed. These variables apply to both SR and ER in all studies with the following exception: in Study IV, SR of PA reflect the mean intensity of all PA items, and SR of NA reflect the mean intensity of all NA items, per dream.

Table 6. Dream affect variables used in the studies

Variable	Description of computation
PA per dream	Sum of PA items (with a score > 0) in a dream
NA per dream	Sum of NA items (with a score > 0) in a dream
Affect per dream	PA + NA (+ "Other"[a])
Non-affective dream	PA = 0 and NA = 0 (and "Other" = 0[a])
Affective dream	PA > 0 or NA > 0 (or "Other"> 0[a])
Positive dream	PA > NA
Negative dream	PA < NA
Balanced dream	PA = NA
Undetermined dream	Dream containing only items categorized by judges as belonging to the "Other" category[a]

Note. [a] "Other" category was used in Studies II–IV for external ratings of items that the judges were not able to classify into any of the existing 20 categories of mDES.

6.3.3 Measurement of waking well-being

Study IV included measures of both mental ill-being and well-being. Ill-being measures included the measurement of symptoms of anxiety (Generalized Anxiety Disorder Scale; Spitzer, Kroenke, Williams, & Löwe, 2006) and symptoms of depression (depression module of the Patient Health Questionnaire; Spitzer, Kroenke, & Williams, 1999). Well-being measures included the measurement of life satisfaction (the Satisfaction With Life Scale; Diener, Emmons, Larsen, & Griffin, 1985), domain satisfaction (the Brunnsviken Brief Quality of Life Scale; Lindner et al., 2016), EWB (Flourishing Scale; Diener, Wirtz, et al., 2009), and peace of mind (Peace of Mind Scale; Lee et al., 2013). Waking PA and NA were measured with three different scales—the Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988), mDES (Fredrickson, 2013), and items from the 12-Point Affect Circumplex Scales (Yik et al., 2011)—to enable a comprehensive measurement of both high- and low-arousal affective states. Scores from the three different scales were combined in the analyses to form composite waking PA and NA scales.

6.3.4 Polysomnography/Electroencephalography

Twenty-four single Ag/AgCI electrodes (Fp1/2, AF7/8, AF3/4, F7/8, F3/4, Fz, T7/8, C3/4, Cz, P7/8, P3/4, Pz, O1/2, Oz) were attached to the participants' scalp according to the standard 10/10 system. Eye movements were monitored with four electrodes (EOG; two pairs of bipolar electrodes to measure vertical and horizontal eye movements), and muscle activity with two bipolar electrodes (EMG) placed on the chin. All (except the bipolar EOG and EMG) electrodes were referenced to the right mastoid. The ground electrode was on the forehead. The EEG signal was amplified (SynAmps Model 5083), notch-filtered at 50 Hz, digitized at 500 Hz, and recorded using NeuroScan equipment and software. All impedances were kept below 5 kΩ.

For Study V, a two-minute pre-awakening EEG segment preceding the dream report was extracted from each REM episode. These REM sleep segments, together with evening and morning eight-minute baseline EEG segments from the two laboratory nights, were processed offline using MATLAB (The MathWorks, Inc., Natick, MA) and the EEGLAB toolbox version 14.1.1 (Delorme & Makeig, 2004) (see Figure 6). The EEG data were pre-processed following the guidelines of Smith, Reznik, Stewart, and Allen (2017) using custom-made scripts. Mean spectral power in the alpha frequency band (8–13 Hz) was obtained and averaged for each participant for all conditions (evening wakefulness, REM sleep, morning wakefulness). According to customary practices, FAA score was calculated by subtracting the natural log-transformed alpha power of the left hemisphere from that of the homologous right hemisphere electrode (i.e., ln[F4]–ln[F3]). Positive values reflect more alpha power in the right hemisphere (i.e., lower right-sided or greater left-sided fontal activity). Although the main analyses focused on FAA over the F4–F3 electrodes, for control analyses FAA across all of the other homologous pairs (e.g., ln[Fp2]–ln[Fp1]) was calculated. Also, exploratory analyses in 1-Hz frequency bins from 1–45 Hz were conducted.

6.4 Statistical analyses

Table 7 gives an overview of the statistical tests used in the five original publications. The Shapiro-Wilk test (Shapiro & Wilk, 1965) was used to test the normality assumption. Normally distributed variables were analysed with parametric tests, whereas non-normally distributed variables were analysed with non-parametric tests.

Table 7. Overview of statistical tests used in the original publications

	Study I	Study II	Study III	Study IV	Study V
Parametric tests					
Independent samples t-test	✓				✓
Paired samples t-test	✓	✓	✓		✓
One-way repeated measures ANOVA					✓
Simple linear regression					✓
Multiple linear regression					✓
Multilevel regression: Linear mixed-effects model				✓	
Pearson correlation (*r*)					✓
Partial correlation (*r*)					✓
Non-parametric tests					
Mann-Whitney U test	✓	✓			✓
Wilcoxon signed-rank test	✓	✓	✓		✓
Spearman rank correlation (r_s)	✓	✓	✓	✓	✓
Non-parametric partial correlation (r_s)					✓
Multilevel regression: Generalized linear mixed-effects model				✓	
Software used	IBM SPSS (v. 20)	IBM SPSS (v. 20)	IBM SPSS (v. 20)	R (v. 3.4.1)	R (v. 3.4.1); IBM SPSS (v. 20)

In Studies I, II, III, and V, measurement occasions (e.g., ratings of dream affect) were aggregated to the subject level for each condition separately. In addition, in Study III, to account for the different number of home and laboratory (early- and late-REM) dream reports, analyses were based on the mean (or median) percentage of affective dream reports out of all reports per participant.

In Study IV, the nested design—measurement occasions (Level 1 data) nested within individuals (Level 2 data)—was accounted for and data analysed using multilevel regression models, also known as mixed model analysis or hierarchical linear modelling (Hox, 2010). Multilevel models are recommended for such nested data because they (a) do not assume the independence of measurement occasions, as compared with standard statistical tests; (b) can be used with unbalanced designs (i.e., different number of measurement occasions for different individuals); and (c) capture both between- and within-subject variation simultaneously; all of which make estimates more precise (Aarts et al., 2014; Hox, 2010; Raudenbush & Bryk, 2002). Generalized linear mixed-effects models were used for outcome variables representing count data (i.e., ER of dream PA and NA), whereas linear mixed-effects models were used for continuous outcome variables (i.e., SR of dream PA and NA). Because the predictors were standardized and grand mean centred, the coefficients (β) presented below (see Section 7.2.1) reflect a magnitude of change in the outcome variable associated with an increase of one standard deviation in the predictor variable. The use of standardized coefficients makes it possible to compare different predictors (measured on a different scale).

Multicollinearity—a strong correlation between predictors—can be problematic in regression analyses with multiple predictors. Therefore, collinearity diagnostics, such as the variance inflation factor and tolerance, were performed. These demonstrated sufficient independence among predictors (Field, Miles, & Field, 2012; Hutcheson & Sofroniou, 1999; Yu, Jiang, & Land, 2015).

All statistical tests were two-tailed. For non-parametric tests, significance was calculated using the exact method, which is recommended for small sample sizes and poorly distributed data (Field et al., 2012). In all analyses, p-values less than 0.05 were considered statistically significant.

Effect sizes (ES) were calculated using Cohen's *d* (t-tests), Pearson's *r* (r=Z/√; Wilcoxon signed-rank test, Mann-Whitney U test; Field et al., 2012) and partial eta squared (ηp^2; ANOVA). In correlation and linear regression analyses, r and r_s values indicate ES. In multilevel models, standardized coefficients (β) provide information concerning the magnitude of the effect (Lorah, 2018). In the results section below (see Chapter 7), I present ES, together with the *p*-values, for the main findings. The following benchmarks, proposed by Cohen (1988), can be used to interpret the ES (see Table 8).

Table 8. Interpretation of effect size values (Cohen, 1988)

	Pearson's *r*	**Cohen's *d***
Small	.1	0.2
Medium	.3	0.5
Large	.5	0.8

7. Results

7.1 Phenomenology of dream affect: Impact of study methodology

Studies I–III investigated how results regarding the phenomenology of dream affect depend on the particular methods used, specifically, whether dream affect is measured with SR or ER and whether data are collected in the home or a sleep laboratory environment. Table 9 presents the percentages of dreams rated as non-affective and affective across the three studies. In the following sections, the main findings of these studies are presented. Dreams and dream reports classified as having a balanced or an undetermined affective tone are not discussed further, because these are not central to understanding the results or conclusions of the studies.

Table 9. Percentages of non-affective and affective dreams in Studies I, II, and III

	Study I		**Study II**		**Study III**			
	Lab *N* = 115		Home *N* = 552		Home *N* = 151	Lab All *N* = 120	Lab Early *N* = 38	Lab Late *N* = 82
	SR	ER	SR	ER	ER	ER	ER	ER
Non-affective dreams	0.0	71.3	2.5	52.2	54.6	70.7	82.2	62.2
Affective dreams	100.0	28.7	97.5	47.8	45.4	29.3	17.8	37.8
Positive dreams	79.1	9.6	55.8	12.5	2.6	8.4	4.4	9.5
Negative dreams	12.2	11.3	35.3	28.1	36.7	12.6	8.3	18.5
Balanced dreams	8.7	1.7	6.3	5.1	3.1	3.2	1.7	3.3
Undetermined	N/A	6.1	N/A	2.2	3.1	5.1	3.3	6.5

7.1.1 Comparison of self- and external ratings of dream affect

Studies I and II compared SR and ER of dream affect. Although the two studies differed in data collection environment (Study I: sleep laboratory; Study II: home setting), dream sampling procedure (Study I: REM awakenings throughout the night; Study II: morning awakenings) and included different groups of participants and numbers of dreams, they yielded similar findings.

With SR, as compared with ER, a significantly larger number of dreams were rated as affective (ES for Study I: $r = .62, p < .001$; ES for Study II: $r = .61, p < .001$) and positive (ES for Study I: $r = .62, p < .001$; ES for Study II: $r = .59, p < .001$) (see Figure 7). Whereas with SR (almost) all of the dreams were rated as affective (100 % in Study I; 97.5 % in Study II), with ER only approximately one-third (28.7 % in Study I) or half (47.8 % in Study II) of the reports were rated as affective (see Table 9). While with SR more than half of the dreams were rated as positive (79.1 % in Study I; 55.8 % in Study II), with ER only about ten percent (9.6 % in Study I; 12.5 % in Study II) of the reports were rated as positive. The number of negative dreams was similar with the two rating methods. In Study I, there were no significant differences between SR and ER (ES $r = .05$, $p > .05$), with both ratings yielding approximately ten percent negative dreams (12.1% with SR, 11.3% with ER). Although in Study II significantly more dreams were rated as negative with SR, as compared with ER, the difference was small (ES $r = .25$, $p = .017$), with both methods resulting in about one-third of negative dreams (35.3 % with SR; 28.1 % with ER). In addition, with SR dreams were rated to contain more PA and NA than with ER (ES for Study I: $r_{PA} = .62$, $r_{NA} = .62$, ps < .001; ES for Study II: $r_{PA} = .62$, $r_{NA} = .62$, ps < .001), although the difference was larger for PA than for NA (ES for Study I: $r = .62, p < .001$; ES for Study II: $d = 0.68, p < .001$).

