NIGHTMARES:
Epidemiological Studies of Subjective Experiences

Nils Sandman

Turun yliopisto
University of Turku

NIGHTMARES:
Epidemiological Studies of Subjective Experiences

Nils Sandman

University of Turku

Faculty of Social Sciences
Department of Psychology and Speech-Language Pathology
Turku Brain and Mind Center
Doctoral Programme of Clinical Investigation

Supervised by

Docent Katja Valli
Department of Psychology and
Speech-Language Pathology
University of Turku
Turku, Finland

Professor Antti Revonsuo
Department of Psychology and
Speech-Language Pathology
University of Turku
Turku, Finland

Reviewed by

Professor Mark Blagrove
Department of Psychology
Swansea University
Swansea, Wales, United Kingdom

Professor Antonio Zadra
Department of Psychology
University of Montreal
Montreal, Canada

Opponent

Professor Mark Blagrove
Department of Psychology
Swansea University
Swansea, Wales, United Kingdom

Cover photo: Subjective by Nils Sandman

ABSTRACT

Nightmares are dreams that evoke intense negative feelings. While occasional nightmares are common and generally harmless, frequent nightmares can be a clinical problem which should not be underestimated: Nightmares often co-occur with psychological problems and may even increase risk for suicide.

In the current thesis I will present empirical studies on epidemiology of nightmares among Finnish general adult population. These studies are based on series of FINRISK health surveys that have been conducted with random cross-sectional population samples of Finnish adults aged 25-74 years every five years since 1972. Surveys of 1972-2012 are utilized in our studies with total N of 78 345.

With FINRISK data, we have investigated the prevalence of nightmares, risk factors for nightmares and association between nightmares and suicide. FINRISK data also includes veterans of the Second World War and we have studied how nightmare frequency of these veterans differs from general population and is the association between nightmares and suicide different among veterans compared to non-veterans.

Our results reveal that nightmares are not uncommon among this population: Around 4% of the participants report frequent nightmares and the prevalence is affected by gender and age of the participant. Women reported more nightmares than men and young participants reported less nightmares than those of advanced age. War veterans have elevated nightmare frequency, even over 30 years after the war has ended. Nightmares also have strong association with various other problems, insomnia and depression being the most prominent ones and frequent nightmares increase suicide risk slightly.

However, as nightmares are dreams and as such their nature is that of a subjective experience, measuring them in epidemiological setting is quite challenging. Therefore, in addition to the empirical studies I will analyse what dreams and nightmares are, how can they be measured and what do retrospective questionnaire studies actually tell us about nightmares. This analysis is based on philosophical and theoretical tradition of the study of consciousness and our epidemiological results will be framed in a novel way based on this philosophical analysis.

TIIVISTELMÄ

Painajaiset ovat unia joiden aikana koetaan voimakkaita negatiivisia tunteita. Satunnaiset painajaiset ovat yleisiä ja tavallisesti harmittomia, mutta usein toistuvat painajaiset voivat olla vakava kliininen ongelma. Usein painajaisia näkevillä henkilöillä esiintyy muita todennäköisemmin muitakin uniongelmia sekä masennusoireita. Heillä on myös kohonnut itsemurhariski, joten painajaisten vaikutusta hyvinvointiin ei tule aliarvioida.

Tämä väitöskirja perustuu painajaisten epidemiologiaa käsitteleviin empiirisiin tutkimuksiin. Aineistoina tutkimuksissa on käytetty Terveyden ja Hyvinvoinnin Laitoksen FINRISKI terveyskyselyitä, joita on kerätty edustavalta otokselta suomalaisia aikuisia viiden vuoden välein vuodesta 1972 alkaen. Tutkimusten aineisto perustuu FINRISKI 1972-2012 kyselyihin, joihin on vastannut kokonaisuudessaan 78345 iältään 25-74-vuotiasta suomalaista.

FINRISKI aineistoa hyödyntäen tutkimuksissa selvitettiin painajaisten yleisyyttä ja riskitekijöitä sekä yhteyttä itsemurhariskiin. Aineisto sisälsi myös toisen maailmansodan sotaveteraaneja ja tutkimme miten painajaisten määrä sekä painajaisten ja itsemurhariskin suhde erosi sotaveteraaneilla muusta väestöstä.

Tutkimusten tulosten perusteella noin 4% suomalaisista aikuisista raportoi kokevansa painajaisia usein ja painajaisten yleisyyteen vaikuttavat sekä ikä että sukupuoli. Naiset näkivät keskimäärin enemmän painajaisia kuin miehet ja ikääntyneet enemmän kuin nuoret. Sotaveteraanit raportoivat enemmän painajaisia kuin valtaväestö, jopa yli 30 vuotta sodan päättymisen jälkeen. Painajaiset liittyivät vahvasti unettomuuteen sekä masennusoireisiin sekä korreloivat myös monien muiden pahoinvoinnista kertovien tekijöiden välillä. Jatkuvat painajaiset myös lisäsivät hieman riskiä tehdä itsemurha.

Painajaiset ovat unikokemuksia, ja unikokemukset ovat luonteeltaan aina subjektiivisia. Tämä tekee painajaisten mittaamisen hyvin haastavaksi, eritoten epidemiologisessa kyselytutkimuksessa. Tämä vuoksi empiiristen tutkimusten lisäksi analysoin tässä väitöskirjassa mitä unet ja painajaiset oikeastaan ovat, miten niistä voidaan saada tietoa ja mitä unennäkö kartoittavat kyselytutkimukset oikeastaan mittaavat. Tämä analyysi perustuu tajunnantutkimuksen filosofiseen ja teoreettiseen traditioon ja sen pohjalta muodostan epistemiologisen kannan, jonka kautta tulkitsen tutkimusteni empiiriset tulokset uudella tavalla.

CONTENTS

ACKNOWLEDGEMENTS

When I started the PhD, I believed many beautiful things about science, world and the future. Little did I know that my pen was too light. Too light to leave any marks of significance.

Now as I write these final sentences, there is precious little left of those beautiful beliefs. Truth is an ideal because it cannot be achieved and stories of real life do not have endings. Sometimes they just end.

What I do have now, is much more weight behind my pen. It carries the experiences and meaning I have shared with all of you during these years of discovery, joy and loss.

I do not believe my pen will ever be heavy enough to write the truth I once believed it could. However, it is heavy enough that as I carry its weight, I will never forget you all.[1]

Thank you.

In Beijing, China, 16th of June, 2017

Nils Sandman
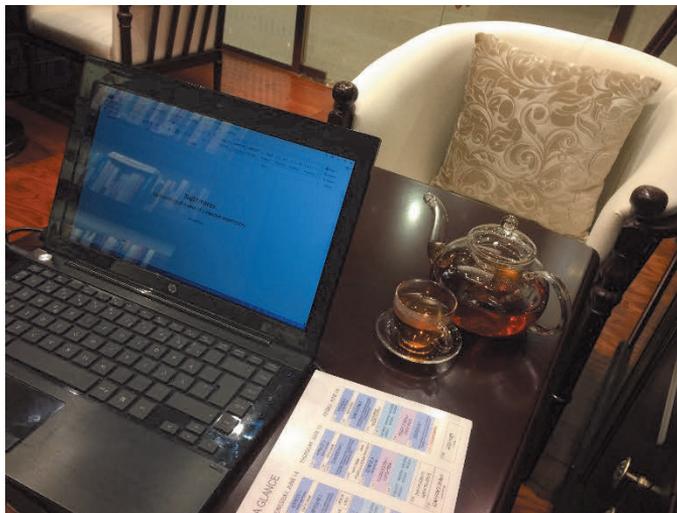
Beijing International Convention Center Book Club

---

[1] In the name of intellectual honesty, "never forget" is beautiful term, but we do know that brains are a fragile thing. So, "never" barring any significant neural damage or degeneration.

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on following original peer-reviewed publications. They are referred in the text as Studies I-IV.

I.   Sandman N., Valli K., Kronholm E., Ollila H., Revonsuo A., Laatikainen T. & Paunio T. (2013). Nightmares: Prevalence among the Finnish general adult population and war veterans during 1972-2007. *SLEEP*, *36*(7), 1041-1050.[a]

II.   Sandman N., Valli K., Kronholm E., Revonsuo A., Laatikainen T. & Paunio T. (2015). Nightmares: risk factors among the Finnish general adult population. *SLEEP, 38*(4), 507–514.[a]

III. Sandman N., Merikanto I., Määttänen H., Valli K., Kronholm E., Laatikainen T., Partonen T.& Paunio T. (2016). Winter is coming: Seasonal affective disorder, nightmares and sleep disturbances in urban and rural areas at latitude 60°N to 66°N. *Journal of Sleep Research*, *25*(5), 612-619.[b]

IV.   Sandman N., Valli K., Kronholm E., Laatikainen T., Vartiainen E. & Paunio T. (2017). Nightmares as a predictor of suicide: An extended replication study. *Scientific Reports, 7:44756.*[b]

ABBREVIATIONS

1PP	First person perspective
3PP	Third person perspective
ANOVA	Analysis of Variance
ASC	Altered State of Consciousness
BDI	Beck Depression Inventory
CBT	Cognitive Behavioural Therapy
CIDI	Composite International Diagnostic Interview
CH	Continuity Hypothesis
CVD	Cardiovascular Disease
DD	Dysphoric Dreaming
DRF	Dream Recall Frequency
DSM-V	The Diagnostic and Statistical Manual of Mental Disorders, 5th edition
E^2	Experience of Experiencing
ES	Experiencing Self
HR	Hazard Ratio
ICD-10	The International Statistical Classification of Diseases and Related Health Problems, version 10
ICSD-3	The International Classification of Sleep Disorders, 3rd edition
IBE	Inference to the best explanation
IRT	Image Rehearsal Therapy
M	Mean
Md	Median
MEQ	Morningness–Eveningness Questionnaire
MH χ^2	Mantel- Haenszel Chi-square test
NREM	Non Rapid Eye Movement

OR	Odds Ratio
PTSD	Post-traumatic stress disorder
REM	Rapid Eye Movement
RS	Remembering Self
SAD	Seasonal Affective Disorder
SD	Standard Deviation
SPAQ	Seasonal Pattern Assessment Questionnaire
TST	Threat Simulation Theory
WWII	World War II
χ^2	Pearson Chi-square test

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

All photos by Nils Sandman (www.fotohiekka.com)

1. INTRODUCTION

Nightmares. What are they and who has them? This thesis explores those questions by combining epidemiological work with science and philosophy of consciousness.

The essence of a dream appears to be that it is a subjective experience, a story unfolding in the inner world of the dreamer that only she can witness. Nightmares are no exception; they are our private theatre of terror, often reaching such a levels of horror that our mind has no choice than to escape from itself to the waking reality. The question of what dreams are and why we experience them is one of the most fascinating as well as one of the most elusive ones for science of the mind.

In addition to their apparent nature as subjective experiences during sleep, nightmares can also be viewed as a clinical problem. Frequent nightmares can disturb sleep, cause anxiety during waking and they appear to be associated with many persistent psychological problems like mood disorders and post-traumatic stress disorder. They are even a risk factor for suicidal thoughts and behaviour and as a result, their clinical significance should not be underestimated (Levin & Nielsen, 2007; Li et al., 2010; Tanskanen et al., 2001).

Science is an ideal of systematic endeavour to produce information that tries to approximate truth. Though unified by the desire for more understanding, different branches of science vary in their methods and epistemological stances as how to pursue this goal. When a scientist immerses herself deep into a rich theoretical, methodological and philosophical framework of her field, it becomes hard to see the logic of other fields with different frameworks or to recognize the often unspoken background assumptions shared by researchers working in her own field.

This makes interdisciplinary work both promising and challenging: By combining different frameworks it might be possible to make up for limitations of both and to reach something new. Alternatively trying to mediate two different frameworks can lead to a profound conceptual confusion and results that are unsatisfactory to practitioners of both fields.

The field of inquiry studying dreams as subjective experiences is part of the science of consciousness. Explanation of consciousness has philosophical roots reaching to Ancient Greece and beyond and philosophy of mind has central role in the field. This stems from the fact that studying subjective experience with methods of natural sciences is deeply problematic as they by definition are subjective, unobservable by objective methods. For this reason the scientific study of consciousness has largely been neglected in psychology after behaviourist in the early parts of the 20th century championed the position that psychology should limit its explanandum to things that can be objectively measured. Cognitive revolution opened the mind again as a topic of study for the psychology in 1950´s but it´s framework of explanation is hard to

apply to explanations of experience and thus the study of consciousness stayed a marginal topic. New surge of interest in the scientific study of consciousness started in 1990´s and while the movement is still gathering momentum, the study of consciousness remains a fragmented endeavour lacking overarching theories and methods. It is a pioneering field which only recently declared itself to be a true science at the "Towards Science of Consciousness" conference in 2015.

The science of consciousness includes a rich tradition of identifying problems related to the study of subjectivity and has made vigorous attempts at developing methods to enable more reliable ways of collecting data from subjective experiences like dreams. There are insights in the field regarding methodology for studying subjectivity that have potential to advance also lines of inquiries where researchers may not be aware how much they are actually relying on subjective reports such as psychological epidemiology.

Nightmares as a clinical problem can be studied with the science of epidemiology, a science of populations. The goal of epidemiology is to find patterns in data that can be used as a starting point of research directed towards identifying the causal reasons for the emergence of these patterns.

As a systematic science, epidemiology is widely considered to have begun in 1849 when Doctor John Snow used statistical analyses to investigate the mode of communication of cholera in London. He observed that those residences which received drinking water from a source contaminated by sewage had over ten times the incidence rate of deaths from cholera compared to residences whose water was uncontaminated. This correlation observed in a sample large enough to reveal it allowed him to infer important risk factors and aspect of the etiology of cholera even though it could be said that he knew nothing of the exact nature of the pathogen. His work saved untold number of lives even though bacteria causing the disease was only identified around 30 years later (Snow, 1849).

Epidemiology is not just a tool for research but also for practical work on preventing diseases. Often epidemiological results can be successfully utilized to decrease incidence of new cases by interventions targeting epidemiologically identified risk factors of disease even before the causal pathway from the risk factor to the disease is fully understood. In modern terms, these kinds of interventions are based on big data approach to the problem: Acting on correlations discovered in representative data without understanding the mechanism behind these correlations (Mayer-Schönberger & Cukier, 2013).

The current thesis is about epidemiology of nightmares. I have conducted with my colleagues four empirical epidemiological studies investigating prevalence, risk factors and consequences of nightmares among the Finnish general adult population.

18

Study I (Sandman et al., 2013) investigated the prevalence of nightmares among adults and how sex and age are associated with the prevalence. We also studied historical trends of nightmare prevalence during 35 year period and compared nightmare frequency of war veterans to that of the general population.

Study II (Sandman et al., 2015) was an exploration of risk factors for frequent nightmares among adults. In this study, the association between nightmares and various factors including mental and physical health, sleep problems, medication, life satisfaction and sociodemographic factors, among other things, were studied.

Study III (Sandman et al., 2016) continued mapping the risk factors for nightmares by capitalizing on the natural experiment Finland presents as a northern country spanning several degrees of latitude by studying the association between seasonal affective problems, latitude and size of the place of residence with nightmares.

Study IV (Sandman et al., 2017) was an extension and improvement of the study by Tanskanen et al. (2001) about nightmares and suicide risk. In this study we replicated the result that nightmares increased risk for completed suicide while controlling for the effect of war veterans present in the study population.

Overall my empirical aim was to describe how common nightmares are in Finland, what kind of people report them, what other problems they may experience and what are the most serious consequences nightmares may cause. These are epidemiological questions with epidemiological answers and clinical implications, but studying nightmares is different from studying cholera: Death by cholera was relatively easy to diagnose but measuring nightmares is much harder. The theoretical goal of the thesis is to acknowledge the problem of measuring subjectivity which also affects epidemiological studies by taking the epidemiological concepts and measurements of nightmares under scrutiny with the philosophical and methodological tradition of the study of consciousness.

The way I proceed with this additional goal is to define in detail what nightmares as subjective experiences are, what epistemological background assumptions are required for their study and how do these perspectives apply to our epidemiological studies. By doing this, I hope to achieve more robust view of what we actually managed to measure in our empirical studies, what can be safely be inferred from our results and what could be done better in the future.

2. PHILOSOPHICAL BACKGROUND: DREAMS AS SUBJECTIVE EXPERIENCES

"But there is no such thing as philosophy free science; there is only science whose philosophical baggage is taken on board without examination."

(Dennett 1995, p.21)

The empirical studies of the current thesis are epidemiological investigations of nightmares by a means of retrospective questionnaires conducted in representative cross-sectional population sample of Finnish adults. The participants of our studies have self-reported that they have experienced nightmares, and in some cases this report is associated with clinically significant consequences.

However, before we can discuss these empirical studies with any degree of scientific confidence we must analyse what nightmares are and how can they be studied. To do that, I will delve into the philosophical tradition of the study of consciousness.

I shall begin by exploring what subjective experiences are, in general, and dreams in particular, and what philosophical background assumptions are needed for the study of dreams.

With dreaming defined, I will discuss the philosophical and methodological problems of studying this phenomenon. This will lead me to identify challenges related to measuring nightmares with retrospective questionnaires and I will formulate philosophical position aspiring to circumvent these challenges to serve as a background for the empirical studies of the current thesis.

2.1. CONSCIOUSNESS – WHAT ARE SUBJECTIVE EXPERIENCES?

Consciousness can be defined as the ability to experience. When conscious, we experience ourselves being situated in a world, thinking thoughts, feeling emotions and perceiving things. Thomas Nagel captured the essence of consciousness by defining it in the following way "*Fundamentally an organism has conscious mental states if and only if there is something that it is like to be that organisms – something it is like for the organism*" (Nagel, 1974). If you are conscious, it feels like something to be you and if you are unconscious, it does not feel like anything at all to be you.

In modern terms what Nagel was referring to is called phenomenal consciousness.

> *Phenomenal consciousness* refers to the experiential nature of being conscious: If one has phenomenal consciousness, it feels like something to be that thing.

There are also other aspects of consciousness, main categories being reflective consciousness (using cognition to analyse contents of phenomenal consciousness) and self-consciousness (the ability to attribute subjective phenomenal contents of consciousness to oneself as an object). What makes communicating about different aspects of consciousness challenging is the fact that the study of consciousness is not a unified field: There exists plenty of conceptual confusion as well as disagreement about terminology concerning the explanandum. However, for the purposes of the present work it is enough to focus on phenomenal consciousness and make just a one key distinction about it: The difference between contents of consciousness and consciousness as a state (Revonsuo, 2006).

> The *contents of consciousness* refers to specific experiences one is having inside one´s phenomenal consciousness at certain moment.

> The *state of consciousness* does not refer to specific experiences but instead it is the mode of operation of background process of consciousness that enables contents of consciousness to appear.

For example, let us assume Descartes sitting in front of a fire. His state of consciousness determines if he has an experience of the fire or experiences at all. If he is in a state of unconsciousness, his phenomenal consciousness is turned off and as a result, he has no contents of consciousness at all. If he is sleeping, the state of his brain is such that he may have contents of consciousness, but the fire in front of him is probably not among them as during a state of sleep sensory information does not typically determine contents of consciousness. If he is wide awake and attending to

the fire, he has an experience of perceiving the fire and therefore the fire appears as a part of the contents of his consciousness. He experiences the fire.[2]

In a typical waking state of consciousness, many of the contents of consciousness are representational: They are triggered by sensory input from the external world and appear to be instrumental in helping us to navigate that world in a meaningful manner. For example, when I gaze at a fire, not only do I have the experience of seeing a colourful dance of the flame but should I reach out and touch it, the burns on my hand would be so real as to be objectively observable by a third party. The conscious representation of the flame in my subjective internal world has an objective counterpart in the objective external world and I feel the experience is an accurate enough representation to let me make informed decision to avoid touching the flame.[3] From such a perspective waking consciousness can be seen as world simulation – quite accurate representation of the external reality (Revonsuo, 1995; Tart, 1987).

Waking consciousness with an accurate correspondence of contents of consciousness to entities in external world is considered as the baseline of conscious states. However, sometimes the state of consciousness is such that the contents of consciousness do not accurately reflect the external world or the nature of the experience is very different from the typical waking experience. This kind of state is considered an *altered state of consciousness* (Revonsuo, Kallio, & Sikka, 2009). Altered state of consciousness can be induced by various factors, including psychoactive substances, certain brain lesions, meditation and hypnosis. Dreaming can also be seen as an altered state of consciousness, the most common natural ASC: During dreaming the dreamer is in a state of sleep and this modifies workings of her phenomenal consciousness to create condition in which the contents of consciousness do not correspond to external reality (Windt, 2010).

Consciousness is arguably the most fundamental aspect of the human mind. Without it our very existence would not feel like anything. For our experience starving minds unconscious state equals nonexistence. One could assume that this would make consciousness the prime target for psychological sciences but one would be wrong.

---

[2] The view where consciousness is represented just by these two dimensions has recently been criticized (Bayne, Hohwy & Owen, 2016) and I agree that more multidimensional model might be needed to capture consciousness better. However, in dream research this kind of model serves a purpose of clearly demonstrating the difference between waking and dreaming and leading to a useful definition for dreaming.

[3] It is not clear that conscious experience is required for action: For example in the case of blindsight there appears to be behavior guided by senses without conscious experience corresponding to the sensory information. It is possible, that consciousness may be an epiphenomenon, a side product of some other mental processes without causal powers of its own (Chalmers, 1996).

Studies specifically targeting consciousness are few and far between and for a good reason: Studying consciousness is studying subjectivity and studying subjectivity scientifically is a hard problem indeed.

2.1.1. The problems of scientific study of subjectivity

The essence of science is objective description of the explanandum. Science uses systematic methods to gather information about how things are in the world. The ideal of science is to produce objective information: claims about the world that are more dependent on the objective nature of the world than the subjective experience of a scientist. While true objectivity cannot be achieved by humans, history of science is riddled with tales of being able to transcend our subjective point of view to produce better explanations of the world than what our intuitions offer us. For example, science has shown that earth revolves around the sun and not the other way around, even if our subjective experience is that we stay still and the sun moves.

The essence of consciousness is the subjective experience – how it feels like to be you. Only the subject having the experience has direct access to it: During the experience she immediately feels what it is like to be her. The experience cannot be accessed in this way from outside of the subject. More formally, subjective experience is only truly observable from a *first person perspective* (1PP), by having the experience. It cannot be experienced and maybe even not observed from a *third person perspective* (3PP) by an outside observer who is not having the experience.

Nagel (1974) illustrated the problem with the example of the experience of being a bat. He assumes that as a bat is a mammal, it has conscious experiences like humans do, but the experience of being a bat is very different from that of being a human. Bats spend a lot of time flying around at night using echolocation to perceive their surroundings. Nagel argues that even if we would know all objective facts about how flying, echolocation and even the neural basis of bat consciousness work, we would not know how it feels to be a bat. The 1PP experience of the bat is not captured by the 3PP description of how the bat works. The only way to know how it feels to be a bat is to be a bat, in other words having a 1PP of the experience.

The subjective nature of consciousness poses a special challenge for the scientific study of consciousness: There are no objective means to acquire data about subjective experiences. The sole consciousness that a scientist has a 1PP access to is that of her own and therefore it is a logically coherent position to claim that this is the only consciousness the scientist knows to exists (Descartes, 1637).

To gather data about experience from a 3PP, we always have to rely on some form of experience reporting by the subject having the experience from a 1PP. Not only that,

but even if we trust these proxy measures of experience enough to arrive at possible objective description of the mechanisms of consciousness, these 3PP explanations do not capture the phenomenal level of experience.

Joseph Levine (1983) coined the term *explanatory gap* to label the problem of 3PP explanations failing to reach the phenomenal level. His reasoning is that in natural sciences many explanations are often based on describing a phenomenon on simpler, more precise terms. For example, physics can describe heat in the statement "heat is motion of molecules". The motion of molecules explains all properties of heat that we observe with simpler units than what we originally used to describe the phenomenon and thus our understanding of the phenomenon has increased. This explanation is satisfactory. However, the same is not true for subjectivity. For example, we can claim that "consciousness is integration of information in the brain". Compared to the explanation of heat, this explanation does not seem adequate: Even if it would explain some properties of consciousness, it does not contain information on why and how the "integration of information" would feel like something for the integrator. The phenomenal level is not explained by this kind of description and so the explanation is unsatisfactory. There exist an explanatory gap between 3PP descriptions of the world and 1PP experience of the world.

This idea was further developed by David Chalmers (1995, 1996). He claimed that there are two different classes of problems concerning the scientific explanation of consciousness. The easy problems concern mechanism of consciousness that can be described from 3PP and therefore are in principle explainable by existing the methods of cognitive neuroscience. For example, studying what happens in the brain when a state of consciousness changes from wake to sleep is an easy problem. Not because the neuroscientific explanation would be easy to produce but because the explanation would not run into the explanatory gap: The explanation "waking state and dreamless sleep differs from each other by a set of neuronal changes X" is an adequate explanation of difference between these states.

The hard problem of consciousness is explaining the experience – why does the information processing of our mind feel like something? Why would the "set of neuronal changes X" be accompanied by vivid subjective experiences on the waking end of the spectrum and total phenomenal oblivion during the dreamless sleep? Solving the hard problem would require bridging the explanatory gap and it appears that none of the existing methods used to study the mind are up to the task (Chalmers, 1996).

Phenomenal consciousness is a subjective 1PP phenomenon that cannot be objectively measured and some philosophers argue that no traditional 3PP explanation, identity statement, can be a satisfactory account for it. This view is not shared by all, for example Daniel Dennett (2003; 2017) argues that the hard problem is a conceptual, not a real problem and once we have satisfactory 3PP explanations

for the mechanisms of consciousness, we would have explained all there is to be explained about subjective experience.

The empirical problem of studying subjective experience that is highlighted by these philosophical arguments is the practical result that since subjective experience can only be accessed from a 1PP, the only way to gather data about it from a 3PP is to rely on experience reporting by the one having the experience. Regardless of which philosophical stance concerning the hard problem one adopts, it cannot be denied that collecting data about subjective experiences with rigorous scientific methods is very problematic.

2.2. DREAMS AS SUBJECTIVE EXPERIENCES

Probably all laypersons and most scientists and philosophers agree that dreams are experiences: They have a phenomenal character; it feels like something to experience a dream (Aristotle 350BC/2014). In the terms defined earlier, this makes dreams an occurrence of phenomenal consciousness: Dreaming involves having contents of consciousness while being in the state of sleep. Jennifer Windt (2010) has proposed a minimal definition of dreaming that we shall take under consideration:

> Dreaming is having of immersive spatiotemporal hallucinations that occur during sleep or sleep/wake transition and are reportable under ideal reporting conditions.

With immersive spatiotemporal hallucinations Windt refers to the experience of time and place from a 1PP. Dreamer has a sense of presence: a point of view and the feeling of passage of time. This feeling of presence does not necessarily require that the dreamer would pose spatially extended dream body. She can also have an experience of being a point in space with a 1PP. What makes dream experience hallucinatory is the fact that the contents of dreams do not generally correspond to the external sleeping environment.