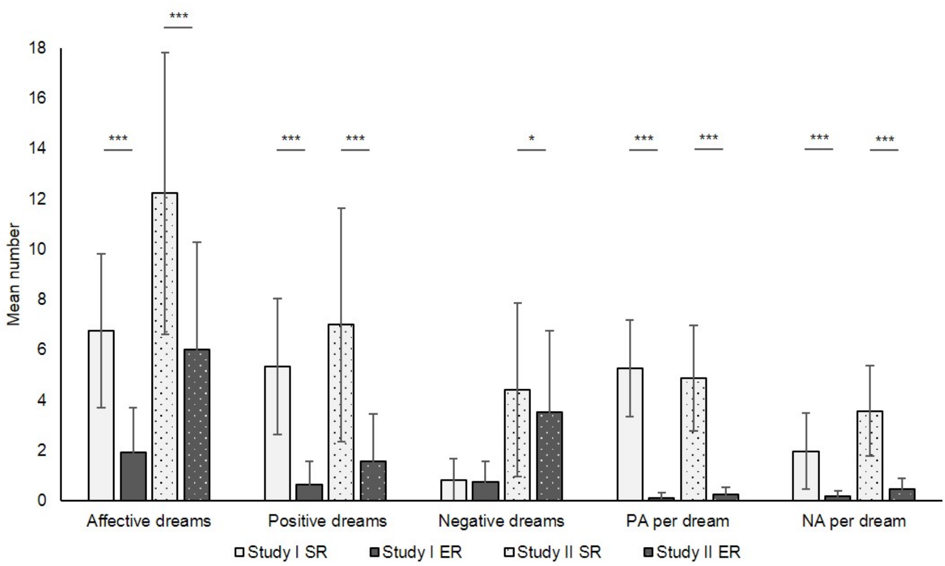

Figure 7. Mean number of affective dreams and affective states per dream, as evaluated with self-ratings (SR) and external ratings (ER). PA = positive affect. NA = negative affect. Study I: PA (min = 0; max = 9), NA (min = 0; max = 9). Study II: PA (min = 0, max = 10), NA (min = 0, max = 10). Error bars represent standard deviation. *p < .05. ***p < .001.

Thus, the two methods differed mostly in the estimation of positive dreams and PA per dream. This was supported by results showing that the NA subscales of SR and ER were positively correlated (Study I: $r_s = .52$, $p = .032$; Study II: $r_s = .49$, $p = .001$), whereas no significant relationships were observed between the PA subscales (Study I: $r_s = .18$, $p = .498$; Study II: $r_s = .22$, $p = .152$) (see Table 10).

Table 10. Intercorrelations between positive affect (PA) and negative affect (NA) subscales of self-ratings (SR) and external ratings (ER)

	ER PA	ER NA	SR PA	SR NA
ER PA	1.00[ab]			
ER NA	.49*[a] .49***[b]	1.00[ab]		
SR PA	.18[a] .22[b]	–.02[a] .02[b]	1.00[ab]	
SR NA	.24[a] .23[b]	.52*[a] .49***[b]	.28[a] .25[b]	1.00[ab]

Note. [a]Study I (Sikka, Valli, Virta, & Revonsuo, 2014). [b]Study II (Sikka, Feilhauer, Valli, & Revonsuo, 2017). *$p < .05$. ***$p < .001$.

Regarding discrete affective states, almost all of the different affect items were rated to occur more frequently with SR than with ER (Study I: 12 out of 20, ES $r = .47 – .61$, ps $< .05$; Study II: 20 out of 20, ES $r = .45 – .60$, ps $< .001$). Thus, the differences between SR and ER were not due to specific affective states. The same items were among the most frequently rated with both methods across the two studies: 'Interested/Alert/Curious', 'Joyful/Glad/Happy', and 'Amused/Fun-loving/Giggly' among the PA items, and 'Angry/Irritated/Annoyed' and 'Stressed/Nervous/Overwhelmed' among the NA items. In Study II, 'Scared/Fearful/Afraid' was also frequently rated among the NA items (with both SR and ER), but it was less frequent in Study I.

Considered separately, the two measurement methods provided a very different picture regarding the affective nature of dreams. With SR, there were significantly more positive than negative dreams (ES for Study I: $r = .62$, $p < .001$; ES for Study II: $r = .31$, $p = .003$) and more PA than NA per dream (ES for Study I: $r = .62$, $p < .001$; ES for Study II: $d = 0.55$, $p = .001$). With ER, however, the number of positive and negative dreams (ES $r = .09$, $p > .05$), as well as of PA and NA per dream (ES $r = .15$, $p > .05$), were either not significantly different (Study I), or negative dreams (ES $r = .38$, $p < .001$) and NA per dream (ES $r = .39$, $p < .001$) prevailed (Study II). Thus, whereas with SR dreams appeared to be mostly positive, with ER they appeared to be either rather balanced (Study I) or mostly negative (Study II).

Study II showed that whether ER of dream reports appeared to be mostly negative or to have a more balanced affective tone depended on whether the reports were provided by women or men. Women expressed more NA in their dream reports than men (ES $r = .33$, $p = .030$) and, as a result, had also more negative dream reports in general (ES $r = .33$, $p = .029$)[18] (see Figure 8). When analysing results for men and women separately, an interesting pattern of results emerged. Women had more negative than positive dream reports (ES $r = .47$, $p < .001$) and more NA than PA per report (ES $r = .47$, $p < .001$), whereas the number of positive and negative dream reports (ES $r = .23$, $p = .203$) and PA and NA per dream report (ES $r = .18$, $p = .336$) was balanced for men. This difference could not be explained by report length, because the reports of men and women did not differ in that regard (ES $r = .06$). Further analyses demonstrated that the NA scales of SR and ER were strongly positively correlated for women ($r_s = .70$, $p < .001$) but not for men ($r_s = .12$, $p = .653$). This suggests that how women rated negative dream affect corresponded better to how they expressed it in their dream reports and indicates that men may have underreported NA in their dream reports. No significant gender differences were observed in Study I, although women tended to express more NA in their dream reports in that study as well[19].

[18] The total number of dream reports provided by women ($M = 12.61$, $SD = 5.92$, $Mdn = 11.00$) and men ($M = 12.44$, $SD = 5.54$, $Mdn = 11.50$) did not differ (Mann Whitney $U = 221.00$, $Z = –0.073$, $p = .947$, $r = .011$).

[19] Although women ($M = 0.25$, $SD = 0.24$, $Mdn = 0.20$) expressed more NA in their dream reports than men ($M = 0.06$, $SD = 0.12$, $Mdn = 0.00$), the difference was not statistically significant (Mann Whitney $U = 17.500$, $Z = –1.804$, $p = .088$, $r = .44$).

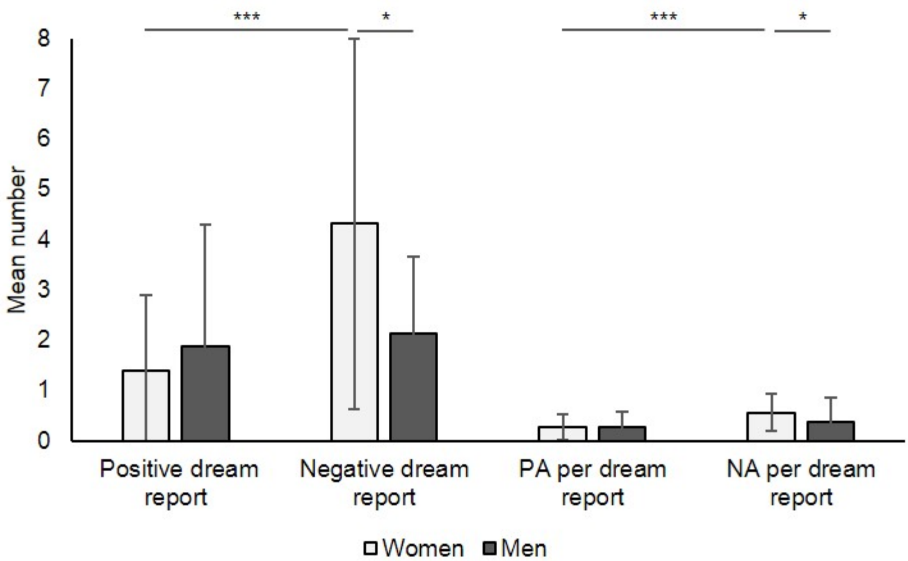

Figure 8. Average number of dream reports and affect expressed in dream reports separately for women (N = 28) and men (N = 16). Error bars represent standard deviation. *p < .05. ***p < .001.

As shown above (see Table 9), dreams in Study II appeared relatively more affective and negative than in Study I, particularly with regard to ER. Whereas in Study I only about one-third (28.7 %) of the dream reports were rated to contain affective states, in Study II almost half (47.8 %) of the reports were rated as affective. While in Study I only about ten percent (11.3 %) of reports were negatively valenced, in Study II more than twice as many were (28.1 %). This raises the question of what may underlie the differences between the two studies. One possible explanation is differences in reporting modality: whereas in Study I dream reports were provided orally, in Study II they were written down. However, the fact that SR also yielded a larger percentage of negative dreams (12.2 % in Study I; 35.3 % in Study II) makes this explanation is unlikely. This brings us to the second possible explanation—differences in the data collection environment. Whereas in Study I data were collected in the sleep laboratory, in Study II data were collected in participants' home environments. Are home dreams more affective and more negatively valenced than laboratory dreams? The results of Study III help shed light on this question.

7.1.2 Comparison of home and laboratory dream reports

Study III compared the affective content of dream reports collected at home upon morning awakenings with those collected in the sleep laboratory upon early- and late-REM sleep awakenings. To this end, home and laboratory dream reports were obtained from the same group of participants and rated by external judges using the mDES.

As Studies I and II suggested, Study III showed that there were significantly more affective home dream reports (45.4 %) than affective laboratory dream reports (29.3 %) (ES $d = 0.58$, $p = .026$). However, this difference appeared because of the smaller percentage of affective early-REM laboratory reports (17.8 %, ES $r = .56$, $p < .001$), whereas the percentage of affective late-REM laboratory dream reports (37.8 %, ES $r = .18$, $p = .296$) was similar to that obtained in the home setting (see Figure 9). Similarly, home dream reports contained significantly more affect per dream only when compared to early-REM laboratory dream reports (ES $r = .56$, $p < .001$), not when compared to late-REM laboratory reports (ES $r = .19$, $p = .258$) (see Figure 10). This suggests that it is time of night—rather than the environment per se—that underlies the enhanced affectivity of home—as compared to laboratory—dream reports.

However, home dream reports contained more affect per 100 words than either early- (ES $r = .53$, $p = .001$) or late-REM (ES $r = .51$, $p = .001$) laboratory dream reports (Figure 10). Such analyses are often used to control for the length of the report but can also be taken to reflect the density of affect in a report. These results show that home dream reports contain a higher density of affect.

There were more negatively valenced dream reports in the home (36.7 %) than laboratory (12.6 %) setting (ES $r = .52$, $p < .001$). Specifically, the percentage of negative home dream reports was higher than that of early- (8.3 %, ES $r = .56$, $p < .001$) and late-REM (18.5 %, ES $r = .39$, $p = .017$) reports (see Figure 9). Home dream reports also contained more NA than laboratory reports overall (ES $r = .52$, $p = .001$) or early- (ES $r = .56$, $p < .001$) or late-REM (ES $r = .42$, $p = .008$) laboratory reports individually (see Figure 10).

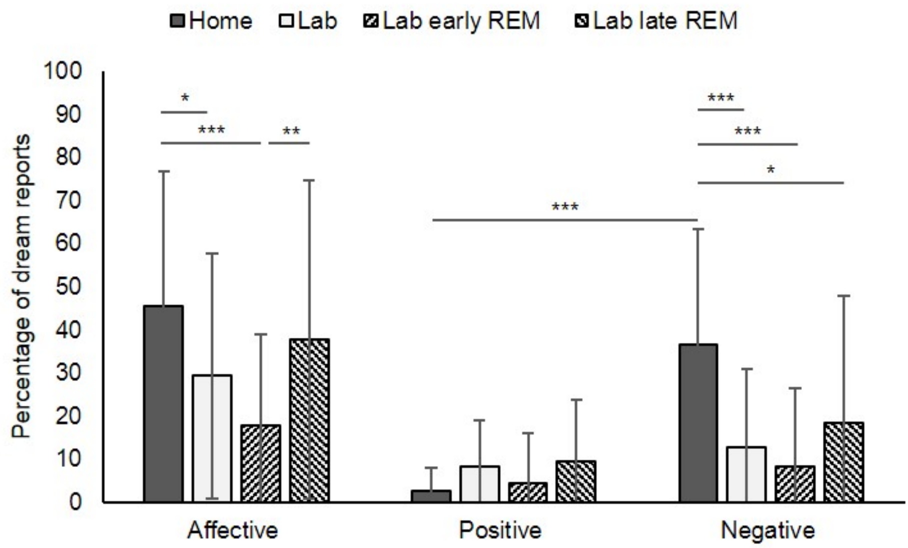

Figure 9. Percentage of affective dream reports in the home and laboratory environments. Error bars represent standard deviation. *p < .05. **p < .01. ***p < .001. Adapted from Sikka, Revonsuo, Sandman, Tuominen, and Valli, 2018, p. 6.

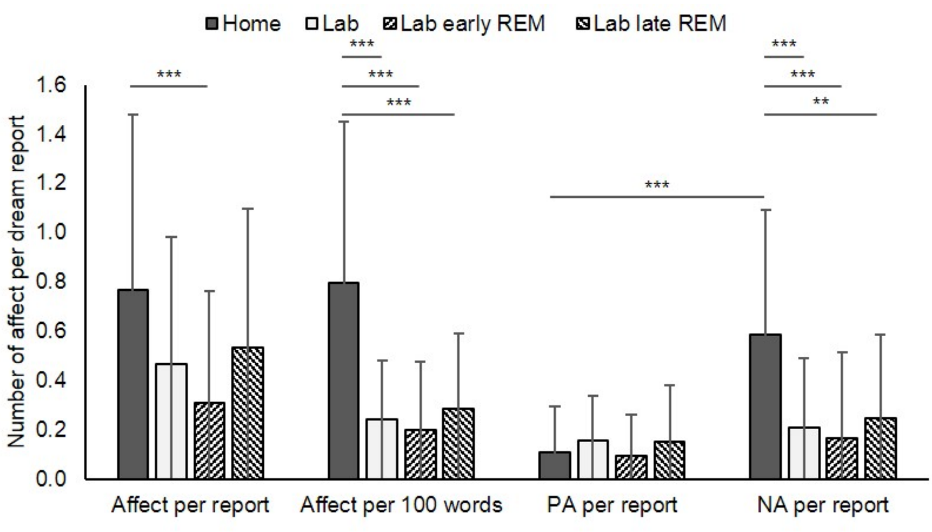

Figure 10. Number of affective states per dream report in the home and laboratory environments. Error bars represent standard deviation. **p < .01. ***p < .001. Adapted from Sikka, Revonsuo, Sandman, Tuominen, and Valli, 2018, p. 6.

Interestingly, when home dream reports were compared to the last laboratory dream of the night before awakening (i.e., the latest REM report), differences in the percentage of negative dream reports and the number of NA per dream report were non-significant. On the one hand, this seems to suggest that differences in the negative affectivity of home and laboratory dream reports are due to the time of night. On the other hand, ES were still of medium magnitude (negative dream reports: ES $r = .29$, $p = .087$; NA per dream report: ES $r = .32$, $p = .056$). Due to the small sample size, we must be cautious when making any inferences based on this finding.

Regarding discrete affective states, the two settings differed only with respect to fear (item 'Scared/Fearful/Afraid'), which was more prevalent in home than laboratory dream reports (ES $r = .45$, $p = .047$). Fear was also among the most frequently reported affective states in Study II, which was conducted in the home environment.

When looking separately at the reports obtained in the two settings, as in Study II, ER of home dream reports demonstrated a preponderance of negative dreams (ES $r = .53$, $p < .001$) and NA per dream (ES $r = .53$, $p < .001$). As in Study I, ER of laboratory dream reports yielded a rather balanced amount of positive and negative dreams (ES $r = .14$, $p = .445$), as well as PA and NA per dream (ES $r = .0.15$, $p = .402$[20]). However, regarding the latter, it is important to note that the laboratory samples of Studies I and III overlapped (although different judges rated the laboratory reports for Study I and for Study III).

7.2 Correlates of dream affect

7.2.1 Dream affect and waking well-being

Study IV investigated the relationship between dream affect and waking well-being. Participants' waking mental ill-being (i.e., symptoms of anxiety, depression) and well-being (i.e., life satisfaction, domain satisfaction, PA, NA, EWB, peace of mind) were measured and related to the affective content of subsequent dreams reported and rated in the home environment during a 21-day period.

[20] The number of PA ($M = 0.16$, $SD = 0.18$, $Mdn = 0.11$) and NA ($M = 0.21$, $SD = 0.28$, $Mdn = 0.06$) in laboratory dream reports was not significantly different (Wilcoxon $Z = -.890$, $p = .402$).

Because SR and ER yield different results regarding dream affectivity (as shown in Studies I–II), they may also relate differently to ill-being and well-being measures. Therefore, both SR and ER of dream affect were included in the analyses. Multilevel regression models showed that when controlling for all of the other ill-being and well-being measures[21], the scale measuring peace of mind predicted ER of dream PA ($\beta = 0.405$, CI [0.102, 0.709], $p = .009$; see also Figure 11), whereas the scale measuring symptoms of anxiety predicted both ER ($\beta = 0.427$, CI [0.188, 0.673], $p < .001$; see also Figure 11) and SR ($\beta = 0.122$, CI [0.008, 0.236], $p = .041$) of dream NA. Thus, SR and ER of dream affect were indeed differently associated with waking well-being.

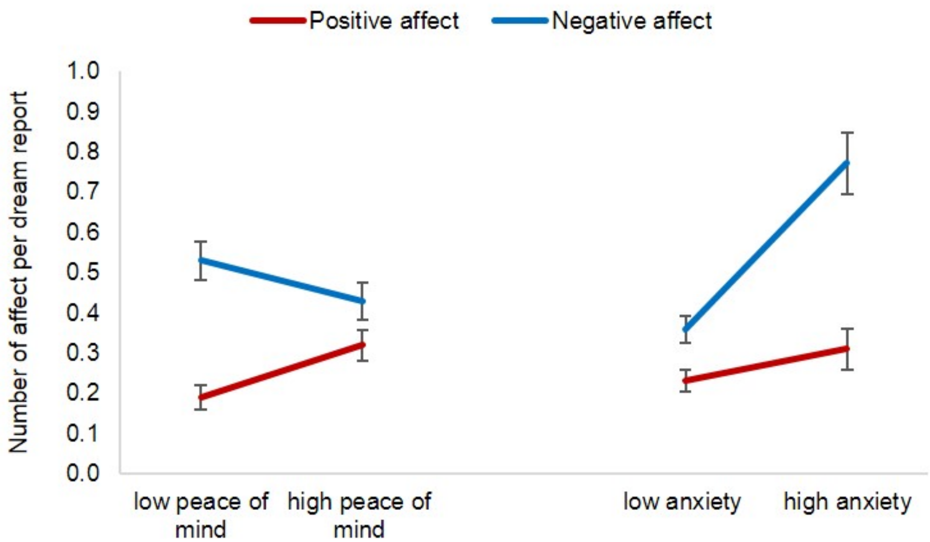

Figure 11. Average number of positive and negative affect per dream report, as measured with external ratings, in people with low versus high levels of peace of mind and anxiety. Participants were divided into groups using median split on the Peace of Mind Scale, or a cut-off value of 5 on the Generalized Anxiety Disorder Scale. The groups were formed for illustrative purposes only. Error bars represent standard errors of the mean. Adapted from Sikka, Pesonen, and Revonsuo, 2018, p. 5.

7.2.2 Dream affect and frontal alpha asymmetry

Study V investigated the EEG correlates of dream affect, specifically, whether FAA—the relative difference in alpha power between the right and left frontal

[21] Analyses also controlled for gender, age, and length of dream report.

areas—during REM sleep and during evening resting wakefulness is related to dream affect. The study focused specifically on SR of anger (as measured with the mDES item ‘Angry/Irritated/Annoyed’) and interest (as measured with the mDES item ‘Interested/Alert/Curious’). ER of affect were too low to enable enough power for all the analyses. Dream anger and dream interest were chosen because (a) in Study I these were rated as the most intensely and frequently experienced affective states in dreams and (b) anger and interest are both high-approach affective states, but with opposite valence (negative vs positive), which enabled us to test the three different theoretical models regarding the role of FAA in affective processing.

Results showed that FAA during REM sleep predicted SR of dream anger ($R^2 = .435$, $r = .660$, $p = .004$; see A in Figure 12) but not SR of dream interest ($R^2 = .198$, $r = .444$, $p = .074$). The relationship was significant only over the F4–F3 electrode sites. Moreover, further analyses demonstrated that this relationship was specifically driven by the right hemisphere region (F4) ($r = .636$, $p = .003$; see B in Figure 12) and was specific to the lower alpha band (7–11 Hz) only (see D in Figure 12). As alpha power is assumed to reflect decreased activity in underlying brain areas (Jensen & Mazaheri, 2010; Klimesch, 2012; Klimesch et al., 2007), the results suggest that reduced activity over the right-frontal region F4 (i.e., indicated by higher alpha power) is related to dream anger. Exploratory analyses demonstrated that the only other affect item associated with FAA over the F4–F3 was ‘Hate/Distrust/Suspicion’ ($r = .572$, $p = .016$), which provides further support for the specificity of the relationship. Interestingly, ER of dream anger were also associated with alpha power over F4 ($r = .535$, $p = .033$).

In addition, FAA was positively correlated across wakefulness and REM sleep (rs = .637 – .720, $p < .01$), and FAA recorded during evening pre-sleep wakefulness predicted SR of dream anger ($R^2 = .411$, $r = .641$, $p = .006$; see C in Figure 12). Thus, FAA appears to be a relatively stable measure that is associated with dream anger.