Windt (2010) argues that spatiotemporal hallucinatory presence during sleep or sleep/wake transition is the minimal requirement for something to be considered a dream: It is a necessary and sufficient condition for an experience to qualify as dreaming and all dreams must have this component.

The condition that the dream experience must be reportable under ideal reporting conditions means that it must be in principle possible to report the dream to an outside observer if the dreamer is put in a position where she has not forgotten the dream and is willing and able to describe it. In other words, the dreamer has access to her own experience. If there exist dreams that cannot be reported under any conditions, there does not exists any way of verifying their existence, due to lack of 3PP methods able to capture 1PP experiences. For pragmatic reasons, Windt takes a position that these hypothetical experiences are not part of dreaming as at the moment as we cannot know anything about them.

The definition of Windt is in line with received view of dreaming shared by most scientist studying dreams empirically (Hobson, Hong, & Friston, 2014; Nielsen, 2010; Revonsuo, 2006). This view of dreaming is an epistemological stance that assumes that dreams are real experiences which have temporal duration and which occur during sleep. What makes this stance received is that it is rarely explicitly stated or challenged and instead it is assumed to be true. Also according to received view, dream reports are a reliable enough source of information to form a basis for the scientific study of dreams. In her recent work, Windt (2015) has framed these

background assumptions of dream research in terms of two hypotheses: The experiential hypothesis claims that dreams are experiences occurring during sleep. The transparency hypothesis posits that dream reports are a trustworthy source of information.

2.2.1. Experiential hypothesis: Are dreams experiences?

Experiential hypothesis states that: "Dreams are conscious experiences in the sense that they are phenomenal states, or that it is like something to dream" (Windt 2015, p.5)

In current dream research, it is also commonly assumed that this means dreams have temporal duration and play out during sleep with the experienced length of the dream correlating with the actual length of the process of dreaming. Experiential hypothesis feels intuitively plausible as it corresponds to our personal experiences of dreaming. However, personal experience does not equal scientific proof. It is possible to formulate alternative explanations to explain why dreaming appears the way it does and it is possible to defend a position that the experiential hypothesis is false and dreams are not experiences at all.

This is possible, because of the problem of observing a 1PP phenomenon from a 3PP perspective. In the case of dreaming this means that that an outside observer does not have access to the dream experience, but can only get indirect information about it with two unavoidable steps that are also potential sources of error. First, the dreamer must recall the dream experience after an awakening and second she must report her memory to the observer. The resulting data is a dream report, not a direct observation of the dream experience. *What we observe is verbal behaviour, not an experience.* As a result, it is possible to deny that the dream experience actually took place and claim that the dream reporting behaviour is caused by something else.

Early arguments against dreams being experiences were voiced by Norman Malcolm (1956, 1959). His thinking is heavily influenced by Wittgenstein´s philosophy and therefore many of his arguments are purely conceptual concerning the limits of language when trying to talk about dreaming. He arrives to the conclusion that it is meaningless to claim that during a state of "sound sleep" there could be experiences. This is because one cannot truthfully claim to have an experience while asleep as being able to claim anything while sleeping would mean one is not sleeping.

While Malcolm´s arguments about impossibility of dreaming can be defended against with a different notion of consciousness or by denying that use of concepts in language bear relevance to the existence of natural phenomenon, he also raises the more lasting concern that information about dreams comes from *dream reporting*

behaviour, not from dreams themselves. As there appears to be no way to verify whether dream reports actually correspond to something with phenomenal character and temporal duration during sleep, it is not possible to verify that dreams are experiences.

Another influential argument along these lines is Daniel Dennett´s (1976, 1979) cassette theory. According to Dennett, dream reporting behaviour could be explained by a process, where brains would form dream narratives that would be stored in memory and recalled at the moment of awakening. The formation of these dream cassettes would not feel like anything - it would not be an experience. When recalled during waking, they would seem like experiences one had during sleep, but this would be an illusion: Dreams are not experienced during sleep, they are false memories recalled and reported after awakening. The point of the cassette theory is not that it would be a probable empirical explanation for dreaming but instead it value lies in the logical possibility: If the data about dreaming cannot distinguish between dreams as experiences and dreams as memory cassettes there is no solid evidence that dreams are experiences and the received view assuming so is built on questionable a foundation.

I see these arguments as valid concerns. Whether dreams are experiences cannot be deduced from dream reporting behaviour alone: This source of information leaves open the possibility that something else than experiences during sleep cause dream reporting. While Windt (2015) considers the experiential hypothesis to be an epistemological question concerning mainly philosophers rather than empirical scientist empirical dream science has recently produced evidence which can be interpreted to provide support for the experiential hypothesis.

Lucid dreams are dreams during which the dreamer knows she is dreaming and might gain control over the dream to the degree not usually experienced. Skilled lucid dreamers are capable of carrying out task given to them before falling asleep and this skill has been utilized in experiments where experienced lucid dreamers have used eye movements to signal that they are dreaming while they attained lucidity in their dreams (Hearne, 1978; La Berge et al.,1981). While most muscles are paralyzed during REM sleep due to REM muscle atonia, muscles moving the eyes are not and the participants in the experiment were able to communicate with voluntary eye movements that they were having a lucid dream during REM sleep. Though lucid dreaming is not representative case of dreaming, these experiments present a strong case for the view that some form of consciousness can indeed occur during sleep.

Another phenomenon pointing towards the conclusion that dreams are experiences during sleep is REM sleep behaviour disorder (RBD). In RBD the muscle atonia that normally paralyzes most muscles during the REM sleep does not function fully and as a result, during REM sleep RBD patients may perform complex and vigorous motor movements (Schenck et al., 1986). This implies that during REM sleep brains generate

motor commands, but they are normally blocked by the muscle atonia. This raises the possibility that these movements can sometimes be dream enactment behaviours in which patient performs movements in his dream and because of the lack of muscle atonia, his body also performs these movements in the external world (Revonsuo, 2006; Valli et al., 2015).

There is some empirical evidence for this view from studies trying to match the movements exhibited during REM sleep by RBD patients to dream reports acquired after an awakening immediately following the movements (Valli et al., 2015). Since RBD movement starts during sleep, carry on for some time and after an awakening can sometimes be correlated with dream report, the parsimonious interpretation seems to be to assume that the patient had an experience with temporal duration during sleep that caused this behaviour. However, one could also argue that RBD behaviour would be explainable with something like a cassette theory where unconscious production of false memory would be accompanied by motor movements without experience and it is noteworthy that not all awakenings of RBD patients after movements are accompanied by dream recall.

Observations that dream reports elicited after long period of REM sleep tend to be longer and more complex than those given after an awakening conducted near the start of REM period (Goodenough et al., 1965; Stickgold, 2001) as well as the fact that nightmares tend to wake people up with clear recall of horrifying experience that peaked just before the awakening are also elegantly explained by assuming that dreams are experiences with temporal duration occurring during the state of sleep.

All in all, none of the evidence presented here provides conclusive evidence that dreams *must* be experiences but they do all point towards that conclusion. Even more importantly, they demonstrate that it is possible to try to empirically investigate whether the experiential hypothesis holds or not. This makes the experiential hypothesis reside within the realm of scientific inquiry instead of just being an epistemological axiom one must adopt to be able to believe in the scientific study of dreams as experiences. In the light of these evidence and the possibility of future verification or falsification, I find it more reasonable to accept the experiential hypothesis than to reject it and therefore proceed with the background assumption that dreams, and nightmares, are experiences that occur during sleep.

2.2.2. Transparency hypothesis: Can we get information about dreams?

Transparency hypothesis states that: "*Dream reports are epistemically transparent in the sense that they are trustworthy sources of evidence about the occurrence and phenomenal character of experience during sleep*" (Wint 2015, p.6)

What Windt means by this is that dream reports, the end product of dream reporting behaviour, are reliable enough source of information that scientific investigation of dreaming is possible. This does not mean that all dreams can be reported nor that all dream reports are complete descriptions of dream experiences. Some dreams will be forgotten and some details of dream are very hard to report, but under ideal reporting conditions dream reports can be seen as trustworthy descriptions of experiences that occurred during sleep and therefore are a valid source of information about existence and phenomenal characteristics of dreams.

The critical question concerning the transparency hypothesis is whether there are any means it can be proven or disproven. The reason Windt (2013, 2015) argues we should accept this hypothesis is that it is the best explanation available for dream reporting behaviour. She uses the philosophical method called Inference to the best explanation (IBE) (Mackonis, 2013) to construct the following argument:

> The surprising fact C, is observed.
>
> But if A were true, C would be a matter of course.
>
> No available competing hypothesis can explain C as well as A does.
>
> Hence, A is true.

Now if C is dream reporting behaviour and A is transparency hypothesis that claims dream reports are reports about experiences during sleep, then we should infer that A is true as long as it is the best available hypothesis. Windt (2013) argues that the reasons why transparency hypothesis is better than for example the cassette theory, is that it is simpler, is in line with many empirical observations and helps to advance science. This increases the "explanatory loveliness" of the transparency hypothesis higher than cassette theory and by IBE it should be accepted, at least until a better explanation is presented.

I agree that accepting the transparency hypothesis seems to be the most fruitful way of conducting empirical dream research as it allows dream scientist to continue producing data with existing methods in hope of making progress. However, I feel the IBE is not very convincing argument for the truth of the hypothesis. The last step, inferring the truth of A, is too strong: If one hypothesis is the best available explanation to a phenomenon, *it does not mean that it is true*. It only means that we do not have a better alternative. It is completely possible for all competing hypotheses presented to explain a phenomenon to be false. Conducting research under the transparency assumption might be the best, or even only, alternative to actually gather empirical data but this requires a degree of epistemological belief that I feel uncomfortable with.

While the transparency hypothesis is an epistemological claim that is not meant to be an empirical question, I will briefly entertain the idea of trying to test it empirically. If we could conceive a way to test this hypothesis, even if it is impractical with current methods, I would be more comfortable to accept it as an epistemological claim.

The way to empirically test a hypothesis about reliability of some measure is to compare the results of that measure to some other measure that is better understood. From 1875 to 1936 measures of length would be measured against prototype of the metre, a platinum-iridium bar with a length of a metre by definition held at *Bureau International des Poids et Mesures in France*. Accuracy of translation from one language to another is commonly measured by back-translating the translation to the original language and measuring the difference to the original. A ballistocardiograph device claiming to measure sleep stages can be compared to widely trusted polysomnographic measure of sleep stages to determine their correspondence.

While empirically there is always the problem of measurement error, and logically there is the problem of infinite regress of comparing measures, a measure that is repeatedly found to compare favourably to other trusted measures is seen as empirically validated.

With dream reporting the problem is that there *does not exists anything we can compare it to*. Dream reports are the only way to supposedly receive information about dream experiences and therefore we cannot validate their reliability against anything or empirically test the transparency hypotheses.

One might hope that brain imaging studies about the neural correlates of conscious experience could possibly serve as another way of measuring experience that could be contrasted with dream reports. There are interesting developments in this area of research (Horikawa et al., 2013) but due to explanatory gap these studies are always themselves based on subjective reports in the first place: It is not possible to measure the neural correlates of an experience without also collecting subjective reports about what was the experience the neuroimaging results are supposed to correlate with. As a result, studies of neural correlates of dreaming are studies of neural correlates of stated preceding dream reporting behaviour, not direct correlates of experience. One cannot study reliability of subjective reports by contrasting them to correlates of subjective reports.

As a result of lack of 3PP methods to produce another measure of dream experiences to compare dream reports against, transparency hypothesis seems to be untestable and therefore also *unfalsifiable*. From empirical perspective, this is very problematic: Unfalsifiable claims are widely seen to be outside the scope of science (Popper, 1934/2005) which leads to a situation where scientific study of dreaming rests on an axiom that is not scientific. Even if it transparency hypothesis is actually true, if there

is no way to prove it empirically, we have more practical than scientific reasons to believe in it.

This makes me tempted to bite the bullet and reject the transparency hypothesis altogether which would also undermine the experiential hypothesis as it is based on observations that require some sort of transparency of dream reports. However, absence of proof is not a proof of absence, and this rejection would also be an assumption with no possibility of verification with the empirical methods currently available to science. This is why transparency hypothesis is a philosophical problem: It cannot at the moment be solved by empirical sciences.

Windt (2013, 2015) adopts an anti-sceptical view of dreaming where the experiential and transparency hypotheses are accepted as the best available background assumptions to support the scientific study of dreaming. While this is a sensible move with regards to the advancement of science, I will not adhere to the anti-sceptical view. Instead I will adopt an agnostic position concerning the transparency hypothesis: While it is a reasonable assumption that dream reporting behaviour is evoked by dream experiences we simply do not know whether dream reports correspond to these experiences reliably enough for making meaningful inferences about dream experiences.[4]

My motivation for adopting this quite strong position are twofold: Firstly, I see agnostic position regarding transparency hypothesis logically coherent as there are no undeniably reasons to accept it. Secondly, I think that working with stricter background assumptions than is common in empirical dream science might lead to more rigorous and novel interpretations of the results of my empirical studies.

---

[4] These problems also generalize to subjective reports in any state of consciousness. If we define dreams as phenomenal consciousness during state of sleep and normal waking consciousness as phenomenal consciousness during a waking state, both of which are subjective experiences that can only be investigated via subjective reports, we arrive to a conclusion that there are no categorical differences between the two in regards to scientific investigation: We rely on subjective reports to infer existence of both dreaming and waking consciousness from 3PP.

This means that we also need the experiential and transparency assumptions as background assumptions for the study of *any* experience and the main difference in studying dreaming and waking would be that it is easier to gather waking reports under ideal reporting conditions than it is to collect dream reports with similar rigor.

These ideas tie into larger methodological challenges of studying consciousness in general but they are also relevant to epidemiology of any subjective symptoms. One could argue against reliability of waking reports of experiences of depression, loneliness or life satisfaction, especially under non-ideal reporting conditions like retrospective questionnaires. However, I will not pursue these ideas further at the moment.

2.3. METHODS FOR STUDYING DREAMING

Philosophically, methods of empirical dream research rest on assumptions that the experiential and transparency hypotheses are true, or at least the interpretations of data would change should this not be the case. However, from empirical perspective the transparency of dream reporting is not all or nothing proposition. Instead it can be seen as a continuum from dream reports that do not correspond to dream experience at all to dream reports that correspond to dream experience as closely as is possible with subjective reports.

Windt (2013, 2015) proposes that transparency of dream reports holds under *ideal reporting conditions* and as reporting conditions become less ideal the transparency of reports diminishes.

What Windt does not do, is to give a single criteria for what the ideal reporting conditions are. She considers only one factor, temporal proximity between the dream and the report, to always be part of ideal reporting conditions (Windt, 2015 p.196). Otherwise the ideal conditions depend on the question about dreaming that is being investigated. Dream reporting is affected by various factors including types of reports collected (e.g. verbal, written, checklist, drawings), phrasing of questions about dreams, whether reports are collected after spontaneous awakening, controlled awakening or retrospectively, sleeping environment, introspective skills and motivation of the participants among other things (Windt, 2015).

The way I understand the ideal reporting conditions of dream reporting is that they are conditions that seek to minimize the sources of error plaguing dream reporting and these sources of error differ depending on the research question under investigation.

2.3.1. From experience to data

In dream research, three steps are required to produce data from the dream experience. During each step there are potential sources of error that might interfere with production of reliable data from the experience.

First, the research subject having the experience must have cognitive access to the experience and must be able to form a memory of the experience. If subject is giving the report in very close temporal proximity to the experience, the progress of reflecting on the experience may change the experience.

Second, to produce a dream report, the subject must be able to recall the experience. In the case of giving the report immediate after awakening, this involves reflecting on

the dream and holding it in short term memory long enough to produce a report. In the case of retrospective investigation, the subject must use his long term memory to try to recall relevant information for the questions he is presented with. In this situation, memory heuristics that enhance recall of some aspects of experience while neglecting others come into play (Kahneman, 2011). It has also been shown that attitude towards dreams plays an important part, at least in retrospective dream recall, with subjects who are very interested in their dreams recalling more dreams than those with less interest in their dreams (Aspy, Delfabbro, & Proeve, 2015; Zadra & Robert, 2012).

After successful recall a subject must be able to produce a dream report, the first behaviour that can be observed from the 3PP. Potential sources of error in producing a dream report include the subject´s ability to describe the experience and social factors like censoring parts of the dream that are embarrassing and confabulating parts that are hard to recall or seem illogical. If the research utilizes questions instead of a free report, the interpretation of those questions may differ between subjects or even affect how the dream is recalled (Rosen, 2013).

Finally, when subject has produced a report, generally before it can be used as data it will be transformed in some way. Free reports are usually content analysed according to some content analysis system such as Hal and Van de Castle(Hall & Van de Castle, 1966). This involves reducing the report to predetermined categories by external judges and the process introduces potential sources of error with the subjective element in the dream scoring and applicability of the categories used. If the data from a dream report is collected with questions, then the data reduction from the report to the data happens when the subject answers the questions, and question interpretation as well as the validity of the questions can introduce noise to the signal.

In the Figure 1 the tree steps from experience to data and the potential sources of error they introduce to research are summarised. This model is very general one and the steps and error sources differ between different methods. However, the fact that measuring dreams is always indirect with many potential pitfalls is hopefully illustrated to a satisfactory degree. In the light of this three step model, reporting conditions could be seen as ideal as possible if they minimize as many of these potential sources of error as possible.

DREAM EXPERIENCE

- Does the experience exists?
- Cognitive access to the experience
- Memory formation, temporal distance to the experience

MEMORY OF THE EXPERIENCE

- Ability to recall the experience, memory heuristics
- Ability to describe the experience, introspective and language skills
- Social desirability, confabulation, censorship, motivation
- Interpretation of the questions, effect of the research setting

DREAM REPORT

- Method used to collecting the report, instructions to the participant
- Data reduction, instruments or questionnaires, content analyses

DATA

- Research questions to be answered, exploratory or hypotheses driven
- Interpretation of the data, usage of statistics

Figure 1. Three steps from experience to data

2.3.2. Questionnaires

The easiest way to get information about dreams is by retrospective questionnaires. Questionnaires can be administered to a large number of subjects in short period of time and in practice, they are the only feasible way to study dreams in samples representative of large populations.

Drawback of questionnaires is that they are generally temporally distant to the experience under investigation and the questions that can be used in a questionnaire administered to a large population must be simple and short for analyses of large datasets to be feasible. This means that questionnaires are limited to investigate very

simple and phenomenologically poor aspects of dreaming and generally constitute less than ideal reporting conditions increasing the uncertainty whether the questionnaire answers correspond to the actual dreaming. Also, estimates of dream recall frequency (DRF) produced by questionnaires are lower than those produced by other methods and this likely means that in questionnaires people underestimate their true dream frequency (Aspy, 2016; Aspy et al., 2015), including nightmare frequency (Robert & Zadra, 2008).

Case can be made that answers to retrospective questionnaires do not constitute dream reporting at all but instead investigate people's attitudes and conceptions of their dreaming.

However, while questionnaires have serious drawbacks, they are the only practical instrument to study dream related variables in large representative population samples and for certain questions, the representativeness of the sample is of utmost importance. For example, the question about what is the prevalence of nightmares among general adult population of a specific country cannot be investigated with a sample of 15 university psychology students without making the ill-advised assumption that there are no factors affecting nightmare frequency that would vary between those students and the rest of the population. Representative samples are especially important when conducting epidemiological research as we will see in chapter 3.2.

2.3.3. Dream logs

Dream logs are open ended or structured questions about dreaming that the participant fills in right after waking up, usually at home. Diaries have advantage over questionnaires in the temporal proximity to the dream experience as they are filled in right after awakening. They also have advantage over dream laboratory studies in ecological validity as participants can sleep in their natural sleeping environment. However, generally diaries are limited to investigation of late-REM dreams that the participant is probably experiencing before a natural awakening and therefore cannot be used to investigate dreaming throughout the night.

Dream logs produce higher estimates of dream recall than questionnaires but lower than laboratory studies. It appears that while questionnaires underestimate DRF, keeping a dream log may increase DRF above typical levels for the participants and therefore overestimate DRF (Aspy, 2016; Aspy et al., 2015). There might not be a way to measure DRF without affecting it making a true estimate of natural DRF impossible.

Though keeping a dream log may increase dream recall frequency, dream log studies probably represent the most ideal reporting conditions for investigating naturally occurring dream recall and therefore might be the best method to also study frequency of distressing dreams (Robert & Zadra, 2008; Zadra & Robert, 2012).

The major drawback of dream logs is that they usually require long term commitment and high motivation from the participant (Zadra & Robert, 2012) and as a result, they are most often conducted in samples of students with good sleep quality and interest in their dreams. This makes the generalization of the results to the level of general population or even to humans as a species problematic.

2.3.4. Dream laboratory

The most involved method for producing dream reports is a laboratory study in which participants sleep in controlled environment where their sleep stages are monitored and they are usually woken up under certain conditions (such as 15 minutes into REM stage) and probed for immediate report of their experiences before the awakening.

Dream laboratory studies are the most ideal reporting condition when it comes to temporal proximity to dream experience and they are considered as the golden standard of collecting reports of dream content. They are also the only way to study dreaming over the whole sleep cycle and not just after spontaneous awakenings.

The disadvantages of dream laboratory is the great amount of effort it requires from the participants and experimenters making samples of these studies generally very small and typically only consisting of highly motivated participants (that are usually psychology students). The other problem is the lack of ecological validity: Dream laboratories are highly unusual sleeping environments and elements of the laboratory and study itself are often incorporated into the dream narratives. A special problem concerning study of nightmares is that nightmares are rarely experienced in the laboratory setting, even among participants with repeated traumatic nightmares (Woodward et al., 2000).

2.4. PHILOSOPHICAL BACKGROUND FOR THE CURRENT THESIS

The philosophical position concerning the nature of dreaming and dream research I have arrived at is as follows:

We cannot objectively observe or verify dreams, only dream reporting behaviour. Regardless, the best available explanation for dream reporting and enactment behaviour as well as ludic dreaming is that people have dream experiences, that is, subjective contents of consciousness without correspondence to external world during state of sleep. After waking up, or during special circumstances while still asleep, they try to convey information about these experiences via dream reporting.

However, currently there are no adequate empirical means to investigate what is the correspondence between dream experiences and dream reports. It is reasonable to

assume that the correspondence is at its best under ideal reporting conditions, but even under ideal conditions it is impossible to empirically test just how accurate the correspondence is.

Therefore I remain agnostic about reliability of dream reports even under ideal reporting conditions: I do not claim that dream reports are not accurate enough sources of information to do science but instead I posit that there is no scientific way of assessing how accurate they are.

Scientific study of dream content under ideal reporting conditions must accept this uncertainty by making a commitment to the transparency of their data without solid proof, but more importantly, the empirical studies we have conducted are based on retrospective questionnaire measures and these certainly do not count as ideal reporting conditions.

Therefore, I will not commit to transparency of the data that is about to be presented: It is not a reliable measure of dreaming as subjective experiences during sleep.

This is an awkward philosophical position to take as far as the current thesis is concerned: Empirical studies we have conducted rest on dream reporting under less than ideal reporting conditions, a source of information that I do not trust. Does my epistemological stance undermine the empirical results that follow?

The answer is not as clear cut as it might first seem. The reliability of our results actually depend on how I am going to frame the question I think our empirical results provide an answer to.

Should I claim to be investigating nightmares as dream experiences, the answer would be yes: The methods used in the current thesis do not reliably convey information about nightmares as subjective experiences undermining the results.

Still, our empirical studies *measured something with robust association to measures of wellbeing* and considering prior work on the topic, we believe to have measured something quite similar to other epidemiological studies on nightmares.

The way I will proceed with the thesis is to aspire to frame our empirical research in such a way as not to rely on the transparency hypothesis but instead formulate a conservative interpretation of what we measured which is not undermined by the philosophical problems of measuring subjectivity. My hope is that this self-inflicted epistemological handicap will increase the rigor of our results without rendering them invalid.

However, I will not try to define what we measured just yet. Instead, I will first review prior empirical work on epidemiology of nightmares and describe our empirical studies in detail. The question of epistemological validity and the correct interpretation of our results will be revisited afterwards in the chapter 6.2.

3. EMPIRICAL BACKGROUND: NIGHTMARES AS A CLINICAL PROBLEM

Empirical research on nightmares rarely concerns itself with problems related to nature of dreaming or transparency of dream reporting. Instead using the background assumptions of the received view on dreaming, it aspires to investigate what kind of people have nightmares, how often they have nightmares and what other problems they might suffer from.

In this chapter I will review previous empirical research on nightmares that bears relevance to epidemiological studies on the subject.

The first step is to examine how nightmares are operationalized for epidemiological studies. Nightmares are generally measured with some kind of a questionnaire and the definition of a nightmare given (or not given) to the participant affects the results of these studies.

After analyzing the definitions of nightmares used in empirical research I will review empirical results concerning prevalence and correlates of nightmares and briefly summarize perspectives on treatment and theories of nightmares. Finally the empirical aims of the current thesis are laid out in more detail in the light of previous research on the subject.

3.1. CLINICAL DEFINITIONS OF NIGHTMARES

The International Statistical Classification of Diseases and Related Health Problems, version 10:2016 (ICD-10) defines nightmares in the following way:

> *Dream experiences loaded with anxiety or fear. There is very detailed recall of the dream content. The dream experience is very vivid and usually includes themes involving threats to survival, security, or self-esteem. Quite often there is a recurrence of the same or similar frightening nightmare themes. During a typical episode there is a degree of autonomic discharge but no appreciable vocalization or body motility. Upon awakening the individual rapidly becomes alert and oriented.* (World Health Organization, 2016)

Definition in the Diagnostic and Statistical Manual of Mental Disorders, Fifth edition (DSM-V) is quite similar:

> *Repeated occurrences of extended, extremely dysphoric and well-remembered dreams that usually involve efforts to avoid threats to survival, security, or physical integrity and that generally occur during the second half of the major sleep episode. On awakening from the dysphoric dreams, the individual rapidly becomes oriented and alert.* (American Psychiatric Association, 2013)

For DSM-V diagnoses of nightmare disorder, nightmares must also cause "clinically significant distress or impairment in social, occupational or other important area of functioning" and not to be attributable to physiological effect caused by some substance or be a secondary symptom of mental or medical disorder.

Third definition is presented in the International Classification of Sleep Disorders, third edition (ICSD-3):

> *A nightmare is a common occurrence in which a person has an intense, frightening dream that causes an awakening. Often upon awakening, the person is still frightened because of the intensity of the nightmare.* (American Academy of Sleep Medicine, 2014)

These clinical definitions share two core elements: Nightmares are dreams with intense negative emotions and they are easily recalled after awakening because of the intense arousal caused by the dream.