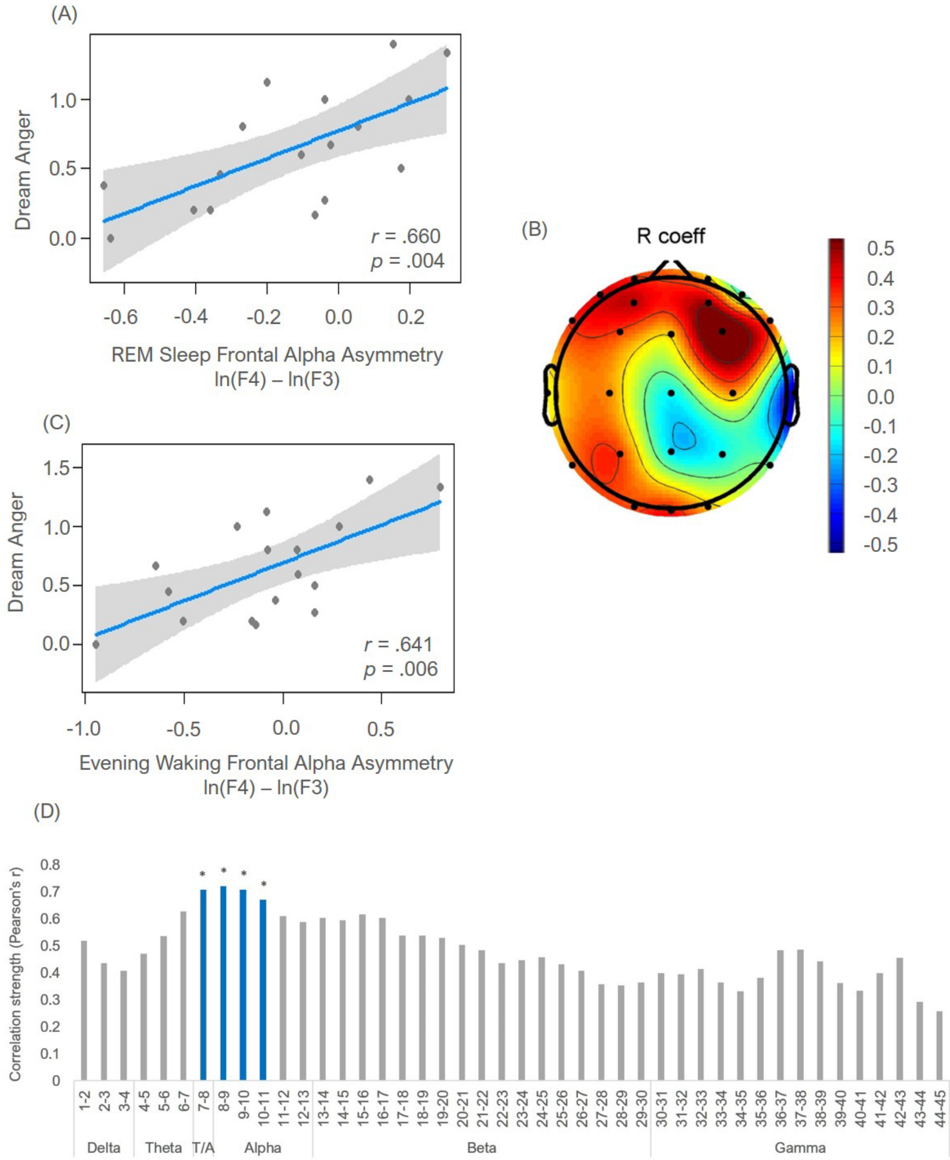

Figure 12. Dream anger and its relationship to frontal alpha asymmetry (FAA). (A) Relationship between dream anger and FAA during REM sleep. The grey area denotes the 95 % confidence interval. (B) Partial correlation coefficients between dream anger and log-transformed alpha power over individual electrode sites, while controlling for the average whole-head alpha power. (C) Relationship between dream anger and FAA during evening resting wakefulness. The grey area denotes the 95 % confidence interval. (D) Partial correlation coefficients between dream anger and log-transformed alpha power over the F4 electrode in 1-Hz bins. Blue-coloured bins marked with asterisks denote statistically significant correlations after the Benjamini-Hochberg False Discovery Rate correction (adjusted p-value = .0045). T/A = Theta/Alpha. Adapted from Sikka, Revonsuo, Noreika, and Valli, 2019, p. 4779.

8. Discussion

The overall aim of the empirical studies carried out in the framework of this PhD thesis was to investigate the phenomenology and correlates of dream affect and how results regarding these are influenced by study methodology. Five studies were conducted: Studies I–III focused on the phenomenology—and Studies IV and V on the correlates—of dream affect.

In this chapter, I discuss the results of these studies in light of existing literature and provide possible explanations for—and address the ramifications of—the main findings. I then discuss the theoretical and empirical implications of the studies as a whole. Finally, I point out limitations of the studies and provide recommendations for future research on dream affect.

8.1 Phenomenology of dream affect: Impact of study methodology

8.1.1 Self- versus external ratings of dream affect

Studies I and II compared SR and ER of dream affect. The results obtained with these two methods of measurement differed greatly. With SR, as compared with ER, a larger number of dreams were rated to contain affect. These findings are well in line with the home dream diary studies of Schredl and Doll (1998) and Kahan and LaBerge (1996), as well as with the home and laboratory studies that have used either ER (e.g., Domhoff, 2018; Hsu & Yu, 2016; Snyder, 1970) or SR (Nielsen et al., 1991; St-Onge et al., 2005; Yu, 2007) as the main method of measurement. Regarding valence, with SR a larger number of dreams were rated as positive. Moreover, although with SR dreams were rated to contain more PA and NA, the difference was larger for PA. Thus, ER and SR differed mostly in the estimation of positive dreams and PA in dreams. Similar conclusions were reached in Schredl and Doll (1998), and Röver and Schredl (2017).

Although the measures used for SR and ER were reliable, the fact that they have yielded different results challenges their validity. Both SR and ER are assumed to measure the same phenomenon or construct—dream affect. This means that they should display (at least some degree of) convergent validity. Convergent validity is a necessary, albeit not sufficient, condition for construct validity (i.e., whether and to what extent we can measure what we intend to measure; Campbell & Fiske, 1959; Cronbach & Meehl, 1955). A high level of convergent validity demonstrates that our measures can capture the phenomenon of interest, and as such, we can make meaningful inferences based on our data. No or low convergent validity, on the other hand, makes it questionable whether our data actually reflect the underlying phenomenon (Carlson & Herdman, 2012). Convergent validity can be indirectly evaluated by looking at the extent to which results obtained with the two measures—SR and ER—converge. However, it is also possible to directly assess convergent validity. One approach is to examine bivariate correlations between measures. For convergent validity to be demonstrated, different measures of the same construct should be sufficiently correlated. Although there are no exact thresholds, correlations less than $r = .50$ are typically considered too low; however, for more precise measurement, correlation coefficients higher than $r = .85$ are required (Carlson & Herdman, 2012).

To directly assess convergent validity, we can examine intercorrelations between SR and ER with respect to the measurement of PA and NA in dreams across the four existing studies (i.e., Studies I–II of the present thesis; Röver & Schredl, 2017; Schredl & Doll, 1998). To compare the different studies, we must be more detailed regarding the measures for SR and ER, specifically, whether content analysis or global ratings have been used, and whether discrete or dimensional affect has been measured. The results of Studies I and II showed that whereas the NA subscales of ER (i.e., content analysis of discrete affect; ER-CA-Dis) and SR (i.e., global ratings of discrete affect; SR-GS-Dis) were positively correlated, PA subscales were not significantly correlated (see Table 11). Thus, whereas both ER and SR converge, at least to some extent, on the measurement of NA, they diverge on the measurement of PA. This suggests that research findings regarding NA are more consistent, which is indeed reflected in the results of Studies IV and V (see Sections 8.2.1 and 8.2.2). Inadequate convergent validity in the measurement of PA means that we must be cautious when interpreting the findings. Schredl and colleagues (Röver & Schredl, 2017; Schredl & Doll, 1998) demonstrated that when the same global dimensional rating scales were used for ER (i.e., ER-GS-Dim) and SR (i.e., SR-GS-Dim), satisfactory positive correlations between the measures were obtained for both PA and NA. However, when detailed content analysis of discrete affect was used for ER (i.e., ER-CA-Dis) but global dimensional rating scales used for SR (i.e., SR-GS-Dim), correlations were low for both PA and NA (see Table 11).

Table 11. Convergent validity between self-ratings (SR) and external ratings (ER) in the measurement of positive and negative dream affect, as evidenced by zero-order correlations between the measures across the four existing studies

	SR-GS-Dim	SR-GS-Dis
Negative affect in dreams		
ER-CA-Dis	0.29 (p = .0007)[a]	0.52 (p = .032)[c]; 0.49 (p = .001)[d]
ER-GS-Dim	0.67 (p = .0001)[a]; 0.57 (p < .0001)[b]	
Positive affect in dreams		
ER-CA-Dis	0.36 (p = .0001)[a]	0.18 (p = .498)[c]; 0.22 (p = .152)[d]
ER-GS-Dim	0.56 (p = .0001)[a]; 0.48 (p < .0001)[b]	

Note. [a]Schredl and Doll (1998); [b]Röver and Schredl (2017); [c]Sikka, Valli, Virta, and Revonsuo, 2014; [d]Sikka, Feilhauer, Valli, & Revonsuo, 2017. SR-GS-Dim = self-ratings using global rating scales of dimensional affect; SR-GS-Dis = self-ratings using a global rating scale of discrete affect; ER-CA-Dis = external ratings using content analysis of discrete affect; ER-GS-Dim = external ratings using global rating scales of dimensional affect.

Together, these results offer four possible explanations for low convergent validity. First, low convergence may result from the fact that the measures used for SR and ER differ not only in the type of report collected and in who rates dream affect but in several other aspects as well (see Table 12). In particular, whereas for ER the collected data are in the form of *narrative dream reports*, for SR the data are in the form of *evaluations of (the memories of) dream experiences*. Also, whereas the unit of analysis for ER using content analysis is every occurrence of affect in the dream report, for SR it is the dream experience as a whole (or globally). Such global ratings involve aggregation—combining multiple episodes of momentary experiences into one rating (Larsen & Fredrickson, 1999). For example, in the dream report provided at the beginning of this thesis (see p. 14), the dreamer would have to evaluate to what extent he or she experienced fear or excitement across the whole dream experience. It is rarely acknowledged that this aggregation process can be biased. Research on waking affect has demonstrated that aggregated end-of-day ratings of both PA and NA are more intense, as compared with momentary ratings (Miron-Shatz et al., 2009; Parkinson, Briner, Reynolds, & Totterdell, 1995; cf. Thomas & Diener, 1990). Similarly, evaluating a dream as a whole may yield higher levels of affect (intensity) than evaluating every episode of affect. In summary, a more fine-grained comparison of ER and SR shows that if the same scales are used for SR and ER (i.e., SR-GS-Dim vs ER-GS-Dim), convergence is adequate. If SR and ER differ in one or several aspects (i.e., SR-GS-Dim vs ER-CA-Dis), convergence is low. Thus, differences in measures used for SR and ER may be one reason underlying discrepant findings. However, this explanation fails to explain why low convergence specifically concerns the measurement of discrete PA (i.e., when ER-CA-Dis and SR-GS-Dis are compared).

Table 12. Variation in methods used for self- and external ratings of dream affect

	ER-CA-Dis	ER-GS-Dim	SR-GS-Dis	SR-GS-Dim
Type of report	Narrative report	Narrative report	Targeted probes	Targeted probes
Rater	External judges	External judges	Dreamer	Dreamer
Type of scale	Nominal	Ordinal	Ordinal	Ordinal
Unit of analysis	Every occurrence of affective state in the dream report	Dream report as a whole (or globally)	(Memories of the) dream experience as a whole (or globally)	(Memories of the) dream experience as a whole (or globally)
Instructions to raters	Explicitly expressed affect	Explicitly and implicitly expressed affect	Experienced affect	Experienced affect
Model of affect	Discrete	Dimensional	Discrete	Dimensional
Quality of affect	mDES	PA, NA	mDES	PA, NA
Aspect of affect	Presence	Intensity	Intensity	Intensity

Note. ER-CA-Dis = external ratings using content analysis of discrete affect; ER-GS-Dim = external ratings using global rating scales of dimensional affect; SR-GS-Dis = self-ratings using a global rating scale of discrete affect; SR-GS-Dim = self-ratings using global rating scales of dimensional affect; mDES = modified Differential Emotions Scale; NA = negative affect; PA = positive affect.

Second, it may be more difficult to achieve adequate convergent validity for the measurement of discrete affect, particularly for discrete PA. Strauch and Meier (1996) showed that whereas negative experiences are expressed in dream reports as discrete "emotions" (e.g., fear, anger), positive experiences are expressed as more general dimensional "mood states" (e.g., positive, pleased), although discrete affect does not necessarily entail emotions, and dimensional affect mood. In addition, when describing positive experiences, people may refer to situations (e.g., "everything was very beautiful”, see report on p. 14), rather than how the positive experiences make them feel (e.g., in awe) (Sikka et al., 2014, 2017). As a result, certain types (i.e., emotions) and models (i.e., discrete) of positive affective experiences may be underreported in narrative dream reports, leading to lower ratings of PA with ER, especially with content analysis of discrete affect (i.e., ER-CA-Dis). On the other hand, research on waking affect has demonstrated that different discrete PA items are less differentiated or granular than NA items, that is, PA items are more blended with each other (e.g., Ellsworth & Smith, 1988). Also, people tend to evaluate neutral events as slightly positive, a phenomenon known as the ‘positivity offset’ (Ito & Cacioppo, 2005). Consequently, people may evaluate the same dream event or experience using several discrete PA items, leading to the over-representation of PA with SR.

Third, as the findings of Schredl and colleagues (Röver & Schredl, 2017; Schredl & Doll, 1998) show, convergent validity may be higher if judges can infer affect from the content of the dream report. However, this may only pertain to the measurement of affective dimensions. Nevertheless, even in the case of the adequate convergent validity of global dimensional scales, ER still reflects less (intense) PA in dreams than does SR.

Finally, it may be that one or both measures do not reflect the underlying construct or that they reflect different aspects of it—the verbal expression of affect or affective language (ER) versus the evaluation of affect (SR).

Research on waking affect could help shed light on this issue. However, it is surprising that the comparison of SR and ER has received little attention outside of dream research, despite both of these measures being actively used by researchers in other fields. Among the existing studies on waking affect, results are mixed. Similar to the findings of the current thesis, some studies have reported positive correlations between SR and ER of NA, but not of PA (Tov, Ng, Lin, & Qiu, 2013). Other studies have found positive correlations between SR and ER of PA, but not of NA (Kahn, Tobin, Massey, & Anderson, 2007). And, several studies have failed to find any correlations between SR and ER of PA or NA (Bantum & Owen, 2009; Grysman, Merrill, & Fivush, 2016; Owen et al., 2006; Sun, Schwartz, Son, Kern, & Vazire, 2019). Thus, low convergence between SR and ER also applies to the measurement of waking affect.

The study of waking affect has the advantage that it is possible to validate the measures using a multimethod approach including other concurrent measures, such as informant ratings, psychophysiological responses, and behavioural (facial) expression, which is virtually impossible in the study of dream affect. Such studies on waking affect have demonstrated that SR of waking affect are positively associated with informant ratings (e.g., Diener, Smith, & Fujita, 1995). Also, response biases (i.e., measurement error) have been shown to exert only a negligible influence on SR of waking affect (Schimmack, 2003; Schimmack et al., 2002). As a result, SR of affect are considered valid measures of affective experiences in wakefulness (Mauss & Robinson, 2009), albeit not without criticism (e.g., Heavey, Hurlburt, & Lefforge, 2012; Hurlburt & Heavey, 2015; Scherer, 2005). Moreover, abundant research on the structure of affect has demonstrated that PA and NA are either independent (i.e., not correlated) or negatively correlated (for a review, see Schimmack, 2008). The findings of Studies I and II showed that SR of PA and NA in dreams were not significantly correlated, whereas ER of PA and NA in dreams were strongly positively correlated (see Table 10). These findings suggest that SR of dream affect are more in line with results obtained in the study of waking affect. However, more research on the comparison of SR and ER of both dream and waking affect is needed to establish whether low convergent validity results from measurement issues or from our assumption—that we are measuring the same construct with both SR and ER—being incorrect.

Nevertheless, differences between SR and ER of dream affect—particularly with regard to PA—are consistent across studies, irrespective of the environment the data have been collected in (home vs lab) or the particular affect rating scale (e.g., dimensional or discrete) used. These differences imply that we must be careful when drawing conclusions about the overall affective nature of dreams using only one type of measurement method. As Studies I and II showed, with SR dreams appeared to be mostly affective, whereas with ER they appeared mostly non-affective. With SR dreams appeared to be positive in both settings (home and laboratory), whereas with ER dreams appeared to be either relatively balanced (laboratory; Study I) or mostly negative (home; Study II). Moreover, Study II further demonstrated that results regarding the affective nature of dream reports depend not only on the measurement method but also on the gender of participants. Specifically, whether dream reports appeared negatively biased or balanced differed depending on whether they were provided by women or men, respectively. Because the empirical literature on gender differences in dream affect is controversial (e.g., Dale, Lortie-Lussier, Wong, & De Koninck, 2016; Hall & Van de Castle, 1966), more research is needed to tease out the reasons for these discrepancies. Regardless, all these differences help explain inconsistent results—whether dreams are mostly affective or mostly non-affective, negatively biased or not—in the empirical literature.

The findings of Studies I and II also have implications beyond the field of dream research. In the age of big data, the automatic detection of affective states from various narratives, such as social media posts in Facebook or Twitter (known as sentiment analysis), is becoming increasingly popular, and it is used to predict, among other things, the well-being of individuals (e.g., Mohammad, 2016). To be able to interpret such findings, it is important to have a clear understanding of what exactly affect expressed in narratives reflects and to what extent it converges with SR of affect.

8.1.2 Dream affect in home versus laboratory dream reports

Study III compared affect expressed in dream reports collected upon morning awakenings at home with those collected upon multiple REM awakenings in the sleep laboratory. Obtained results corroborate previous studies using similar non-constant sampling and reporting procedures: dreams appear to be more affective and more negative at home than in the laboratory (Foulkes, 1979, Study 4; Okuma et al., 1075; St-Onge et al., 2005). Although Study III used only ER of dream affect, the findings are very similar to a previous study using SR (St-Onge et al., 2005). This suggests that observed differences in the affective content of home and laboratory dream reports are likely not due to the particular affect rating method used.

However, when home morning reports were compared separately with early- and late-REM laboratory reports, results showed that it is not the environment per se, but rather the time of night, that explains the enhanced affectivity of home dream reports. This indicates that home dreams appear more affective because they represent (mostly) late-REM dreams. At the same time, home dream reports contained a higher density of affect than early- and late-REM laboratory reports. This is most likely due to differences in reporting modality: home dream reports were written down, whereas laboratory dream reports were provided orally. It has been shown that written, as compared with oral, reports have higher lexical density, that is, the same information is condensed into fewer words (Casagrande & Cortini, 2008).

Results regarding negative affectivity were more controversial. On the one hand, home dream reports were more negative than either early- or late-REM dream reports in the laboratory. This seems to speak against the time of night effect. On the other hand, the difference between home and early-REM laboratory reports was larger than that between home and late-REM laboratory reports. Perhaps dreams become more negative across every sleep cycle as the night proceeds, with the most negative dreams in the morning just before awakening (cf. Cartwright et al., 1998).

This means that dream reports obtained upon morning awakenings at home and in the laboratory should yield similar findings, as has indeed been demonstrated previously (Foulkes, 1979, Study 3; Weisz & Foulkes, 1970). The lack of significant differences between home dream reports and the latest REM dream reports found in Study III also seems to support the time of night effect. However, if dreams become increasingly negative over the course of the night, late-REM laboratory dream reports should be more negative than early-REM laboratory dream reports, something that was not found in Study III, or in other previous studies (e.g., Fosse et al., 2001; Hall, 1966).

Another explanation is that dreams may become more negative over the course of the same sleep cycle, meaning that the longer the REM sleep stage lasts, the more negative the dream becomes. Merritt et al. (1994) have demonstrated that dreams do indeed progress towards increased negativity. Perhaps laboratory dream reports had less negative affectivity, because REM sleep—and the corresponding dreams—were interrupted after five minutes, whereas at home the sleep stage and dreams unfolded naturally. Studies specifically investigating the effect of the length of the REM period on dream affect are needed to examine the plausibility of this explanation.

As in previous studies, it was specifically fear that was more prevalent in home, as compared with laboratory, dream reports (Foulkes, 1979, Studies 3 and 4; St-Onge et al., 2005). This helps explain why fear and anxiety are among the most frequent affective states in studies using home morning awakenings, especially when younger participants and ER are used (e.g., Hall & Van de Castle, 1996; St-Onge et al., 2005). Also, the sleep laboratory constitutes a safe and controlled environment, which may be reflected in the content of dreams. This is supported by findings showing that nightmares tend to occur less often in the laboratory (Spoormaker, Schredl, & van den Bout, 2006).

In summary, home dream reports appear to be more affective and more negative than laboratory dream reports. Rather than due to the setting per se, differences in general affectivity seem to be mostly due to the time of night effect. Differences in negative affectivity may reflect true differences between settings or, alternatively, differences in the timing of awakenings used in the two settings. The situation is arguably even more complex, with the circadian (across 24 hours), ultradian (between and within sleep stages), and sleep-dependent (across the night) rhythms all interacting with each other in influencing dream content (Nielsen, 2010; Wamsley, 2007).

Nevertheless, the results echo previous conclusions that typically collected home dream reports (i.e., obtained upon morning awakenings) represent a selective subset of dreams—the most recent, affective, and negatively valenced dreams—which are not representative of the dreams of the whole night (Foulkes, 1979; Goodenough et al., 1974; Meier et al., 1968). As such, home dreams reports seem to reflect peak-end affective experiences.

These findings underscore the importance of considering the data collection environment and dream sampling procedure when collecting data and interpreting results. It may be difficult to generalize findings from one setting (e.g., laboratory) to another (e.g., home), an implication relevant to both dream and sleep research. Also, if we want to understand the nature (and possible function) of dream affect, we cannot rely solely on dreams collected upon morning awakenings. For a truly representative sample, we must collect dreams throughout the night (from early- and late-night periods), from different stages of sleep (NREM and REM), and from different lengths into the sleep stage. Having said this, it does not necessarily mean that studies conducted in one or the other setting, or based only on morning dreams, are of less value. What it does imply is that we must be more explicit about the limits of the generalizability of results obtained using such methods.