These definitions do not define what is meant by dreaming, but they work well with the definition of dreaming as experiences, or spatiotemporal hallucinations during sleep and they implicitly assume received view of dreaming to be true. However, slight disagreement exists in the definitions about the scope of emotions that can be considered to be nightmarish and whether the dream must lead to an awakening to be considered a nightmare. In clinical context it is also important to consider whether

nightmares are of post-traumatic or idiopathic variety and whether they cause distress or not. In this chapter I will analyse these components of the definitions of nightmares one by one.

3.1.1. Waking criteria

Many dreams contain negative emotions but are not considered to be nightmares. Lack of a clear definition of a nightmare hampers the comparisons between empirical studies on nightmares. Therefore a clear behavioural sign of a nightmare would be a solid foundation for a definition of a nightmare. This sign could be awakening from the nightmare: If the dream is so horrifying as to cause an awakening then it is a *nightmare*. In contrast, a dream containing intense negative emotions but which does not cause an awakening is a *bad dream* (Halliday, 1987).

Waking criterion has been part of definitions of nightmares by many researchers, including (Hartman, 1984; Levin & Fireman, 2002; Schredl, 2010; Zadra & Donderi, 2000). It is also included in the definition of nightmare in ICSD-3.

A clear behavioural sign that could be used to define a nightmare would unquestionably be useful, but is waking criterion a valid way of defining a nightmare? This question can be framed differently by asking whether nightmares with awakening are phenomenologically different and/or greater threat to wellbeing of the dreamer than bad dreams which do not lead to an awakening? Some empirical studies have investigated these issues.

Zadra and Donderi (2000, 2006) have studied the frequency of nightmares and bad dreams in student samples with daily dream logs and consistently found bad dreams to be more common than nightmares. These studies also found participants to either have nightmares with awakening and bad dreams or just bad dreams, but not just nightmares. Nightmares were also found to have slightly stronger correlation to measures of wellbeing and to contain more intense emotions than bad dreams. Blagrove (2006) found similar results in an independent dream log study in student sample: Nightmares were more common and had slightly more negative tone than bad dreams. Participants were also subjectively quite sure they could accurately judge whether a dream woke them up, especially in the case of nightmares. Finally, in sizeable dream log sample Robert and Zadra (2014) found nightmares to contain more intensive emotions and more aggression than bad dreams.

As a result, Zadra et al. (2000, 2006) and Levin and Nielsen (2007) propose that nightmares are a more extreme form of the same basic phenomenon of negatively toned dreams as bad dreams. They consider waking criterion in the nightmare

definition to be a useful addition that helps to identify the most severe cases of negatively charged dreams.

The waking criterion is an attractive way of defining a nightmare as it is easy to operationalize. However, even though there is some empirical evidence that nightmares with awakening are more severe than bad dreams there does not seem to be any categorical difference between the two dream types and people with nightmare problem regularly experience both nightmares and bad dreams. This makes it problematic to use waking criterion as a defining feature of nightmare because excluding bad dreams may cut out a large part of the phenomenon under investigation.

Waking criterion can be a useful tool in research to distinguish the most severe nightmares. However, particularly in epidemiological setting, investigating only nightmares causing awakening might exclude many participants who have problems with dysphoric dreaming, and it might be better to either use questions measuring both nightmares and bad dreams or one item which includes both. Since bad dreams are more common than nightmares, it is also important to pay attention to the definition used in empirical research when comparing prevalence estimates obtained in different studies.

From here onwards I will make a distinction between different operationalisations of nightmares in the following way: When I use the term *nightmares*, I mean all dysphoric dreams, whether they wake up the dreamer or not. Usually I will use this term when referring to a study that did not define nightmares for the study participants. When I use term *bad dreams*, I mean dysphoric dreams that did not wake up the subject and when I use term *nightmares with awakening* I refer to a dysphoric dream that caused the dreamer to wake up. I generally use these terms when referring to a study that uses waking criterion in the definition of a nightmares.

3.1.2. Content of nightmares

Typically nightmares are thought of as frightening dreams and definitions of ICD-10 and ISCD-3 reflect this notion. Regardless, empirical research has shown that people experience dreams with various negative feelings as nightmares. The dream log study with large sample by Robert and Zadra (2014) found fear to be the dominant emotion in 65% of nightmares with awakening and 45% of bad dreams. Other common emotions were sadness, anger and confusion. Therefore, it is too simplistic to see nightmares only as scary dreams: Even though fear is the most common emotion, any intense negative emotion can constitute a nightmare (Robert & Zadra, 2014; Zadra et al., 2006).

Important distinction regarding content of nightmares is whether nightmares are related to an actual frightening waking experience. Idiopathic nightmares have

content that has no clear relation to traumatic waking experiences although psychoanalytic tradition would posit that these nightmares could be related to traumatic events in indirect, symbolic ways. Be that as it may, post-traumatic nightmares have content that is related to actual highly distressing waking experience in quite a direct manner. We shall return to post-traumatic nightmares soon, but first review typical content of idiopathic nightmares.

In a dream log study of Canadian students and volunteering adult participants (Robert & Zadra, 2014) the most common theme of idiopathic nightmares with awakening was physical aggression defined as "Threat or direct attack to one´s physical integrity" while the most common theme of bad dreams was interpersonal conflicts defined as "Conflict based interaction between two characters involving hostility, opposition, insults, humiliation, rejection, infidelity, lying, etc." Interestingly, other studies investigating nightmare content with retrospective questionnaires have found falling and being chased very common nightmare themes besides physical attacks (see Robert & Zadra, 2014 for review). Falling and being chased were the two most common nightmare themes also in the questionnaire study by Schredl (2010) that sets itself apart from most dream content studies with a random population sample of 2019 participants instead of a sample mostly consisting of students.

Nightmares are consistently found to be more common among women than men but data on sex differences in nightmare content are scarce for two reasons: First, there does not exists many high quality studies about nightmare content in the first place, and second, samples of the existing studies tend to have few male participants. In the previously mentioned studies Canadian men reported more themes of disasters and insects than women and women reported more themes of sexual harassment (Robert & Zadra, 2014) while German men reported more themes of physical aggression, war/terror and job loss than women while women reported more themes of sexual harassment, close persons disappearing or dying and teeth or hair falling out than men (Schredl, 2010).

Interestingly, in the questionnaire study conducted in Germany (Schredl, 2010) some nightmare themes including horror films, examinations, quarrel with spouse, loss of job and disgracing oneself and sexual harassment decreased with advancing age among adults.

3.1.3. Post-traumatic nightmares and post-traumatic stress disorder

After experiencing or witnessing a traumatic event such as serious accident or violent crime most people experience anxiety and nightmarish dreams about the event for some time, but these generally disappear on their own as person recovers from the

trauma. However, minority of trauma survivors develop a long term problem of Post-Traumatic Stress Disorder (PTSD).

In DSM-V diagnostic criteria for PTSD require exposure to trauma (defined as actual or threatened death, serious injury or sexual violence) either by the patient himself or by someone very close to him. After trauma exposure person begins to re-experience the trauma by having intrusive thoughts, nightmares and flashbacks and develops avoidance behaviour towards trauma related stimuli, symptoms of depression and heightened arousal especially in response to trauma-related stimuli.

Recurrent replicative nightmares about the original trauma are a key symptom of PTSD. Content of these post-traumatic nightmares may accurately replicate the original trauma, replicate it with variations or just contain unmistakable elements of the event. Most accurate replicative nightmares tend to be the most severe and cause the greatest amount of distress. Around half of the patients diagnosed with PTSD report replicative nightmares with around a quarter reporting trauma-related non-replicative nightmares (Levin & Nielsen, 2007; Pigeon & Mellman, 2017; Ross et al., 1989).

Prevalence estimates of PTSD, even in similar populations, have large variation due to different ways the disorder is measured, but lifetime prevalence of PTSD in the general population of United States is estimated to be around 5% for men and 10% for women with 12-month prevalence being around 2% (Krystal, Stein, & Szabo, 2017). Among general population sudden deaths of loved ones and violent crime are the most common triggering traumatic events (Breslau, 2001; Pigeon & Mellman, 2017). As PTSD is triggered by exposure to trauma, the prevalence varies significantly as a function of the risk of trauma exposure of the study population. As a result, prevalence estimates from one area of the world or from certain professions cannot be generalized to be representative of other populations facing different odds of trauma exposure.

Shortly after disasters (industrial accidents, terrorist attacks, natural disasters) survivors as well as rescue workers have been found to have PTSD prevalence of up to 40% (Neria, Nandi, & Galea, 2008). Large scale disasters can also cause PTSD symptoms to large populations via indirect exposure by media coverage and by loved ones being exposed to the disaster. After 9/11 terrorist attack in New York, prevalence of PTSD measured by internet questionnaire administered to a representative population sample was found to be 11.2% in New York Metropolitan area compared to national point prevalence of 4.0%. Time watching news coverage of the attack was a significant predictor of PTSD symptoms (Schlenger et al., 2002). Another international internet questionnaire study also found nightmare frequency of male participants to have increased after 9/11 (Nielsen, Stenstrom, & Levin, 2006).

PTSD is also more common among professions who deal with traumatic events in their work. Recent meta-analysis found 10% of the rescue workers from various

countries to suffer from PTSD (Berger et al., 2012). War experiences are cause of PTSD which has received the most attention. In fact, the modern concept of PTSD was formulated in 1970´s in the aftermath of widespread problems experienced by soldiers returning to US from Vietnam War. Prevalence of PTSD among war veterans is a politically loaded issue and the estimates of these problems among US veterans of Vietnam and Iraq wars vary significantly between studies with range of around 2-17% (Richardson, Frueh, & Acierno, 2010). Post-traumatic symptoms related to war experiences can persist for decades. In studies by Schreuder et al. (1998, 2000) it was found that Dutch war veterans reported war related dysphoric dreams still 40 years after the end of the war.

3.1.4. Nightmare distress and nightmare frequency

Nightmares are associated with mental health problems and even suicide risk but dreams as experiences, distressing as they may be, do not in themselves cause harm. Therefore the adverse effects of nightmares are mediated by the dreamer´s emotional reactions, attitudes to and interpretations of her nightmares. This is reflected in the divide between *nightmare frequency*, which is the absolute number of nightmares, and *nightmare distress*, which is the psychological disturbance caused by nightmares.

In empirical studies nightmare distress is not strongly correlated with nightmare frequency and nightmare distress has stronger correlations to adverse outcomes such as measures of psychopathology than nightmare frequency, at least among student samples (Belicki, 1992; Levin & Fireman, 2002)**.** It appears that there are people who have frequent nightmare but experience little distress about their dreams and people who have few nightmares which nevertheless cause great distress to them. Levin and Nielsen (2009, 2007) have framed the concepts of nightmare distress and frequency in a slightly different way in the framework of their neurocognitive theory of nightmares. Their view is that the number of stressors the dreamer experiences, called affect load, is strongly related to dream and nightmare frequency but not to nightmare distress. Instead, the dreamer's reaction to stressors, called affect distress, then determines the severity of nightmares and level of distress they cause.

Regardless of the exact formulation of these concepts studies of nightmares as a clinical problem should measure nightmare distress and frequency separately. If people are grouped only by their nightmare frequency, the same group of frequent nightmare dreamers may contain both people who perceive nightmares as a problem and those who do not. A separate measure for frequency and distress would give a more complicated but most likely also more correct picture of the relationship between nightmares and wellbeing.

3.1.5. Usage of definitions of nightmares

So, what are nightmares? The phenomena under investigation here are dream experiences containing intensive negative feelings, in the general sense called *dysphoric dreaming* (DD)[5]. What counts as DD and especially nightmare is a matter of drawing boundaries into the space of all possible dream experiences and those boundaries are bound to be arbitrary.

In the Figure 2 simple visual representation of the situation is presented: If we represent all possible dream experiences with only two dimensions, emotional intensity from low to high and emotional valence from positive to negative, the dreams we label as nightmares will be located in the area at the corner of high intensity and negative valence. However, as the space of dream experiences is continuous in all dimensions, there does not exist obvious boundary or step where to draw the line separating nightmares from rest of DD or dreaming in general: Different definitions frame different parts of the space as nightmares proper and there is no clear consensus in the literature on a single definition.
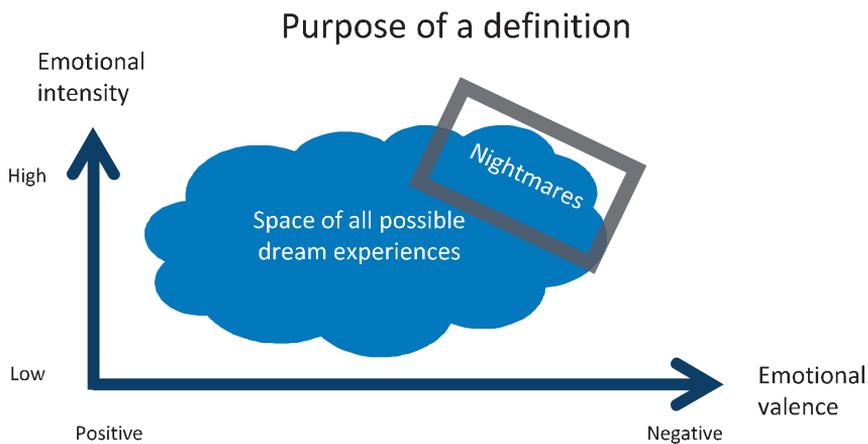
Figure 2. Definitions aim to carve out area from space of all possible dreaming.

When defining a class of natural phenomenon (in contrast to logical entities), the criteria for a good definition stem from its use: As the definition is bound to be arbitrary, it should be constructed in such a way that it is a useful tool for the purposes it is defined for. Criteria for usefulness depend on the context and in the

---

[5] Under the anti-skeptical assumptions that dreams are reportable experiences occurring during sleep.

case of nightmares in research, it depends on the research question of the study using the definition and in clinical setting the definition should include those people who actually have a current problem with dysphoric dreaming.

The clinical definition usually rest on the waking criterion defining nightmares as a DD that must awaken the dreamer. This definition is used in several dream log studies usually conducted among university students (Zadra & Donderi, 2000; Zadra et al., 2006) and in some questionnaire studies (Schredl, 2010).

In terms of the space of dream experiences, waking criterion tries to establish a natural boundary that would allow us to frame nightmares in a natural, non-arbitrary way. It stems from the thinking that nightmares are a failure of the function of dreaming and therefore can be defined as a category of dreaming that has a clear and measurable difference to all other dreams.

However, while nightmares with awakening are found to be generally more intensive than bad dreams, there is no compelling empirical reason to consider the difference between nightmares with awakening and bad dreams as being that of the kind and not of a degree (Levin & Nielsen, 2007). Instead, the difference appears to relate to the intensity of the emotion and might also be affected by factors unrelated to dreaming such as the time of night and general sleep quality of the dreamer.

Most importantly, both nightmares with awakening and bad dreams can cause distress and this makes the waking criterion problematic as the defining aspect of nightmares, at least in research focusing on associations between nightmares and well-being. As the intensity of bad dreams and nightmares is a continuum, it is highly unlikely that the distress caused by bad dreams would be a non-significant predictor of the same problems as nightmares with awakening. Therefore, ignoring bad dreams in the study population would cause one to overlook around 75% of the DD that participants experience and that may be clinically significant.[6]

Though waking criterion might be too strict a cut-off as a sole definition of a nightmare, asking study participants both about their nightmares with awakening and bad dreams separately can give interesting information about both the frequency and intensity of nightmares in the population assuming that nightmares with awakening are systematically more intense than bad dreams. However, in questionnaires with

---

[6] If boundary between nightmares and bad dreams is seen as a continuum, also the boundary between bad dreams and dreams in general can become blurry. This is a problem with no clear answer. If nightmares are separated from rest of the dreaming only be intensity of negative emotions, the threshold of intensity will always be arbitrary as well as very hard to measure. Practical approach would be to leave the assessment to the participant, but this makes the measurement of nightmares even more subjective than it already is.

limited space this might not be practical and a single broader definition of a nightmare might be a preferable solution.

Classical definitions of nightmares typically state that for a dream to be a nightmare, the dominant emotion must be fear. Though this typically is the case, the proportion of other negative feelings in dream people consider being nightmares is not insignificant (Robert & Zadra, 2014; Zadra et al., 2006). In the light of these results, DSM-V way of defining nightmares as extremely dysphoric dreams instead of frightening dreams might be a good solution. The intensity of emotion during a nightmare is more important than the exact nature of the negative emotion experienced.

Post-traumatic nightmares that replicate the trauma can be considered to be the most severe form of DD. Replicative nature of post-traumatic nightmares might have potential to be a natural boundary where one could draw line in the space of dream experiences and claim to have definitely isolated nightmare territory. The problem of using traumatic nightmares as a component of definition of nightmares is again that it is too strict criteria and excludes many dreams of even chronic nightmare sufferers (Pigeon & Mellman, 2017). However, in research investigating nightmares and wellbeing it would be beneficial to investigate whether nightmares reported by the subjects are traumatic in nature, or does the subject experience only idiopathic nightmares. By making this distinction it would be possible to investigate whether traumatic nightmares are associated with more problems of wellbeing than idiopathic ones.

When dreams are seen as subjective experiences cutting out nightmares from the space of possible experiences is always arbitrary. Therefore when investigating nightmares and their effect on wellbeing, in the end the most important measurement one can make might be simple subjective assessment of nightmare distress. The few studies which have investigated relation between nightmare frequency and distress point toward this conclusion: Nightmare distress is the variable most strongly correlated with psychopathology (Levin & Fireman, 2002) and since retrospective assessment of nightmare frequency is in any case somewhat unreliable, just measuring subjective nightmare distress could be a better variable than any other criteria discussed here to identify people who have problems with nightmares.

The focus of the current thesis will be epidemiology of nightmares among the general adult population and unfortunately studies investigating nightmares in representative population samples tend to share one common characteristic: They do not define nightmares for the study participants at all, but instead rely on variations of the very general question: "Have you had nightmares?"

Answering this question leaves the definition of a nightmare up to the participant and the researcher remains in the dark about what the participants consider nightmares

to be. Interestingly, even in studies conducted in different cultures results produced by this kind of question are quite comparable with prevalence estimates for frequent nightmares falling to a range of 2-6% among adult population (see chapter 5.1.2.). This implies that the reliability of the question measuring nightmares without definition is decent: People in many different cultures appear to understand the question in similar way. However, the validity of this question is unknown: It measures nightmare distress and frequency at the same time and includes both idiopathic and post-traumatic nightmares with and without awakening.

3.1.6. Ideal questionnaire for epidemiological study of nightmares

Based on the discussion concerning definition and nature of nightmares, I shall now sketch what would a comprehensive but compact questionnaire investigating nightmare frequency look like. There are three main themes that could be considered in this kind of questionnaire: The waking criterion, whether nightmares are idiopathic or posttraumatic and how much distress they cause.

A long version of nightmare questionnaire investigating all of these themes would have questions about frequency of nightmares with awakening and bad dreams, then follow-up questions on whether the nightmares with awakening and bad dreams are related to actual (traumatic) experiences. This line of questions could be the further explored with questions whether traumatic dreams are of replicative or symbolic in nature or is there continuity with waking life in general without relation to a trauma. Lastly, the questionnaire should investigate nightmare distress and possible daytime consequences of nightmares.

Shorter version of the questionnaire could be useful when there are strict length limitations concerning the questions. This version would drop the distinction between nightmares with awakening and bad dreams as well as questions about replicative nightmares.

An example of the form these questionnaires might take is presented in Box 1. In addition to direct questions about DD there could be questions about general dream recall frequency and attitude towards dreams as baseline dream recall frequency is a confounding factor for measuring dream frequency.

Both versions of the questionnaires could be used with various different frequency options. When selecting the time period that would be under investigation, it should be kept in mind that the longer the period, the more likely is that the participants don't remember their nightmare frequency accurately. However, just investigating a period of week of days might be more prone to random effects.

Answer options for questions Q1, Q2, Q1s and Q2s could range from "almost every morning" to "I did not have nightmares/bad dreams."

Answer options for Q3, Q4 and Q2s questions could be "Most of my nightmares were like this, Some of my nightmares were like this, I did not have nightmares like this."

Answer options for Q5 and Q3s would be: "I am often distressed by my nightmares and they interfere with my sleep and daily life, I am sometimes distressed by my nightmares and they sometimes interfere with my sleep and daily life, Even though I sometimes have nightmares, they do not affect me in any way."

These kinds of questions would allow researchers to make inferences about the main dimensions of the nightmare problem: Frequency, distress and linkage to traumatic experiences. However, to my knowledge no study has used this kind of combination of questions, at least not with a sample of decent size and representativeness.

Long version of the nightmare questionnaire

Q1. During the last 30 days, how often have you had nightmares? Nightmares are dreams that evoke so strong negative feelings that they wake you up.

Q2. During the last 30 days, how often have you had bad dreams? Bad dreams are dreams that evoke strong negative feelings but do not wake you up.

Q3. If you had nightmares **that woke you up** during the last 30-days, what kind of nightmares these were?

> **Q3a.** Nightmares that accurately replicate exceptionally scary or unpleasant experience that has happened to you?
> **Q3b.** Nightmares that are related to, but do not accurately replicate exceptionally scary or unpleasant experience that has happened to you?
> **Q3c.** Nightmares that are related to experiences in your daily life which were not exceptionally scary or unpleasant?
> **Q3d.** Nightmares that do not have any clear relation to your daily life?

Q4. If you had bad dreams that were unpleasant, but **did not wake you up** during the last 30-days, what kind of bad dreams these were?

> **Q4a.** Bad dreams that accurately replicate exceptionally scary or unpleasant experience that has happened to you?
> **Q4b.** Bad dreams that are related to, but do not accurately replicate exceptionally scary or unpleasant experience that has happened to you?
> **Q4c.** Bad dreams that are related to experiences in your daily life which were not exceptionally scary or unpleasant?
> **Q4d.** Bad dreams that do not have any clear relation to your daily life?

Q5. How do your bad dreams and nightmares affect your daily life?

Short version of the nightmare questionnaire

Q1s. During the last 30 days, how often have you had nightmares? Nightmares are dreams that evoke strong negative feelings.

Q2s. Do you have nightmares about scary or unpleasant events that have really happened to you?

Q3s. How do your bad dreams and nightmares affect your daily life?

3.2. EPIDEMIOLOGY OF NIGHTMARES

Epidemiology is a science of populations. In a situation where many different individuals exhibit some condition, usually a disease, and there is incomplete understanding of why this occurs, methods of epidemiology can be utilized as a first line of research towards understanding the causes of this state of affairs. Epidemiology searches for systematic patterns in data: How many people in certain population are suffering from a disease at certain point of time (prevalence), how many new cases of disease appear over certain time in the population (incidence) and how do the prevalence and incidence of the disease differ between different sub-populations such as males or females.

For epidemiological pursuits to be successful, two things are required: The right kind of data to identify the relevant patterns and good enough measures of relevant variables setting subpopulations in the data apart from each other.

In the case of the classical historical case of cholera in London this meant data that included populations receiving water from different sources, information of the source of the water and information on the causes of death attributable to cholera in these populations. From this information it was possible to infer that something in the water from sources contaminated by sewage caused cholera. For studying epidemiology of nightmares, representative samples of general population and accurate enough measures of nightmares to set frequent nightmare sufferers apart from those without nightmares are required.

Most studies on nightmares, and dreaming in general, are conducted among small samples that often consist of university students. While this approach can produce interesting information on what kind of dreaming exists and small samples allow the use of in-depth methods, these kinds of samples are not representative of the general population of those countries studies are performed in, let alone of humans in general. Samples in psychology in general tend to be from WEIRD[7] cultures and student samples inside these cultures are more educated, younger, healthier, individualistic and motivated to participate in research than even the general WEIRD population.

In the case of study of dreaming, research that recruits participants by adverts also attracts people with high dream recall and interest in dreams and often good sleep

---

[7] WEIRD: Western, Educated, Industrialized, Rich and Democratic. A term coined in a seminal paper by Henrich, Heine & Norenzayan (2010) where it was shown that many psychological experiments that produce consistent results among western university students do not produce same results in other cultures undermining the claims that psychological experiments conducted in one culture reveal patterns universal to human race.

quality is required to take part in dream log or laboratory studies. It is easier to collect dream reports from these kind of participants, but they can´t be seen to represent majority of dreamers and especially not those with sleep problems.

While dream research trying to study phenomenology of dreaming is interested in acquiring as much high quality dream reports as possible to understand what kind of dream experiences exists, epidemiology of dreaming should be much more concerned about the representativeness of the sample about dreaming.

Epidemiology of nightmares is interested in what kind of people have nightmares and what other problems these people have. This information might reveal patterns that provide clues to the nature of nightmares both as a specific class of dream experiences as well as a clinical problem. To answer these kinds of questions, it is crucial to use samples that are representative of the population under investigation.

Representative population samples are usually characterised by large sample size but simple measures (and less than ideal reporting conditions) and this presents challenges in measuring dreaming as we have established. Still, these kinds of samples are needed to answer question regarding the prevalence, risk factors and consequences of nightmares at population level. One cannot infer from a student sample the prevalence of frequent nightmare among older adults or study the association between nightmares and insomnia among participants screened for good sleep quality. Even with representative population samples one should keep in mind that they represent one population, such as the adults in Finland, and thus generalization of results to other populations should be made with caution.

In this chapter I will review epidemiological studies on nightmares focusing on studies with population level samples while discussing other research when necessary.

3.2.1. Prevalence of nightmares

Prevalence estimates for frequent nightmares among general adult population generally fall within range of 2-5%. Though there certainly is variation in these estimates, they are remarkably consistent considering that the studies investigating the prevalence vary in sample characteristics, measure of nightmares and are collected from diverse cultures including East Asia, Nordic countries and central Europe. Population level surveys investigating the prevalence of nightmares are summarized in Table 1.

Most of these studies do not define nightmares for the participants. Waking criterion is used in two studies. In Schredl (2010) it produces a prevalence estimate that 2.4% of population are awakened by a nightmare during last week, an estimate that is in

the low end of the prevalence rate discovered by studies without definition of nightmares, but not radically different. Unfortunately the other study using the awakening criterion (Munezawa et al., 2011) only reports monthly prevalence and therefore is harder to compare to results of other studies.

My hypothesis to explain the relatively high consistency of these estimates even when nightmares are not defined for the participants is that nightmares are a very well know phenomenon among the participants. People appear to have very consistent folk psychological conception for nightmares and this conception appears to be similar in different cultures producing similar prevalence estimates. This makes the question about nightmares without any definition reliable, it produces similar results in different studies, but it is unclear what exactly it measures and as such the validity of the question is unknown.[8]

---

[8] Interesting demonstration about the effect of consistency of folk psychological concepts to prevalence is the case of sleep paralysis. Sleep paralysis is generally not widely known in Europe outside of sleep research and for does not have everyday term in English or Finnish. However, it is widely recognized in Japan with a native term "kanashibari". A study in Japan (Munezawa et al. 2011) found that 8.3% of high school students reported to have experienced Kanashibari during the last month while study conducted in Germany and Italy (Ohayon et al. 1999) found only 1.4% of participants to have experienced sleep paralysis during last month. This large difference in prevalence is probably primarily explained by cultural differences in recognizing and categorizing symptoms of sleep paralysis. True prevalence of this phenomenon remains unknown.

Table 1. Prevalence of nightmares among adults and adolescents. Modified from Sandman et al. 2013.

Study	Sample	N	Age	Measure of nightmares	Prevalence
Bjorvatn, Grønli & Pallesen, 2010	Random population sample in Norway	1000	M 47, Range 18-96	Have you experienced nightmares?	2.8% at least once a week
Hublin et al., 1999	Cohort of Finnish twins	3547	M 44, Range 33-60	How often do you have nightmares?	Weekly, 2.5% of males and 3.2% of females
Janson et al., 1995	Random sample from selected cities in Sweden, Iceland and Belgium	2202	M 33, Range 20-44	How often do you have nightmares?	0.9-6.8% at least once a week
Li et al,. 2010	Sample of families with school aged children from Hong Kong	8558	M 41, Range 20-78	During the past 12 months, how often have you had nightmares?	5.1% at least once a week
Munezawa et al., 2011	Random sample of high school students in Japan	90081	Range 13-16	Have you been wakened by a nightmare during the previous month?	35.2% at least once during previous month
Schredl, 2010	Random sample in Germany	2019	M 46, Range 14-96	How often have you experienced strongly negatively toned dreams with fear or panic resulting in immediate awakening?	2.4% at least once a week
Stepansky et al., 1998	Random sample in Austria	1000	Range 14-69	Do you suffer from nightmares?	4% suffers from nightmares
Tanskanen et al., 2001	Series of random population samples in Finland	36211	M 46, Range 25-64	How often have you had nightmares during the past month?	1.8-6.0% often during the past month

3.2.2. Age and sex affect nightmare prevalence

Prevalence of nightmares is affected by the age and sex of dreamer. There is general agreement in the literature that children experience more nightmares than adults (Levin & Nielsen, 2007) but scientific evidence for this claim is methodologically problematic, even more so than among adults.

Many studies investigating nightmares of children rely on the reports of parents or even retrospective questions about nightmares in childhood of adults. These ways of measuring nightmare frequency make the assessment indirect in even more ways than is typical in retrospective questionnaire. For the parent to have reliable opinion about the nightmare frequency of his children those children must first report nightmares to the parent which is not always the case. This can be seen in the observation that nightmare frequency is often higher when asked directly from the child compared to parents. Distinguishing between night terrors and nightmares is also more of an issue among children who have higher prevalence of night terrors than adults. Retrospective assessments of adult participant's nightmares in his childhood are heavily limited by memory and may be biased to any direction.

Methodological challenges in studying nightmares of children are reflected in wide variety of prevalence estimates, ranging from 2% to 20% for frequent nightmares and from 17% to 81% for occasional nightmares (see Gauchat, Séguin, & Zadra, 2014 for review, also (Hublin et al. 1999; Li et al., 2011). Regardless of the large variation in results, they do converge towards conclusion that children do experience more nightmares than adults.

Among adults nightmare frequency appears to change with age, but there are conflicting views as to in which direction. There are some results about nightmare frequency decreasing with age with lowest frequency found among dreamers of over 60 years of age (Nielsen et al., 2006; Wood et al., 1993) but these studies are not conducted with representative samples.

In studies with representative population samples and wide age range, (Li et al., 2010; Li, Zhang, et al., 2010) found frequent nightmare sufferers in Hong Kong to be generally slightly younger than those with less nightmares, (Schredl, 2010; Stepansky et al., 1998) found no age effect at all and Bjorvatn, Grønli, & Pallesen (2010) and Hublin et al. (1999) did not report how the age of participants affected nightmare prevalence. Tanskanen et al., 2001 found nightmares to become more common with advancing age and the same result is found in meta-analyses of various studies with smaller samples (Schredl & Reinhard, 2011). These contradictory results leave the association between nightmare frequency and age an open question.

Effect of sex is more straightforward: In most population level studies women report more nightmares than men (Bjorvatn, Grønli & Pallesen, 2010; Hublin et al., 1999; Li

et al., 2010; Munezawa et al., 2011; Schredl 2010; Tanskanen et al., 2001). A meta-analysis of gender difference in nightmare frequency that is based on studies with various methods and samples also supports the result that women report more nightmares, but only from adolescence to late adulthood: The sex difference was not observed among children or elderly (Schredl & Reindhard, 2011). In summary, it is a well established result that adult women report more nightmares but there may be an age-sex interaction in nightmare frequency.

3.2.3. Correlates of frequent nightmares

Several studies have found association between nightmares and psychiatric problem. Hublin et al. (1999) found weekly nightmares to be around five times more common among Finnish adults who had received reimbursements for psychiatric treatment than among those without history of psychiatric treatment. Li et al. (2010) found similar result with clinical phone interviews: Frequent nightmare sufferers were around five times more likely to meet diagnostic criteria for some DSM-IV disorder with mood disorders being most common. Various studies have also found association between nightmares and symptoms of depression and anxiety using questionnaires in various populations (Munezawa et al., 2011; Tanskanen et al., 2001; R. Levin & Fireman, 2002; Li et al., 2012; Levin & Nielsen 2007). Personality with high emotional reactivity and openness to experience may also be risk factor for having nightmares (Hartmann, Elkin, & Garg, 1991; Levin & Nielsen, 2009).

Nightmares frequently co-occur with symptoms of insomnia. Significant association between self-reports of frequent nightmares and insomnia symptoms is reported in large epidemiological studies conducted among general population by Li et al. (2010), Munezawa et al. (2011) and Tanskanen et al. (2001). Ohayon et al. (1997) also observed that among a sample of 1049 insomnia sufferers 18.3% reported frequent nightmares.

Two studies, Nielsen (2010) with internet questionnaire and Merikanto et al. (2012) using FINRISK 2007 survey, have found that evening chronotypes report slightly more nightmares than morning types. Li et al. (2010) also observed an association between nightmares and symptoms of sleep-disordered breathing and Munezawa et al. (2011) found nightmares to be more common among those sleeping over 9 hours per night or less than 7 hours per night compared to those sleeping 7 to 9 hours per night.

There is also some evidence that substances that affect the structure of REM-NREM cycle during sleep may induce nightmares. These kind of substances include ethanol, beta-blockers and some selective serotonin reuptake inhibitors among many others (Pagel & Helfter, 2003; Pagel, 2012).

Two studies, Schredl (2013) and Stepansky et al. (1998), have found nightmares to be more common in urban areas compared to sparsely populated areas in Germany and Austria. This points towards a possibility that characteristics of the living environment affect nightmare prevalence.

Nightmares are central part of PTSD symptoms as was established in chapter 3.1.3 and therefore they are more prevalent in populations with high probability of experiencing trauma (Pigeon & Mellman, 2016; Levin & Nielsen 2007; Ross et al., 1989). There is also evidence that nightmares are associated with being bullied in school (Wolke & Lereya, 2014).

3.2.4. Nightmares and suicide risk

In 2001 study Tanskanen et al. found by linking population level survey data with national causes of death register in Finland that frequent nightmares increased the risk for completed suicide. Study IV of the thesis is an extension of this study and details of the study of Tanskanen et al. will be covered in chapter 5.3.2.

After the study of Tanskanen et al., several studies have investigated the association between nightmares and suicide and most have found association between nightmares, suicidal ideation or attempt (Ağargün et al., 2007; Ağargün et al., 1998; Bernert et al., 2015; Cukrowicz et al., 2006; Li et al., 2010; Liu, 2004; Sjöström, Hetta, & Waern, 2009; Sjöström, Waern, & Hetta, 2007; Wong, Brower, & Zucker, 2011). Drawback of these studies is that most of them use modestly sized samples that often consist of psychiatric patients. Regardless there is accumulating evidence that experiencing frequent nightmares increases risk for suicidal thoughts and behaviour.

3.2.5. Treatment of nightmares

Freud conceptualized dreams as a psychological process of translating sometimes forbidden unconscious wishes to a symbolic form (Freud, 1913). When this process did not work well enough, nightmares would ensue. From Freud´s ideas, the tradition of psychoanalytic dream interpretation was born and while its impact among scientific community has waned, it is still used in clinical practice. However, there is meagre systematic evidence for its effectiveness as a treatment for nightmares and nightmares in this context are seen more as a part of symptoms and information source of other problems rather than target for intervention.

Approaches to reduce nightmares based on Cognitive Behavioural Therapy (CBT) have received some empirical support. CBT approaches to treatment of nightmares

generally involve recording previous nightmares in some form while performing relaxation exercises to reduce distress related to the nightmare. In more active techniques, notably in Image Rehearsal Therapy (IRT), nightmares are also relived in imagination during the day while also trying to change their narrative to more positive one. Systematic reviews have found that various CBT techniques and especially IRT decrease nightmare frequency and increase sleep quality among patients with frequent nightmares or PTSD with small to medium effect sizes. (Augedal et al., 2013; Casement & Swanson, 2012; Lancee et al., 2008).

In regard to pharmacological interventions, Prazosin, an α1- receptor antagonist, has received some empirical support in alleviating PTSD related nightmares with similar effect size to CBT (Augedal et al., 2013; George et al., 2016).

3.2.6. Theories of nightmare function and epidemiology

There are plethora of theories about the nature and function of dreams and nightmares, but theoretical progress in the field has not been converging towards a unified theory. There are three main categories of theories in the field about nature of dreams: Theories that see dreaming as a by-product of other brain activity without function of its own (e.g. (Domhoff, 2001; Hobson, 2009), theories that see dreaming serving emotion regulation function (e.g. Hartmann, 1998; Levin & Nielsen, 2007) and theories that posit dreaming to be functional in evolutionary terms (Revonsuo, 2000; Revonsuo, Tuominen, & Valli, 2015a). Examples of theories of each of these categories that are relevant to study of nightmares are continuity hypothesis (CH), neurocognitive model and threat simulation theory (TST).

Continuity Hypothesis posits that dream content is derived from waking experiences. Dreaming is not believed to serve independent function but to be a by-product of neurocognitive processing of waking experiences (Schredl & Hofmann, 2003). In this framework nightmares can also be seen as by-products of processing waking experiences.

Neurocognitive model of nightmares by Levin and Nielsen (2007, 2009) proposes that normal dreaming serves emotional regulation and fear extinction function by processing memories with negative emotional tone towards more positive valence. When this process is unable to effectively process negative memory material, the dream turns into a nightmare. The amount of nightmares depend of affect load, the amount of stressful stimuli the person has to process, as well as affect distress, the degree which the person to be vulnerable to stress and prone to negative emotions. Therefore frequent nightmares stem from high affect load, especially among people who have high affect distress.

Threat Simulation Theory (Revonsuo 2000, Valli & Revonsuo, 2009) is an evolutionary argument that simulating threatening events in dreams leads to learning of threat avoidance and coping skills that increase changes of dreamers survival and reproduction, or at least have done so during human evolution. If threatening dreams would increase survival and reproduction, the trait of having threatening dreams would be selected for during evolution: Individuals with neural structure producing these kinds of dreams would increase in the population during many generations and therefore tendency to experience threatening dreams would become common among humans. In this framework frequent nightmares can be seen as over activation of the threat simulation system – in similar way that immune system is usually beneficial, but during allergic reaction its over activation becomes maladaptive.

Some of these theories are mutually exclusive which means they cannot all be on the right track. To distinguish between competing theories, one should derive empirically testable predictions from them in such a manner that data could be used to provide evidence for one theory and not the others. Systematic empirical comparison of different theories of dreaming has been called for in recent discussion about the function of dreaming (Revonsuo, Tuominen, & Valli, 2015b), but it has not been conducted in large scale.

Epidemiological studies are not much help in distinguishing between the current competing theories of dream, or nightmare, function: Results from studies of prevalence and risk factors of nightmares are quite compatible with any existing theories and it is hard to make a case that they would support one theory more clearly than others. For example, people who experience stress or trauma experience more nightmares – this can be explained by CH, Neurocognitive model or TST. Actually theories of nightmare function are already based on these kinds of epidemiological observations, so only epidemiological results that would be very different and surprising compared to existing literature would challenge these theories.

Theories of dream or nightmare function are also affected to similar degree by the challenges of measuring dreaming. If the data about content of dreams is unreliable, so are theories that base their assumptions on this kind of data. I am not claiming that all existing theories are false because of the issues of studying dreaming. My position is that dream reporting might or might not be a reliable source of information about dream experiences and the problem is that we cannot test how reliable it is. This leaves open the possibility that future methodological advances would render much of the existing data about dreaming invalid undermining theories that are based on it. On the other hand, those methodological advances might also vindicate some aspect of the existing data and provide support for certain theories. Time might tell which the case is.

Because epidemiological results cannot seem to provide more evidence for one theory of dreaming compared to others I will not focus on theories of dreaming or nightmare function in this thesis.

3.3. AIMS OF THE CURRENT THESIS

We have now established that nightmares (or at least reports of having frequent nightmares) are not uncommon: 2-5% of adults report them with prevalence being higher among women than men. Age affects the prevalence, but there are mixed results about the nature of this interaction. Frequent nightmare sufferers often also exhibit symptoms of mood disorders and insomnia and they even have increased risk for suicidal thoughts and behaviour.

The empirical aim of the current thesis is to paint a comprehensive picture of epidemiology of nightmares in Finland by answering the following questions:

What kind of people have nightmares? How frequently they have them? Are there historical trends in nightmare prevalence? What factors are associated with frequent nightmares? Do nightmares increase risk for suicide?

By answering these questions it is possible to characterize a hypothetical person who would be typical example of an individual reporting frequent nightmares in Finland.

To do this we conducted four empirical studies utilizing a large representative population sample of Finnish adults from a Finnish national FINRISK study. Our sample brings to the table the uncommon advantages in nightmare research: Representativeness of the study population, high statistical power, time series of 35 years, location data and survival data.

The empirical aims of our studies are as follows:

1. Describe prevalence of nightmares among Finnish general adult population and study how sex and age affect the prevalence, aiming to shed light to unclear issues of association between age and nightmare prevalence.
2. Study historical trends of nightmare prevalence from 1970´s and analyse how nightmare prevalence of war veterans differs from general population.
3. Explore wide variety of potential risk factors for frequent nightmares in representative sample, including known risk factors like depression and insomnia, but also studying novel associations like nightmares and seasonal affective symptoms or life satisfaction.
4. Improve upon the study of nightmares increasing suicide risk published by Tanskanen et al. in (2001) by studying the relationship between nightmares and suicide with design that identifies and aims to control for war experiences of the participants.
5. Finally, our theoretical aim is to analyze the limitations inherent in our way of measuring nightmares with retrospective questionnaire and to arrive at a philosophically defensible interpretation of our results.

4. METHODS

All the empirical studies of the thesis are based on the Finnish National FINRISK study collected by the Finnish National Institute of Health and Welfare. FINRISK is a series of comprehensive health surveys conducted every five years since 1972 with latest survey completed in 2012.

FINRISK started as an epidemiological part of larger North Karelia project. After Second World War, especially during the 1960s, mortality due to cardiovascular diseases (CVDs) among men in Eastern Finland was among the highest in the world. North Karelia project, started in 1972, was an endeavour to find out what caused the high CVD mortality and to produce interventions to reduce it. The project was successful in both advancing knowledge about CVD risk factors as well as reducing CVD mortality in Eastern Finland and as a result key parts of the project were expanded to national level (Borodulin et al., 2015; Puska et al., 2016).

The primary goal of FINRISK health surveys was originally to produce information on the prevalence and risk factors of CVDs and to monitor whether the interventions of North Karelia project produced results, but as time went by it evolved to a general health and lifestyle survey of the Finnish general adult population. The North Karelia project officially ended in 1997 but FINRISK is still ongoing: At the time of writing this thesis data are being collected for FINRISK 2017.

4.1. FINRISK DATA

A single FINRISK survey comprises of a questionnaire that includes questions about physical and mental health, lifestyle and socioeconomic factors. The questionnaire is usually mailed to participants with an invitation to fill out the questionnaire at home and then return it at the local healthcare centre where a physical examination is conducted. The examination includes measurements of height, weight, blood pressure, serum cholesterol and in later surveys, collection of DNA samples. The exact procedure differed slightly between FINRISK surveys: Most notably, in some years there were additional questionnaires sent to the participants or to subsamples of participants and these had different return rates compared to the main questionnaires. This significantly affects the sample size of studies II and III.

For every FINRISK survey an independent random population sample was drawn from the population register of the study regions. The samples of 1972 and 1977 were simply random 6.6% of the population of the study regions. Samples of the later surveys were stratified for sex and 10-year age groups. Since the surveys were based on random samples, there were some participants who answered more than one survey by chance, but the number of these participants is small. For all practical purposes FINRISK surveys are cross-sectional with no possibility for longitudinal studies in the FINRISK data itself. However, if the participant gave approval for it, the FINRISK data can be linked to several health related databases in Finland. The linkage to National Causes of Death Register is used in the study IV.

The sampling regions, sample size and age range of participants differ between surveys. The surveys sent out in the 1970s were conducted only in Eastern Finland, with age range of participants being 25-59 in 1972 and 25–64 in 1977. Afterwards the number of sampling regions increased to cover Turku and Loimaa region in 1980s, Helsinki-Vantaa and Oulu region in 1990s and parts of Lapland in 2000´s. The age range of the participants expanded to 25-74 years of age in 1997. The sample sizes of individual surveys range from 11870 to 6051 with a grand total of 78345 participants in all eight surveys. The sample sizes, age ranges, and survey regions can be seen in Table 2.

Table 2. Numbers of FINRISK participants

Year	N	Women (%)	Age range	Survey Regions	Used in Study
1972	11870	51.0	25-59	PK, PS	I, IV
1977	12155	51.5	25-64	PK, PS	I, IV
1982	9347	50.6	25-64	PK, PS, TL	I, IV
1987	6479	52.5	25-64	PK, PS, TL	I, IV
1992	6051	52.9	25-64	PK, PS, TL, HV	I, IV
1997	8446	49.6	25-74	PK, PS, TL, HV, OU	I, IV
2002	9580	53.2	25-74	PK, PS, TL, HV, OU, LA	I, IV
2007	7993	53.2	25-74	PK, PS, TL, HV, OU, LA	I, II, IV
2012	6424	52.7	25-74	PK, PS, TL, HV, OU	II, III, IV
Total	78345	51.7			

PK = North Karelia, PS = Kuopio region, TL = Turku & Loimaa, HV = Helsinki & Vantaa, OU = Oulu region, LA = Lapland.

4.1.1. Ethical permissions

Each of the FINRISK surveys has been conducted according to the ethical and legal guidelines of the time and in accordance with the principles of the declaration of Helsinki. Informed consent was obtained from all participants (verbal 1972–1992 and written since 1997).

The latest and currently still existing ethical committee to approve FINRISK studies is the ethical committee of Hospital District of Helsinki and Uusimaa.

4.2.MEASUREMENTS

FINRISK questionnaires include both single questions and validated research instruments. Some of the questions have changed between surveys and most of the instruments have been added only to the most recent surveys. Regardless, there are some questions that have stayed unchanged for the whole research period and question about nightmares is one of them.

4.2.1. Nightmares

The question about nightmares in FINRISK is part of a block of questions investigating problems with sleep and anxiety. The question reads as follows:

"Ajatelkaa viimeksi kulunutta kuukautta. Ilmoittakaa, kuinka usein kysytty asia on ollut mielessänne tai oire Teitä vaivannut… Näettekö painajaisunia?"

This translates into:

Think about the last month. Tell us, how often the matter in question has been on your mind or the symptom has bothered you… Have you had nightmares?

There are three answer options: "usein/joskus/ei lainkaan" or often/sometimes/not at all. The question had remained exactly the same in all nine surveys from 1972 to 2012.

4.2.2. Sleep related variables

There are variety of different questions concerning sleep in FINRISK surveys.

Symptoms of insomnia are investigated with a question phrased similarly and appearing in the same question block as the question about nightmares with answer options of having insomnia symptoms often/sometimes/not at all during the last month. The question has remained the same in all surveys.

Self-assessment of the average sleep length during the night is present in surveys of 1972, 1977, 2007 and 2012. In 2007 and 2012 there are also questions about duration of napping and satisfaction with sleep duration.

Every survey has a general question about the use of hypnotics, but the phrasing of the question varies and none of the surveys includes information on the exact type of the medication used.

4.2.2.1.   Morningness–Eveningness Questionnaire (MEQ)

Variety of processes in the body and brain follow circadian rhythms and therefore work differently at different time of the day. Most notable of these processes is the sleep-wake cycle, but also cognitive functions, thermoregulation, immune response, digestion and many other processes have circadian rhythms (Roenneberg & Merrow, 2016). Behavioural patterns that emerge due to circadian processes are called chronotype. The chronotype of the individual consist of preferences for timing of sleep and wake as well as timing of periods of feeling energetic or drowsy during the day. Morning types prefer to wake up early and feel most energetic during the morning while evening types show an opposite pattern. Intermediate or day types fall somewhere between morning and evening types.

Chronotype of the participant was investigated using a shortened version of the Morningness–Eveningness Questionnaire (MEQ). The original MEQ was developed in 1976 and validated with core temperature measurements (Horne & Ostberg, 1976)**.** The short version used in FINRISK consists of six of the original MEQ items (4, 5, 9, 15, 17, and 19) that correlated best with the sum score of the original 19 items in the regression analysis, explaining 83% of the variation in the sum score (Hätönen et al., 2008). The sum score of shortened MEQ range from 5 to 27 and was categorized to three classes in the following way: morning type (19 to 27 points), intermediate type (13 to 18 points) and evening type (5 to 12 points).

MEQ is present in the surveys of 2007 and 2012 and is used in studies II and III.

4.2.3. Symptoms of depression

According to DSM-V depression is cluster of symptoms including depressed mood or loss of interest and pleasure in daily activities that last over two weeks and causes impaired functioning. It is a condition that is responsible for a major part of the disease burden of the world with one year prevalence rate around the world of around 3% (Moussavi et al., 2007).

Symptoms of depression are investigated in several ways in FINRISK. In older surveys there is single item inquiring about "depressed mood" and from 2002 onwards there is another item asking to report whether the participant has received a diagnosis for depression. These questions are utilized in some analyses of all the studies but the most important measures of depression in FINRISK are short Beck Depression Inventory (BDI) introduced in 2007 and Seasonal Pattern Assessment Questionnaire (SPAQ) present only in survey of 2012.

4.2.3.1.   Beck Depression Inventory (BDI)

Beck Depression Inventory is a questionnaire widely used to investigate symptoms of depression with 21 questions concerning mood, self-esteem and physical symptoms of depression (Beck et al., 1961). The version used in FINRISK is Finnish translated 13 item short version that includes questions 1, 2, 3, 4, 5, 7, 9, 12, 13, 14, 15, 17, and 18 of the original instrument and it can be categorized to represent four levels of depression: No depression (0-4), mild depression (5–7), moderate depression (8–15), and severe depression (over 16).

This version of the BDI is validated in a Finnish population sample against Composite International Diagnostic Interview (CIDI) (Aalto et al., 2012). It was found to have reasonable sensitivity of 0.76 and specify of 0.75 and patients with more severe and recent depressive symptoms as measured by CIDI had consistently higher BDI-13 scores than those with less severe depressive symptoms.

Questionnaire measures of depression are susceptible to same philosophical concerns as dream reporting if depression is seen primarily as a subjective experience of being depressed. However, depression can also be framed as objectively observable changes in behaviour and psychophysical state and therefore is not as problematic of a construct as dreaming.

4.2.3.2.   Seasonal Pattern Assessment Questionnaire (SPAQ)

Depressive symptoms that follow seasonal pattern and are hypothesized to be caused by variation in the environment due to season is called Seasonal Affective Disorder (SAD). SAD is a mood disorder with seasonal pattern that consists of symptoms of depressive mood, lack of energy, hypersomnia and increased appetite, especially towards carbohydrates (Rosenthal et al., 1984). Symptoms of SAD typically start during autumn and remit at spring and this seasonal pattern repeats yearly. There has been debate whether SAD is a disorder on its own or whether there is just depression with seasonal pattern that is not caused by the seasons per se. In DSM-V SAD does not have an independent diagnostic category and instead exists as a seasonal pattern modifier that can be added to mood disorder (DSM-V).

The leading hypothesis for the underlying mechanism of SAD is that symptoms of SAD are triggered by changes in the amount of light between seasons (Rosenthal *et al*., 1984). Finnish people experiences profound seasonal variation in light and temperature making Finland interesting natural experiment of the effects of this variation.

In FINRISK symptoms of SAD are investigated with modified Seasonal Pattern Assessment Questionnaire (Rintamäki et al., 2008; Rosenthal, Bradt, & Wehr, 1984). This version of SPAQ includes six questions investigating seasonal changes in sleep duration, social activity, mood, weight, appetite and energy level as well as one question inquiring whether the participant experiences seasonal changes as a problem.

Potential SAD cases were categorized according to Kasper criteria (Kasper et al., 1989) scaled for the modified SPAQ used in FINRISK. According to the criteria, those who scored at least 8 points from questions investigating seasonal symptoms and experienced seasonal changes as a moderate to severe problem were classified as SAD cases.

Previous research has found SPAQ to overestimate SAD prevalence in population samples (Mersch et al., 2004; Thompson, Thompson, & Smith, 2004) and this should be kept in mind when interpreting the prevalence of SAD reported in study III. Regardless, investigation of association between nightmares and depressive symptoms with seasonal pattern was considered to be a valuable addition to our research and the prevalence of SAD was not our focus.

4.2.4. Location data

Finland is a long country, spanning five degrees of northern latitude. In southern Finland at latitude 60°N there is continental climate and length of the daylight varies from 6 to 18 hours per day between seasons. Northern parts of the country reach into arctic with latitudes of 66°-68°N and in these latitudes northern twilight and midnight sun occur: In midwinter sun will not rise above the horizon and during midsummer it will not set.

There is also large variation between rural and urban living environments in Finland. The country has few cities of 200,000 to 600,000 inhabitants with high population density reaching several thousand people per square kilometre and large stretches of remote countryside with population densities of less than 20/km^2. These characteristics lead to unique opportunities to conduct research.

FIRNISK 2012 included GPS coordinates of the addresses the study participants had reported as a site of permanent residence. In study III we used this information in three ways to investigate whether there was variation in nightmare prevalence between urban and rural areas and how nightmares associated with seasonal affective symptoms and photoperiod.

First, from the coordinates we calculated the latitude of the participant's residence. The survey participants were located between latitudes of 60°-66°N and lived both in the major cities of Finland as well as rural areas. The latitudes of sampling regions of FINRISK 2012 are presented in Figure 3.