8.2 Correlates of dream affect

8.2.1 Dream affect and waking well-being

Whereas Studies I and II showed that SR and ER yield different results regarding the phenomenology of dream affect, Study IV further demonstrated that the two measures are also differently associated with waking well-being and ill-being. Whereas ER of dream PA were positively related to peace of mind and ER of dream NA to symptoms of anxiety, SR of dream NA were only related to symptoms of anxiety. Thus, ER of dream affect are better related to waking ill- and well-being than SR of dream affect.

The finding that both SR and ER of dream NA were associated with symptoms of anxiety provides further evidence for the better convergence of the two measures in the measurement of negative dream affect, as compared to the measurement of positive dream affect. However, ER of dream NA seem to be a stronger predictor of symptoms of anxiety than SR of dream NA. This may also be one explanation for the inconsistency of previous findings regarding the relationship between dream affect and anxiety. Another explanation for these inconsistencies may be that state and trait anxiety are differently associated with dream affect. In Study IV, state anxiety (i.e., symptoms of anxiety over the past two weeks) was measured. State anxiety has been shown to be related to both SR and ER of dream affect (Blagrove et al., 2004; King & DeCicco, 2007). However, trait anxiety has been shown to be related to ER of dream affect (Pesant & Zadra, 2006) but not to SR of dream affect (Beaulieu-Prévost & Zadra, 2005; Demacheva & Zadra, 2019; Zadra & Donderi, 2000). The problem may also lie in the trait anxiety measure itself, because the most commonly used questionnaire—the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970)—has been criticized for not being a pure anxiety measure (Bados, Gómez-Benito, & Balaguer, 2010; Caci, Baylé, Dossios, Robert, & Boyer, 2003).

Because Studies I and II showed that SR and ER do not converge in the measurement of dream PA, results regarding the relationship between ER of dream PA and peace of mind remain more uncertain. However, even if SR and ER of dream PA measure different aspects of the underlying construct, the results suggest that it may be specifically the verbal expression of affect in dream reports that reflects participants' well-being and ill-being. In fact, outside of dream research, there is evidence that the expression of PA in waking narratives is associated with better mental health (Stein, Folkman, Trabasso, & Richards, 1997), physical health (Pennebaker & Francis, 1996), and even longevity (Danner, Snowdon, & Friesen, 2001; Pressman & Cohen, 2012).

Another issue to keep in mind is that Study IV was based on home dream reports collected upon morning awakenings, which, as discussed above, constitute a selective sample of dreams. As such, future research should investigate whether similar results are obtained when dream reports are collected from different times of night.

Contrary to previous findings (Gilchrist et al., 2007; Schredl & Reinhard, 2009-2010; Yu, 2007), dream affect was not found to be related to waking state affect. One reason for this may be that in Study IV waking affect was not measured continuously across the 21 days but only at one point in time (i.e., before the dream diary part of the study). As with the measurement of dream affect, future studies should measure waking affect daily, since it is, by definition, a temporary state. Dream affect was not associated with symptoms of depression, which corroborates previous findings on nonclinical samples (e.g., Pesant & Zadra, 2006) and suggests that this relationship may be observed only for nightmares (Zadra & Donderi, 2000) or in clinical populations (Schredl & Engelhardt, 2001). The finding that dream affect was not significantly associated with life satisfaction fits well with previous studies demonstrating either no (St-Onge et al., 2005) or only a weak relationship (Gilchrist et al., 2007) between these variables.

The finding that aspects of ill-being and well-being were differently related to dream affect implies that it is not enough to simply measure ill-being. This highlights the increasing acknowledgement of the distinction between ill-being and well-being in well-being research (Keyes, 2005; Seligman, 1999). Importantly, Study IV included a novel aspect of well-being—peace of mind—that had previously not been studied as part of a unified framework of well-being, either in dream or well-being research. The results regarding peace of mind have implications for both dream research and well-being research in demonstrating that peace of mind complements existing measures of well-being and helps develop a more comprehensive understanding of well-being and its relationship to dream affect. This is important because researchers have overlooked this aspect of well-being, both in dream research and well-being research.

Based on the findings of this study, we also put forward a new theoretical proposition: whereas high levels of anxiety may reflect affect dysregulation, high levels of peace of mind may reflect enhanced affect regulation, across the two states of consciousness—waking and dreaming. As a result, individuals with anxiety experience more NA, but individuals with peace of mind relatively more PA, in both the waking and dreaming states. Future studies are needed to empirically test this proposition, as well as to explore whether peace of mind is empirically distinct from the other conceptions of well-being (i.e., HWB and EWB).

In summary, both the method of measurement (ER vs SR) and conceptualization of ill-being (state vs trait anxiety) and well-being (ill-being vs well-being; different aspects of well-being) may explain inconsistent findings in previous studies. The results also demonstrate that there is (at least some) continuity between dream affect and waking well-being, which may rely on affect regulation ability.

8.2.2 Neural correlates of dream affect

Study V was the first study to investigate the relationship between discrete affective states in dreams and FAA and is among the few existing studies to link affective dream experiences—recalled and reported upon awakening—to the neural processes of pre-awakening sleep.

Results showed that FAA during REM sleep—and during evening pre-sleep wakefulness—was related to SR of anger in REM sleep dreams. Further analyses demonstrated that the relationship was specifically driven by the right hemisphere: individuals with more alpha power (i.e., assumed to reflect less activity) in the right-frontal cortical area experienced more anger in dreams. Although this study focused mainly on SR of dream affect, SR and ER yielded similar findings regarding the relationship between right-frontal alpha band oscillations and anger in dreams. As such, this study lends further credence to our ability to more consistently measure NA in dreams.

The results are in line with several findings on FAA and anger in wakefulness (for a review, see Harmon-Jones & Gable, 2018). Also, as in previous studies (Benca et al., 1999; Schmidt et al., 2003), FAA was positively correlated across wakefulness and REM sleep. Thus, the findings suggest that FAA is a relatively stable trait-like marker of affective processing that not only reflects the affective state of anger during REM sleep dreaming but may also be used to predict anger in REM sleep dreams.

These findings have important implications for both affective neuroscience and dream research. In affective neuroscience there is a heated debate regarding what exactly FAA reflects: affective valence, approach-avoidance motivation, or supervisory control (e.g., Gable et al., 2018; Harmon-Jones & Gable, 2018). The finding that the relationship between FAA and dream affect was specific to dream anger (a high-approach negative affective state) but not dream interest (a high-approach positive affective state) provides support for the supervisory control model of FAA (Gable et al., 2015, 2018). This seems to suggest that individuals with reduced activity over the right-frontal cortical areas (as evidenced by higher alpha power) may be less able to regulate their affective states not only in wakefulness but also during dreaming. This conclusion is supported by several neuroimaging, EEG, and brain stimulation studies demonstrating the role of the right PFC in the regulation of waking affect (Kim & Hamann, 2007) and in inhibitory control more generally (e.g., Depue, Orr, Smolker, Naaz, & Banich, 2016; Kelley et al., 2017). Although in Study V the results were specific to anger, this does not mean that this relationship necessarily holds for anger only. Because in the current sample the ratings of other dream affect items were low, we may have failed to detect similar relationships for other affective states that may require enhanced regulation (e.g., fear).

This study also demonstrates the importance of being aware of the different conceptual models of affect and choosing the measures and analysis strategies accordingly. The results would have arguably been very different if instead of discrete affective states (anger and interest), different dimensions encompassing several discrete affects (e.g., PA vs NA; approach vs avoidance) were analysed. If we want to investigate the neural correlates of affect, we must decide on the appropriate conceptual model of affect (i.e., whether to search for the correlates of discrete affective states, affective dimensions, or some other affect-related processes).

Regarding dream research, the findings contribute to the accumulating evidence that the neural processes underlying dream experiences are shared with those of waking experiences (Dresler et al., 2011; Hong et al., 1996; Horikawa et al., 2013; Perogamvros et al., 2017; Siclari et al., 2017). Moreover, the results demonstrate that the neural correlates of affective processing and affect regulation are continuous across wakefulness and dreaming and that FAA may be one marker of such continuity. However, to determine the full extent of this continuity, studies that explore the relationship between FAA during NREM sleep and dream affect are needed. Moreover, it remains to be determined whether the trait-like nature of FAA reflects a more stable trait-like style of affective processing (e.g., trait anger, trait affect regulation)—individual's affective style—across different states of consciousness.

8.3 Summary and general implications of empirical findings

In dream research it is generally assumed that both SR and ER accurately reflect—and that both home and sleep laboratory dream reports give a representative picture of—affective dream experiences. The empirical studies of the present thesis indicate that these assumptions may not be warranted. The findings show that the results and conclusions regarding the phenomenology of dream affect differ considerably depending on which methods have been used to collect and analyse the data. Together, these findings have important theoretical and empirical implications.

First, the discrepant findings help understand why theories of dreaming disagree about the frequency and nature of dream affect, such as whether dreams are inherently affective versus cognitive and whether they are negatively biased or not. Different methods yield different data regarding the same phenomenon, which can lead to diametrically opposite interpretations. As it stands now, it is possible to either confirm or refute predictions derived from an existing theory depending on which method is chosen for the collection and analysis of data. For example, theories that predict dreams to be inherently affective (e.g., random activation theories, see Section 4.1 for an overview of the theories) would be supported when SR of dream affect are used, but contradicted by ER of dream reports collected in the sleep laboratory, whereas the opposite would be true for theories that consider dreams to be mostly cognitive in nature (e.g., cognitive and neurocognitive theories). Similarly, theories that predict dreams to be negatively biased (e.g., threat simulation theory, certain emotion processing and regulation theories) would be supported using ER of dream reports collected in the home environment (especially from females) but contradicted by SR of dream affect. The problem is that we do not know which method yields more trustworthy results. We have a 'validation crisis' (Schimmack, 2019) in dream research: we use measures, without knowing what exactly they measure and how well they measure it, to make theoretical claims about dream affect. However, to be able to make theoretical progress—to test and develop different theories—we must ensure that we have methods that reflect the phenomenon or construct being studied as accurately and precisely as possible. "When measures only marginally capture intended constructs, we run a high risk of convicting the innocent (theory) while praising the unworthy" (Carlson & Herdman, 2010, p. 11).

Second, the methodological choices we make have implications for the study of the correlates of dream affect. Differences in study methodology, together with differences in how constructs are conceptualized, underlie empirical and theoretical disagreements regarding the associations between dream affect and other constructs, such as whether and to what extent dream affect is continuous with waking well-being and what the neural correlates of dream affect are. If SR and ER measure different aspects of the same underlying construct—evaluations versus verbal expression of affective experiences—we cannot use these measures interchangeably and generalize findings obtained with one method only to the affective nature of dreams in general. Likewise, results regarding ill-being do not directly translate to well-being, nor do neural correlates of discrete affect to neural correlates of dimensional affect.