The second way we utilized location information was to obtain information on the population size and density of the municipality where participants residence was located. This information was obtained from Population Register Centre of Finland and National Land Survey of Finland (Maanmittauslaitos 2012; Väestörekisterikeskus 2012)In these data it was discovered that population density and population size of the municipalities had very strong correlation and therefore only population size was used in the analyses.

Last, we estimated the degree of urbanicity of the living environment of the participant by mapping the participant's site of permanent residency to a urban-rural classification of the Finnish Environmental Institute (Helminen et al., 2014). This classification estimates the degree of urbanicity of every 250X250m square of Finland using various information from population size, population density, city plans and commuting and divides these squares into categories ranging from city centres to sparsely populated rural areas. For more information on the usage of location data in the study refer to (Määttänen, 2016).

4.2.1. War veterans

Post-traumatic nightmares are a common symptom of exposure to trauma and a symptom of PTSD. FINRISK sample includes war veterans and as this population probably has higher rate of PTSD and post-traumatic nightmares their identification from the whole sample is important.

During the Second World War (WWII) Finland fought the Soviet Union in Winter War (1939-40) and Continuation War (1941-44). In the FINRISK surveys of 1972 and 1977 there are two questions related to participation to these wars. These are:

"Did you serve on the front during the last wars? Yes/No"

"Were you wounded during the war?" with answer options: *"no," "yes, slightly*

(no permanent injury)" and *"yes, I am a war invalid."*

These questions identify 3191 men with mean age of 55 years in surveys of 1972 and 1977 who are confirmed war veterans as they answered "yes" to the question about serving on the front lines. Of these veterans 1306 were wounded during the war and 402 were war invalids. 163 women also answered to have served at the front during the war, but this group was too small to conduct analyses on and therefore in all analyses about war veterans in FINRISK only male participants are included.
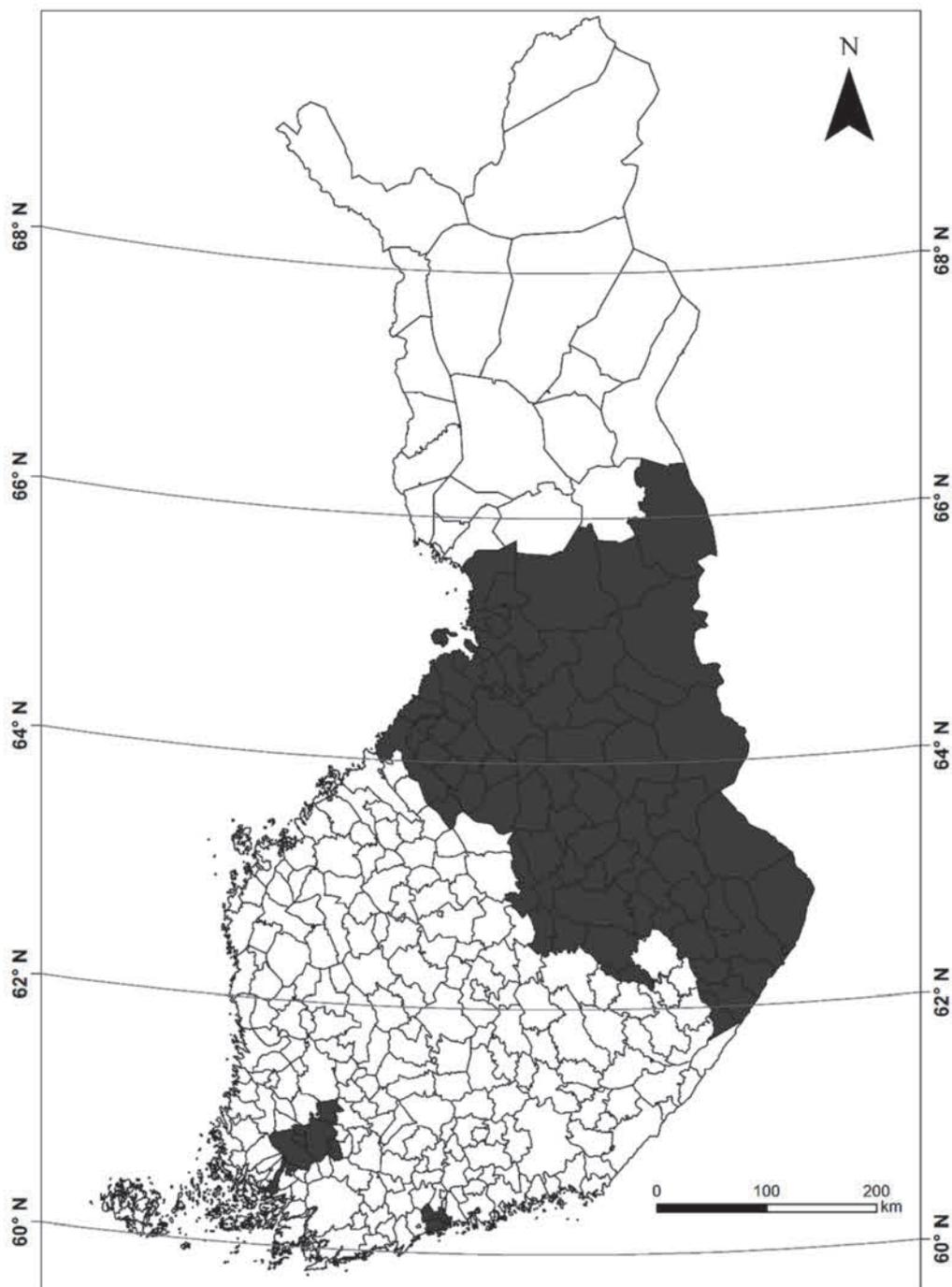
Figure 3. Latitudes of FINRISK sampling regions

Questions about war experiences were omitted from FINRISK surveys after 1977 but surveys as late of 1997 include participants who were at least 18 years of age in 1944 and therefore could potentially be war veterans who saw frontline combat during WWII. These potential war veterans can be identified from the data as a group born before 1927. We call this group the "war generation" and based on the ratio of war veterans to non-veterans among men of the surveys of 1972 and 1977, we estimate that approximately two-thirds of the men of war generation are actually war veterans.

Unfortunately the FINRISK does not have any measure of PTSD or questions about traumatic experiences, so we do not have direct questions whether the nightmares experienced by war veterans are war related. Another limitation is lack of information about any other ways than frontline service in which the war might have profoundly affected participants. The war affected the whole country of Finland, not only frontline veterans.

Regardless of these limitations, the existence of data about nightmares of veterans of WWII in these data was a unique opportunity that we tried to harness to its full potential. In studies I and IV we conducted analyses with war veterans as well as the war generation.

4.2.2. Other questionnaire items

Overall FINRISK surveys include hundreds of questions with some variability between surveys. In Study II we explored as many as 60 different items that had potential to be risk factor for nightmares. Notable categories included questions about sociodemographic factors, physical health, medication, use of alcohol and subjective life satisfaction. Details of the various questions can be found in the original publications.

4.3. STATISTICAL METHODS

Various statistical methods were used in the original publications:

Multinomial logistic regression was utilized in all four studies. Regression analyses aspire to model how change in one or more independent variables changes the dependant variable: In the case of our studies regression was generally used to model how change in potential risk factors affected the odds of the participant to belong to "frequent nightmare group" instead of "occasional nightmares" or "no nightmares group". Since the nightmare variable is not normally distributed and has three categories, multinomial logistic regression was the regression method of choice.

Results of the multinomial logistic regression analyses come in the form of odds ratios (OR) and their 95% confidence intervals. Odds ratio represents the odds of certain outcome, in our case usually belonging to frequent nightmare group, happening with an exposure to a risk factor compared to no exposure to the risk factor. In cross-sectional setting it works as a measure of the strength of association, effect size, with OR:s over one representing increasing risk and OR:s less than one representing decreasing risk compared to the level of independent variable chosen to represent the baseline level of risk. For example, in our regression model of study II, we used male gender as a baseline level for risk of belonging to the frequent nightmares group and compared to males, females had OR of 1.63 to belong to this group.

Since most of the variables we studied were non-normally distributed and categorical, Pearson Chi-square test (χ^2) was utilized as a test for statistical significance in all studies. Cramer V measure was used in conjunction with χ^2 tests to give some estimation of the strength of the association in addition to the P-value.

Confirmatory factor analysis was used in studies II and III to test whether previously reported factor structure of BDI and SPAQ was present in FINRISK data before performing additional analyses on the separate factors of these instruments.

Mantel Haenszel Chi-square *(MH χ^2)* was used to study the trends in nightmare prevalence over time in study I. MH χ^2 is a non-parametric significance test for linear trend between ordinal variables.

In situations where usage of parametric testing was feasible, we used two-way analysis of variance (ANOVA) as a significance test and to produce η2 effect size. ANOVA was used in study II.

In study IV Cox Proportional Hazard Regression was used to estimate increase in suicide risk conferred by nightmares and other factors. This version of regression is a survival analysis that estimates how exposure to independent variable affects the risk of an event occurring during a follow-up after the exposure. It produces Hazard Ratios

(HR) that represent the increase of risk of event occurring during follow-up to a group who experienced one level of exposure to explanatory variable (e.g. frequent nightmares) compared to another level (e.g. no nightmares).

Significance testing, especially with χ^2 test, easily produces low P-values when sample size is high and in our sample of thousands of participants, most of the tested associations were found to be statistically significant. Because of this, P-value was a poor indicator of associations of interest and we relied on effect sizes to pick out potentially truly significant results from just statistically significant ones.

Because of the high power and also because we also performed multiple hypotheses testing in the same data, especially in study II, we selected very low alpha level of 0.001 to signify statistical significance for single associations.

Analyses for study I were performed with SAS 9.2 and SPSS 20. Analyses of the studies II-IV were performed with SPSS 21.

4.4. METHODOLOGICAL CONSIDERATIONS

The main limitation of our studies is the simple question used to inquire about nightmares in the FINRISK surveys. It does not define nightmares for the participant and does not make distinctions between nightmare wit awakening and bad dreams, or idiopathic and traumatic nightmares.

There are also some other drawbacks in the FINRISK data:

The design of the FINRISK is cross-sectional and therefore we cannot make causal inferences from the data.

Though these data present a unique opportunity to be able to identify war veterans in data, there was no measure of post-traumatic symptoms and therefore we do not know which of the veterans suffer from PTSD symptoms. Veterans could also only be reliably identified in two of the earliest surveys while veterans were still present in several later surveys.

FINRISK is also been going on for 40 years and few questions have remained unchanged during the whole time series. Luckily nightmare question has stayed constant, but modern instruments like BDI are only available in the newest surveys and in study I and IV where long time series were used, there were challenges with questions changing between the surveys.

Regardless of these limitations, the main strength of FINRISK for dream research is the fact that it is a representative large population sample and even among these kinds of samples, the now 40 year time series as well as the possibility to identify war veterans, utilize location data and link the surveys to causes of death register make it unique in its versatility and historical value.

4.4.1. Data overlap with study of Tanskanen et al. 2001

Many papers have been published from FINRISK data, but only one of them has previously focused on nightmares. A study by Tanskanen et al. (2001) investigated the association between nightmares and suicide in FINRISK 1972-1992 surveys and in their paper reported a prevalence of nightmares as well as the observation that frequent nightmares increased risk for suicide. Data used in this study are partially the same as those used in studies I and IV but the focus of study I is different from that of Tanskanen et al. and study IV is actually an extension of that study. Details about the data overlap can be found in methods of study IV.

5. RESULTS

It is now time to turn our attention to the empirical results of the thesis. Prevalence of nightmares is the first topic of this chapter with special attention paid to the effect of sex and age to the frequency of nightmares. Next, results related to risk factors of nightmares are presented. Finally association between nightmares and suicide is discussed.

5.1. PREVALENCE OF NIGHTMARES

The first question we investigated was prevalence of nightmares. FINRISK data enabled us not only to study the prevalence of nightmares among the general adult population but also to study the interaction of age and sex regarding nightmare frequency, describe secular trends in the nightmare prevalence from 1972 to 2007 and to study nightmare prevalence among veterans of WWII. These questions were the focus of study I.

5.1.1. Data used to study prevalence of nightmares

Study I was conducted before data from FINRISK 2012 was available for analyses and therefore data from eight FINRISK surveys, 1972, 1977, 1982, 1987, 1992, 1997, 2002 and 2007 were utilized. This dataset included 69813 participants of whom 52% were women. Age ranges of participants varied in different surveys with survey of 1972 having participants aged 25-59, surveys of 1977-1992 having age range of 25-64 and 2002 & 2007 having range of 25-74 years. As established in chapter 4.2.5 data included 3191 male war veterans as well as 11215 members of war generation who are potential war veterans.

5.1.2. Prevalence of nightmares among general adult population

Among the whole sample with data from surveys of 1972 to 2007 combined the percentage of participants who reported frequent nightmares was 4.2% and 40.0% reported having had occasional nightmares during the last month. 55.8% of the participants reported that they had no nightmares during the last month.

5.1.3. Effect of sex and age on nightmare prevalence

In the whole sample 4.8% of women reported frequent and 43.5% occasional nightmares while 3.5% of men reported frequent and 36.2% occasional nightmares. The difference was statistically significant (Cramer V = 0.09, χ^2 P < 0.0001). Gender differences are illustrated in Figure 4. However, the overall result does not capture the whole picture about the sex difference in nightmare prevalence in these data.
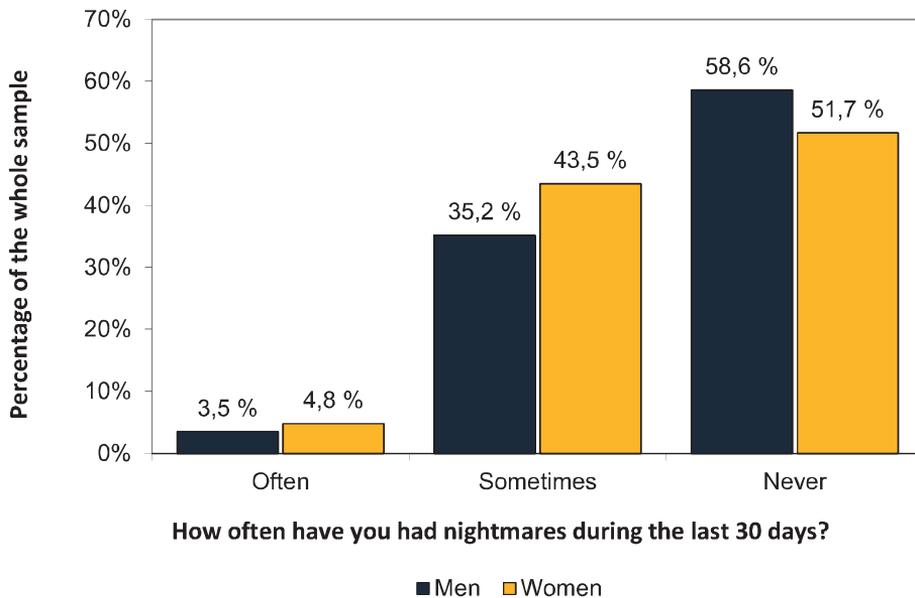
Figure 4. Prevalence of nightmares among men and women, N = 69 813

In FINRISK data nightmares became more common with advancing age as was first noted by Tanskanen et al. 2001. Moreover, the age and sex interact: Among men, the number of participants who reported frequent (Cramer V = 0.08, MH χ^2 P < 0.0001) and occasional nightmares (Cramer V = 0.06, MH χ^2 P < 0.0001) increased statistically significantly and quite linearly with advancing age. Among women there were similar trends but they were statistically less significant and not as linear. Frequent nightmares among women generally increased with age but their prevalence peaked in the age group of 51-55 years, decreased for a while and peaked again at 71-74 years (Cramer V = 0.04, MH χ^2 P < 0.0001). The frequency of occasional nightmares was highest among age group 25-30 years, dropped significantly during 30-35 years and increased steadily after that but did not reach the levels of 25-30 years again (Cramer V = 0.05, MH χ^2 P < 0.0001).

The sex difference in nightmare prevalence was largest among young adults with female participants aged 25-30 years reporting frequent nightmares over twice as often than men, but as the nightmare frequency of men increased more with age than that of women the sex difference in prevalence of frequent nightmares disappeared around 55 years of age and the difference in occasional nightmares levelled at around 65 years of age. These trends are presented in Figure 2.

a. Prevalence of frequent nightmares in different age groups

b. Prevalence of occasional nightmares in different age groups
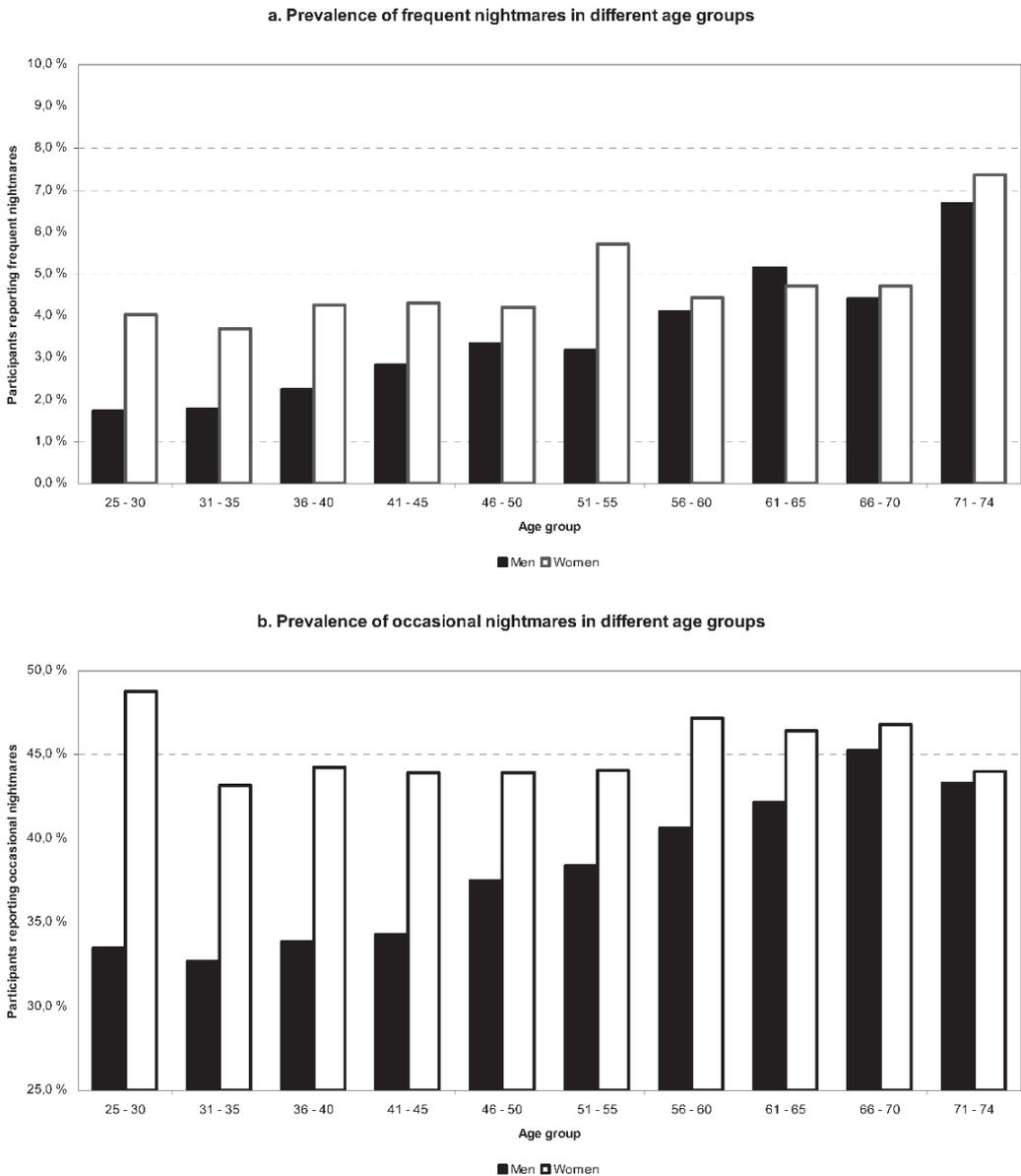
Figure 4. Prevalence of nightmares in different age groups N = 69 813
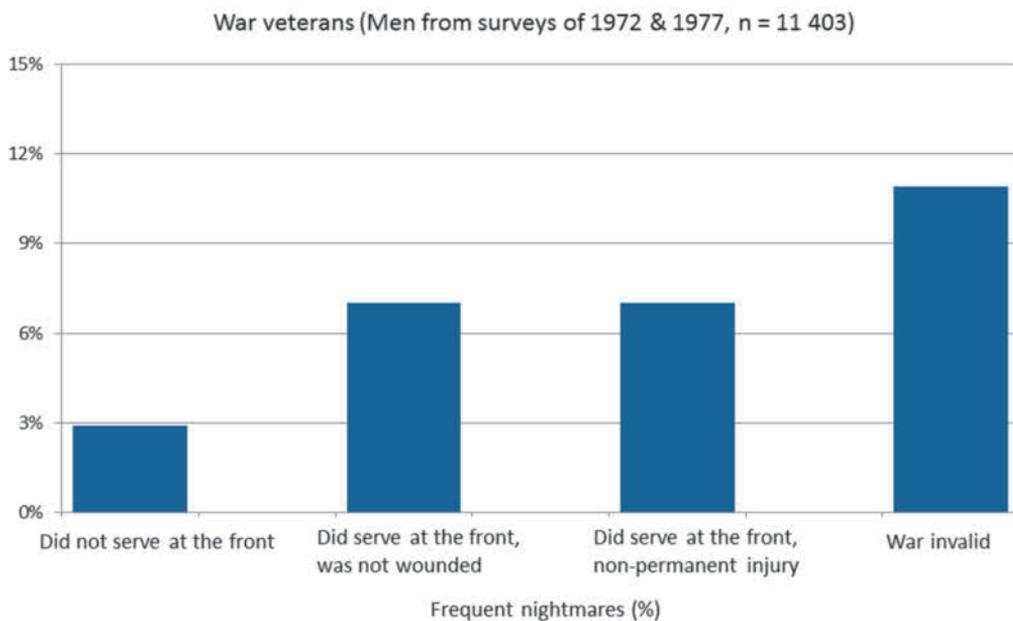
Figure 5. Prevalence of nightmares among war veterans

5.1.4. Prevalence of nightmares among war veterans and war generation

Both confirmed war veterans and the whole war generation reported more nightmares than the general population. Among men who answered the surveys of 1972 and 1977 (the only surveys with direct questions about war participation) 2.9% of men who had not served at the front during WWII reported frequent nightmares while 7.0% of war veterans who were not war invalids did. Among war invalids the prevalence was 10.9%. The difference is statistically significant and is presented in Figure 5 (Cramer V = 0.12, χ^2 P < 0.0001).

We also compared members of the war generation (all participants born before 1927 and therefore being 18 or older during the war) to the members of post-war generation in the surveys of 1972, 1977, 1982, 1987 and 1997 and found the whole war generation to report frequent nightmares more often than the post-war generation (Cramer V = 0.10, χ^2 P < 0.0001). It is also noteworthy to mention that among war generation there is no significant sex difference in nightmare prevalence with 7.2% of men and 7.0% of women reporting frequent nightmares.

These results are confounded to some degree by the fact that war veterans and the war generation are systematically older than the non-veterans and post-war generation and we have established that in these data nightmares become more common, especially among men, with advancing age. We tried to control for this bias

by comparing war generation to similar age group in surveys of 2002 and 2007 which did not contain members of war generation. War generation reported significantly more (Cramer V = 0.08, χ^2 P < 0.0001) frequent nightmares than this control group (among which 4.2% of men and 4.8% of women reported frequent nightmares), but the control group lived in different era and this attempt to control for the age problem is far from perfect. However, the difference in prevalence of frequent nightmares between the war generation and both post-war generation and modern control group was quite large so it is reasonable to assume it is not only caused by effect of age or era. Instead we hypothesize that among the war generation there is a higher number of people with post-traumatic nightmares (related to war experiences) compared to participants with no war experiences.

5.1.5. Secular trends from 1972 to 2007

Data used in study I covers a period of 35 years from 1972 to 2007. The prevalence of nightmares has not stayed constant during this period and we observed two significant secular historical trends.

Prevalence of frequent nightmares is highest in 1972, decreases until 1987 and then stays constant save for small increase in 2007. This change was statistically significant (for men Cramer V = 0.03, MH χ^2 P < 0.0001 and for women Cramer V = 0.05, MH χ^2 P < 0.0001). The pattern was connected with the war generation: When we excluded war generation from the data, the prevalence of frequent nightmares in 1970´s dropped significantly leading to abolishment of any trend among men (MH χ^2 P = 0.038) and lessening the significance of the historical trend among women (Cramer V = 0.03, MH χ^2 P = 0.0002).

The trend for occasional nightmares was different from than for frequent nightmares. Though there was peak in the prevalence of occasional nightmare 1972 and slight decrease until 1987 (similarly to the trend observed with frequent nightmares), after 1987 there was significant increase in the prevalence with high point in 1997, slight decrease to 2002 and then increase to highest level in 2007. The increasing trend was significant for both sexes (Cramer V = 0.07, MH χ^2 P < 0.0001 for men, Cramer V = 0.08, MH χ^2 P < 0.0001 for women). The trend stayed significant also when the war generation was excluded.

These trends are presented in Figure 6. Additionally, we now have data available also from FINRISK 2012 that was not available during the publication of Study I. In 2012 the prevalence of nightmares has decreased slightly from 2007. The prevalence of frequent nightmares among men in 2012 was 2.6% and for women 4.6%, down from 3.3% and 5.0% in 2007. With occasional nightmares the pattern is similar. Prevalence was 39.8% among men and 49.1% among women, down from 42.4% and 49.5% in 2007.

a. Prevalence of frequent nightmares in different study years
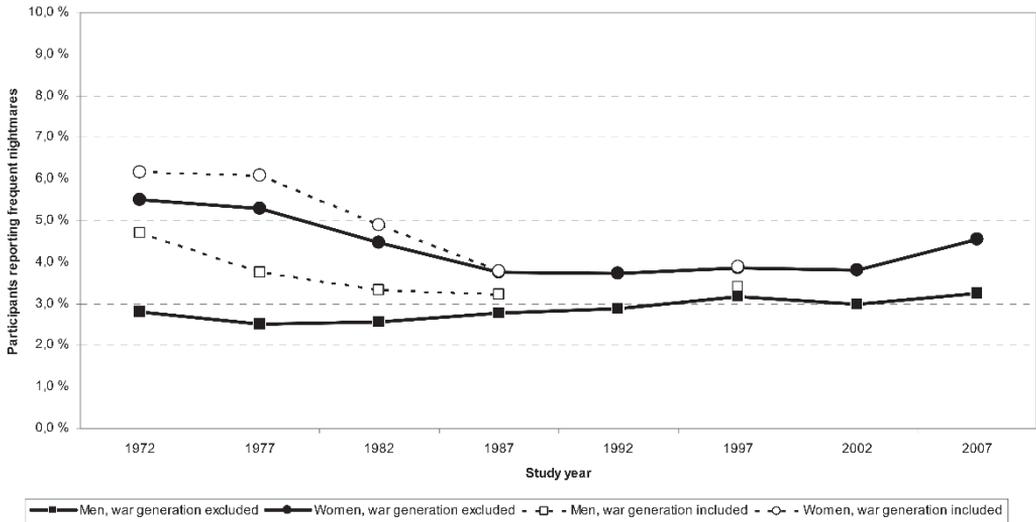
b. Prevalence of occasional nightmares in different study years
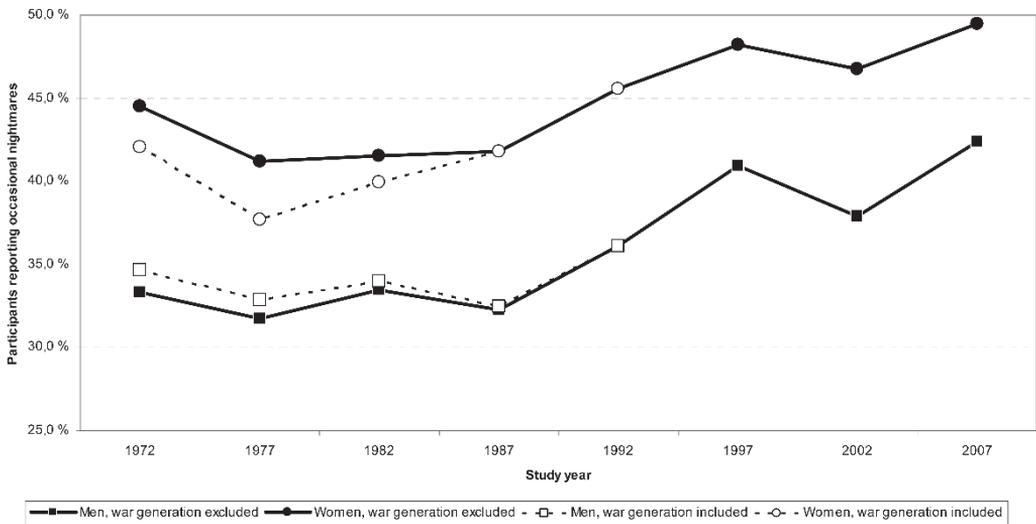
Figure 6. Prevalence of nightmares from 1972 to 2007

5.2. RISK FACTORS FOR FREQUENT NIGHTMARES

After having described the prevalence of nightmares in Finnish adult population and analysed factors affecting it we turned our attention to risk factors for having frequent nightmares. In study II a wide variety of risk factors for frequent nightmares were analysed and in study III the associations between nightmares and seasonal affective problems as well as place of residence were studied.

Since our study design is cross-sectional, it was only possible to observe correlations between nightmares and other variables and inferences about causality cannot be made. Because of this, some would prefer not to use the term risk factor and instead talk only about correlations or associations. However, we adopted the term risk factor to describe variables that increase the chance of reporting frequent nightmares though no direct causality assessment can be made.

FINRISK includes a wide variety of variables related to physical and mental health and lifestyle. Since the dataset is also very large, we found plethora of statistically significant associations even when using strict alpha level of 0.001. While these associations are not random in a statistical sense, the practical significance of most of them can be questioned as their effect sizes were very low. To make more sense of these associations we produced regression models where only the strongest risk factors reached statistical significance.

5.2.1. Data used to study risk factors of nightmares

While the time series of 40 years of FINRISK is impressive the instruments that were used to measure mental health in the surveys before 2000´s are markedly less so. To get access to BDI, MEQ, SPAQ and modern questions about medication and health we had to restrict studies II and III to the latest FINRISK surveys.

Study II utilized surveys of 2007 and 2012. Combined these surveys included 13922 participants aged 25-74 of whom 53% were women. Due to sub-sampling in these surveys, only 8567 participants were available for every analysis.

Data used in Study III is from a subsample of FINRISK 2012 which consist of 4905 participants aged 25 to 74 years of whom 54.5% were women. We could only use this part of FINRISK data in this study because the instrument measuring symptoms of SAD, Seasonal Pattern Assessment Questionnaire (SPAQ) is only present in part of the FINRISK 2012 survey.

5.2.2. Insomnia and depression

In all analyses conducted in study II symptoms of insomnia and depression emerged as the strongest risk factors for frequent nightmares.

Among those participants who reported having symptoms of insomnia often (measured with single Likert scale question), percentage of frequent nightmare sufferers was 17.1% and among those who did not have any insomnia symptoms during the last month the percentage was 1.3%. The association between insomnia and nightmares was statistically significant with largest Cramer V effect of any variable in the data (Cramer V = 0.24, χ^2 P < 0.001).

Depression measured by BDI-13 score had a significant association to nightmares with medium effect size ($\eta 2$ 0.090, F P < 0.001). When BDI-13 was categorised to categories "severe, moderate, mild and no depression" 28.4% of participants with severe depression reported also frequent nightmares while only 1.6% of those with no depression reported frequent nightmares (Cramer V = 0.21, χ^2 P < 0.001).

A problem arose when we wanted to use the question about insomnia and BDI-13 in the same multivariable analysis: Part of BDI also measures insomnia and therefore BDI and insomnia question contained overlapping information and their use in the same regression model is questionable. We solved the problem by breaking down the BDI to three components by using factor analysis.

These three components were negative attitude towards self (measured by statements such as "I am disappointed in myself"), lowered mood ("I feel sad") and performance impairment ("I am tired"). All of these components individually had a significant association to nightmare frequency similarly to the whole BDI, but in a multivariable model that included also other questions related to insomnia and ability to work, only factor "negative attitude towards self" remained significant.

5.2.1. Nightmares and seasonal affective symptoms

Similarly to depression measured with BDI-13, SAD measured with SPAQ had a strong relationship with nightmare frequency (and symptoms of insomnia). Among participants classified as SAD cases 16.2% reported frequent nightmares while only 2.4% of participants without SAD symptoms did (Cramer V 0.16, χ^2 p < 0.0001). These results are presented in Figure 7.

The association between SAD and nightmares also remained significant in a regression model where the association was adjusted with sex, age, marital status, alcohol consumption during the last week, years of education, amount of physical exercise,

smoking, population size of the place of residence, latitude and the month during which the survey was completed. The adjusted OR for having frequent nightmares among SAD cases was 2.97 with 95% confidence interval of 1.87 – 4.72.

SPAQ can be spilt into two factors, one measuring psychological symptoms including changes in sleep duration, social activity, mood and energy levels and another physical factor including questions measuring changes in weight and appetite. When factorized, only the psychological factor had a significant association with nightmares.

5.2.1. Regional variation of nightmare prevalence

There was no latitude gradient in the prevalence of SAD in these data: SPAQ scores were not significantly different in the southern parts of the country compared to the northern parts, even though the photoperiod and temperature between southern and northern Finland are significantly different during winter months when FINRISK 2012 was conducted. The prevalence of nightmares was highest in the middle of the country, from latitude 62°N to 64°N, but the association between latitude and nightmares was very weak (Cramer V 0.036, χ^2 p = 0.01).

Nightmares had a statistically non-significant U-shaped association with population size of the place of residence with prevalence being slightly higher in municipalities with less than 50,000 residents and in those with over 500,000 residents (Cramer V 0.064, χ^2 p = 0.06). With more detailed urban-rural classification statistically weak result about nightmares being less common in areas surrounding urban areas than in urban centers or rural areas emerged (Cramer V 0.031, χ^2 p = 0.03).

Overall there was no strong regional variation in the prevalence of nightmares and the prior results about nightmares being more common in cities compared to rural areas were not supported (Schredl, 2013; Stepansky et al., 1998).
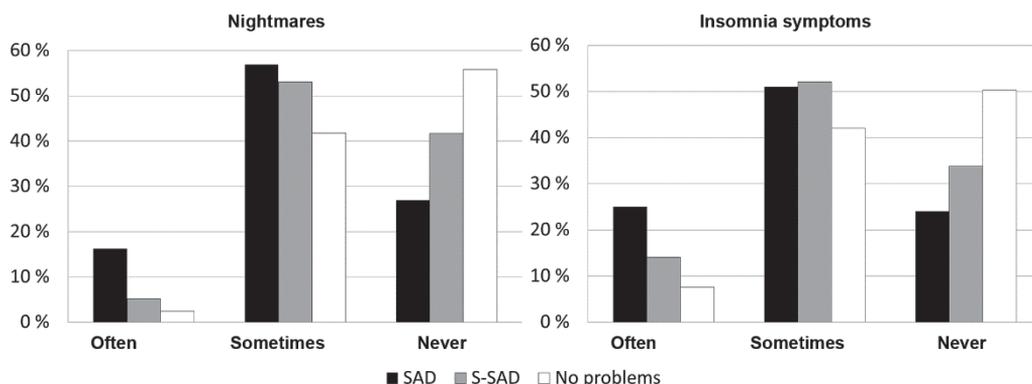
Figure 7. Seasonal affective symptoms, nightmares and insomnia

5.2.2. Multivariable model of the major risk factors

To detect the most important risk factors for frequent nightmares from the large number of variables available, we constructed a multinomial logistic regression model starting with 22 variables with the most significant individual associations to nightmares, and then narrowed down the number of variables both by hand and by stepwise automatic process. Both methods produced the same final model that included eight significant risk factors as well as one significant interaction which was between insomnia and BDI factor negative attitude towards self. The model was statistically significant ($p < 0.0001$), had a Nagelkerke statistic of 0.217, and correctly classified 62.6% of the observations (with the chance level being 33.3%).

The major independent risk factors for having frequent nightmares according to our model were gender, age, the BDI factor 'negative attitude toward the self', insomnia, feeling exhausted, headaches, the ability to work, and the frequency of being intoxicated.

As already become apparent the study I, female gender and advancing age increased the probability of having frequent nightmares. Negative attitude towards self and insomnia were strong predictors of frequent nightmares, as were being exhausted and having lowered working ability. While these variables remained independent in the model, they can all be seen as indicators of mood and sleep disorders.

Being intoxicated several times a week was an independent risk factor for frequent nightmares and may point towards a rebound in REM sleep and accompanied increase in recall of vivid dreams that follows from REM-supressing effect of ethanol.

Frequent headaches as an independent risk factor for nightmares remains a puzzling result. Though it may reflect daytime consequence of insomnia or some other factor, there is also a possibility of questionnaire artefact coming into play here. The question about headache were in very close proximity to questions about nightmares and insomnia and it is within a realm of possibility that some participants were primed by thinking about their sleep problems to also give an affirmatory answer to other problems presented in the question block, namely headaches.

The interaction between negative attitude towards self and insomnia was investigated further by studying the association between insomnia and nightmares at different levels of depressive symptoms. We found out that among those with moderate, mild or no depressive symptoms insomnia was significantly associated with nightmares and those with insomnia symptoms in addition to depressive symptoms had the most nightmares. However, among those with severe symptoms of depression there was no significant association between insomnia and nightmares as 20-30% of all participants with severe depression had nightmares regardless of their insomnia symptoms.

The full model is presented in Table 3.

Table 3. The multinomial logistic regression model, n=7575. Modified from Table 2 of Study II.

Variable		Frequent nightmares		Occasional nightmares	
		P	OR 95% CI	P	OR 95% CI
Gender	Female	0.002	1.20–2.23	<0.001	1.26–1.56
	Male				
Age (10 year intervals)		<0.001	1.17–1.50	<0.001	1.06–1.15
Neg. attitude toward self		<0.001	1.30–1.69	<0.001	1.10–1.22
Insomia	Often	<0.001	7.63–25.12	<0.001	2.14–3.60
	Sometimes	<0.001	1.54–4.52	<0.001	1.76–2.25
	Never				
Exhaustion	Often	<0.001	3.44–11.71	<0.001	1.60–2.32
	Sometimes	0.001	1.45–4.61	<0.001	1.56–2.00
	Never				
Headache	Often	<0.001	2.64–6.28	<0.001	1.48–2.22
	Sometimes	0.007	1.15–2.33	<0.001	1.50–1.86
	Never				
Work ability	Unable	<0.001	1.92–5.10	0.038	1.02–1.72
	Partial	<0.001	1.59–3.02	0.002	1.09–1.44
	Full				
Intoxicated	Weekly	<0.001	1.51–4.23	<0.001	1.50–2.23
	Monthly	<0.001	1.54–3.69	<0.001	1.36–1.88
	Seldom	0.087	0.96–1.90	0.009	1.04–1.33
	Never				
Insomnia*Neg.att.self		0.002			0.200

5.2.3. Sleep

While symptoms of insomnia was the only sleep related variable in our regression model that remained independent, we also analysed associations between nightmares, sleep length and chronotype.

Nightmares and sleep length had a U-shaped association that has also been observed between sleep length and various measures of health and well-being. Participants who reported sleeping less than five hours or more than ten hours per 24 hours included significantly more people with frequent nightmares than those who slept 6-10 hours (Cramer V = 0.07, χ^2 P < 0.001). However, this association was not very strong and in the regression model insomnia symptoms were a stronger predictor of nightmares than self-reported sleep length. The association between sleep length and nightmares is presented in Figure 8.

Prior research has reported an association between nightmares and evening chronotype (Nielsen, 2010) but in our data the relation was quite weak. Among women evening types reported more nightmares than other chronotypes (Cramer V = 0.07, χ^2 P < 0.001) but among men there was no statistically significant association. Chronotype did not remain a significant predictor in the regression model.

5.2.4. Life satisfaction

FINRISK included various measures of life satisfaction and all of them had a significant association with nightmares. Self-assessment of quality of life on the scale from 1 to 10 produced a mean life quality of 7.5 in these data. Among participants with frequent nightmares this was only 6.0 while among those with no nightmares it was above the population average with mean score of 7.8. The association between subjective life quality and nightmares was significant with medium effect size ($\eta2$ 0.062, F p < 0.001). Similar associations were found with nightmares and satisfaction to financial situation, achievements in life, family life and physical health. However, these variables did not remain significant independent predictors in regression model which included questions about symptoms of depression.
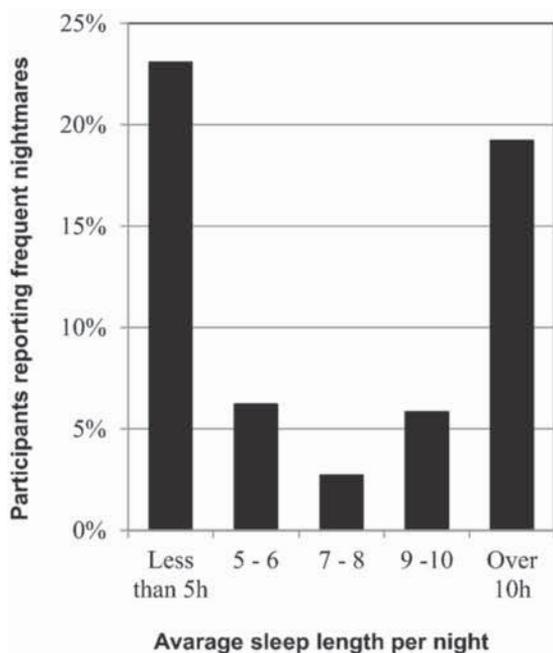
Figure 8. Nightmares and sleep length

5.2.5. Other associations of interest

Use of hypnotics and antidepressants had a significant association with nightmares on their own but they did not remain significant in the regression model including symptoms of insomnia and depression. This points towards a conclusion that these medications are not the cause of the nightmares while the problems they are used to treat probably are.

Use of painkillers was found to have a significant association with nightmares, especially painkillers used to treat joint and muscle pain (Cramer V 0.108, χ^2 $p < 0.001$). This might be an indication of a relationship between nightmares and chronic pain.

Alcohol use was measured both as a self-report of the amount of alcohol consumed and the frequency of being intoxicated. The association between amount of alcohol consumed and nightmares was weak, especially when compared with the association of nightmares and frequency of intoxication. Intoxication frequency had a strong relation to nightmares which also remained independent in the regression model.

Lastly, being pregnant did not have significant association with nightmares in these data, a result that contradicts some earlier findings (Nielsen & Paquette, 2007).

5.3. NIGHTMARES AS PREDICTORS OF SUICIDE

As noted in chapter 3.2.4 several studies have found a link between frequent nightmares and increased risk for suicidal ideation and behaviour. Only one of these studies, Tanskanen et al. (2001), analysed the connection between nightmares and actual completed suicide. This study was conducted by linking FINRISK data from surveys of 1972 to 1992 (N = 36 211) with the Finnish National Registry for Causes of Death and using frequent nightmares during the time of answering a FINRISK-survey as a predictor in Cox Proportional Hazard Regression model to estimate the risk of completed suicide later in life.

In the Study by Tanskanen et al. (2001) it was found that among men nightmares increased the risk for completed suicide with Hazard Ratio (HR) of 1.66 [1.15-2.39]. A similar trend was observed among women (HR 1.22 [0.57-2.60]), but it was statistically non-significant due the small number of suicides committed by women.

In our study I we discovered that FINRISK surveys 1972, 1977, 1982, 1987 and 1997 include the war generation with identifiable war veterans in the surveys of 1972 and 1977 and these participants have increased nightmare frequency compared to participants without war experiences.

In the light of the results of study I, we asked a question whether the results of Tanskanen et al. (2001) were affected by the presence of war veterans in their data. In that study war veterans were not identified but they exist in the data and might confound the association between nightmares and suicide risk: If these participants would have increased risk for suicide and nightmares due to PTSD symptoms related to war experiences nightmares might not be an independent risk factor for suicide as the results now led to believe.

Therefore in study IV we set out to perform an extended and improved version of the study of Tanskanen et al. (2001) where we tried to control for the effect of war veterans and enjoyed increased statistical power since we had more data available.

5.3.1. Data used to study suicide risk

In study IV we used data from FINRISK surveys 1972-2012 which included 71,068 participants (51.6% women) who had given permission to link their FINRISK data with causes of death register. These participants were followed from the time of their answering of the survey until 31 December 2014 or until death recorded in the causes of death register. In total the follow-up time was 1,521,327 person-years which was

191% more than what was available in the study of Tanskanen et al. (2001). During the follow-up 398 suicides were committed, 307 by men and 91 by women.

Cox Proportional Hazard Regression was used to estimate the change in the suicide risk caused by nightmares and we tried to control for the presence of war veterans in data by producing models where veterans were or the whole war generation was excluded as well as by analysing the association between nightmares and suicide only among confirmed war veterans.

5.3.2. Nightmares and suicide risk

As was the case in the study of Tanskanen et al. (2001), in the whole sample, including the war generation, nightmares increased the risk for completed suicide. In a model adjusted with sex, age, relationship status, employment status, smoking, use of alcohol, amount of exercise, symptoms of insomnia, symptoms of depression and use of psychotropic medication HR for suicide among participants with frequent nightmares was 1.84 [1.15-2.93] and among those with occasional nightmares it was 1.33 [1.05-1.69]. In similar models where men and women were analysed separately a similar trend emerged but it was statistically weaker as the number of suicides was lower.

When confirmed war veterans or the war generation were excluded, the results did not change significantly. In a fully adjusted model with the war generation excluded the HR for suicide among frequent nightmare sufferers was 2.01 [1.19-3.41] and 1.38 [1.07-1.79] among those with occasional nightmares. With data from men who answered surveys of 1972 and 1977, we constructed model that was adjusted with war experiences (served at front vs did not serve at the front). In this population there was a similar trend that nightmares increased risk for suicide, but it was weaker than among the whole population (in part due the smaller sample size). Frontline service was not a statistically significant predictor of suicide (HR 1.37 [0.77-2.45]). These results are presented in Table 4.

Overall the results of Tanskanen et al. (2001) did not significantly change when participants with war experiences were taken into consideration. The results that nightmares increase risk for suicide, albeit slightly, stands.

Table 4. Cox regression model of suicide risk according to frequency of nightmares.

RISK OF SUICIDE: WHOLE SAMPLE[1]

Nightmares	Hazard Ratio	95% CI	P	N of suicides	N
Often	1.84	1.15 – 2.93	0.010	26	2174
Occasionally	1.33	1.05 – 1.69	0.018	149	21774
Not at all	1			157	31252
Total				332	54815

RISK OF SUICIDE: MEN OF 1972 AND 1977[2]

Nightmares	Hazard Ratio	95% CI	P	N of suicides	N
Often	1.51	0.68 – 3.36	0.308	8	401
Occasionally	1.51	1.06 – 2.15	0.024	64	3253
Not at all	1			72	6169
War experiences					
Served at front	1.37	0.77 – 2.45	0.282	25	2695
Did not serve at front	1			119	7264
Total				144	9815

[1]Adjusted with sex, age, relationship status, employment status, smoking, use of alcohol, amount of exercise, symptoms of insomnia, symptoms of depression and use of psychotropic medication

[2]Adjusted with age, relationship status, employment status, smoking, use of alcohol, amount of exercise, symptoms of insomnia, symptoms of depression and use of psychotropic medication

5.3.3. Methodological challenges related to survival analyses

While study IV was an improvement over the original study of Tanskanen et al. (2001), both versions of the study where nightmares were used to predict suicide rest on the assumption that having frequent nightmares is a trait or at least a very long term problem. Nightmares were measured only when the participant answered a FINRISK survey and if the participant committed suicide later in his life, Cox Proportional Hazard Regression model interpreted nightmares at the start of the follow-up period to increase the risk even if that follow-up period lasted for many years. The mean time from answering the survey to suicide was actually 13.9 years.

It is a strong assumption that having nightmares a decade earlier is related to suicide after such a long time. If one of the reasons for suicidality is PTSD or major depression, it might be possible that this problem and related nightmares have lasted years or even decades. It is also possible that there is a shared underlying trait that affects nightmare frequency, related problems and suicidality and stays constant for a long time. However, from the data available we cannot know if this is the case, only that there appears to be small but robust increase in suicide risk among people who report frequent nightmares year prior to actual suicide.

While this weakness in the study design is quite alarming, possibility of correcting it in a representative sample is quite a challenge. Since suicides are fortunately a very rare occurrence (incidence rate of 26.2 per 100,000 person years in our sample), a study which would investigate the effect of nightmares on suicide risk among general population with for example a maximum of one year follow-up time would need a sample size of several hundreds of thousands to produce statistically meaningful results.

5.4.SUMMARY OF EMPIRICAL RESULTS

Around 4% of Finnish adults reported having frequent nightmares. However, the prevalence was affected by age and gender. Four to six percent of women of all ages reported frequent nightmares with a slight increase with age. Among 25-30 year old men less than 2% reported frequent nightmares but nightmare prevalence increased with advancing age reaching 5% prevalence similar to women at around 55 years of age and the gender difference is not present after this age.

Nightmare prevalence was elevated in populations with high chance of traumatic experiences: Seven percent of veterans of WWII reported having frequent nightmares in 1972 and 1977, three times the amount compared to non-veteran men, even though over 30 years had passed since the end of the war.

From 1972 to 1987 the prevalence of occasional nightmares stayed quite constant with around 42% of women and 32% of men reporting them. After 1987 there has been an increasing trend in the prevalence of occasional nightmares with a peak in 1997 when 48% of women and 41% of men reported occasional nightmares. Although there was a slight decrease from 1997 to 2002, the increasing trend resumed afterwards. Nightmares were slightly more common in very urban or very rural areas compared to semi-urban areas surrounding city centres and rural areas with good infrastructure.

Nightmares had a strong association with symptoms of depression and insomnia. Over 20% of participants reporting marked depression symptoms and 17% of participants suffering from frequent insomnia symptoms also reported frequent nightmares. In addition to depression symptoms, 16% of participants with strong symptoms of seasonal affective disorder reported frequent nightmares. In addition to symptoms of depression and insomnia female gender, advancing age, daytime tiredness, frequent headaches, lowered working ability and frequent intoxications were significant risk factors for reporting frequent nightmares. Overall nightmares associated with various measures of subjective well-being with increased nightmare frequency correlating with decreased well-being.

Reporting frequent nightmares increased the risk for completed suicide later in life and this result could not be explained by just the potential traumatic experiences of war veterans. Therefore frequent nightmares appear to be risk factor for suicide, albeit not a very strong one (HR 1.84 [1.15 – 2.93]).

From these results we can construct a profile of typical adult reporting frequent nightmares in Finland: She is a woman who can be of any age, but slightly more likely to be 50 years or older. Her complaints are nightmares, problems of getting enough sleep and symptoms of depression that may get worse during wintertime. She is generally not satisfied with her life and experiences high stress.

Typical male nightmare sufferer differs slightly from his female counterpart. He is likely to be 55 years of age or older. He is likely to experience problems with adequate sleep and symptoms of depression but may also be heavy user of alcohol and even have thoughts related to self-harm.

6. DISCUSSION AND FUTURE DIRECTIONS

"Whereof one cannot speak, thereof one must be silent."

Wittgenstein, 1921

We have now established that there are philosophical and methodological challenges in measuring dreaming, especially with retrospective questionnaires, and have also gotten acquainted with the empirical work done on epidemiology of nightmares. Even with weak transparency of retrospective questionnaires, our results about prevalence, risk factors and suicide risk related to nightmares are statistically significant and appear to have clinical implications.

In this chapter I will first discuss the result from an empirical perspective: What do the results imply and what further questions they raise. Then I will revisit the question, what did we actually measure with the retrospective question about nightmare frequency and what can be safely claimed based on our results.

6.1. PERSPECTIVES ON EPIDEMIOLOGICAL RESULTS

The main strength our empirical results is the large representative population sample of FINRISK data. With such data, it is reasonably safe to claim that our results reflect the true state of matters among Finnish adults. With generally high statistical power, random errors should not have had a large impact on the results.

The weakness of FINRISK data is the way nightmares, as well as many other subjective phenomenon are measured. Before discussing this limitation more, I shall first examine our empirical results at face value.

6.1.1. Prevalence

Overall prevalence estimate for frequent nightmares in our studies was around 4%. This estimate is slightly higher than the 2.4-2.8% reported by Bjorvatn, Grønli and Pallesen (2010) or Schredl (2010) but very similar to 4-5.1% reported by Li et al. (2010) and Stepansky et al. (1998), even though all of these studies used different questions to measure nightmares.

Based on these studies and our own, it can be claimed with some degree of scientific confidence that 2-5% of general population in highly developed countries report frequent nightmares. This is not an insignificant prevalence: In Finland alone we can expect to have over 200 000 people who currently have nightmares frequently.

As reported by all previous studies, we also found women to report more nightmares than men. However, we also found the gender difference only to apply to participants under 55 years of age. Nightmares also become more common with advancing age, especially among men. This result is in line with meta-analyses by Schredl & Reindhard (2011) in which sex difference in nightmare prevalence was not found among children or elderly and it is also in line with study utilizing representative population sample by Li et al. (2010) where there was tendency for nightmares to increase with age. Our result contradicts other studies which found nightmares to be less common among elderly (Nielsen et al. 2006, Wood et al. 1993), but these studies were conducted with less representative sample than Li et al. 2010 and our Study I.