Third, the findings of dream studies are often assumed to reflect universal features of dream affect. However, studies of the current thesis show that the plausibility of this assumption depends on the sampling of dream reports and participants. The content of a selective sample of dream reports, such as those collected upon morning awakenings, may not be representative of affective dream experiences as such. Similarly, the content of dream reports obtained from a selective sample of participants, such as female undergraduates, may not represent the affective dream experiences of the whole population. Although it is well acknowledged that differences between demographic groups, such as between different gender, age, and cultural groups, may affect results regarding dream affect (Domhoff & Schneider, 2008), most dream studies are biased towards including young, WEIRD female undergraduates (Kahan & Claudatos, 2016). Furthermore, as demonstrated by the results of Studies IV and V, other differences between individuals are systematically related to dream affect, especially to affect expressed in dream reports.

The existence of individual differences raises questions as to whether and to what extent it is possible to make general claims about the nature of dream affect, such as the negativity bias of dreams. The results from the current and previous studies suggest that the affective nature of dreams depends on the state- and trait-like differences between individuals; that is, it is influenced by both the circumstances of one's current environment and one's dispositions (e.g., Levin & Nielsen, 2009; Nielsen & Levin, 2007; Malinowski & Horton, 2015). This can be likened to individual differences in the negativity bias (Ito & Cacioppo, 2005; Norris, Larsen, Crawford, & Cacioppo, 2011) and attentional bias to threat (Öhman & Wiens, 2003) in wakefulness. In contrast to the prevalent assumption that the attentional bias to threat is universal (Vogt, De Houwer, Crombez, & Van Damme, 2012), evidence shows that such a bias is characteristic only to individuals with high levels of state or trait anxiety (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; MacLeod, Grafton, & Notebaert, 2019). In fact, healthy, non-anxious individuals have been shown to display a positivity bias instead (Pool, Brosch, Delplanque, & Sander, 2016). Similarly, the negativity bias of dreams, particularly as expressed in dream reports, may apply only to those with high levels of state or trait anxiety, or to those exhibiting inefficient or maladaptive affect regulation. Therefore, *in addition to* investigating the phenomenology of affect in dreams in general, we must move towards understanding who, and under what conditions, has certain kinds of affective experiences. This also means that we must be careful when drawing general inferences based on selective samples.

The results of Studies IV and V also suggest that although wakefulness and sleep are two distinct behavioural and neurophysiological states, the experiences we have in these states and their neural correlates are, at least to some extent, continuous across the two states. There seem to be some stable trait-like characteristics—purportedly in affect regulation—that underlie affective experiences during dreaming and well-being during wakefulness, and FAA may be the neural correlate of this ability. As such, the findings of the current thesis provide support for theories that postulate cross-state continuity in the phenomenology and neural correlates of dream experiences (e.g., the continuity hypotheses, memory consolidation theories, emotion processing and regulation theories; see Section 4.1 for an overview of the theories). This continuity is in line with the converging views on dreaming as a simulation of the waking life (e.g., Foulkes, 1985; Nielsen, 2010; Revonsuo et al., 2016a; Windt, 2015), and suggests that subjective experiences may rely on similar mechanisms in wakefulness and sleep (see also De Gennaro et al., 2012; Domhoff & Fox, 2015; Fox et al., 2013; Wamsley, 2013).

In summary, in addition to the methods used to collect and analyse data, conceptual issues and individual differences (e.g., variation in gender, affect-relevant states and traits) may account for discrepancies in research findings. All of these may limit the validity, generalizability, and replicability of findings and, as a result, pose a challenge to theory building and theory testing.

8.4 Limitations of empirical studies of the current thesis

The studies conducted in this thesis should be considered in light of limitations that may have influenced the findings.

The first limitation has to do with the representativeness of the samples. The samples included healthy, young Finnish and Swedish adults (mostly students). Hence, the studies suffer from the same methodological problem as much of dream research and psychological research in general—the use of convenience samples consisting mostly of WEIRD females (Arnett, 2008; Rad, Martingano, & Ginges, 2018). This means that we must be careful when generalizing the findings to the population at large. Furthermore, relatively small sample sizes may enhance Type I and Type II errors, exaggerate ES, and lead to problems with replicability (Button et al., 2013; Forstmeier, Wagenmakers, & Parker, 2017). This is less problematic for within-subject comparisons (in Studies I–III) and for those findings that have been replicated across different samples and procedures (i.e., comparison of SR and ER of dream affect in Studies I–II), but it should be specifically considered when generalizing the results of between-subject analyses and entirely novel findings (such as those reported in Studies IV–V). Furthermore, several other individual differences not controlled for in the studies, such as alexithymia, may have influenced the results.

The results may have been confounded by systematic order effects. In Study III, home dream reports were collected before laboratory dream reports. In Studies I, II, IV, and V, participants first reported their dreams and then rated the affect they experienced in those dreams. Regarding the latter, the dream reporting process and the narrative report itself may have influenced subsequent affect ratings. On the one hand, participants may have rated their affect based on what they believed they felt based on the dream storyline, rather than how they actually remembered feeling. On the other hand, knowing that the report would be followed by a list of affect items, participants may have left those details out of the report. Studies counterbalancing the order of narrative reports and targeted probes can help shed light on the extent to which this may influence findings regarding dream affect.

Several reporting and response biases may have influenced self-reports of dream experiences. In narrative dream reports, participants were asked to describe their dream experiences in as much detail as possible. Without more specific instructions regarding the reporting of dream affect, participants may have not paid attention to—or put enough effort into—describing their affective experiences. As a result, the narrative dream reports may have systematically contained less affective content not because participants experienced less affect but because they simply reported less affect. Also, the reporting modality differed in the home (written reports) and laboratory (oral reports) environments. Although it remains to be determined whether the affective content of dreams is represented differently in written versus oral discourse, the possible influence of this must be considered.

8.5 Looking forward: Recommendations for the study of dream affect

In what follows, the conceptual and methodological issues addressed in this thesis are condensed into concrete recommendations for future research on dream affect. While it is difficult to provide general guidelines applicable to all studies, some common steps can be taken to improve the quality of research.

8.5.1 Conceptual clarity and terminological consistency

We need more clarity in how concepts (e.g., dream, affect) are defined and more consistency in how terms (e.g., feeling, emotion) are used. Without precise definitions, there is variation in what is studied and possibly even a mismatch between the phenomenon of interest and the construct that has been measured, leading to problems with validity. The inconsistent and mixed use of terms makes it difficult to compare results across different studies, thus undermining replicability.

First, in addition to the conceptual definition, empirical papers should provide clear operational definitions of dreams and/or dreaming: whether all remembered and reported/rated experiences during sleep are considered dreams (A in Figure 2), or if only a subset of these experiences is defined as dreams (C in Figure 2), clear criteria should be provided regarding what count as dreamless and what as dream experiences. To distinguish dreamless experiences from dream experiences, a fruitful approach would be to follow the minimal definition of dreaming put forward by Windt (2010, 2015) and use spatiotemporal self-location as an empirical criterion for such a distinction. Additional criteria provided by Windt et al. (2016) can be used to distinguish the different types of dreamless sleep experiences.

Second, it is important to explicitly state the underlying conceptual and theoretical foundation of the study: which type of affective phenomenon (e.g., state or trait affect), which type of affective experience (e.g., emotion or mood or affective states in general), and which model of affect (e.g., discrete or dimensional or their combination) is investigated and why. This theoretical framework—rather than (historical) tradition or ease of application—should guide choices concerning which type of self-report and affect rating scale to use. Consequently, a clear rationale should be provided for why a certain scale (or list of items) has been chosen (Ekkekakis, 2013). This also means that results obtained with methods used to study one phenomenon, type of affective experience, and model of affect may not be directly comparable to results obtained with methods used to study other phenomena, types of affective experiences, or models of affect.

Third, if no empirical distinction is made between emotions and moods, terms encompassing both concepts—such as *affective states* or *affective feelings*—should be used. However, distinguishing emotions from moods may prove valuable, because it can possibly explain at least some discrepancies in results obtained with SR and ER of dream affect. Currently, no agreed-upon criteria exist for making operational distinctions between the two types of affective states, either in dream or emotion research. As suggested in Sikka et al. (2017), conceptual distinctions—intensity (i.e., high vs low), duration (i.e., short lasting vs longer lasting), and context (i.e., as a reaction to an object/stimulus/event vs free-floating)—can also be used as empirical criteria.

8.5.2 Methodological rigour

As discussed throughout this thesis, a host of methodological aspects can influence results regarding dream affect, and several methodological decisions must be made in the process of designing a study. Table 1 can help guide the decision-making process by helping researchers to consider the issues involved in each decision. Although the combination of methods used depends on the goals of a particular study, some general guidelines can be put forward (see also the "ideal reporting conditions" proposed by Windt, 2015, p. 196; Sikka, 2019).

(1) Representativeness

Sampling strategy at both the individual and dream level—i.e., the extent to which the participants are representative of the target population and the collected self-reports representative of the dream lives of the participants—should be carefully considered. Although a representative sample at the individual level is not feasible for many dream studies, the following practices, suggested by Falk et al. (2013) and LeWinn et al. (2017), can improve the generalizability and comparability of results. First, researchers should define the target population and explain to what extent the sample used is representative of this population. Second, the sampling and recruitment methods should be thoroughly reported. Third, the socio-demographic characteristics of the sample should be reported, ideally for all the different stages of the study implementation (i.e., recruitment, data collection, data analysis). Moreover, in addition to the commonly reported characteristics of gender and age, others such as ethnicity, nationality, and socioeconomic status should be reported (Rad et al., 2018).

A representative sample at the dream level means that the collected data should represent dream experiences across both one night and several nights. This means that it is important to collect self-reports from different times of night, different sleep stages, and different lengths into sleep stages, which entails the need to use sleep monitoring equipment. If such sampling is not feasible, the limits of the generalizability of results should be explicitly stated.

Adequate sample sizes at both the individual (number of participants) and dream (number of self-reports) levels are important because they enable the exploration of both within- and between-person variability in dream affect, something we know little about but which can have important implications for dream theories. This, however, demands careful consideration regarding the statistical analysis of the data. Often, such nested designs (i.e., dream reports nested within individuals) are neglected, and the analyses conducted at either the dream level (which confounds within- and between-person variability and violates the assumption of independence of observations) or the individual level (dream-level data are aggregated per participant, a practice not inherently incorrect but which overlooks within-subject or state-level variation). Therefore, together with adequate sample size (which ensures appropriate statistical power), dream studies should increasingly move towards the usage of multilevel modelling, which enables the simultaneous consideration of within- and between-person variation.

Finally, measuring relevant state (situational) and trait (dispositional) variables, such as state anxiety or trait emotion regulation, enables not only to control for these variables but also to explore the extent to which these variables can explain differences in results regarding dream affect.

(2) Ecological validity

For the collected data to be ecologically valid, affective dream experiences should be studied in a real-life environment. Therefore, naturalistic settings (i.e., home) should be preferred over more artificial (i.e., laboratory) environments. However, to avoid compromising tight experimental control and the representativeness of data, valid ambulatory polysomnography equipment (e.g., Ajilore, Stickgold, Rittenhouse, & Hobson, 1995) is needed.

(3) Temporal proximity

Dream experiences, particularly affective experiences, are subject to memory biases (e.g., Goodenough et al., 1974; Parke & Horton, 2009; Payne, 2010). Therefore, to study affective dream *experiences* (i.e., state affect), it is important to minimize the memory–experience gap (Miron-Shatz et al., 2009) and to have as short of a time lag as possible between having and reporting/rating these experiences. This means that self-reports of dream experiences should be obtained immediately upon awakening (Windt, 2015). If general beliefs or evaluations about affective dream experiences (i.e., trait affect) are the focus of the study, dream questionnaires should be used instead.