Therefore I consider the result that nightmares increase with age, especially among men, to have more support than the opposite view that nightmares decrease with age. This is certainly the case in Finland, but it might be possible that this is not a universal trend but is affected by culture of the study region. Finland is quite an individualistic culture and elderly often live on their own or in a nursing home. It would be interesting to compare nightmare prevalence of the elderly in Finland to a more collective culture where elderly typically live with extended family.

Of course, cultural differences in treatment of elderly would not explain the linear trend of increasing nightmare prevalence among men of all ages that we observed. This trend could be further investigated with biological methods as we mentioned in the discussion of Study I: Testosterone, a hormone that affects competitive and risk taking behaviour among other things and decreases in men with advancing age would be one study candidate (Hermans et al., 2007; Hermans et al., 2006; Vermeulen, Rubens, & Verdonck, 1974). Could it be that levels of testosterone would be correlated with susceptibility to nightmares in such fashion that individuals with high levels of the hormone would be less likely to experience nightmares? This is a purely speculative hypotheses, but it would be empirically testable with some promise of explaining interesting phenomenon.

Results of veterans of WWII in our data lead to two conclusions: Most likely the increased nightmare prevalence of the veterans is related to history of trauma exposure and resulting post-traumatic nightmares. Since the measurement of nightmares was conducted over 30 years after the war, we can infer that post-traumatic nightmares may be a lifelong problem and definitely should be targeted for interventions. This notion is now widely recognized in psychology but unfortunately it cannot benefit the majority of Finnish veterans (with mean age of 91 years in 2017) anymore.

The other insight from the increased nightmare prevalence of the veteran population is a methodological one: Inclusion or omission of the veterans and the war generation significantly affected the results of studies I and IV. Future studies of nightmares in population samples should be conscious of whether there exists sizeable sub-populations in their samples with high chance of trauma exposure. These populations should be identified and separately analyzed if possible. Their inclusion in the data, especially if researcher is not aware of their existence, can skew the results of the whole study and studying them separately as subpopulations can lead to interesting additional information.

To my best knowledge, study I is the only study that has investigated historical trends in nightmare prevalence. From these results two things can be observed.

First, as mentioned previously, these results are different depending on whether the war generation is included in the sample or not: A significant number of war veterans in the sample almost doubles the prevalence of frequent nightmares among men in the survey of 1972 (4.7% with war generation, 2.8% without). With the war generation included in the sample, there was a trend that frequent nightmares have decreased from 1970´s to 1980´s. However, with the war generation excluded the trend disappears among men and weakens among women. Excluding the war generation is not a perfect control condition for traumatic nightmares as the war generation is also systematically older than the post-war generation, but it points towards a conclusion that if the war generation is not considered separately, there is no significant chance in the percentage of people of general population reporting

frequent nightmares in Finland from 1972 to 2007. However, if we also consider the war generation, frequent nightmares on population level have decreased in Finland as the numbers of people belonging to the war generation have decreased.

Second, the number of participants reporting occasional nightmares had increased significantly in Finland during 1987-2007. This trend is not related to the war generation, because there was an insignificant number of members of war generation present in these surveys. The trivial explanation for this increase would be to assume that for some reason participants of the recent surveys are just keener on reporting nightmares compared to participants of later surveys, but since this trend is not seen in frequent nightmares this explanation seems lacking.

Moreover, occasional nightmares are not the only sleep related complaint than has increased in Finland during the last decades. There has been a small decrease in self-reported sleep duration and sleep quality as well as increase in use of hypnotics (Kronholm et al., 2008) in Finland during the last four decades. There has also been discussion of deteriorating sleep quality in recent times, but evidence for this has been mixed (Youngstedt et al., 2016). Though the evidence is not conclusive, there might be a trend that sleep quality is decreasing at the societal level in Finland and possibly in developed countries in general. Increase in the prevalence of occasional nightmares might be one part of this bigger problem.

If sleep quantity and quality have truly decreased, reasonable hypotheses about the causes would be rapid technological progress and changes in society towards being more active during the nights. In the environment where human sleep has evolved, night and day were determined by the sun, not by the clock. In the environment where human sleep evolved, (or even three decades ago) there were no led-screens or smartphones. Modern technological environment might disturb sleep on societal level by increasing stress and conflicting with human circadian rhythms. However, whether this is the case is empirical question; It cannot be determined a priori based on technophobic of technophilic attitudes of the discussants.

Regardless of the cause, increased levels of stress at the population level would be a reasonable, though vague, explanation for the increased prevalence of occasional nightmares. An interesting observation about the prevalence of occasional nightmares is also the peak at 1997 which coincides with last years of 1990´s great economic depression in Finland. By 1997 Finnish economy had started to recover from a crash that happened in 1991-1994 but unemployment rate was still high, trust in the economy was low and political situation was uncertain.

In the light of our observations that presence of war veterans in data affect the nightmare prevalence at population level and the occasional nightmares peaking after economic depression, I propose that nightmare prevalence at population level can reflect larger trends in society: It might be a quite sensitive measure to overall levels

of stress and psychological well-being of a population. This might be true especially for occasional nightmares – while frequent nightmares are often associated with clinical problems such as depression occasional nightmares might reflect the amount of stress, or affect load of a population. People who do not suffer from clinical problems may still react to increasing stress in their lives with some nightmares and this is picked up by population level estimates of nightmare prevalence. If this hypotheses holds and societal atmosphere affects nightmare prevalence on population level, another peak in occasional nightmares should be observable during recent years in western world due to increasing political uncertainty. Some data to test this hypothesis will emerge in the form of FINRISK 2017 in the coming months.

These thoughts about decrease in sleep quality and increase in stress and nightmares at population level are still quite general and lack strong empirical support. Regardless, these themes, especially the question whether sleep quality is really decreasing and why, warrant more research in the future.

6.1.2. Risk factors

The strongest risk factors for reporting frequent nightmares were symptoms of depression and insomnia. This is in line with previous studies (Munezawa et al., 2011; Ohayon et al., 1997; Levin & Fireman, 2002; Li et al., 2012; Levin & Nielsen, 2007). In study III we discovered that symptoms of SAD were also associated with frequent nightmares in a similar manner to depressive symptoms measured by BDI. This is a novel albeit not too surprising finding.

Another novel perspective to the association between nightmares, insomnia and depression was revealed by the factorized BDI in our regression modeling in study II. In this study we wanted to use BDI and a question about insomnia symptoms in the same model but because there is already question about sleep problems embedded in the BDI, we factorized BDI to three factors that measured depressive mood, negative attitude towards self and physical symptoms (including trouble sleeping). When these factors were used in the regression model with insomnia symptoms, gender, age, exhaustion, headache, working ability and frequency of intoxication, of all BDI factors only factor "negative attitude towards self" remained independent predictors of frequent nightmares.

Insomnia was a strong risk factor in this model, indicating that physical symptoms of depression are related to nightmares, but according to our model depressive mood is not related to nightmares as strongly as negative attitude towards self. This might support the idea that that negative inner speech, rumination and low self-esteem are psychological tendencies that carry from waking to dreaming. If waking consciousness is seen as a simulation of the outside world colored by internal stimuli, and dreaming

as conscious simulation that is only driven by our internal stimuli it would make sense that waking and dreaming consciousness would have a similar affective tone.

The big open question regarding the symptomatic triad of depression, insomnia and nightmares is the question of causality: Are these complains symptoms of the same underlying problem or genetic vulnerability, independent but often co-existing issues, or do some of them lead to the development of others? There are studies that have found that symptoms of insomnia can precede the onset of depression (Baglioni et al., 2011) making insomnia both a risk factors and a symptom of depression. Similar study should also be conducted with nightmares: Do nightmares at time 1 predict depression at time 2? If this would be the case, both nightmares and insomnia could be seen as a modifiable risk factor of depression and targeting them with early intervention could be used as a way of preventive treatment for depression.

In the model of study II, all major risk factors for frequent nightmares could be seen to reflect symptoms of depression or insomnia expect age, gender and being intoxicated several times a week. While heavy alcohol use certainly is often a part of depression, especially in Finland, its status as an independent risk factor in our regression model points towards the interpretation that frequent intoxication is associated with frequent nightmares also without depressive symptoms. Prior work has identified ethanol as possible inducer of nightmares, possibly because it has REM-suppressing effects early on in the sleep cycle causing REM rebound later in the night (Pagel & Helfter, 2003). Since most vivid dreams are reported from late night REM awakenings, increasing amount of REM sleep can also increase the chance of experiencing nightmares.

The practical message of this association is that self-medication of nightmares with alcohol is most likely to lead to more, not less, dysphoric dreams.

Though only negative attitude towards self, insomnia symptoms, gender, age, exhaustion, headache, working ability and frequency of intoxication were left as independent risk factors for frequent nightmares in the regression modelling of study II, there were dozens of statistically weaker but logical associations between nightmares and various factors related to life satisfaction and physical and psychological wellbeing discovered in those data. Associations to subjective life satisfaction and health in addition to depression and sleep problems paint a picture of nightmares as a general sign of ill-being. Similarly to tiredness or inflammation being general and unspecific signs that there is something wrong with the body, having nightmares might be a general, unspecific sign that the person is experiencing psychological stress. If this is the case, nightmares might work as an early warning sign of psychological load that should be taken into account before more severe symptoms evolve.

This view, as our results in general, are compatible with main theories of dream and nightmare function. Continuity hypotheses would predict psychological load to be reflected on dream content (Schredl & Hofmann, 2003), Neurocognitive Model uses the concept of affect load and predicts nightmares to increase with increasing affect load (Nielsen & Levin, 2007) and even Threat Simulation Theory predicts that experiencing the environment as more threatening would increase the number or intensity of threating dreams (Revonsuo, 2000). Data at hand will not help to distinguish between competing theories, but the results can be seen as a clinically significant observations. Maybe nightmares would have value as an early warning sign or potential target for early intervention. Nightmares could be used to identify people who would benefit from paying attention to their level of psychological stress, hopefully before developing more problems associated with nightmares.

6.1.3. Nightmares and suicide

In Study IV earlier work by Tanskanen et al. (2001) received more support: Frequent nightmares appear to increase suicide risk, even when the war generation with potentially high prevalence of PTSD was taken into account. Clinical question raised by this observation is whether nightmares are a modifiable risk factor for suicide - would intervention targeting nightmares decrease suicide risk? Whether this is the case or not, according to our results nightmares were not very strong risk factor for suicide and there are not many studies that have investigated the issue. Therefore it might be more cost efficient to consider other options in suicide prevention. However, among people with history of suicidal behavior, increase in nightmare frequency can be seen as a warning sign that should not be ignored.

One of the limitations of study IV was that the mean time from measurement of nightmares in FINRISK to suicide was 11 years. This means that if we trust the result that nightmares really do have an association with a suicide committed a decade later, we must assume that either nightmares themselves are a relatively stable trait or that they are an indicator of a stable trait that is also risk factor for suicide. Theories of nightmare function that view nightmares as psychologically functional tend to posit that there are relatively stable personality traits associated with nightmare frequency. In the light of our results, this personality traits could also be the link between nightmares and suicide risk (Hartmann et al., 1991; Nielsen & Levin, 2007).

Whether nightmare frequency is a stable trait over long periods of time is also an empirical question. An epidemiological study with longitudinal design could investigate both how stable a trait nightmare frequency is during a certain timespan and whether nightmares predict the onset of depression.

6.2. PHILOSOPHICAL CONSIDERATIONS: WHAT DID WE MEASURE?

Measuring dreaming is always indirect: Outside observer does not have access to the dream experience, only to dream reporting behaviour. Correspondence of dream report to the actual dream experience, transparency, is a central issue in studying dreaming and transparency is assumed to be best under ideal reporting conditions (Windt, 2015) and a central part of ideal reporting conditions is temporal proximity between the experience and the report.

Our results are based on retrospective questionnaires that investigate frequency of nightmares during last 30 days. Nightmares are not defined and the answer categories are not absolute but instead qualitative. This is not an ideal reporting condition by any stretch of imagination; the temporal proximity to actual nightmare experiences is long and we do not know what "nightmare" means for different participants.

While at first qualitative answer categories used in the question might seem like a weakness, this is not necessarily so: The answers to questions which try to investigate absolute dream frequency over a period of a month probably produce unreliable results simply because people do not remember exactly the number of dreams they have recalled during such a long time. In our data, the categories "frequently" and "occasionally" clearly define two different groups and the "frequent" group is comparable to groups of weekly nightmare frequency of other studies (Janson et al., 1995; Li et al., 2010; Schredl, 2010).

It does appear, that epidemiological studies of nightmares measure something similar in different populations and cultures, but it certainly is not the dream experiences themselves and not necessarily even the number of recalled nightmares. Without a dream log, it is unlikely that the participant has clear memory of the absolute number of dreams she has recalled in a typical study period of one month. It should also be noted that the number of recalled dreams is not the same thing as the true number of experienced dreams as most of them are not recalled.

For defining what I think retrospective questionnaire studies of dreaming measure, I will introduce concepts of two selves coined by Daniel Kahneman (Kahneman, 2011).

With Experiencing Self (ES) Kahneman (2011, p. 377) means our mind when it lives through reality on moment to moment basis. In terminology of this thesis, ES is the stream of the contents of phenomenal consciousness. For example, if Descartes in front of the fire decides to reach out his hand towards the flame, so close that the heat causes pain but does not yet produce burns, his ES feels the pain for as long as he continues to hold his hand too close to the flame. Should Descartes decide to stop this unpleasant experiment after 30 seconds, his ES felt the pain for those 30 seconds.

Another view to the experience is held by the Remembering Self (RS). With RS, Kahneman (2011, p. 377) means cognitive processes that are used to recall and judge our memory of an experience after the actual experience is over. After experimenting with the fire, if Descartes tries to recall the experience, he must utilize RS as the true experience, contents of phenomenal consciousness and the reality of ES, are gone forever and only memory of them remains. Therefore the reality of RS is the reality of memories of experiences and this is quite different from an actual ongoing experience.

More specifically, experiments by Kahneman and Redelmeier (1993, 1996) have found that when judging a past experience, RS tends to use memory heuristics that are sometimes a bit bizarre. For example, when making judgements about pleasantness of an experience, people tend to neglect the duration of the experience and base their judgements on the peak intensity as well as quality of ending of the experience episode. If these results would hold for Descartes, his RS would say that he experienced more pain when he held his hand too close to the flame for 30 seconds compared to a situation where he did so for 60 seconds but during the last 10 seconds withdraw his hand away very slowly. The diminishing pain towards the end of the longer episode would produce more pleasant memory than in the shorter episode and therefore RS would claim that it was the less painful one. If ES would be able to rank the experiences, it would surely prefer to suffer for shorter period of time but after the fact there is only RS with its memory heuristics giving reports while ES of the time is gone.

In other words, if one is interested in conscious experience, the reality of ES, one must gather information from the experience in real time. Temporal proximity is the biggest factor affecting transparency of experience reports and therefore experience sampling methods are the most transparent way of investigating experiences.

But what if the ES cannot be sampled? It is impossible to conduct experience sampling on a sleeping person, as she cannot provide a report without waking up and after waking up, her experience during the sleep is over and the report she produces comes from RS, not from ES. This is always the case with dreaming to some extend and especially true for retrospective questionnaire studies.

6.2.1. Experience of Experiencing (E^2)

So, what did we measure in the current thesis? Not nightmares as dream experiences lived through by ES but instead we measured outcome of RS´s cognitive process when it formed an answer to the question whether it had experienced nightmares.

The answer given by RS is not only related to actual nightmare frequency, but is also heavily influenced by memory heuristics, like availability heuristic (if one instance of a thing is easy to remember, people overestimate its frequency) and duration neglect (the ending and peak intensity of experience are more important than duration when assessing pleasantness) used by the RS (Kahneman, 2011). It is also affected by item-order effects of the questionnaire, way the questions are phrased as well as current mood and attitudes of the participant.

Because of memory heuristics, a person who had a nightmare recently (e.g. the night before the survey) or remembers one very intense nightmare would most likely report to having more nightmares than a person with actually higher nightmare frequency but less salient memories of them available. Therefore it is likely that retrospective estimate of nightmare frequency is not based on actual number of nightmares experienced but instead it is heavily influenced by the intensity and memorability of few intense nightmares. This may also explain why certain nightmare themes, like falling, are frequently reported in studies about nightmare themes, even if they do not represent majority of nightmares actually experienced. If certain nightmares, like dreams about falling, are more easily remembered than others, they will be overrepresented in questionnaire studies because of availability heuristic. Attitudes the person holds about herself and nightmares also affect the assessment of nightmare frequency – for example depressed people tend to direct their attention more towards negative things and this could make them recall, or feel to have recalled, more nightmares.

I propose that the construct measured in our studies is the impression of the RS about itself as a person who has nightmares. This is not directly related to nightmare frequency of the person, but instead is strongly influenced by the most recent and most intense nightmares the person has experienced as well as distress caused by those experiences. It is also affected by situational factors, persons attitudes and susceptibility to anxiety.[9] I call this construct the *Experience of Experiencing* (E^2).

> The *Experience of Experiencing* is a person's impression of herself as a person with certain kind of experiences. It is a cognitive judgement that is made when answering any retrospective question about one´s subjective experiences.

In the figure Figure 9 I present a rough sketch of a cognitive model about the production of E^2 assessment using the FINRISK nightmare question as an example. We can see that the actual nightmare experiences are just one of the factors affecting

---

[9] Susceptibility to anxiety and attitudes towards dreams are most likely the key components affecting nightmare distress. Therefore the line of thinking proposed here might be able to shed light on why nightmare distress appears to be more important than nightmare frequency to the negative consequences of nightmares. This relation could be explored more in the future.

production of E^2 that is also affected by situational factors like the environment where the question about nightmares is encountered and phrasing of the question, self-related factors like attitude towards dreams and current mood. The actual nightmare experiences are also affecting E^2 indirectly – nightmares must be recalled, they must leave some memory trace, that trace must be recalled (using also memory heuristics) and only after these steps they influence the E^2. The action of answering the question about nightmares is then report of the E^2 that is feeling of being a person with certain kind of nightmare frequency.
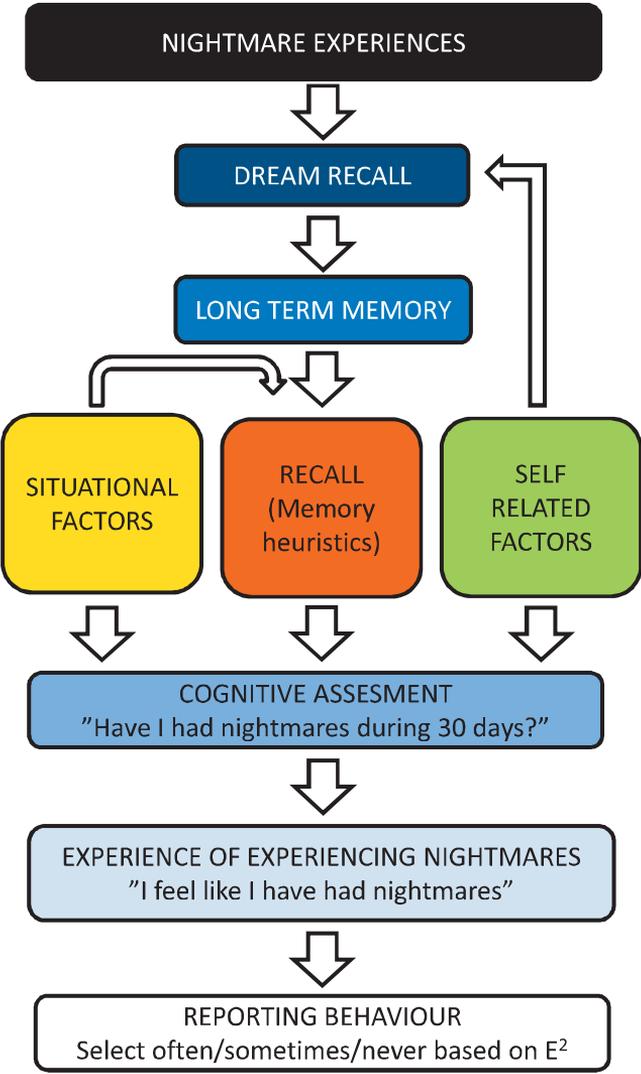

Figure 9. Cognitive model of Experience of Experiencing nightmares

Now armed with concept of E^2 we can reach an epistemologically satisfactory position concerning the experiential and transparency hypotheses in regards to our data:

Dreams are most likely experiences during a state of sleep and nightmares are dysphoric experiences during sleep. Some parts of these experiences may be recalled and reported after an awakening but we do not have a scientific way of verifying what the transparency of these reports is. We only know that with retrospective questionnaires it is probably quite imperfect.

Therefore I will not commit to the transparency hypotheses concerning our data and do not claim that we have measured dream experiences in our empirical studies. Instead I propose that we have been measuring E^2, the experience of experiencing nightmares. E^2 is a construct of Remembering Self that is made up by memory heuristics and unspecified psychological factors in addition to true memories about recalled dreams. E^2 cannot be claimed to be very transparent towards the experiences it is about but this does not mean that it is not a significant property of the person or it is meaningless to measure it: It just means that only certain kinds of scientific questions can be answered with E^2 data.

For example, a question about phenomenology of dreams or true dream recall are very hard to investigate with E^2 measures because there is bound to be an unknown amount of distortion caused by processes between the experience and formation of E^2 answers by RS. As a result, questions that are about the actual experience are best investigated by methods with as high transparency as possible, such as experience sampling and dream laboratory studies.

However, questions concerning the association between E^2 and other measures of interest, such as well-being, symptoms of depression or even suicide, have decent reliability across studies as well as clinical significance. From studies of epidemiology of nightmares we have learned that E^2 of having nightmares is robustly associated with several clinically significant factors: E^2 matters, even if it is not a true measure of what it is claiming to measure. Noteworthy is also that many other clinically significant phenomena, like depression or loneliness are generally also investigated with E^2 measures and as a result, do not really measure subjective experience of depression or loneliness but instead the cognitive judgement whether the person identifies with these experiences. The field of epidemiology of subjective experiences is epidemiology of the world of the remembering self.

In conclusion, the results of our studies should be read in such a way as to add the E^2 specifier in front of all instances when nightmares are mentioned. The experience of experiencing nightmares is associated with symptoms of depression and insomnia, around 4% of Finnish adults have the experience of experiencing frequent nightmares and the experience of experiencing nightmares increases suicide risk. This is the philosophically rigorous way of presenting these kinds of results.

While concept of E^2 pacifies the most pressing philosophical issues concerning the measurement of nightmares with epidemiological methods, it leads to other, hopefully more empirically approachable sets of questions.

The most obvious question concerns the transparency of E^2 measures. How does the E^2 measure compare to the actual experience? As we have established, there are no ways to actually test the transparency of methods against the true experiences of ES, but the transparency of methods can be tested against each other. In the case of dreaming, it would be feasible to compare dream laboratory studies with home dream logs and different retrospective questionnaires with the assumption that dream laboratory would have the best transparency. Some studies with these kinds of design have been conducted (Aspy, 2016) with results mostly concerning the under-estimation of dream frequency by retrospective measures. What I would propose to add to this line of research, would be to incorporate insights from memory and judgement research to the design and, for example, test how different ways of phrasing the retrospective question would affect the discrepancy between it and log or laboratory measures.

However, for me the question about the amount of transparency of the E^2 measures might not be the most fruitful one. Instead of trying to exactly measure what the transparency of E^2 measures might be, one can simply think of them as measuring a *different but meaningful thing* than actual subjective experience. Instead of being just a proxy measure, E^2 measures might be seen as an interesting form of information about a person on their own right.

From this line of reasoning rises a question of what is the relative importance of actual experience and E^2 for outcomes of significance such as depression or well-being in general. For example, in statistical sense we know that E^2 of nightmares has a significant relationship with depression (another E^2 measure). This means that people who have experience of experiencing symptoms of depression often experience themselves as experiencing nightmares. These *two cognitive judgements are associated* and this is already clinically significant information. However, this association might not be quite similar to that of association between the actual experiences of feeling subjectively depressed and experiencing nightmares during sleep.

Logically it is possible to dissociate E^2 measures and actual experience from each other, especially if the actual experience is not easily recalled. For example, we can imagine a person who experiences terrible nightmares (that do not awaken her) every night *but does not remember them* in the morning. In this case her ES has nightmares and RS does not and her E^2 would be that she does not have nightmares.

Would this person suffer any negative consequences from the nightmares when she is awake? Would she have higher risk for depression or some other problems because she has actually lived through many nightmares or is E^2 of nightmares required for nightmares to produce negative daytime consequences? In other words, what happens when E^2 and actual experiences do not correspond in the persons mind? This question might be susceptible to empirical analyses, at least with some form of experience, if not with dreams (as it is impossible to study dreams that are not recalled).

For now, my treatment of the concept of E^2 has only been a rough sketch, preliminary idea of what a rigorous model of retrospective experience reports could look like. In the future, the concept should be clarified and its usefulness critically examined. Regardless, at the moment, I feel optimistic about its utility as a concept that brings together many ideas from study of consciousness into an easily approachable moniker that could be useful in the study of psychological epidemiology and beyond.

In addition to questions concerning E^2, the field of dream research could benefit from work aiming to specify ideal reporting conditions for different research questions. While the term is intuitively appealing and useful, Windt (2015) did not define these conditions in any concrete way. Producing guidelines for study of dreams and subjective experiences in general would be useful in many fields, but achieving consensus on these guidelines might not be an easy task.

6.3. CONCLUSIONS

In this thesis, I have framed epidemiological work on nightmares within philosophical tradition of study of consciousness. This has led me to an conclusion, that our retrospective questionnaire assessment of nightmares did not measure dream experiences but instead experience of experiencing nightmares.

E^2 nightmares is not uncommon among Finnish adult population and it is associated with various problems of well-being, most notably E^2 depression and insomnia. War veterans report more E^2 nightmares than general population decades after the war and E^2 nightmares increase risk for completed suicide.

All in all, E^2 nightmares are clinically significant symptom: They may represent general sign of ill-being that might be useful as an early warning sign for more severe problems.

As for the concept of E^2, with more work it could evolve into a useful tool of reminding researchers that what they think they measure may not be what it seems at the first glance. At least it has afforded me some degree of peace of mind concerning our empirical work.

We humans are unique animals because we live in two worlds: The world of experience and the world of stories. Still, our dreams and nightmares as well as our stories of our dreams and nightmares are aspects of one reality. It is a reality we may never really learn to understand but that should not discourage as from trying to tell as beautiful stories about its nature as possible.

REFERENCES

Aalto, A. M., Elovainio, M., Kivimäki, M., Uutela, A., & Pirkola, S. (2012). The Beck Depression Inventory and General Health Questionnaire as measures of depression in the general population: a validation study using the Composite International Diagnostic Interview as the gold standard. *Psychiatry Research, 197*(1-2), 163–171.

Agargun, M. Y., Besiroglu, L., Cilli, A. S., Gulec, M., Aydin, A., Inci, R., & Selvi, Y. (2007). Nightmares, suicide attempts, and melancholic features in patients with unipolar major depression. *Journal of Affective Disorders, 98*(3), 267–270.

Aspy, D. J. (2016). Is dream recall underestimated by retrospective measures and enhanced by keeping a logbook? An empirical investigation. *Consciousness and Cognition, 42*, 181–203.

Aspy, D. J., Delfabbro, P., & Proeve, M. (2015). Is dream recall underestimated by retrospective measures and enhanced by keeping a logbook? A review. *Consciousness and Cognition, 33*, 364–374.

American Psychiatric Association. (2013) *Diagnostic and Statistical Manual of Mental Disorders: DSM-5.* American Psychiatric Association.

Augedal, A. W., Hansen, K. S., Kronhaug, C. R., Harvey, A. G., & Pallesen, S. (2013). Randomized controlled trials of psychological and pharmacological treatments for nightmares: A meta-analysis. *Sleep Medicine Reviews, 17*(2), 143–152.

Ağargün, M. Y., Cilli, A. S., Kara, H., Tarhan, N., Kincir, F., & Oz, H. (1998). Repetitive and frightening dreams and suicidal behavior in patients with major depression. *Comprehensive Psychiatry, 39*(4), 198–202.

Baglioni, C., Battagliese, G., Feige, B., Spiegelhalder, K., Nissen, C., Voderholzer, U., … Riemann, D. (2011). Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. *Journal of Affective Disorders, 135*(1-3), 10–19.

Aristotle (350BC) De Somno. In Barnes, J. (2014). *Complete Works of Aristotle: The Revised Oxford Translation* (Vol. 1). Princeton, N.J.: Princeton University Press.

Bayne, T., Hohwy, J., & Owen, A. M. (2016). Are there levels of consciousness? *Trends in Cognitive Sciences, 20*(6), 405–413.

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4*(6), 561–571.

Belicki, K. (1992). Nightmare frequency versus nightmare distress: relations to psychopathology and cognitive style. *Journal of Abnormal Psychology, 101*(3), 592–597.

Berger, W., Coutinho, E. S. F., Figueira, I., Marques-Portella, C., Luz, M. P., Neylan, T. C., … Mendlowicz, M. V. (2012). Rescuers at risk: a systematic review and meta-regression analysis of the worldwide current prevalence and correlates of PTSD in rescue workers. *Social Psychiatry and Psychiatric Epidemiology, 47*(6), 1001–1011.

Bernert, R. A., Kim, J. S., Iwata, N. G., & Perlis, M. L. (2015). Sleep disturbances as an evidence-based suicide risk factor. *Current Psychiatry Reports, 17*(3), 1–9.

Bjorvatn, B., Grønli, J., & Pallesen, S. (2010). Prevalence of different parasomnias in the general population. *Sleep Medicine, 11*(10), 1031–1034.

Blagrove, M., & Haywood, S. (2006). Evaluating the awakening criterion in the definition of nightmares: how certain are people in judging whether a nightmare woke them up? *Journal of Sleep Research, 15*(2), 117–124.

Borodulin, K., Vartiainen, E., Peltonen, M., Jousilahti, P., Juolevi, A., Laatikainen, T., … Puska, P. (2015). Forty-year trends in cardiovascular risk factors in Finland. *European Journal of Public Health, 25*(3), 539–546.

Breslau, N. (2001). The epidemiology of posttraumatic stress disorder: what is the extent of the problem? *The Journal of Clinical Psychiatry, 62*(17, Suppl), S16–S22.

Casement, M. D., & Swanson, L. M. (2012). A meta-analysis of imagery rehearsal for post-trauma nightmares: effects on nightmare frequency, sleep quality, and posttraumatic stress. *Clinical Psychology Review, 32*(6), 566–574.

Chalmers, D. J. (1995). Facing up to the problem of consciousness. *Journal of Consciousness Studies, 2*(3), 200–219.

Chalmers, D. J. (1996). *The conscious mind: In search of a fundamental theory*. Oxford: Oxford University Press.

Cukrowicz, K. C., Otamendi, A., Pinto, J. V., Bernert, R. A., Krakow, B., & Joiner, T. E., Jr. (2006). The impact of insomnia and sleep disturbances on depression and suicidality. *Dreaming, 16*(1), 1–10.

Dennett, D. (2003). Who's on first? Heterophenomenology explained. *Journal of Consciousness Studies, 10*(9-10), 19–30.

Dennett, D. C. (1976). Are dreams experiences? *The Philosophical Review, 85*(2), 151–171.

Dennett, D. C. (1979). The onus re experiences. *Philosophical Studies, 35*(3), 315–318.

Dennett, D. C. (1995). Darwin's dangerous idea. *The Sciences, 35*(3), 34–40.

Dennett, D. C. (2017). *From bacteria to Bach and back: The evolution of minds*. London: WW Norton & Company.

Descartes, R. (1637). Discourse on the method of rightly conducting the reason, and seeking truth in the sciences.

Domhoff, G. W. (2001). A new neurocognitive theory of dreams. *Dreaming, 11*(1), 13–33.

Freud, S. (1913) The Interpretation of Dreams, Third Edition. Trans. by A. A. Brill. New York: The Macmillan Company.

Gauchat, A., Séguin, J., & Zadra, A. (2014). Prevalence and correlates of disturbed dreaming in children. *Pathologie Biologie, 62*(5), 311–318.

George, K. C., Kebejian, L., Ruth, L. J., Miller, C. W., & Himelhoch, S. (2016). Meta-analysis of the efficacy and safety of prazosin versus placebo for the treatment of nightmares and sleep disturbances in adults with posttraumatic stress disorder. *Journal of Trauma & Dissociation, 17*(4), 494–510.

Goodenough, D. R., Lewis, H. B., Shapiro, A., Jaret, L., & Sleser, I. (1965). Dream reporting following abrupt and gradual awakenings from different types of sleep. *Journal of Personality and Social Psychology, 2*(2), 170–179.

Hall, C. S., & Van de Castle, R. L. (1966). *The content analysis of dreams*. New York, NY: Appleton-Century-Crofts.

Halliday, G. (1987). Direct psychological therapies for nightmares: A review. *Clinical Psychology Review, 7*(5), 501–523.

Hartmann, E. (1984). *The nightmare.* New York: Basic Books.

Hartmann, E. (1998). Nightmare after trauma as paradigm for all dreams: A new approach to the nature and functions of dreaming. *Psychiatry Interpersonal and Biological Processes, 61*(3), 223–238.

Hartmann, E., Elkin, R., & Garg, M. (1991). Personality and dreaming: The dreams of people with very thick or very thin boundaries. *Dreaming, 1*(4), 311–324.

Hearne, K. M. T. (1978). *Lucid-dreams: an electrophysiological and psychological study.* (Doctoral dissertation), University of Liverpool. Retrieved May 12 2017 from https://www.keithhearne.com/science-2/

Helminen, V., Nurmio, K., Rehunen, A. et al.(2014). Kaupunki-maaseutu-alueluokitus. Suomen ympäristökeskuksen raportteja, 25.

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). Most people are not WEIRD. *Nature, 466*(7302), 29–29.

Hermans, E. J., Putman, P., Baas, J. M., Gecks, N. M., Kenemans, J. L., & van Honk, J. (2007). Exogenous testosterone attenuates the integrated central stress response in healthy young women. *Psychoneuroendocrinology, 32*(8), 1052–1061.

Hermans, E. J., Putman, P., Baas, J. M., Koppeschaar, H. P., & van Honk, J. (2006). A single administration of testosterone reduces fear-potentiated startle in humans. *Biological Psychiatry, 59*(9), 872–874.

Hobson, J. A. (2009). REM sleep and dreaming: towards a theory of protoconsciousness. *Nature Reviews Neuroscience, 10*(11), 803–813.

Hobson, J. A., Hong, C. C.-H., & Friston, K. J. (2014). Virtual reality and consciousness inference in dreaming. *Frontiers in Psychology, 5*, 1133.

Horikawa, T., Tamaki, M., Miyawaki, Y., & Kamitani, Y. (2013). Neural decoding of visual imagery during sleep. *Science, 340(*6132), 639–642.

Horne, J. A., & Ostberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology, 4*(2), 97–110.

Hublin, C., Kaprio, J., Partinen, M., & Koskenvuo, M. (1999). Nightmares: familial aggregation and association with psychiatric disorders in a nationwide twin cohort. *American Journal of Medical Genetics, 88*(4), 329–336.

Hätönen, T., Forsblom, S., Kieseppä, T., Lönnqvist, J., & Partonen, T. (2008). Circadian phenotype in patients with the co-morbid alcohol use and bipolar disorders. *Alcohol and Alcoholism, 43*(5), 564–568.

Kahneman, D. (2011). *Thinking, fast and slow*. New York, NY: Farrar, Straus & Giroux.

Kahneman, D., Fredrickson, B. L., Schreiber, C. A., & Redelmeier, D. A. (1993). When more pain is preferred to less: Adding a better end. *Psychological Science, 4*(6), 401–405.

Kasper, S., Wehr, T. A., Bartko, J. J., Gaist, P. A., & Rosenthal, N. E. (1989). Epidemiological findings of seasonal changes in mood and behavior. A telephone survey of Montgomery County, Maryland. *Archives of General Psychiatry, 46*(9), 823–833.

Kronholm, E., Partonen, T., Laatikainen, T., Peltonen, M., Härmä, M., Hublin, C., … Sutela, H. (2008). Trends in self reported sleep duration and insomnia related symptoms in Finland from 1972 to 2005: a comparative review and re analysis of Finnish population samples. *Journal of Sleep Research, 17*(1), 54–62.

Krystal, A. D., Stein, M. B., & Szabo, S. T. (2017). Anxiety Disorders and Posttraumatic Stress Disorder. In M. Kryger, T. Roth & W. C. Dement (Eds.), *Principles and Practice of Sleep Medicine* (6th ed., pp. 1341–1351). Philadelphia, PA: Elsevier.

La Berge, S. P., Nagel, L. E., Dement, W. C., & Zarcone V. P., Jr. (1981). Lucid dreaming verified by volitional communication during REM sleep. *Perceptual and Motor Skills, 52*(3), 727–732.

Lancee, J., Spoormaker, V. I., Krakow, B., & van den Bout, J. (2008). A systematic review of cognitive-behavioral treatment for nightmares: toward a well-established treatment. *Journal of Clinical Sleep Medicine, 4*(5), 475–480.

Levin, R., & Fireman, G. (2002). Nightmare prevalence, nightmare distress, and self-reported psychological disturbance. *Sleep, 25*(2), 205–212.

Levin, R., & Nielsen, T. (2009). Nightmares, bad dreams, and emotion dysregulation a review and new neurocognitive model of dreaming. *Current Directions in Psychological Science, 18*(2), 84–88.

Levin, R., & Nielsen, T. A. (2007). Disturbed dreaming, posttraumatic stress disorder, and affect distress: A review and neurocognitive model. *Psychological Bulletin, 133*(3), 482–528.

Levine, J. (1983). Materialism and qualia: The explanatory gap. *Pacific Philosophical Quarterly, 64*(4), 354–361.

Li, S. X., Lam, S. P., Yu, M. W., Zhang, J., & Wing, Y. K. (2010). Nocturnal sleep disturbances as a predictor of suicide attempts among psychiatric outpatients: a clinical, epidemiologic, prospective study. *Journal of Clinical Psychiatry, 71*(11), 1440–1446.

Li, S. X., Yu, M. W., Lam, S. P., Zhang, J., Li, A. M., Lai, K. Y., … Wing Y.K. (2011). Frequent nightmares in children: familial aggregation and associations with parent-reported behavioral and mood problems. *Sleep, 34*(4), 487–493.

Li, S. X., Zhang, B., Li, A. M., & Wing, Y. K. (2010). Prevalence and correlates of frequent nightmares: a community-based 2-phase study. *Sleep, 33*(6), 774–780.

Liu, X. (2004). Sleep and adolescent suicidal behavior. *Sleep, 27*(7), 1351–1358.

Maanmittauslaitos. Suomen pinta-ala kunnittain 1.1.2012. Retrieved August 10, 2015, from http://www.maanmittauslaitos.fi/sites/default/files/alat12_su_nimet.pdf

Mackonis, A. (2013). Inference to the best explanation, coherence and other explanatory virtues. *Synthese, 190*(6), 975–995.

Malcolm, N. (1956). Dreaming and skepticism. *Philosophical Review, 65,* 14–37.

Malcolm, N. (1959). *Dreaming: Studies in Philosophical Psychology*. Literary Licensing.

Mayer-Schönberger, V., & Cukier, K. (2013). *Big data: A revolution that will transform how we live, work, and think*. Houghton Mifflin Harcourt.

American Academy of Sleep Medicine. (2014). The international classification of sleep disorders: diagnostic and coding manual (3dr ed.): American Academy of Sleep Medicine.

Merikanto, I., Kronholm, E., Peltonen, M., Laatikainen, T., Lahti, T., & Partonen, T. (2012). Relation of Chronotype to Sleep Complaints in the General Finnish Population. *Chronobiology International, 29*(3), 311–317.

Mersch, P. P., Vastenburg, N. C., Meesters, Y., Bouhuys, A. L., Beersma, D. G., van den Hoofdakker, R. H., & den Boer, J.A. (2004). The reliability and validity of the Seasonal Pattern Assessment Questionnaire: a comparison between patient groups. *Journal of Affective Disorders, 80*(2-3), 209–219.

Moussavi, S., Chatterji, S., Verdes, E., Tandon, A., Patel, V., & Ustun, B. (2007). Depression, chronic diseases, and decrements in health: results from the World Health Surveys. *Lancet, 370*(9590), 851–858.

Munezawa, T., Kaneita, Y., Osaki, Y., Kanda, H., Ohtsu, T., Suzuki, H., … Ohida,T. (2011). Nightmare and sleep paralysis among Japanese adolescents: a nationwide representative survey. *Sleep Medicine, 12*(1), 56–64.

Määttänen, H. K. (2016). *Urban-rural differences in nightmare prevalence in Finland : a population-based study.* (Master's thesis), University of Turku.

Nagel, T. (1974). What Is It Like to Be a Bat? *The Philosophical Review, 83*(4), 435–450.

Neria, Y., Nandi, A., & Galea, S. (2008). Post-traumatic stress disorder following disasters: a systematic review. *Psychological Medicine, 38*(04), 467–480.

Nielsen, T. (2010). Nightmares associated with the eveningness chronotype. *Journal of Biological Rhythms, 25*(1), 53–62.

Nielsen, T., & Levin, R. (2007). Nightmares: A new neurocognitive model. *Sleep Medicine Reviews, 11(*4), 295–310.

Nielsen, T., & Paquette, T. (2007). Dream-associated behaviors affecting pregnant and postpartum women. *Sleep, 30*(9), 1162–1169.

Nielsen, T. A. (2010). Dream analysis and classification: The reality simulation perspective. In M. Kryger, T. Roth & W. C. Dement (Eds.), *Principles and Practice of Sleep Medicine* (5th ed., pp. 595–603). Philadelphia, PA: Elsevier.

Nielsen, T. A., Stenstrom, P., & Levin, R. (2006). Nightmare frequency as a function of age, gender, and September 11, 2001: Findings from an Internet questionnaire. *Dreaming, 16*(3), 145–158.

Ohayon, M. M., Zulley, J., Guilleminault, C., & Smirne, S. (1999). Prevalence and pathologic associations of sleep paralysis in the general population. *Neurology, 52*(6), 1194–1194.

World Health Organization (2016). The ICD-10 classification of mental and behavioural disorders: diagnostic criteria for research. Geneva: World Health Organization.

Pagel, J., & Helfter, P. (2003). Drug induced nightmares—an etiology based review. *Human Psychopharmacology: Clinical and Experimental, 18*(1), 59–67.

Pagel, J. F. (2012). What physicians need to know about dreams and dreaming. *Current Opinion in Pulmonary Medicine, 18*(6), 574–579.

Pigeon, W. R., & Mellman, T. A. (2017). Dreams and Nightmares in Posttraumatic Stress Disorder. In M. Kryger, T. Roth & W. C. Dement (Eds.), *Principles and Practice of Sleep Medicine* (6th ed., pp. 561-–66). Philadelphia, PA: Elsevier.

Popper, K. (1934/2005). *The logic of scientific discovery*. London: Routledge.

Puska, P., Vartiainen, E., Nissinen, A., Laatikainen, T., & Jousilahti, P. (2016). Background, principles, implementation, and general experiences of the North Karelia Project. *Global Heart, 11*(2), 173–178.

Redelmeier, D. A., & Kahneman, D. (1996). Patients' memories of painful medical treatments: Real-time and retrospective evaluations of two minimally invasive procedures. *Pain, 66*(1), 3–8.

Revonsuo, A. (1995). Consciousness, dreams and virtual realities. *Philosophical Psychology, 8*(1), 35–58.

Revonsuo, A. (2000). The reinterpretation of dreams: An evolutionary hypothesis of the function of dreaming. *Behavioral and Brain Sciences, 23*(6), 877–901.

Revonsuo, A. (2006). Inner presence: Consciousness as a biological phenomenon. Cambridge, MA: MIT Press.

Revonsuo, A., Kallio, S., & Sikka, P. (2009). What is an altered state of consciousness? *Philosophical Psychology, 22*(2), 187–204.

Revonsuo, A., Tuominen, J., & Valli, K. (2015a). The avatars in the machine: Dreaming as a simulation of social reality. In T. Metzinger & J.M. Windt (Eds) *Open MIND*. Frankfurt am Main: MIND Group.

Revonsuo, A., Tuominen, J., & Valli, K. (2015b). The simulation theories of dreaming: how to make theoretical progress in dream science. In T. Metzinger & J.M. Windt (Eds) *Open MIND*. Frankfurt am Main: MIND Group.

Richardson, L., Frueh, B., & Acierno, R. (2010). Prevalence estimates of combat-related PTSD: a critical review. *Australian & New Zealand Journal of Psychiatry, 44*, 4–19.

Rintamäki, R., Grimaldi, S., Englund, A., Haukka, J., Partonen, T., Reunanen, A., … Lönnqvist, J. (2008). Seasonal changes in mood and behavior are linked to metabolic syndrome. *PLoS One, 3*(1), e1482.

Robert, G., & Zadra, A. (2008). Measuring nightmare and bad dream frequency: impact of retrospective and prospective instruments. *Journal of Sleep Research, 17*(2), 132–139.

Robert, G., & Zadra, A. (2014). Thematic and content analysis of idiopathic nightmares and bad dreams. *Sleep, 37*(2), 409–417.

Roenneberg, T., & Merrow, M. (2016). The circadian clock and human health. *Current Biology, 26(*10), 432–443.

Rosen, M. G. (2013). What I make up when I wake up: anti-experience views and narrative fabrication of dreams. *Frontiers in Psychology, 4,* 514.

Rosenthal, N., Bradt, G., & Wehr, T. (1984). *Seasonal Pattern Assessment Questionnaire (SPAQ).* Bethesda, Md: National Institute of Mental Health.

Rosenthal, N. E., Sack, D. A., Gillin, J. C., Lewy, A. J., Goodwin, F. K., Davenport, Y., … Wehr, T. A. (1984). Seasonal affective disorder. A description of the syndrome and preliminary findings with light therapy. *Archives of General Psychiatry, 41*(1), 72–80.

Ross, R. J., Ball, W. A., Sullivan, K. A., & Caroff, S. N. (1989). Sleep disturbance as the hallmark of posttraumatic stress disorder. *The American Journal of Psychiatry, 146(*6), 697–707.

Sandman, N., Valli, K., Kronholm, E., Ollila, H. M., Revonsuo, A., Laatikainen, T., & Paunio, T. (2013). Nightmares: Prevalence among the Finnish General Adult Population and War Veterans during 1972-2007. *Sleep, 36*(7), 1041–1050.

Sandman, N., Valli, K., Kronholm, E., Revonsuo, A., Laatikainen, T., & Paunio, T. (2015). Nightmares: risk factors among the Finnish general adult population. *Sleep, 38*(4), 507–514.

Sandman, N., Merikanto, I., Määttänen, H., Valli, K., Kronholm, E., Laatikainen, T., … Paunio, T. (2016). Winter is coming: nightmares and sleep problems during seasonal affective disorder. *Journal of Sleep Research, 25*(5), 612–619.

Sandman, N., Valli, K., Kronholm, E., Vartiainen, E., Laatikainen, T., & Paunio, T. (2017). Nightmares as predictors of suicide: an extension study including war veterans. *Scientific Reports, 7*, 44756.

Schenck, C. H., Bundlie, S. R., Ettinger, M. G., & Mahowald, M. W. (1986). Chronic behavioral disorders of human REM sleep: a new category of parasomnia. *Sleep, 9*(2), 293–308.

Schlenger, W. E., Caddell, J. M., Ebert, L., Jordan, B. K., Rourke, K. M., Wilson, D., … Kulka, R.A. (2002). Psychological reactions to terrorist attacks: findings from the National Study of Americans' Reactions to September 11. *JAMA, 288*(5), 581–588.

Schredl, M. (2010). Nightmare frequency and nightmare topics in a representative German sample. *European Archives of Psychiatry and Clinical Neuroscience, 260*(8), 565–570.

Schredl, M. (2013). Nightmare frequency in a representative German sample. *International Journal of Dream Research, 6*(2), 119–122.

Schredl, M., & Hofmann, F. (2003). Continuity between waking activities and dream activities. *Consciousness and Cognition, 12*(2), 298–308.

Schredl, M., & Reinhard, I. (2011). Gender differences in nightmare frequency: A meta-analysis. *Sleep Medicine Reviews, 15*(2), 115–121.

Schreuder, B. J. N., Egmond, M., Kleijn, W. C., & Visser, A. T. (1998). Daily reports of posttraumatic nightmares and anxiety dreams in Dutch war victims. *Journal of Anxiety Disorders, 12*(6), 511–524.

Schreuder, B. J. N., Kleijn, W. C., & Rooijmans, H. G. M. (2000). Nocturnal re experiencing more than forty years after war trauma. *Journal of Traumatic Stress, 13*(3), 453–463.

Sjöström, N., Hetta, J., & Waern, M. (2009). Persistent nightmares are associated with repeat suicide attempt: a prospective study. *Psychiatry Research, 170*(2-3), 208–211.

Sjöström, N., Waern, M., & Hetta, J. (2007). Nightmares and sleep disturbances in relation to suicidality in suicide attempters. *Sleep, 30*(1), 91–95.

Snow, J. (1849). *On the Mode of Communication of Cholera*. London: John Churchill.

Stepansky, R., Holzinger, B., Schmeiser-Rieder, A., Saletu, B., Kunze, M., & Zeitlhofer, J. (1998). Austrian dream behavior: Results of a representative population survey. *Dreaming, 8*(1), 23–30.

Stickgold, R., Malia, A., Fosse, R., Propper, R., & Hobson, A. J. (2001). Brain-mind states: I. Longitudinal field study of sleep/wake factors influencing mentation report length. *Sleep, 24*(2),171–179.

Tanskanen, A., Tuomilehto, J., Viinamäki, H., Vartiainen, E., Lehtonen, J., & Puska, P. (2001). Nightmares as predictors of suicide. *Sleep, 24*(7), 845–848.

Tart, C. T. (1987). The world simulation process in waking and dreaming: A systems analysis of structure. *Journal of Mental Imagery, 11*, 145–158.

Thompson, C., Thompson, S., & Smith, R. (2004). Prevalence of seasonal affective disorder in primary care; a comparison of the seasonal health questionnaire and the seasonal pattern assessment questionnaire. *Journal of Affective Disorders, 78*(3), 219–226.

Valli, K., Frauscher, B., Peltomaa, T., Gschliesser, V., Revonsuo, A., & Högl, B. (2015). Dreaming furiously? A sleep laboratory study on the dream content of people with Parkinson's disease and with or without rapid eye movement sleep behavior disorder. *Sleep Medicine, 16*(3), 419–427.

Valli, K., & Revonsuo, A. (2009). The threat simulation theory in light of recent empirical evidence: A review. The American *Journal of Psychology, 122*(1), 17–38.

Vermeulen, A., Rubens, R., & Verdonck, L. (1974). Testosterone secretion and metabolism in male senescence. *Reproduction and Aging, 34*(4), 730–735.

Väestörekisterikeskus. Väestötietojärjestelmän rekisteritilanne 31.01.2012. Retrieved August 10, 2015 from http://vrk.fi/default.aspx?docid=5920&site=3&id=0

Windt, J. M. (2010). The immersive spatiotemporal hallucination model of dreaming. *Phenomenology and the Cognitive Sciences, 9*(2), 295–316.

Windt, J. M. (2013). Reporting dream experience: Why (not) to be skeptical about dream reports. *Frontiers in Human Neuroscience, 7,* 708.

Windt, J. M. (2015). *Dreaming: A conceptual framework for philosophy of mind and empirical research.* Cambridge, MA: MIT Press.

Wittengstein, L. (1922). Tractatus Logico-Philosophicus. Retrieved June, 13, 2017 from: https://people.umass.edu/klement/tlp/tlp.pdf

Wolke, D., & Lereya, S. T. (2014). Bullying and parasomnias: a longitudinal cohort study. *Pediatrics, 134*(4), e1040–e1048.

Wong, M. M., Brower, K. J., & Zucker, R. A. (2011). Sleep problems, suicidal ideation, and self-harm behaviors in adolescence. *Journal of Psychiatric Research, 45*(4), 505–511.

Wood, J. M., Bootzin, R. R., Quan, S. F., & Klink, M. E. (1993). Prevalence of nightmares among patients with asthma and chronic obstructive airways disease. *Dreaming, 3*(4), 231–241.

Woodward, S. H., Arsenault, N. J., Murray, C., & Bliwise, D. L. (2000). Laboratory sleep correlates of nightmare complaint in PTSD inpatients. *Biological Psychiatry, 48*(11), 1081–1087.

Youngstedt, S. D., Goff, E. E., Reynolds, A. M., Kripke, D. F., Irwin, M. R., Bootzin, R. R., … Jean-Louis, G. (2016). Has adult sleep duration declined over the last 50+ years? *Sleep Medicine Reviews, 28*, 69–85.

Zadra, A., & Donderi, D. (2000). Nightmares and bad dreams: Their prevalence and relationship to well-being. *Journal of Abnormal Psychology, 109*(2), 273–283.

Zadra, A., Pilon, M., & Donderi, D. C. (2006). Variety and intensity of emotions in nightmares and bad dreams. *The Journal of Nervous and Mental Disease, 194(*4), 249–254.

Zadra, A., & Robert, G. (2012). Dream recall frequency: Impact of prospective measures and motivational factors. *Consciousness and Cognition, 21(*4), 1695–1702.

Annales Universitatis Turkuensis

Turun yliopisto
University of Turku