(4) Training participants

Because self-reports of dream experiences are subject to various biases, training the participants in recalling, reporting, and rating their (affective) experiences is increasingly emphasized (Kahan, 2012; Nielsen & Kaszniak, 2007; Nielsen & Stenstrom, 2005; Solomonova, Fox, & Nielsen, 2014; Stenstrom, Fox, Solomonova, & Nielsen, 2012; Windt, 2015). In particular, training helps participants to develop introspection, language, and reporting skills (i.e., how to differentiate, label, and report different affective states); to counteract selective reporting (i.e., to ensure that all details, especially regarding affective experiences, are reported) and demand characteristics (i.e., to ensure that participants report only those affective states that they actually experienced); and to help distinguish dream experiences from waking beliefs, expectations, and waking affect (i.e., to ensure that participants report affective states as they actually experienced them during the dream, whether or not these would normally be present or absent in similar waking life situations). At the same time, it is important to be aware that training as such may inadvertently influence the data (Windt, 2015).

(5) Specific instructions

Because participants put more emphasis on reporting the dream story than how they feel (Kahan, 1994; Kahan & Horton, 2012), instructions specific to reporting dream affect are needed. However, because instructions have been shown to influence the results of dream content (e.g., Stern, Saayman, & Touyz, 1978), it is important to conduct research on the possible effect of instructions on results regarding dream affect (see also Schredl, 2018).

(6) Multimethod approach

Different data collection and analysis methods have different strengths and weaknesses. No method is perfect and free from measurement error. The concurrent use of methods helps overcome the limitations inherent in one method and make use of the strengths that these methods have individually. Although different researchers advocate some methods over others, any conclusions regarding which method to prefer may be premature. One important task for future research is to gain a better understanding of the degree of convergence and divergence of results obtained with different methods for collecting and analysing dream affect (e.g., SR vs ER). Only by using a multimethod approach can we gain a better understanding of the construct validity of our methods (Campbell & Fiske, 1959; Cronbach & Meehl, 1955). In case of convergence, we can be more confident that our findings reflect the underlying dream experiences rather than stem from methodological issues. In case of divergence, we know to be more cautious when interpreting and generalizing our findings (Brewer & Hunter, 2006).

(7) *Empirically validated affect rating scales*

The use of a large number of different affect rating scales, many of which are ad hoc lists of items created and used by researchers for the occasion, means that it is difficult to compare the results of different studies. Also, the lack of the usage of empirically validated scales and the lack of information regarding the psychometric properties of the scales contribute to the ‘validity crisis’ (Schimmack, 2019). Hence, it is important to evaluate the psychometric properties of the scales used to measure dream affect, and when choosing which scale to use, to prefer psychometrically strongest scales (Ekkekakis, 2013). Also, more research is needed to adapt or develop scales that can be used for the measurement of affect across the different states of consciousness (i.e., dreaming and wakefulness). Last but not least, the same (set of) empirically validated scales should be consistently used across different studies to be able to draw broad and generalizable conclusions (Weidman et al., 2017).

(8) Dream episode as a unit of analysis

As discussed previously, global SR of dream affect—ratings of the dream experience as a whole—may be biased due to the aggregation processes. Similarly, ER based on the coding of each and every affective state expressed in the dream report may also involve biases: it may well be that the same affective state has been expressed several times not because it was experienced repeatedly but because participants referred to the same experience repeatedly. Therefore, to account for these possible biases, one solution is to divide the dream report into a sequence of episodes that are then rated using a particular affect rating scale. This would be similar to the continuous moment-by-moment analysis (known as cued review; Rosenberg & Ekman, 1994) used in emotion research. Upon reporting the dream, the dreamer goes through the dream experience (or report) so that the temporal dimension of the original experience is 'replayed' during the rating procedure (Larsen & Fredrickson, 1999). This not only helps to ground the ratings on the 'actual' remembered events but enables the application of the operational criteria for distinguishing emotions from moods, by marking the duration (beginning and end of an affective episode), intensity, and cause/context of the affective state. External judges could then rate the same episodes using the same scale as the dreamers. Although a similar approach has been previously used (Nielsen et al., 1991), due to the scarcity of research, this recommendation should be taken as a suggestion for future research.

(9) Measuring waking affect in conjunction with dream affect

Including the measurement of waking affect, together with dream affect, would serve several purposes: it would help (a) validate our methods of dream affect measurement, (b) explore the continuity of affect across different states of consciousness, and (c) provide a baseline with which to compare data regarding dream affect (see also Kahan & Claudatos, 2016; Kahan & Horton 2012; Revonsuo et al., 2016a). Because it is debatable whether the appropriate comparison condition for dream experiences would involve waking life events or waking imagination (mind-wandering or daydreaming), it is important to measure affect across the different waking states.

8.5.3 Interdisciplinary approach

The study of dream affect has been somewhat isolated from other scientific fields and research areas. Progress in understanding dream affect would be enhanced if we better integrated dream research with other areas of research, such as emotion, well-being, and consciousness research. On the one hand, dream research would benefit from the knowledge and methods obtained and developed in other fields. For example, emotion and well-being research can provide psychometrically validated measures of affect or well-being, something that has been underemployed in dream research. On the other hand, the study of affective experiences during dreaming complements our understanding of waking experiences. In fact, because dream experiences are largely isolated from environmental influences and motor behaviour, they may provide a unique window into the 'pure' subjective experiences of affect. Therefore, the study of dream affect can help inform ongoing empirical and theoretical debates in other fields regarding, for example, the neural correlates of affective experiences (e.g., Hamann, 2018; Kragel & LaBar, 2016) and the role of physiological feelings in the conscious experience of affect (e.g., Pace-Schott et al., 2019).

8.5.4 Theoretical progress

A multitude of dream theories exist which differ in their explanations regarding the nature, function, and correlates of affect experienced in dreams. Such explanatory pluralism, as it is called in the philosophy of science (Van Bouwel, 2014), can be taken to reflect the immaturity of the field (Kuhn, 1962), the complexity of the phenomenon under investigation (Mitchell, 2003), or considered necessary for scientific progress to occur (Popper, 1962). Regardless of the underlying cause of plurality, the question is how to move dream science forward theoretically.

Theoretical progress refers to "progress scientists make (or possibly could make) with theories" (Saatsi, 2019, p. 612). As in empirical dream research, dream theories would benefit from enhanced conceptual clarity: precise definitions of the phenomena (i.e., whether theories apply to dreams in the broader or narrower sense, to affective experiences in general or to emotions in particular) would help elucidate points of convergence and divergence between the various theories.

Further, given the plurality of theories, rather than coming up with ever more theories, effort should be put into systematically testing existing theories. Testing implies that we derive specific hypotheses and predictions from the theory that can then be potentially falsified (i.e., shown to be false) (Stanovich, 2010). However, the problem with several dream theories is that they are rather vague, imprecise, and have not put forward falsifiable propositions (Revonsuo, Tuominen, & Valli, 2016b). Therefore, we need to clarify existing theories, and formulate testable hypotheses (from competing theories) that can then be repeatedly tested using valid and reliable methods. Theories that survive falsification are supported, at least for the time being. Theories that are falsified may need to be modified or discarded altogether (Popper, 1959). "Thus, it is by theory adjustment caused by falsified predictions that sciences such as psychology get closer to the truth" (Stanovich, 2010, p. 34).

However, the falsification of theory-driven hypotheses does not necessarily mean that the theory is incorrect. It is likely that the particular theory applies under certain conditions, but not under other circumstances. For example, theories predicting the dominance of negative affectivity in dreams may apply to individuals who have an increased disposition to negative affectivity and who are subjected to stressful life events. Therefore, it is important to establish the boundary conditions of theories, that is, to specify the conditions under which the theory is applicable (i.e., who, where, when) (Busse, Kach, & Wagner, 2017).

Over time, the repeated empirical testing of theories will show whether some theories have more explanatory power over others, or whether the unification of (some of) those will lead to a stronger theory (with more explanatory and predictive power). Hence, the progress of (dream) science depends on our ability to derive empirically testable hypotheses from (rival) theories (Revonsuo et al., 2016b) *and* on having valid methods to test those hypotheses. In this sense, theoretical progress goes hand in hand with methodological rigour and empirical progress.

9. Conclusion

Different dream theories and empirical findings agree that our dreams contain affective experiences, but they disagree about the frequency, nature, and correlates of these experiences. In this thesis, I have shown that these disagreements stem from several conceptual and methodological issues in the study of dream affect.

The empirical studies conducted in the framework of this thesis demonstrate that different methods for collecting and analysing data can lead to very different results and conclusions regarding the phenomenology of dream affect. Whether dreams appear to be mostly affective or non-affective, negatively biased or not, and how frequently fear seems to be experienced in dreams, depends on whether dream reports have been collected using sleep laboratory awakenings or home dream diaries (Study III) and whether dream affect has been measured using SR or ER (Studies I–II). In addition, several individual differences, such as gender, affect-related states and traits, contribute to differences in results regarding the affective nature of dreams (Studies II, IV, and V). Because SR and ER yield different results regarding the phenomenology of dream affect, they are also differently correlated with other constructs such as waking well-being (Study IV). This applies especially to positive dream affect. As SR and ER converge better in the measurement of negative dream affect, findings regarding the correlates of NA in dreams are more consistent and reliable (Studies IV–V). Together, these results call for caution in making broad generalizations about affective dream experiences as such based on studies that use only one type of data collection and analysis measures, and that are based on selective samples of dream reports and participants.

The results also demonstrate that ER of dream affect are related to aspects of waking well-being and ill-being—peace of mind and symptoms of anxiety, respectively (Study IV)—and that certain discrete affective states in dreams, specifically anger, rely on similar neural processes as in wakefulness (Study V). These novel findings suggest that there is cross-state continuity with regard to both the phenomenology and the underlying neural processes of affective experiences.

This continuity may rely on the ability of affect regulation, the neural marker of which may be FAA.

This thesis contributes to dream research and theory by calling for the need—and suggesting ways—to enhance the conceptual clarity and methodological rigour of research on (affective) dream experiences. Only precise definitions of constructs, and reliable and valid methods to measure them, enable us to replicate results and draw accurate conclusions. Theories, thus, are only as good as the methods we use. Due to the interdisciplinary nature of the thesis, the contributions extend beyond dream research. Specifically, this thesis contributes to the following:

(a) emotion research, as well as to other areas within and outside psychological science (e.g., medicine, linguistics) that use SR and ER of affect, by highlighting problems with and encouraging more research on the convergent validity of these measures;

(b) sleep research, by showing the limits of the generalizability of data collected in one setting only (e.g., at home vs in the sleep laboratory);

(c) well-being research, by drawing attention to a novel aspect of well-being—peace of mind—that has been neglected in the current framework of well-being;

(d) affective neuroscience, by demonstrating the continuity of affect-related neural processes, such as FAA, across different states of consciousness, and by providing evidence for the supervisory control model of FAA; and

(e) consciousness research, by discussing what to consider when studying the phenomenology and correlates of subjective experiences (of affect).

To conclude, although we still do not know why we have (affective) dream experiences, knowing the *what* (it is that we study) and *how* (to measure it) will put us on the right path towards answering this question.

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